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INTERNATIONAL STANDARD

colour inside

Electricity metering equipment (AC) – General requirements, tests and test conditions –
Part 31: Product safety requirements and tests

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTRICITY METERING EQUIPMENT (AC) – GENERAL REQUIREMENTS, TESTS AND TEST CONDITIONS –

Part 31: Product safety requirements and tests

FOREWORD

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The text of this standard is based on the following documents:

FDIS	Report on voting
13/1639/FDIS	13/1645/RVD

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

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

A list of all parts of IEC 62052 series, under the general title *Electricity metering equipment (AC) – General requirements, tests and test conditions*, can be found on the IEC website.

In this standard, the following print types are used:

- requirements and definitions: in roman type;
- NOTES: in smaller roman type;
- *conformity and tests: in italic type.*

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INTRODUCTION

NOTE 1 The following text is based on IEC Guide 104, ISO/IEC Guide 51 and IEC 60255-27:2013.

The IEC addresses safety aspects by establishing *basic*, *group* and *product* safety publications.

A *basic safety publication* covers a specific safety-related matter, applicable to many electrotechnical products. It is primarily intended for use by technical committees in the preparation of standards in accordance with the principles laid down in IEC Guide 104 and ISO/IEC Guide 51. It is not intended for use by manufacturers or certification bodies. One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications in the preparation of its publications. The requirements, test methods or test conditions of basic safety publications will not apply unless specifically referred to or included in the relevant publications.

A *group safety publication* covers all safety aspects of a specific group of products within the scope of two or more product TCs. Group safety publications are primarily intended to be stand-alone product safety publications, but may also be used by TCs as source material in the preparation of their publications.

A *product safety publication* covers all safety aspects of one or more products within the scope of a single product TC.

Existing product standards established by TC 13 include a range of safety requirements, test methods and test conditions. However, an important requirement of IEC Guide 104:2010, 5.2.3 has not been met so far:

> *"Safety aspects and performance aspects should not be covered in the same publication, as this makes it difficult to assess conformity with safety requirements alone. If, exceptionally, there are reasons to cover them in the same publication, safety aspects and performance aspects shall be clearly distinguished from each other. If there are performance criteria which have safety implications, these are considered to be safety aspects and this shall be made clear in the publication."*

In addition, some important aspects of product safety, such as safety under single fault conditions, have not been covered so far.

The objectives of the development of this International Standard are the following:

- to specifically reference and include relevant requirements, test methods or test conditions of relevant basic safety publications so that they become applicable;
- to specifically reference and include – where appropriate, in a modified form – relevant requirements, test methods or test conditions of relevant group safety publications;
- to consider the latest developments in the technology used for the design and manufacture of equipment for electrical energy measurement and control;
- to remove any ambiguity resulting from the lack of a comprehensive product safety standard for products in the Scope of TC 13;
- to achieve a uniform approach to product safety throughout the international metering industry.

This *product safety standard* is based on, among others, the following:

- the *basic safety standard* IEC 60664-1:2007, established by TC 109;
- standards from the IEC 60364 series related to electrical installations of buildings, established by TC 64;
- the *group safety standard* IEC 61010-1:2010 established by TC 66;

- the *group safety standard* IEC 62477-1:2012 established by TC 22;
- IEC 60255-27:2013, a *product safety standard* for measuring relays and protection equipment, established by TC 95. These products are similar in their design and to some extent in their use in equipment for electrical energy measurement and control,

To facilitate the use of this standard, an integral text has been prepared, with appropriate 539 references to source documents.

This standard cancels and replaces the safety requirements specified in earlier standards established by IEC TC 13. See also Annex L (Informative).

NOTE 2 When this standard is published, an amendment to the relevant standards affected by this standard in IEC 62052, IEC 62053 and IEC 62054 will be published, to indicate which parts of those standards are replaced / cancelled by this standard.

Being a product safety standard, this standard takes precedence over the group safety standards IEC 61010-1:2010 and IEC 62477-1:2012.

ELECTRICITY METERING EQUIPMENT (AC) – GENERAL REQUIREMENTS, TESTS AND TEST CONDITIONS –

Part 31: Product safety requirements and tests

1 Scope and object

1.1 Scope

This part of IEC 62052 specifies product safety requirements for equipment for electrical energy measurement and control.

NOTE 1 For other requirements, see the relevant standards.

This International Standard applies to newly manufactured metering equipment designed to measure and control electrical energy on 50 Hz or 60 Hz networks with a voltage up to 600 V, where all functional elements, including add-on modules are enclosed in or form a single case.

NOTE 2 The voltage mentioned above is the voltage line-to-neutral derived from nominal voltages. See Table 7.

This International Standard also applies to metering equipment containing supply and load control switches, but only those which are electromechanical in operation.

NOTE 3 For components and sub-assemblies, see Clause 13.

When such equipment is designed to be installed in a specified matching socket, then the requirements apply to, and the tests shall be performed on, equipment installed in its specified matching socket. However, requirements for sockets and inserting / removing the meters from the socket are outside the scope of this standard.

This International Standard is also applicable to auxiliary input and output circuits.

NOTE 4 Examples are impulse inputs and outputs, control inputs and outputs, circuits for meter data exchange.

In this standard distinction is made between:

- electromechanical meters, static meters and equipment for tariff and load control;
- direct connected, current transformer operated, voltage and current transformer operated meters;
- protective class I and protective class II equipment;
- wall or cabinet mounted, rack mounted and panel mounted equipment;
- equipment intended for indoor use and outdoor use.

Equipment used in conjunction with equipment for electrical energy measurement and control may need to comply with additional safety requirements. See also Clause 13.

NOTE 5 Examples are telecommunication modems and customer information units.

This International Standard does not apply to:

- equipment where the voltage line-to-neutral derived from nominal voltages exceeds 600 V;
- portable meters;

  NOTE 6 Portable meters are meters that are not permanently connected.

- laboratory and mobile meter test equipment;
- reference standard meters.

The safety requirements of this standard are based on the following assumptions:

- metering equipment has been installed correctly;
- metering equipment is used generally by unskilled persons, including meter readers and consumers of electrical energy. In many cases, it is installed in a way that it is freely accessible. Its terminal covers cannot be removed and its case cannot be opened without removing seals and using a tool;
- during normal use all terminal covers, covers and barriers providing protection against accessing hazardous live parts are in place;
- for installation, configuration, maintenance and repair it may be necessary to remove terminal cover(s), (a part of) the case or barriers so that hazardous live parts may become accessible. Such activities are performed by skilled personnel, who have been suitably trained to be aware of working procedures necessary to ensure safety. Therefore, safety requirements covering these conditions are out of the Scope of this standard.

1.2 Object

1.2.1 Aspects included in scope

NOTE 1 Subclause 1.2 is based on IEC 61010-1:2010, 1.2.

The purpose of the requirements of this standard is to ensure that hazards to the user and the surrounding area are reduced to a tolerable level.

Requirements for protection against particular types of hazard are given in Clauses 6 to 12 as follows:

a) electrical shock or burn (see Clause 6);
b) mechanical hazards and stresses (see Clauses 7 and 8);
c) spread of fire from the equipment (see Clause 9);
d) excessive temperature (see Clause 10);
e) penetration of dust and water (see Clause 11);
f) liberated gases, explosion and implosion (see Clause 12).

Requirements for components and sub-assemblies are specified in Clause 13.

Requirements for protection against hazards arising from reasonably foreseeable misuse are specified in Clause 14.

Risk assessment for hazards or environments not fully covered above is specified in Clause 15.

NOTE 2 Attention is drawn to the existence of additional requirements specified by national authorities responsible for health and safety.

1.2.2 Aspects excluded from scope

This standard does not cover:

a) performance, reliability or other properties of the equipment not related to safety;
b) EMC requirements, which are covered by the relevant type testing standards;

   NOTE 1 For EMC requirements and test methods, see IEC 62052-11:2003, IEC 62052-21:2004 and IEC 62055-31:2005

c) protective measures for explosive atmospheres (see IEC 60079-0);

d) functional safety requirements;

e) effectiveness of transport packaging;

f) safety requirements of installations.

NOTE 2 The latter is generally subject to national regulation.

1.3 Verification

NOTE This subclause reproduces IEC 61010-1:2010, 1.3.

This standard also specifies methods of verifying that the equipment meets the requirements of this standard, through inspection, type tests, risk assessment and routine tests. See Clauses 4, 15 and Annex I respectively.

1.4 Environmental conditions

1.4.1 Normal environmental conditions

NOTE 1 Subclause 1.4 is based on IEC 61010-1:2010, 1.4.

This standard applies to metering equipment designed to be safe at least under the following conditions:

a) indoor use;

b) altitude up to 2 000 m;

c) climatic conditions according to 3K5, but with low air temperature -10 °C; see IEC 60721-3-3:1994;

   NOTE 2 3K5 specifies low air temperature -5 °C, high air temperature +45 °C, low relative humidity 5 %, high relative humidity 95 %. See the climatogram in IEC 60721-3-3:1994, Figure B.5.

d) voltage fluctuations up to -20…15 % of the nominal voltage;

   The equipment may have several nominal voltages.

e) transient overvoltages up to the levels of overvoltage category III;

f) transient overvoltages occurring on the mains supply (see 6.7.1.1);

g) applicable pollution degree of the intended environment (pollution degree 2 in most cases).

Manufacturers may specify more restricted environmental conditions for operation; nevertheless, the equipment shall be safe within these normal environmental conditions.

1.4.2 Extended environmental conditions

This standard applies to metering equipment designed to be safe not only under the environmental conditions specified in 1.4.1, but also under any of the following conditions for which the equipment is rated by the manufacturer:

a) outdoor use;

b) altitude above 2 000 m;

c) climatic conditions according to 3K6; see IEC 60721-3-3:1994;

   NOTE 1 3K6 specifies low air temperature -25 °C, high air temperature +55 °C, low relative humidity 10 %, high relative humidity 100 %. See the climatogram in IEC 60721-3-3:1994, Figure B.6.

d) transient overvoltages higher than what is required for overvoltage category III.

   NOTE 2 Under such circumstances, additional protection can be provided by external overvoltage protection elements. However, this is beyond the Scope of this standard. Information on the effects of installing varistors in large quantities on the network can be found in IEC TR 61000-2-3:1992, 6.6.1.

1.4.3 Extreme environmental conditions

NOTE 1 The following text is based on IEC 60721-3-0:1984, 5.2.

It is recognized that extreme environmental conditions may exist.

Elements determining the environmental conditions may occur with any of their severities in combination with other elements and their respective severities. An assumption that each element may occur with its highest severity would lead to unnecessary overdesign and cost. Therefore, specifications for products to operate under such extreme environmental conditions are a matter for negotiation between the manufacturer and the purchaser.

NOTE 2 For specific climatic conditions, see IEC 60721-3-3:1994.

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 60027-1, *Letter symbols to be used in electrical technology – Part 1: General*

IEC 60068-2-75:2014, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

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

IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60269-3, *Low-voltage fuses – Part 3: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household or similar applications) – Examples of standardized systems of fuses A to F*

IEC 60332-1-2:2004, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*

IEC 60332-2-2:2004, *Tests on electric and optical fibre cables under fire conditions – Part 2-2: Test for vertical flame propagation for a single small insulated wire or cable – Procedure for diffusion flame*

IEC 60364-4-44:2007, *Low-voltage electrical installations – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances*

IEC 60417-DB-12M, *Graphical symbols for use on equipment*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*
Amd1:1999
Amd2: 2013

IEC 60617-DB-12M, *Graphical symbols for diagrams*

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

IEC 60695-2-11, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products (GWEPT)*

IEC 60695-10-2, *Fire hazard testing – Part 10-2: Abnormal heat – Ball pressure test method*

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

IEC 60950-1:2005, *Information technology equipment – Safety – Part 1: General requirements*
Amd 1: 2009
Amd 2: 2013

IEC 61032:1997, *Protection of persons and equipment by enclosures – Probes for verification*

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

IEC 62053-52, *Electricity metering equipment (a.c.) – Particular requirements – Part 52: Symbols*

ISO 75-2, *Plastics – Determination of temperature of deflection under load – Part 2: Plastics and ebonite*

ISO 306, *Plastics – Thermoplastic materials – Determination of Vicat softening temperature (VST)*

ISO 3864-1, *Graphical symbols, Safety colours and safety signs – Part 1: Design principles for safety signs and safety markings*

ISO 7000:2004, *Graphical symbols for use on equipment – Registered symbols*

3 Terms and definitions

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

3.1 Equipment and states of equipment

3.1.1
equipment
device with functions related to electrical energy measurement and control

Note 1 to entry: Examples include but are not limited to electricity meters, payment meters, tariff and load control equipment. The term “meter” is used in the text sometimes as a synonym of “metering equipment”. A meter may include, in addition to the basic energy metering function, other functions.

3.1.2
permanently connected equipment
equipment that is electrically connected to a supply by means of a permanent connection which can be detached only by the use of a tool

[SOURCE: IEC 61010-1:2010, 3.1.2]

3.1.3
tool
external device, including keys and coins, used to aid a person to perform a mechanical function

[SOURCE: IEC 61010-1:2010, 3.1.5]

3.1.4
isolation
function intended to prevent hazardous electric energy from appearing, for reasons of safety, in an electrical installation, or in a discrete section of the electrical installation, by separating the electrical installation or section of it from every source of electric energy

[SOURCE: IEC 60050-826:2004, 826-17-01, modified – “to make dead” replaced by “to prevent hazardous electric energy from appearing “ and “all or a discrete section of the electrical installation” replaced by “in an electrical installation, or in a discrete section of the electrical installation”]

3.2 Parts and accessories

3.2.1
protective barrier
electrically protective barrier
part providing protection against direct contact from any usual direction of access

Note 1 to entry: Depending on its construction, a protective barrier can be called a casing, cover, screen, door, guard, etc.

A protective barrier can act alone; it is then only effective when it is in place. A protective barrier can also act in conjunction with an interlocking device with or without guard locking; in this case, protection is ensured whatever the position of the protective barrier.

[SOURCE: IEC 60050-195:1998, 195-06-15]

3.2.2
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 60255-27:2013, 3.56, IEC 60550:1998, 195-04-04, modified – "and knowledge of any safety hazards" and a Note have been added]

3.2.3
base
back of the meter by which it is generally fixed and to which are attached the measuring element, the terminals or the terminal block, and the cover. For a flush-mounted meter, the meter base may include the sides of the case

[SOURCE: IEC 62052-11:2003, 3.3.3]

3.2.4
cover
enclosure on the front of the meter, made either wholly of transparent material or opaque material provided with window(s) through which the operation indicator (if fitted) and the display can be read

[SOURCE: IEC 62052-11:2003, 3.3.4]

3.2.5
case
comprises the base and the cover. When the case is closed, it provides protection against certain external influences and, in any direction, protection against direct contact and spread of fire

[SOURCE: IEC 62052-11:2003, 3.3.5, modified – second sentence added to align with the term “enclosure” defined in IEC 61010-1:2010]

3.2.6
terminal cover
cover which covers the meter terminals and, generally, the ends of the external wires or cables connected to the terminals. When the meter is mounted in its normal working position and when the terminal cover is in place, it provides protection in any direction against direct contact (together with the case)

[SOURCE: IEC 62052-11:2003, 3.3.9, modified – second sentence added]

3.2.7
terminal
conductive part of a device, electric circuit or electric network, provided for connecting that device, electric circuit or electric network to one or more external conductors

[SOURCE: IEC 60050-151:2001, 151-12-12, modified – Note which is not relevant in the context of this standard omitted]

3.2.8
protective conductor terminal
terminal which is bonded to conductive parts of an equipment for safety purposes and is intended to be connected to an external protective earthing system

[SOURCE: IEC 61010-1:2010, 3.2.3]

3.2.9
reference earth
part of the Earth considered as conductive, the electric potential of which is conventionally taken as zero, being outside the zone of influence of any earthing arrangement

Note 1 to entry: The concept "Earth" means the planet and all its physical matter.

[SOURCE: IEC 60050-195:1998, 195-01-01]

3.2.10
earth
local earth
part of the Earth which is in electric contact with an earth electrode and the electric potential of which is not necessarily equal to zero

[SOURCE: IEC 60050-195:1998, 195-01-03]

3.2.11
indoor meter
meter intended for operation under normal climatic conditions in a building or in a meter cabinet

3.2.12
outdoor meter
meter intended for operation under extended climatic conditions

3.2.13
ventilated, adj
designed with a means to permit circulation of air sufficiently to remove an excess of heat, fumes, or vapours

[SOURCE: IEC 60050-151:2001, 151-16-37]

3.2.14
meter cabinet
enclosure for housing metering equipment and affording protection suitable for the intended application

Note 1 to entry: It may be fixed on a wall, built in a wall recess or it may be free-standing and self-supporting. It may also accommodate elements of the electrical installation, like fuses, circuit breakers, residual current devices.

3.2.15
specified matching socket
base with jaws which accepts and connects to socket-mounted metering equipment

Note 1 to entry: This includes terminals for connection to the supply and load circuits; also appropriate secure fixing and sealing arrangements.

Note 2 to entry: This term only relates to metering equipment designed as a socket-mounted unit.

Note 3 to entry: The metering equipment is capable of meeting the relevant type testing requirements when it is properly installed in any specified matching socket.

[SOURCE: IEC 62055-31:2005, 3.1.9, modified – additional information is given in the Notes]

3.2.16
packaging
products used for the containment, protection, handling, delivery and preservation of the meter from the producer to the user or consumer

3.3 Quantities

3.3.1
rated value
value of a quantity used for specification purposes, established for a specified set of operating conditions of a component, device, equipment, or system

[SOURCE: IEC 60050-151:2001, 151-16-08]

3.3.2
rating
set of rated values and operating conditions

[SOURCE: IEC 60050-151:2001, 151-16-11]

3.3.3
operating range
range for which the equipment under specified conditions is able to perform its intended function(s) according to the specified requirements

[SOURCE: IEC 60050-447:2010, 447-03-16]

3.3.4
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.

[SOURCE: IEC 60255-27:2013, 3.54]

3.3.5
ambient air temperature
the temperature, determined under prescribed conditions, of the air surrounding the complete equipment

Note 1 to entry: For equipment installed inside a meter cabinet, it is the temperature of the air inside the meter cabinet.

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

[SOURCE: IEC 60050-441:1984, 441-11-13, modified – definition adapted to metering and Note 2 added]

3.3.6
rated maximum ambient temperature
t_a
maximum temperature at which the equipment may be operated continuously

[SOURCE: IEC 61558-1:2009, 3.5.8, modified – definition adapted to metering and Note omitted]

3.3.7
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

[SOURCE: IEC 60050-581:2008, 581-21-19]

3.3.8
rated impulse voltage
impulse withstand 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

[SOURCE: IEC 60664-1:2007, 3.9.2]

3.3.9
utilization category
UC
a combination of specified requirements related to the condition in which a direct connected meter with or without supply control switches fulfils its purpose, selected to represent a characteristic group of practical applications

Note 1 to entry: The specified requirements may concern e.g. the values of short circuit current, making capacities and breaking capacities (if applicable) and other characteristics, the associated circuits and the relevant conditions of use and behaviour.

Note 2 to entry: The utilization category provides information for the selection of the right meter the characteristics of which are properly co-ordinated with the characteristics of the supply side short current protection device that protects the meter.

[SOURCE: IEC 60050-441:1984, 441-17-19, modified – definition adapted to metering and Note 2 added]

3.3.10
maximum current
I_{max}
highest value of current the meter can carry continuously and remain safe, and at which it purports to meet the accuracy requirements of the relevant standard

Note 1 to entry: The term "current" indicates r.m.s. values unless otherwise specified.

[SOURCE: IEC 62052-11:2003, 3.5.2, modified – to cover both the the safety and the accuracy aspect]

3.3.11
maximum overload current
I_{ovl}
highest value of current, which is not caused by a short circuit, that a direct connected meter can carry for a limited duration and remain safe

Note 1 to entry: The term "current" indicates r.m.s. values unless otherwise specified.

Note 2 to entry: The value is at least equal to the maximum current and it is subject to agreement between the manufacturer and the purchaser taking into account the characteristics of the overcurrent protection elements used in the installation for which the metering equipment is intended and other installation conditions.

Note 3 to entry: This current is not a rating and is not mandatorily marked on the equipment.

3.4 Tests

3.4.1
type test
test of one or more samples of equipment (or parts of equipment) made to a particular design to show that the design and construction meet one or more requirements of this standard

Note 1 to entry: This is an amplification of the IEC 60050-151:2001, 151-16-16 definition to cover design as well as construction.

[SOURCE: IEC 61010-1:2010, 3.4.1]

3.4.2
routine test
conformity test made on each individual item during or after manufacture

[SOURCE: IEC 60050-151:2001, 151-16-17]

3.5 Safety terms

3.5.1
accessible part
part which can be touched by means of the standard test finger or test pin

[SOURCE: IEC 60050-442:1998, 442-01-15, modified – to allow using either a test finger or a test pin as appropriate]

3.5.2
hazard
potential source of harm

[SOURCE: IEC 61010-1:2010, 3.5.2]

3.5.3
hazardous live
capable of rendering an electric shock or electric burn

[SOURCE: IEC 61010-1:2010, 3.5.3]

3.5.4
current circuit
internal connections of the meter and part of the measuring element through which flows the current of the circuit to which the meter is connected

[SOURCE: IEC 62052-11:2003, 3.2.6]

3.5.5
voltage circuit
internal connections of the meter and part of the measuring element supplied with the voltage of the circuit to which the meter is connected

Note 1 to entry: In the case of static meters, the electronic circuits are generally supplied from the voltage circuits. See also 3.5.9.

[SOURCE: IEC 62052-11:2003, 3.2.7, modified – additional information on supplying the electronic circuits moved to the Note]

3.5.6
mains
electrical network supplying the premises

3.5.7
mains-circuit
electrical circuit which is conductively connected to and energized directly from the mains

Note 1 to entry: Voltage circuits intended to be connected to the secondary side of measuring voltage transformers are classed also as mains-circuits.

3.5.8
non-mains-circuit
electrical circuit not energized directly from the mains

Note 1 to entry: This circuit may be isolated by a transformer or supplied by a battery.

Note 2 to entry: Whereas IEC 61010-1:2010 uses the terms “primary circuit” and “secondary circuit”, in this standard the terms “mains circuit” and “non-mains circuit’ are used, to avoid confusion with primary and secondary circuits of instrument transformers used with transformer operated meters.

[SOURCE: IEC 62477-1:2012, 3.26, modified – additional information is given in the Notes]

3.5.9
auxiliary supply
a.c. or d.c. electrical power supply, other than the measurand, provided via dedicated terminals

Note 1 to entry: Provision of an auxiliary power supply may be necessary if the voltage circuits may become de-energized for extended periods, and some functions of the meter shall be nevertheless maintained. Such situations often occur with measuring voltage transformer operated meters in substations.

[SOURCE: IEC 60688:2012, 3.1.4, modified – definition adapted to metering and Note added]

3.5.10
auxiliary device
device in the meter intended to perform a particular function additional to the basic metrology function

Note 1 to entry: Examples are: clock, tariff / load / supply control switch, impulse input / output, data exchange unit.

Note 2 to entry: An auxiliary device may be internal or external to a meter.

3.5.11
auxiliary circuit
circuit other than the voltage measurement, current measurement and auxiliary supply circuits intended to be connected to (an) external device(s)

[SOURCE: IEC 62052-11:2003, 3.2.8, modified – to reflect changes in technology]

3.5.12
protective impedance
component or assembly of components whose impedance, construction and reliability are suitable to provide protection against electric shock

[SOURCE: IEC 61010-1:2010, 3.5.6]

3.5.13
protective bonding
electrical connection of accessible conductive parts or of protective screening to provide electrical continuity to the means of connection of an external protective conductor

[SOURCE: IEC 61010-1:2010, 3.5.7]

3.5.14
normal use
operation, including stand-by, according to the instructions for use or for the obvious intended purpose

[SOURCE: IEC 61010-1:2010, 3.5.8]

3.5.15
normal condition
condition in which all means of protection against hazards are intact

[SOURCE: IEC Guide 104:2010, 3.7, modified – "against hazards" added]

3.5.16
single fault condition
condition in which there is a fault of a single protection (but not a reinforced protection) or of a single component or a device

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

[SOURCE: IEC Guide 104:2010, 3.8, modified – wording of Note 1 amended, "unavoidably" added]

3.5.17
direct contact
electric contact of persons or animals with live parts

[SOURCE: IEC 60050-195:1998, 195-06-03]

3.5.18
indirect contact
electric contact of persons or animals with exposed-conductive-parts which have become live under fault conditions

[SOURCE: IEC 60050-195:1998, 195-06-04]

3.5.19
user
person, other than a service person, installer or operator

[SOURCE: IEC 60950-1:2005, 1.2.13.6, modified – to include installer and operator]

3.5.20
service person
person having appropriate technical training and experience necessary to be aware of hazards to which they may be exposed in performing a task and of measures to minimize the risks for themselves or other persons

[SOURCE: IEC 60950-1:2005, 1.2.13.5]

3.5.21
installer
service person responsible for the installation of metering equipment and, when applicable, the provision of necessary safety related information to the user

3.5.22
operator
service person responsible for operation and maintenance of metering equipment and, when applicable, the provision of necessary safety related information to the user

3.5.23
reasonably foreseeable misuse
use of a product in a way not intended by its provider but which may result from readily predictable human behaviour

Note 1 to entry: Fraudulent attempts are not considered as foreseeable misuse.

[SOURCE: IEC 61010-1:2010, 3.5.14, modified – additional information in the Note added]

3.5.24
risk
combination of the probability of the occurrence of harm and the severity of that harm

[SOURCE: IEC 61010-1:2010, 3.5.15]

3.5.25
tolerable risk
level of risk that is accepted in a given context based on the current values of society

[SOURCE: ISO/IEC Guide 51:2014, 3.15]

3.5.26
overvoltage category
numeral defining a transient overvoltage condition

Note 1 to entry: IEC 60664-1:2007 specifies overvoltage categories I, II, III and IV.

Note 2 to entry: The term 'overvoltage category' is synonymous with the term 'impulse withstand voltage' used in IEC 60364-4-44:2007, 443.

[SOURCE: IEC 60664-1:2007, 3.10, modified – Note 1 references IEC 60664-1:2007]

3.5.27
transient overvoltage
short-duration overvoltage

Note 1 to entry: Transient overvoltages may be immediately followed by temporary overvoltages. In such cases, the two overvoltages are considered as separate events.

Note 2 to entry: IEC 60071-1 defines three types of transient overvoltages, namely slow-front overvoltages, fast-front overvoltages and very fast-front overvoltages according to their time to peak, tail or total duration, and possible superimposed oscillations.

Note 3 to entry: The duration does not exceed a few milliseconds.

Note 4 to entry: The form of the transient overvoltage may be oscillatory or non-oscillatory, but is usually highly damped.

[SOURCE: IEC 60050-604:1987, 604-03-13, modified – additional information moved to Notes]

3.5.28
temporary overvoltage
overvoltage of relatively long duration

Note 1 to entry: The overvoltage is undamped or weakly damped. Though normally at the power frequency, in some cases its frequency may be several times smaller or higher than power-frequency.

[SOURCE: IEC 60050-604:1987. 604-03-12, modified – to cover overvoltages with power frequency or with other frequencies]

3.6 Insulation

3.6.1
electric insulation
part of an electrotechnical product which separates conducting parts at different electrical potentials during operation or insulates such parts from the surroundings

[SOURCE: IEC 60050-212:2010, 212-11-07]

3.6.2
functional insulation
insulation between conductive parts, necessary for the proper functioning of the equipment

[SOURCE: IEC 60050-195:1998, 195-02-41]

3.6.3
basic insulation
insulation of hazardous-live-parts which provides basic protection

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

[SOURCE: IEC 60050-195:1998, 195-06-06]

3.6.4
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 61010-1:2010, 3.6.2, IEC 60050-195:1998, 195-06-07, modified – as in IEC 61010-1]

3.6.5
double insulation
insulation comprising both basic insulation and supplementary insulation

[SOURCE: IEC 60050-195:1998, 195-06-08]

3.6.6
reinforced insulation
insulation which provides protection against electric shock not less than that provided by double insulation

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

[SOURCE: IEC 61010-1:2010, 3.6.4, IEC 60050-195:1998, 195-06-09, modified – as in IEC 61010-1]

3.6.7
class I equipment
protective 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

[SOURCE: IEC 60255-27:2013, 3.7]

3.6.8
class II equipment
protective class II equipment
equipment with:

- basic insulation as provision for basic protection against electric shock, and
- supplementary insulation as provision for fault protection; or
- 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 60255-27:2013,3.8, 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]

3.6.9
pollution
addition of foreign matter, solid, liquid or gaseous that can produce a permanent reduction of dielectric strength or surface resistivity of the insulation

Note 1 to entry: Ionized gases of a temporary nature are not considered as to be a pollution.

[SOURCE: IEC 60050-442:1998, 442-01-28]

3.6.10
pollution degree
numeral characterizing the expected pollution of the micro-environment

[SOURCE: IEC 60050-581:2008, 581-21-07]

3.6.11
pollution degree 1
no pollution or only dry, non-conductive pollution occurs, which has no influence

[SOURCE: IEC 61010-1:2010, 3.6.7]

3.6.12
pollution degree 2
only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation is expected

[SOURCE: IEC 61010-1:2010, 3.6.8]

3.6.13
pollution degree 3
conductive pollution occurs, or dry, non-conductive pollution occurs which becomes conductive due to condensation which is expected

Note 1 to entry: In such conditions, equipment is normally protected against exposure to direct sunlight, precipitation, and full wind pressure, but neither temperature nor humidity is controlled.

[SOURCE: IEC 61010-1:2010, 3.6.9]

3.6.14
micro-environment
immediate environment of the insulation which particularly influences the dimensioning of the creepage distances

[SOURCE: IEC 60050-851:2008, 851-15-16]

3.6.15
clearance
distance between two conductive parts along a string stretched the shortest way between these conductive parts

[SOURCE: IEC 60050-441:1984, 441-17-31]

3.6.16
creepage distance
shortest distance along the surface of a solid insulating material between two conductive parts

[SOURCE: IEC 60050-151:2001, 151-15-50]

3.6.17
solid insulation
solid insulating material interposed between two conductive parts

[SOURCE: IEC 60664-1:2007, 3.4]

3.6.18
disruptive discharge
failure of insulation under electric stress, in which the discharge completely bridges the insulation under test, reducing the voltage between electrodes to practically zero

Note 1 to entry: Non-sustained disruptive discharge in which the test object is momentarily bridged by a spark or arc may occur. During these events the voltage across the test object is momentarily reduced to zero or to a very small value. Depending on the characteristics of the test circuit and the test object, a recovery of dielectric strength may occur and may even allow the test voltage to reach a higher value. Such an event should be interpreted as a disruptive discharge.

Note 2 to entry: A disruptive discharge in a solid dielectric produces permanent loss of dielectric strength; in a liquid or gaseous dielectric the loss may be only temporary.

[SOURCE: IEC 60060-1:2010, 3.1.1]

3.6.19
sparkover
disruptive discharge that occurs in a gaseous or liquid dielectric

[SOURCE: IEC 60060-1:2010, 3.1.2]

3.6.20
flashover
disruptive discharge that occurs over the surface of a dielectric in a gaseous or liquid dielectric

[SOURCE: IEC 60060-1:2010, 3.1.3]

3.6.21
puncture
disruptive discharge that occurs through a solid dielectric

[SOURCE: IEC 60060-1:2010, 3.1.4]

3.6.22
extra-low-voltage
ELV
voltage not exceeding the relevant voltage limit of band I specified in IEC 60449

Note 1 to entry: For the purposes of this standard, the ELV values are specified in 6.3.

[SOURCE: IEC 60050-826:2004, 826-12-30]

3.6.23
SELV system
electric system in which the voltage cannot exceed the value of extra-low voltage:

- under normal conditions; and
- under single-fault conditions, including earth faults in other circuits

Note 1 to entry: SELV is the abbreviation for safety extra low voltage.

[SOURCE: IEC 60050-826:2004, 826-12-31]

3.6.24
PELV system
electric system in which the voltage cannot exceed the value of extra-low voltage:

- under normal conditions, and
- under single-fault conditions, except earth faults in other circuits

Note 1 to entry: PELV is the abbreviation for protective extra low voltage.

[SOURCE: IEC 60050-826:2004, 826-12-32]

3.7 Terms related to switches of metering equipment

3.7.1
switch
mechanical switch
mechanical switching device capable of making, carrying and breaking currents under normal circuit conditions which may include specified operating overload conditions and also carrying for a specified time currents under specified abnormal circuit conditions such as those of short circuit

Note 1 to entry: A switch may be capable of making but not breaking short-circuit currents.

[SOURCE: IEC 60050-441:1984, 441-14-10]

3.7.2
supply control switch
SCS
switch intended to control the supply to the premises

Note 1 to entry: It comprises the contacts and the parts operating the contacts, and it may include a means for manual operation.

Note 2 to entry: The supply control switch should not be confused with the supply side protection device that disconnects the supply in the case of an overcurrent fault.

3.7.3
load control switch
LCS
switch intended to control loads within the premises

Note 1 to entry: It comprises the contacts and the parts operating the contacts.

3.7.4
auxiliary control switch
switch intended to control auxiliary devices

Note 1 to entry: It comprises the contacts or their electronic equivalent and the parts operating the contacts.

[SOURCE: IEC 62052-21:2004, 3.5.3 and 3.5.4, merged and modified – to make the definition more general and to provide additional information in the Note]

3.7.5
maximum total current
I_{tot}
r.m.s. value of the total current that all the switches of a stand-alone tariff- or load-control equipment can carry continuously at the same time under specified conditions

[SOURCE: IEC 62052-21:2004, 3.5.8, modified – “r.m.s” and “stand alone” added]

3.7.6
short-circuit current
over-current resulting from a short circuit due to a fault or an incorrect connection in an electric circuit

[SOURCE: IEC 60050-441:1984, 441-11-07]

3.7.7
prospective current <of a circuit with or without a switching device>
current that would flow in the circuit if it was replaced by a conductor of negligible impedance

[SOURCE: IEC 60050-441:1984, 441-17-01, modified – Note removed]

3.7.8
breaking current <of a switching device or a fuse>
current in a pole of a switching device or in a fuse at the instant of initiation of the arc during a breaking process

[SOURCE: IEC 60050-441:1984, 441-17-07]

3.7.9
breaking capacity <of a switching device or a fuse>
value of prospective current that a switching device or a fuse is capable of breaking at a stated voltage under prescribed conditions of use and behaviour

[SOURCE: IEC 60050-441:1984, 441-17-08, modified – Notes removed]

3.7.10
making capacity <of a switching device or a fuse>
value of prospective current that a switching device is capable of making at a stated voltage under prescribed conditions of use and behaviour

[SOURCE: IEC 60050-441:1984, 441-17-09, modified – Note removed]

3.7.11
short-circuit making capacity
making capacity for which the prescribed conditions include a short circuit at the terminals of the switching device

[SOURCE: IEC 60050-441:1984, 441-17-10]

3.7.12
short-time withstand current
current that a circuit or a switching device in the closed position can carry during a specified short time under prescribed conditions of use and behaviour

[SOURCE: IEC 60050-441:1984, 441-17-17]

3.7.13
fused short-circuit current
conditional short-circuit current when the current limiting device is a fuse

[SOURCE: IEC 60050-441:1984, 441-17-21]

3.7.14
minimum switched current
smallest current that a switch is able to make, carry and break at the rated breaking voltage and under prescribed conditions

[SOURCE: IEC 62055-31:2005, 3.5.1, modified – payment meter” replaced by “switch”]

3.7.15
trip-free mechanical switching device
mechanical switching device, the moving contacts of which return to and remain in the open position when the opening (i.e. tripping) operation is initiated after the initiation of the closing operation, even if the closing command is maintained

Note 1 to entry: To ensure proper breaking of the current which may have been established, it may be necessary that the contacts momentarily reach the closed position.

Note 2 to entry: The wording of IEC 60050-441:1984, 441-16-31 has been completed by adding "(i.e. tripping)" since the opening operation of a trip-free mechanical switching device is automatically controlled.

[SOURCE: IEC 60947-1:2007, 2.4.23]

4 Tests

4.1 General

NOTE This subclause is based IEC 61010-1:2010, 4.1.

Tests in this standard are type tests to be carried out on samples of equipment or parts. Their only purpose is to check that the design and construction ensure conformity with this standard.

Annex I specifies routine tests to be performed by manufacturers on equipment which has both hazardous live parts and accessible conductive parts.

The equipment shall at least meet the requirements of this standard. It is permissible to exceed the requirements. If, in this standard, a lower limit is specified for a conformity value, then the equipment may demonstrate a larger value. If an upper limit is specified for a conformity value, the equipment may demonstrate a lower value.

Tests on sub-assemblies that meet the requirements of the relevant standards specified in this standard, and are used in accordance with them, need not be repeated. However, sub-assemblies are exposed to the tests when fitted in the equipment. The complete equipment with the sub-assemblies fitted shall pass the tests.

See also Clause 13.

Conformity with the requirements of this standard is checked by carrying out all applicable tests, except that a test may be omitted if examination of the equipment and design documentation demonstrates conclusively that the equipment would pass the test. Tests are carried out under both reference test conditions (see 4.3) and fault conditions (see 4.4).

Where conformity statements in this standard require inspection, this may include examination of the equipment by measurement, examination of the markings on the equipment, examination of the instructions supplied with the equipment, examination of the data sheets of the materials or components from which the equipment is manufactured, etc. In each case, the inspection will either demonstrate that the equipment meets the applicable requirements of the clause, or will indicate that further testing is required.

If, when carrying out a conformity test, there is any uncertainty about the exact value of an applied or measured quantity (for example, voltage) due to the tolerance:

a) the manufacturer should ensure that at least the specified test value is applied;

b) the test house should ensure that no more than the specified test value is applied.

4.2 Type test – sequence of tests

NOTE This subclause reproduces IEC 61010-1:2010, 4.2.

The sequence of tests is optional unless otherwise specified. The equipment under test shall be carefully inspected after each test. If the result of a test causes doubt whether any earlier tests would have been passed if the sequence had been reversed, these earlier tests shall be repeated.

4.3 Reference test conditions

4.3.1 Atmospheric conditions

NOTE 1 This subclause is based on IEC 60068-1:2013, but with values taken from IEC 62052-11:2003.

The standard range of atmospheric conditions for carrying out measurements and tests shall be as follows:

a) ambient temperature: 15 °C to 25 °C;

   In countries with hot climates, the manufacturer and the test laboratory may agree to keep the ambient temperature between 20 °C to 30 °C.

b) relative humidity 45 % to 75 %;

c) atmospheric pressure of 86 kPa to 106 kPa.

d) No hoar frost, dew, percolating water, rain, solar radiation, etc. shall be present.

If the parameters to be measured depend on temperature, pressure and/or humidity and the law of dependence is unknown, the atmospheric conditions for carrying out measurements and tests shall be as follows:

e) ambient temperature: 23 °C ± 2 °C;

f) relative humidity 45 % to 55 %.

NOTE 2 The values are from IEC 60068-1:2013, 4.2, wide tolerance for temperature and wide range for humidity.

4.3.2 State of the equipment

4.3.2.1 General

NOTE Subclause 4.3.2 is based on IEC 61010-1:2010, 4.3.2, modified as appropriate for metering.

Unless otherwise specified, each test shall be carried out on the equipment assembled for normal use, and under the least favourable combination of the conditions given in 4.3.2.2 to 4.3.2.10. In case of doubt, tests shall be performed in more than one combination of conditions.

To be able to perform some tests, like testing in single fault condition, verification of clearances and creepage distances by measurement, placing thermocouples, checking corrosion, a specially prepared specimen may be needed and / or it may be necessary to cut a permanently closed specimen open to verify the results.

4.3.2.2 Position of equipment

The equipment shall be mounted in its normal working position, including a matching socket where applicable and with any ventilation unimpeded. Equipment intended to be built into a wall, recess, cabinet, etc., shall be installed as specified in the manufacturer's instructions. See also 10.4.

4.3.2.3 Plug-in modules

Any plug-in modules that may be used with the equipment under test and / or batteries shall be either connected or not connected.

NOTE Examples for plug-in modules are communication modules provided or recommended by the manufacturer.

4.3.2.4 Covers and removable parts

Covers or parts which can be removed without using a tool shall be removed or not removed.

4.3.2.5 Connection of the voltage and current circuits

The equipment shall be connected for its intended purpose, (i.e. together with a specified matching socket where applicable), or not connected.

Unless otherwise specified, the least favourable conditions that may occur in real life conditions shall be selected from the following as applicable:

a) the voltage circuits of meters shall be either energized or not energized. When energized, the voltage shall be between 80 % of the lowest reference voltage and 115 % of the highest reference voltage. If the permitted tolerance is higher, then the voltage shall be at any voltage in the operating range;

b) in the case of single-phase equipment, the voltage shall be connected with both normal and reverse polarity (line and neutral reversed);

c) in the case of three-phase equipment, one, two, or three phase voltages shall be connected. When all three phase voltages are connected, then the voltages shall be connected with both normal and reverse phase sequence;

d) the current circuits shall be loaded with a current up to I_{max} or not loaded;

   In the case of polyphase equipment, the current circuits shall carry a balanced load.

   NOTE For supply and load control switches, see 4.3.2.6. For auxiliary control switches, see 4.3.2.7.

e) equipment for tariff and load control shall be either energized or not energized. When energized, the voltage shall be between 80 % of the lowest reference voltage and 115 % of the highest reference voltage. If the permitted tolerance is higher, then the voltage shall be at any voltage in the operating range;

f) in the case of equipment with a (separate) auxiliary power supply, the auxiliary supply voltage shall be connected or not connected. In the case of d.c. or single phase a.c. auxiliary power supply, the voltage shall be connected with both normal or reverse polarity if this latter is possible;

g) the frequency shall be any rated frequency.

4.3.2.6 Supply and load control switches

Unless otherwise specified, all supply control switches (SCSs) and load control switches (LCSs) shall be in the closed position. When a SCS is closed, it shall carry a current equal to I_{max}. When a LCS is closed, it shall carry a current equal to its rated operational current I_e. If there are several LCSs present, the total current shall not be more than I_{tot}.

NOTE 1 Switches may be controlled locally or remotely and they may be operated locally.

NOTE 2 For testing direct connected meters equipped with SCSs see 6.10.6. For testing load control switches see and 6.10.7.

4.3.2.7 Connection of the auxiliary circuits

Auxiliary input circuits shall be either connected to any voltage within their rated operating voltage range or not connected.

The rated load impedance of auxiliary output circuits shall be either connected or not connected.

Auxiliary control switches shall be either in the closed or in the open position. When an auxiliary control switch is closed, it shall be loaded or not loaded with rated current.

4.3.2.8 Connection of batteries

In the case of equipment equipped with a battery, if the means of connection permits reversal, the battery shall be connected with both reverse and normal polarity.

4.3.2.9 Protective conductor terminals

Protective conductor terminals, if any, shall be connected to earth.

4.3.2.10 Physical token carriers

Payment meters equipped with physical token carrier acceptors may be tested with the token carrier (or metallic test token carrier) inserted or not inserted unless explicitly specified for particular tests.

4.3.2.11 Test cables

NOTE 1 This subclause does not apply to installation, which is generally subject to national wiring regulations.

NOTE 2 This subclause is based on IEC 60947-1:2007, 8.3.3.3.4.

Test cables for connecting the current circuits, supply control switches and load control switches shall be single core or stranded, suitable insulated cables with cross-sections as given in Table 1. The length of the test cables shall be:

- 1 m for cross-sections up to and including 35 mm^2 (or AWG 2);
- 2 m for cross-sections larger than 35 mm^2 (or AWG 2).

For the terminals of voltage circuits and auxiliary circuits the test cables shall be single core or stranded, suitably insulated cables of 1 mm^2, unless otherwise specified by the manufacturer.

Table 1 – Test copper conductors for current and switch terminals

Range of test current A	Conductor size [a, b]		
	Cross-section mm^2	**Size** AWG / kcmil	**Equivalent cross-section** mm^2 (for sizes given in AWG / kcmil)
$0 < I \leq 8$	1,0	18	0,82
$8 < I \leq 12$	1,5	16	1,3
$12 < I \leq 15$	2,5	14	2,1
$15 < I \leq 20$	2,5	12	3,3
$20 < I \leq 25$	4,0	10	5,3
$25 < I \leq 32$	6,0	10	5,3
$32 < I \leq 50$	10	8	8,4
$50 < I \leq 65$	16	6	13,3
$65 < I \leq 85$	25	4	21,2
$85 < I \leq 100$	35	3	26,7
$100 < I \leq 115$	35	2	33,6
$115 < I \leq 130$	50	1	42,4
$130 < I \leq 150$	50	0	53,5
$150 < I \leq 175$	70	00	67,4
$175 < I \leq 200$	95	000	85
$200 < I \leq 225$	95	0000	107,2
$225 < I \leq 250$	120	250 kcmil	127
$250 < I \leq 275$	150	300 kcmil	152
$275 < I \leq 300$	185	350 kcmil	177
$300 < I \leq 350$	185	400 kcmil	203
$350 < I \leq 400$	240	500 kcmil	253

NOTE This table is based on IEC 60947-1:2007, Table 1 and Table 9.

AWG: American Wire Gauge size.

Circular mils: The standard unit of a – large – wire's cross-sectional area.

kcmil: thousand circular mils.

[a] For convenience of testing and with the manufacturer's consent, smaller conductors than those given for a stated test current may be used.

[b] Either of the two conductors specified for a given test current range may be used.

Unless otherwise specified by the manufacturer, stranded cables shall be terminated by fitting cable end ferrules and they shall be correctly crimped with an appropriate crimping tool. All contact surfaces shall be free of oxide layers.

NOTE 3 See DIN 46228-1:1992-08 *Aderendhülsen; Rohrform ohne Kunststoffhülse*. English title: *Tubular end-sleeves without plastic sleeve*.

Terminal screws, where used, shall be tightened according to the manufacturer's instructions.

4.3.2.12 Information on tests

NOTE 1 The following is based on IEC 60255-27:2013, 10.4.

The following data for each test to be conducted shall be available from the manufacturer on request:

- the type, cross-sectional area, length and termination of connecting cables, if these can affect the type test results, for example temperature rise. If these are different from the values specified in Table 1, the reasons shall be given;
- the position of the equipment where relevant;
- the state of the equipment;

  NOTE 2 This includes voltages and currents applied to the terminals, parts fitted or not, position of switches etc.

- measurement uncertainty for all measurement results.

Where applicable, the data shall include:

- initial measurement;
- measurement during the individual test;
- final measurement.

4.4 Testing in single fault condition

4.4.1 General

NOTE Subclause 4.4 is based on IEC 61010-1:2010, 4.4, modified as applicable for metering.

The manufacturer may provide guidance to the test laboratory on how to perform tests in single fault condition. The following general guidelines and requirements apply.

a) examination of the equipment and its circuit diagram will generally show the fault conditions which are liable to result in hazards and which, therefore, shall be applied;
b) fault tests shall be made as specified for checking conformity, unless it can be demonstrated that no hazard could arise from a particular fault condition;
c) the equipment shall be operated under the least favourable combination of reference test conditions (see 4.3). These combinations may be different for different faults and they shall be recorded for each test.

4.4.2 Application of fault conditions

4.4.2.1 General

Fault conditions shall include those specified in 4.4.2.2 to 4.4.2.8. They shall be applied one at a time and shall be applied in turn in any convenient order. Multiple simultaneous faults shall not be applied unless they are a consequence of an applied fault.

After each application of a fault condition, the equipment or part shall pass the applicable tests of 4.4.4.

4.4.2.2 Protective impedance

The following requirements apply:

a) if a protective impedance is formed by a combination of components, and unless each component is certified to fail in an open circuit state, each component shall be short-circuited or disconnected, whichever is less favourable;
b) if a protective impedance is formed by the combination of basic insulation and a current or voltage limiting device, both the basic insulation and the current or voltage limiting device shall be subjected to single faults, applied one at a time. Basic insulation shall be bridged and the current or voltage limiting device shall be short-circuited or disconnected, whichever is less favourable;

c) if a protective impedance is formed with a single component that meets the requirements of 6.5.4, it need not be short-circuited or disconnected.

4.4.2.3 Equipment or parts for short-term or intermittent operation

These shall be operated continuously if continuous operation could occur in a single fault condition.

NOTE Individual parts include relays and other electromagnetic devices.

4.4.2.4 Transformers

4.4.2.4.1 General

NOTE Subclause 4.4.2.4 applies only to transformers used within the metering equipment.

Transformers shall be tested as specified in 4.4.2.4.2 to 4.4.2.4.4.

A transformer damaged during one test may be repaired or replaced before the next test.

4.4.2.4.2 Short circuit test for voltage transformers

NOTE This subclause reproduces IEC 61010-1:2010, 4.4.2.7.2.

Each untapped output winding, and each section of a tapped output winding, which is loaded in normal use, shall be tested in turn, one at a time, to simulate short circuits in the load. Overcurrent protection devices remain fitted during the test. All other windings are loaded or not loaded; whichever load condition of normal use is less favourable.

4.4.2.4.3 Overload

NOTE This subclause reproduces IEC 61010-1:2010, 4.4.2.7.3.

Each untapped output winding, and each section of a tapped output winding, is overloaded in turn one at a time. The other windings are loaded or not loaded whichever load condition of normal use is less favourable. If any overloads arise from testing in the single fault conditions of 4.4, secondary windings shall be subjected to those overloads.

Overloading is carried out by connecting a variable resistor across the winding. The resistor is adjusted as quickly as possible and readjusted, if necessary, after 1 min to maintain the applicable overload. No further readjustments are then permitted.

If overcurrent protection is provided by a current-breaking device, the overload test current is the maximum current which the overcurrent protection device is just capable of passing for 1 h. Before the test, the device is replaced by a link with negligible impedance. If this value cannot be derived from the specification, it is to be established by test.

For equipment in which the output voltage is designed to collapse when a specified overload current is reached, the overload is slowly increased to a point just before the point which causes the output voltage to collapse.

In all other cases, the loading is the maximum power output obtainable from the transformer.

4.4.2.4.4 Open circuit of current transformers

The secondary side of (a) current transformer(s) (CTs) shall be open-circuited.

If this condition cannot occur in practice, this test may be omitted. For example, this test may be omitted for potted CTs soldered and mechanically secured to the printed wiring board, or for CTs with their secondary side connected to the printed wiring board by mechanically secured cables, such that solder joints are protected from mechanical stress.

4.4.2.5 Equipment with auxiliary supply

NOTE This subclause reproduces IEC 61010-1:2010, 4.4.2.9.

Equipment designed to be operated with an auxiliary supply shall be connected to that supply or not, whichever is less favourable.

4.4.2.6 Mains-circuits and hazardous voltage non-mains-circuits

NOTE 1 This subclause is based on IEC 60255-27:2013, 5.2.2.6.

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

NOTE 2 A single fault condition test for varistors is under consideration.

4.4.2.7 Overloads

NOTE 1 This subclause is based on IEC 60255-27:2013, 5.2.2.7.

NOTE 2 This subclause refers to all auxiliary circuits, and not to the main current and load control circuits.

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.

4.4.2.8 Intermittently rated resistors

NOTE This subclause is based on IEC 60255-27:2013, 5.2.2.8.

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

4.4.2.9 Double insulation

If double insulation is applied then it shall be verified by short circuiting the basic and then the supplementary insulation, one at a time. It shall be ascertained that basic insulation is maintained.

For components bridging insulation, see 13.4.

4.4.3 Duration of tests

NOTE This subclause reproduces IEC 61010-1:2010, 4.4.3.1.

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 hazard of electric shock, spread of fire or injury to persons may eventually occur, the test shall be continued for 4 h unless one of these hazards arises before that.

4.4.4 Conformity after application of fault conditions

NOTE This subclause reproduces IEC 61010-1:2010 4.4.4, mutatis mutandis.

4.4.4.1 General

Conformity with the requirements for protection against electric shock after the application of single faults is checked as follows:

a) *by making the measurements of 6.3.3 to check that no accessible conductive parts have become hazardous live;*

b) *by performing a voltage test on double insulation or reinforced insulation to check that the protection is still at least at the level of basic insulation. The voltage tests are made as specified in 6.10.4.3.3 without humidity preconditioning, with a test voltage for basic insulation;*

c) *by measuring the temperature of transformer windings if the protection against electrical hazards is achieved by double insulation or reinforced insulation within the transformer. The temperatures of Table 33 shall not be exceeded.*

4.4.4.2 Temperature

Conformity with the requirements for protection against excessive temperature rise is checked by determining the temperature of the accessible surface of the enclosure and of the parts. See Clause 10.

4.4.4.3 Spread of fire

Conformity with the requirements for protection against the spread of fire is checked by placing the equipment on white tissue-paper covering a softwood surface and covering the equipment with cheesecloth. No molten metal, burning insulation, flaming particles, etc. shall fall on the surface on which the equipment is placed and there shall be no charring, glowing, or flaming of the tissue paper or cheesecloth. Melting of insulation material shall be ignored if no hazard could arise.

4.4.4.4 Other hazards

Conformity with other requirements for protection against hazards is checked as specified in Clauses 7 to 14.

5 Information and marking requirements

5.1 General

NOTE Clause 5 is based on the following references:

- IEC 62052-11:2003, 5.12, IEC 62052-21:2004, 5.12, IEC 62055-31:2005, 5.13;
- IEC 61010-1:2010 Clause 5; and
- IEC 62477-1:2012 Clause 6.

The purpose of this Clause 5 is to define the safety-related information necessary for the safe selection, installation and commissioning, for use, and for maintenance of metering equipment. The required information is presented in Table 2 showing where the information shall be provided. References to explanatory and technical subclauses are given.

Unless otherwise stated, the requirements of this Clause shall apply to all metering equipment in the scope of this standard.

All information shall be in an appropriate language, and documents shall have identification references.

Table 2 – Information requirements

Information	Subclause reference	Location [a, b]						Technical subclause reference
		C	D	P	IM	UM	MM	
For selection	5.3							
General information	5.3.2							
Manufacturer's name or trade mark		M		M	M	M	M	–
Designation of function		O	O	O	O	O	O	–
Type		M		M	M	M	M	
Space for approval mark		M						–
Serial number		M	O	O				–
Protective class		M		M	M		M	–
Rated impulse voltage		M		M	M		M	6.7.1.3 6.7.3.1 Annex K
Utilization category (UC) for direct connected meters only		M		M	M		M	6.9.8.3 6.9.8.4
Environmental conditions, storage				O	M		M	–
Environmental conditions, operation, including				O	M		M	1.4
• mechanical conditions				O	O		O	
• climatic conditions				O	O		O	
• altitude				O	O		O	
• location (dry or wet)				O	O		O	
IP rating		O		M	M		M	11
Reference to standards		M		M	M	M	M	–
Reference to instructions					M	M	M	–
For meters	5.3.3							
Reference voltage(s)		M			M	M	M	–
Reference current and current range		M			M	M	M	
For stand-alone tariff and load control equipment	5.3.4							
Supply voltage(s)		M			M	M	M	–
Supply control switches	5.3.5							6.9.8
The rated operating voltage: U_e;		M		M	M	M	M	
Load control switches								
The rated operating voltage: U_e;		M		M	M	M	M	
The rated operating current: I_e;		M		M	M	M	M	
The maximum permanent total current of the load control switches: I_{tot};		M		M	M	M	M	
For installation and commissioning	5.4							
Handling and mounting	5.4.2			O	M		M	–
Enclosure	5.4.3				M			6.9.4, 10.1
Connection requirements	5.4.4				M		M	–
Connection and wiring diagrams	5.4.4.2	M			M		M	–
Mains terminals	5.4.4.3	M			M		M	6.9.7
Auxiliary terminals	5.4.4.4	M			M		M	–
Connecting cables	5.4.4.5				M		M	6.9.7.2
Isolation from the supply	5.4.4.6				M		M	–

Information	Subclause reference	Location [a, b]						Technical subclause reference
		C	D	P	IM	UM	MM	
Protection requirements	5.4.5				M		M	–
Protective class and earthing	5.4.5.1	M			M		M	6.5.2
External protection devices	5.4.5.2				M		M	–
Auxiliary power supply	5.4.6				M		M	–
Supply for external devices	5.4.7				M		M	–
Batteries	5.4.8	M		M	M	O	M	12
Self-consumption	5.4.9				M		M	
Commissioning	5.4.10				M		M	–
For use	5.5							
General	5.5.1					M		–
Display, push buttons and other controls	5.5.2					M		10.1
Switches	5.5.3	M	M			M		6.9.8
Connection to user's equipment	5.5.4					M		6.8
External protection devices	5.5.5					M		–
Cleaning	5.5.6				M	M	M	5.2.2
For maintenance	5.6							–
Maintenance instructions	5.6						M	

[a] Location:

C = Case. These markings may appear on nameplate(s) or may be carried by the meter cover(s) in a permanent manner. Connection diagrams may be marked on the underside of the terminal cover(s).

D = Display;

P = Packaging;

IM = Instruction manual. UM = User manual. MM = Maintenance manual.

[b] M = Mandatory, O = Optional

[c] The installation, user and maintenance manuals may be combined as appropriate and, if acceptable to the customer, may be supplied in electronic format. When more than one of any product is supplied to a single customer, it is not necessary to supply a manual with each unit, if acceptable to the customer.

5.2 Labels, signs and signals

5.2.1 General

Labelling shall be in accordance with good ergonomic principles so that notices, controls, indications, test facilities etc. are sensibly placed and logically grouped to facilitate correct and unambiguous identification.

NOTE The term "Label" is used here in a general sense. Labels are realized using various technologies, e.g. moulding, laser marking and engraving, on adhesive labels, etc.

The size of warning markings shall be as follows:

a) symbols shall be at least 2,75 mm high. Text shall be at least 1,5 mm high and contrast in colour with the background;
b) symbols or text moulded, stamped or engraved in a material shall be at least 2,0 mm high. If not contrasting in colour, they shall have a depth or raised height of at least 0,5 mm.

All safety related equipment labels should be placed in such a way that they will:

c) be readily visible to the intended viewer; and
d) alert the viewer to any hazard in time to take appropriate action.

Where a hazard is present after the removal of a cover, a warning label shall be placed on the equipment. The label shall be visible before the cover is removed.

SAFETY MARKING SHALL WHEREVER POSSIBLE TAKE PRECEDENCE OVER ANY FUNCTIONAL MARKINGS.

Letter symbols for quantities and units shall be as specified in IEC 60027-1.

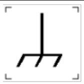
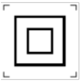
Graphic symbols shall conform to IEC 62053-52, IEC 60417-DB-12M, IEC 60617-DB-12M, and ISO 7000 as appropriate. IEC 60417-DB-12M and ISO 7000 symbols that may be used on metering equipment are shown in Table 3. Symbols not shown in these standards shall be explained where used. There are no colour requirements for symbols.

The documentation of the metering equipment shall include a statement that it shall be consulted in all cases where symbol 14 of Table 3 is marked, in order to find out the nature of the potential hazards and any actions which have to be taken to avoid them.

Labels shall:

- be conspicuous, legible and durable;
- be concise and unambiguous;
- state the hazards involved and give ways in which risks can be reduced.

Table 3 – IEC 60417 symbols and ISO 7000 that may be used on metering equipment

Number	Symbol	Reference	Description
1			Not used
2			Not used
3			Not used
4			Not used
5a		IEC 60417-5017	Earth; ground
5b		IEC 60417-5018	Functional earthing; functional grounding (US) [a]
6		IEC 60417-5019	Protective earth; protective ground
7		IEC 60417-5020	Frame or chassis
8			Not used
9			Not used
10			Not used
11		IEC 60417-5172	Protective class II equipment (Double or reinforced insulation)
12		IEC 60417-5036	Dangerous voltage
13			Not used
14		ISO 7000-0434B	Caution, refer to accompanying documents.
15		ISO 7000-1641	Operator's manual; operating instructions

[a] There may be national differences concerning the use of this symbol.

When instructing the person(s) concerned as to:

- **what to avoid**: the wording should include “no”, “do not”, or “prohibited”;
- **what to do**: the wording should include “shall”, or “must”;
- **the nature of the hazard:** the wording should include “caution”, “warning”, or “danger”, as appropriate;
- **the nature of safe conditions**: the wording should include the noun appropriate to the safety device.

Safety signs shall comply with ISO 3864-1.

The signal words indicated hereinafter shall be used and the following hierarchy respected:

- **DANGER** to call attention to a high risk, for example: “High voltage”;
- **WARNING** to call attention to a medium risk, for example: “This surface can be hot”;
- **CAUTION** to call attention to a low risk, for example; “Some of the tests specified in this standard involve the use of processes imposing risks on persons concerned.”

Danger, warning and caution markings on the metering equipment shall be prefixed with the word “DANGER”, “WARNING”, or “CAUTION” as appropriate in letters not less than 3,2 mm high. The remaining letters of such markings shall be not less than 1,6 mm high.

Conformity is checked by inspection.

5.2.2 Durability of markings

When feasible, placement of the label should provide protection from foreseeable damage, fading, or visual obstruction caused by abrasion, ultraviolet light, or substances such as lubricants, chemicals and dirt.

An adhesive that is permanent shall be used to secure adhesive labels.

Conformity is checked by performing the following test for durability of markings on the outside of the equipment. The markings are rubbed by hand, without undue pressure, for 30 s with a cloth soaked with each cleaning agent recommended by the manufacturer and with 70 % isopropyl alcohol.

After the above treatment the markings shall be clearly legible and adhesive labels shall not have worked loose or become curled at the edges.

5.3 Information for selection

5.3.1 General

Metering equipment shall be provided with information relating to its function, electrical characteristics and intended environment, so that its fitness for purpose can be determined. This information includes, but is not limited to the information specified in 5.3.2 to 5.3.5 that follow here.

5.3.2 General information

- manufacturer's name or trade mark;
- designation of function and type. Designation of the function shall be preferably in local language;

  NOTE 1 Examples for function are “kWh meter”, “Smart meter”, “Time switch”, “Ripple control receiver”.

- space for approval mark;

- serial number. The serial number shall uniquely identify the metering equipment. If it is located on a removable cover, the number shall also be marked on the base of the metering equipment or stored in its non-volatile memory and displayed on its electronic display;

  NOTE 2 Metering equipment often carry additional identifiers, like bar codes, location identifiers, etc.

- protective class;
- rated impulse voltage;
- utilization category (UC), for direct connected meters only;
- environmental conditions for storage;
- environmental conditions, operation: the conditions under which the metering equipment is designed to be used. This shall identify:
  – mechanical conditions (vibration, shock);
  – climatic conditions (indoor / outdoor, temperature, humidity, altitude, pollution, ultra-violet etc.);
  – altitude where relevant;
  – location – dry or wet – where relevant;
- IP rating. See also 5.4.3 and Clause 11;
- reference to the relevant product standard(s);
- reference to instructions for installation (IM), operation (UM) and maintenance (MM).

5.3.3 Information related to meters / metering elements

- reference voltage(s) and voltage range(s) as specified in the relevant product standards;
- reference current and current range as specified in the relevant product standards.

5.3.4 Information related to stand-alone tariff-and load control equipment

- supply voltage reference voltage(s) and voltage range(s) as specified in the relevant product standards.

5.3.5 Information related to supply control and load control switches

For supply control switches (SCSs) the following information shall be provided:

- the rated operating voltage: U_e if different from the reference voltage of the meter;

For load control switches (LCSs) the following information shall be provided:

- the rated operating voltage U_e if different from the reference voltage of metering equipment;
- the rated operating current I_e. The marking shall be provided at or near the load side terminal of the circuit switched. If the load switch has independent terminals, the marking shall appear in square brackets;
- the maximum permanent total current of the load control switches at the maximum operating temperature: I_{tot}.

See also 6.9.8.4 and 6.9.8.5.

5.4 Information for installation and commissioning

5.4.1 General

Safe and reliable installation is the responsibility of the installer. The manufacturer of metering equipment shall provide information to support this task. This information shall be unambiguous, and may be in diagrammatic form.

Since any electrical equipment can be installed or operated in such a manner that hazardous conditions can occur, compliance with the requirements of this standard does not by itself assure a safe installation. However, when equipment complying with those requirements is properly selected and correctly installed, commissioned and used, the hazards will be minimized.

5.4.2 Handling and mounting

In order to prevent injury or damage, the installation documents shall include warnings of any hazards which can be experienced during installation. Where necessary, instructions shall be provided for:

- packing and unpacking;
- moving;
- lifting;
- strength and rigidity of mounting surface;
- fastening;
- provision of adequate access for operation, adjustment and maintenance.

Optionally, handling and mounting instructions can be provided on the packaging.

Conformity is checked by inspection.

5.4.3 Enclosure

Information shall be provided on whether the metering equipment is intended for indoor or outdoor use.

If metering equipment is designed for use in an enclosure like a meter cabinet, this shall be stated.

When metering equipment surfaces at temperatures exceeding 90 °C are close to mounting surfaces, the installation manual shall contain a warning to consider the combustibility of the mounting surface.

In normal operation, such condition may occur if metering equipment is used under extremely hot climatic conditions.

Conformity is checked by inspection.

5.4.4 Connection

5.4.4.1 General

Information shall be provided to enable the installer to make safe electrical connections to the metering equipment. This shall include information for protection against hazards (for example, electric shock or availability of energy) that may be encountered during installation.

5.4.4.2 Connection diagrams

If necessary for safety, the connection diagram shall show where the supply control and load control switches and the internal power supply are connected.

Where there is insufficient space, symbol 15 of Table 3 may be used.

Conformity is checked by inspection.

5.4.4.3 Mains terminals

Mains terminals comprise the terminals of the current and voltage circuits of the meter and the terminals of the supply and/or load control switches.

For each mains terminal, the maximum rating of the terminal at which it has been designed to operate while maintaining safety shall be given.

Where terminals have the same rating the marking does not have to be repeated.

Terminals rated at the maximum current of the meter do not have to be marked.

5.4.4.4 Auxiliary terminals

Terminals and connectors of auxiliary circuits shall be readily identifiable by the equipment markings. Individual terminals within a connector shall be unambiguously identifiable.

The following information shall be provided in the documentation as applicable:

- the function(s): e.g. pulse input/output, control input/output;

  NOTE Some I/O lines have a programmable function.

- the kind of the circuit(s), e.g. optocoupler, relay, solid state relay;
- kind of voltage (a.c. or d.c.), nominal, minimum and maximum voltages. If the control voltage of (a) control input(s) or output(s) is different from the reference voltage of the metering equipment, this shall be specified on the name-plate or on a separate label;
- nominal, minimum, continuous and short time maximum current as applicable;
- the burden;
- nominal and maximum frequency as applicable;
- insulation from other circuits, insulation voltage, any other relevant information for testing;
- in the case of inputs, information on clamping of overvoltages;
- in the case of output relays:
  - type of the contact(s): normally open, normally closed, changeover;
  - contact impedance;
  - withstand voltage across open contacts;
  - duty cycle;
  - number of operating cycles;
- any other safety related information.

Conformity is checked by inspection.

5.4.4.5 Connecting cables

NOTE Generally, national regulations are in place concerning electrical installations. These regulations, among others, specify the type and size of the connection cables to be used.

Metering equipment shall be suitably marked to warn the installer to consult the local regulations and the installation manual before installation. The marking shall be adjacent to the terminals and visible both before and during connection. The symbol 15 of Table 3 is an acceptable marking.

The installation manual shall contain recommendations for the type, size, voltage and temperature rating of connecting cables to be used for each terminal, including the protective earth terminal if present. For the current terminals, the minimum size of the connecting cables which can be safely accommodated shall also be specified. Recommended cable terminations and tightening torque values shall be also specified where applicable.

Conformity is checked by inspection.

5.4.4.6 Isolation from the supply

Recommendations shall be provided on how supply to the metering equipment can be isolated before installation and removal.

If it is possible to install the meter without isolating the supply, i.e. on live network, then appropriate instructions and safety warnings shall be provided.

Specific aspects and safety hazards related to external voltage and current transformers, auxiliary supplies and local generation shall be covered.

Conformity is checked by inspection.

5.4.5 Protection

5.4.5.1 Protective class and earthing

Equipment of protective class II – fully protected by double insulation or reinforced insulation – shall be marked with symbol 11 of Table 3. Equipment which is only partially protected by double insulation or reinforced insulation shall not be marked with symbol 11.

Where equipment of protective class II has provision for the connection of an earthing conductor for functional reasons, it shall be marked with symbol 5b) of Table 3.

For metering equipment of protective class I, the protective conductor terminal shall be marked with the symbol 6 of Table 3. The symbol shall be placed on the terminal or close to it.

The installation manual shall include a statement that the protective earth connector shall be connected first and that it shall not be removed until supply to the meter is fully isolated.

Conformity is checked by inspection.

5.4.5.2 External protection devices

NOTE 1 Generally, there exist national regulations covering the protection of the electrical installation. These regulations, among others, specify the kind, rating and characteristics of external protection devices, for example circuit breakers, fuses, fuse cutouts. Their selection depends on the location where the metering equipment is installed.

Metering equipment shall be suitably marked to warn the installer to consult local regulations and the installation manual for the necessary protection requirements before installation. The marking shall be adjacent to the terminals and visible both before and during connection beside the terminals. Symbol 15 of Table 3 is an acceptable marking.

The installation manual shall contain recommendations for the supply side external protection devices to be used. In the case of voltage transformer connected meters, this shall include recommendations for protecting the voltage circuit.

NOTE 2 When local generation is present, “supply side protection” comprises both protection from supply from the distribution network and protection from supply from local generation.

The installation manual shall also contain a statement that the installer is responsible for co-ordinating the rating and the characteristics of the supply side overcurrent protection devices with the maximum current rating and, in the case of direct connected meters, with the UC rating of the metering equipment. See also 6.9.8.3.

Conformity is checked by inspection.

5.4.6 Auxiliary power supply

If an auxiliary supply input is present, the following information shall be provided:

- the kind of auxiliary supply voltage (a.c. and/or d.c.);
- the rated value(s);
- the current in A and the power consumption in VA under worst case conditions.

5.4.7 Supply for external devices

If the metering equipment provides a supply for external devices, e.g. communication modules, then the following information shall be provided:

- nominal voltage and operating voltage range;
- maximum load;
- kind of and rating of protection, when available, e.g. resettable fuse;
- polarity, when relevant.

5.4.8 Batteries

NOTE This subclause is based on IEC 60255-27:2013, 9.1.8.1.

If the equipment has replaceable batteries and by opening the battery compartment a hazard appears or if the replacement of the batteries by an incorrect type of battery could result in an explosion (for example, in the case of certain types of Lithium batteries) then:

- if a user can access the battery, there shall be a marking close to the battery or a statement in the instruction manual, user manual and maintenance manual;
- if the battery is elsewhere in the equipment, marking is required; this shall be close to the battery or in a statement included in the maintenance manual.

The marking or statement shall be similar to the following.

⚠	CAUTION – Risk of fire if battery is replaced with incorrect type or polarity. Dispose of used batteries according to instructions.

It is permissible, where space is limited on the equipment to use the warning mark, see Table 3 symbol 14 .

The polarity of the battery shall be marked on the equipment unless it is not possible to insert the battery with incorrect polarity.

Conformity is checked by inspection.

5.4.9 Self-consumption

For the voltage circuits of meters, for stand-alone tariff and load control equipment and for auxiliary circuits the following information shall be provided in the instruction and maintenance manuals:

- the maximum power consumption in watts (active power) or volt-amperes (apparent power), or the maximum rated input current, with all accessories or plug-in modules connected. If the equipment can be used on more than one voltage range, separate values shall be specified for each voltage range unless the maximum and minimum values do not differ by more than 20 % of the mean value. The stated value shall not be less than 90 % of the maximum value.

For the current circuits of meters:

- the burden in VA for each current circuit of the metering equipment, measured at the rated operating current of that circuit.

Conformity is checked by inspection.

5.4.10 Commissioning

NOTE 1 This subclause is based on IEC 61010-1:2010, 5.4.6.

Aspects resulting from integration into systems or effects resulting from special ambient or application conditions may be addressed to the user and/or the installer, if clearly described in the instruction manual or in special safety instructions.

NOTE 2 The following paragraph is based on IEC 60364-1:2005, 131.7.

In particular, a statement shall be included to the effect that where danger or damage is expected to arise due to an interruption of supply, suitable provisions shall be made in the installation or installed equipment.

If commissioning tests are necessary to ensure the electrical and thermal safety of metering equipment, information to support these tests shall be provided.

Commissioning information shall include references to hazards that might be encountered.

Conformity is checked by inspection of the documentation.

5.5 Information for use

5.5.1 General

The user manual shall be written in a language that can be easily understood by the intended readership and it shall include all information regarding the safe operation of the metering equipment.

All safety marking shall be clearly explained. The user manual shall also indicate any hazards, which can result from reasonably foreseeable misuse of the metering equipment.

5.5.2 Display, push buttons and other controls

The user manual shall provide a detailed description of all items that can be displayed by the metering equipment. All push buttons and any other control devices shall be identified and their function described.

5.5.3 Switches

The position (Connected / ON – Disconnected / OFF – Ready for reconnection as applicable) of any switch(es) shall be unambiguously and clearly indicated, their operation and any related hazards shall be explained in the user manual.

In particular, there shall be a warning mark adjacent to the switch(es) and an explanation within the user manual that the open position of the supply or load control switch does not provide isolation from the mains network. Symbol 14 of Table 3 is a suitable marking.

5.5.4 Connection to user's equipment

Where it is possible for the user to connect any equipment to the meter, the necessary connection diagrams, the identification, marking and description of the connectors as well as the description of the necessary operations shall be provided.

Where any hazards exist in the process of connecting an external device, suitable marking shall be provided on the meter.

5.5.5 External protection devices

If external protection devices such as fuses and circuit breakers may be operated by the user, then any safety hazards related to their operation shall be explained in the user manual of the metering equipment.

5.5.6 Cleaning

The instruction, user and maintenance manuals shall provide information for cleaning, including the cleaning agents that may be used.

5.6 Information for maintenance

NOTE This subclause is based on IEC 62477-1:2012, 6.5.1

Safety information shall be provided in the maintenance manuals including – as applicable – the following:

- preventive maintenance procedures and schedules;
- safety precautions during maintenance;
- location of live parts that can become accessible during maintenance (for example, when covers are removed);
- adjustment procedures;
- sub-assembly and component repair and replacement procedures;
- information on safe disposal of the equipment and any replaceable parts;
- verification of the safe state of the equipment after repair;
- any other relevant information.

These may best be presented as diagrams.

A list of special tools should be provided, when appropriate.

6 Protection against electrical shock

6.1 General requirements

NOTE 1 This subclause is based on IEC 61010-1:2010, 6.1.1 and IEC 60255-27:2013, 5.1.

Metering equipment shall be designed and constructed to ensure personal safety against electric shock.

Accessible parts (see 6.2) shall not be hazardous live (see 6.3). This requirement also applies to parts that can be accessed after removing a cover, opening a door etc. without using a tool.

NOTE 2 Accessibility of parts is to be understood from the point of view of the user. See also 1.1.

Protection against electric shock shall be maintained in normal condition, see 6.4 , and single fault condition, see 6.5.

Any conductive part that is not separated from the hazardous live parts by at least basic insulation shall be considered to be 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. See 6.9.2.

Unearthed accessible conductive parts which may become hazardous live under a single fault condition shall be separated from hazardous live parts by double insulation or reinforced insulation or be connected to the protective conductor or meet the requirements of 6.2 to 6.6.

Conformity is checked by the determination of accessible parts as specified in 6.2, and the measurements of 6.3 to establish that the levels of 6.3.2 and 6.3.3 are not exceeded, followed by the tests of 6.4 to 6.10.

6.2 Determination of accessible parts

6.2.1 General

NOTE 1 Subclause 6.2 is based on IEC 61010-1:2010, 6.2.1 and IEC 60255-27:2013 5.1.5.1.

NOTE 2 This subclause reproduces IEC 61010-1:2010, 6.2.1 (with the note modified).

Unless obvious, determination of whether a part is accessible is made as specified below in 6.2.2 to 6.2.4 in all positions of normal use. Test fingers and pins are applied without force unless a force is specified. Parts are considered to be accessible if they can be touched with any part of a test finger or test pin.

NOTE 3 Electricity metering equipment in normal use do not require any actions that increase the accessibility of parts. All service-related actions that eventually increase the accessibility of parts (e.g. battery replacement, calibration, re-sealing, etc.) are performed by skilled personnel.

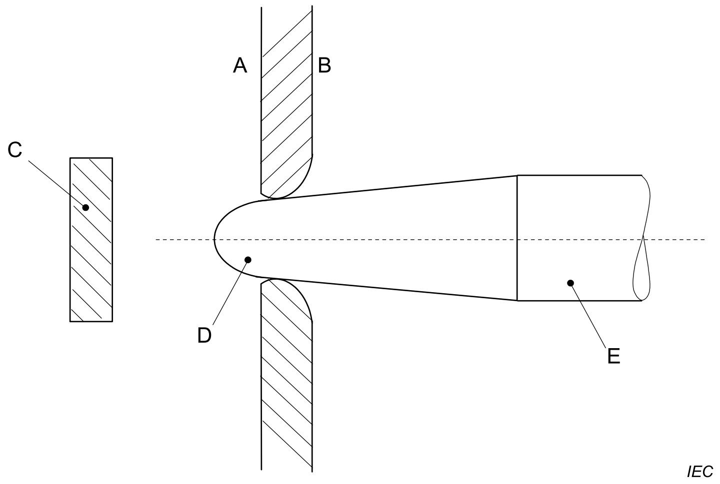
Rack-mounted and panel-mounted equipment is installed as specified in the manufacturer's instructions before making the examinations of 6.2.2 to 6.2.4. For such equipment, the operator is assumed to be in front of the panel.

6.2.2 Examination

NOTE This subclause reproduces IEC 61010-1:2010, 6.2.2, except that references are made to IEC 61032:1997.

The jointed test finger (test probe B), specified in IEC 61032:1997 is applied in every possible position. If a part could become accessible by applying a force, the rigid test finger (test probe 11), specified in IEC 61032:1997 is applied with a force of 10 N. The force is exerted by the tip of the test finger so as to avoid wedge and lever action. The test is applied to all outer surfaces, including the bottom. However, on equipment accepting plug-in modules the tip of the jointed test finger is inserted only to a depth of 180 mm from the opening in the equipment.

The test finger is likewise applied to all openings in the enclosure, including holes. In these cases, the accessible parts of the enclosure are considered to include any part of the test finger, which can be inserted into the hole or terminal (see Figure 1).



Key

A Inside of the equipment

B Outside of the equipment

C Hazardous live part

D Tip of test finger is considered to be accessible

E Test finger

Figure 1 – Measurements through openings in enclosures

6.2.3 Openings above parts that are hazardous live

NOTE 1 This subclause reproduces IEC 61010-1:2010, 6.2.3.

A metal test pin 100 mm long and 4 mm in diameter rod is inserted into any openings above parts which are hazardous live. The test pin is suspended freely and allowed to penetrate up to 100 mm.

The additional safety measures of 6.5.1 for protection in single fault condition are not required solely because a part is accessible only by this test.

NOTE 2 This exception is permitted because the insertion of an object similar to this test pin is considered to be a single fault condition and one means of protection is sufficient.

This test is not applied to terminals.

6.2.4 Openings for pre-set controls

NOTE This subclause is based on IEC 61010-1:2010, 6.2.4.

A metal test rod of 100 mm long and 3 mm in diameter is inserted through holes intended to give access to pre-set controls which require the use of a screwdriver or other tool, or to openings for payment meter physical token acceptors. The test pin is applied in every possible direction through the hole. Penetration shall not exceed three times the distance from the enclosure surface to the surface of the control or 100 mm, whichever is smaller.

6.2.5 Wiring terminals

NOTE This subclause is based on IEC 60255-27:2013, 5.1.5.2.6.

Wiring terminals covered by a terminal cover, or in a restricted access area and that cannot be touched in normal use shall be deemed non-accessible.

Circuits intended to be connected to an external accessible circuit shall be considered as accessible conductive parts.

Example: Communication circuits.

6.3 Limit values for accessible parts

6.3.1 General

NOTE This subclause is based on IEC 60255-27:2013, 5.1.5.3.1.

Voltage between an accessible part and earth or between any two accessible parts on the same piece of equipment (over a surface or through air), touch current and discharge energy shall not exceed the values of 6.3.2 in normal condition nor of 6.3.3 in single fault condition.

6.3.2 Levels in normal condition

NOTE This subclause reproduces IEC 61010-1:2010, 6.3.1.

Voltages above the levels of a) are deemed to be hazardous live if any of the levels of b) or c) are exceeded at the same time.

a) the a.c. voltage levels are 33 V r.m.s., 46,7 V peak and the d.c. voltage level is 70 V. For equipment intended for use in wet locations, the a.c. voltage levels are 16 V r.m.s., 22,6 V peak and the d.c. voltage level is 35 V.
b) the current levels are:
   1) 0,5 mA r.m.s. for sinusoidal waveforms, 0,7 mA peak for non-sinusoidal waveform or mixed frequencies, or 2 mA d.c., when measured with the measuring circuit of Figure A.1. If the frequency does not exceed 100 Hz, the measuring circuit of Figure A.2 can be used. The measuring circuit of Figure A.4 is used for equipment intended for use in wet locations.
   2) 70 mA r.m.s. when measured with the measuring circuit of Figure A.3. This relates to possible burns at higher frequencies.
c) the levels of capacitive charge or energy are:
   1) 45 μC charge for voltages up to 15 000 V peak or d.c. Line A of Figure 3 shows the capacitance versus voltage where the charge is 45 μC.
   2) 350 mJ stored energy for voltages above 15 000 V peak or d.c.

6.3.3 Levels in single fault condition

NOTE This subclause reproduces IEC 61010-1:2010, 6.3.2.

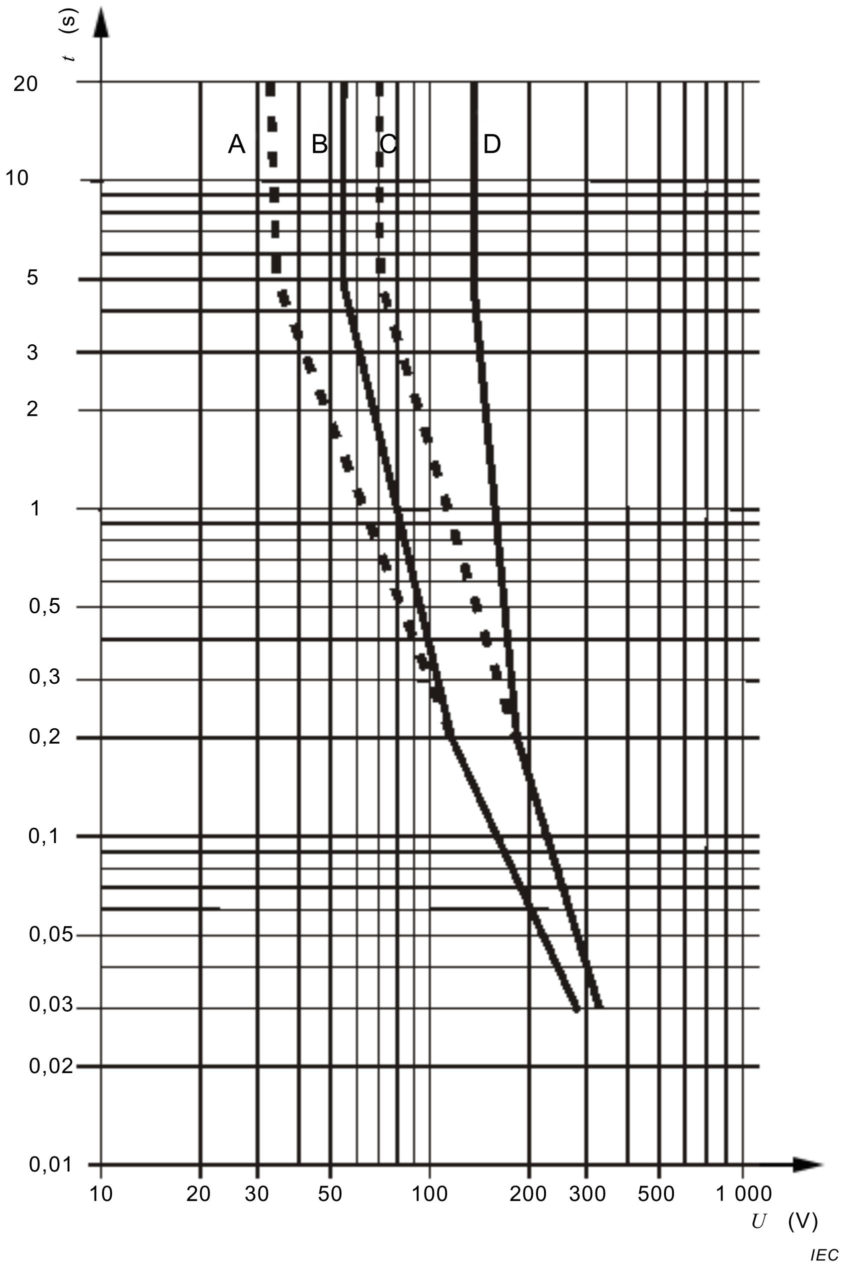
Voltages above the limits of a) are deemed to be hazardous live if any of the values of b) or c) are exceeded at the same time.

a) the a.c. voltage levels are 55 V r.m.s., 78 V peak and the d.c. voltage level is 140 V d.c. For equipment intended for use in wet locations, the a.c. voltage levels are 33 V r.m.s., 46,7 V peak and the d.c. voltage level is 70 V. For voltages of short duration, the duration versus voltage levels are those of Figure 2, measured across a 50 kΩ resistor;
b) the current levels are:
   1) 3,5 mA r.m.s. for sinusoidal waveforms, 5 mA peak for non-sinusoidal waveforms or mixed frequencies, or 15 mA d.c., when measured with the measuring circuit of

Figure A.1. If the frequency does not exceed 100 Hz, the measuring circuit of Figure A.2 can be used. The measuring circuit of Figure A.4 is used for equipment intended for use in wet locations;

2) 500 mA r.m.s. when measured with the measuring circuit of Figure A.3. This relates to possible burns at higher frequencies.

c) the capacitance level is line B of Figure 3.



Key

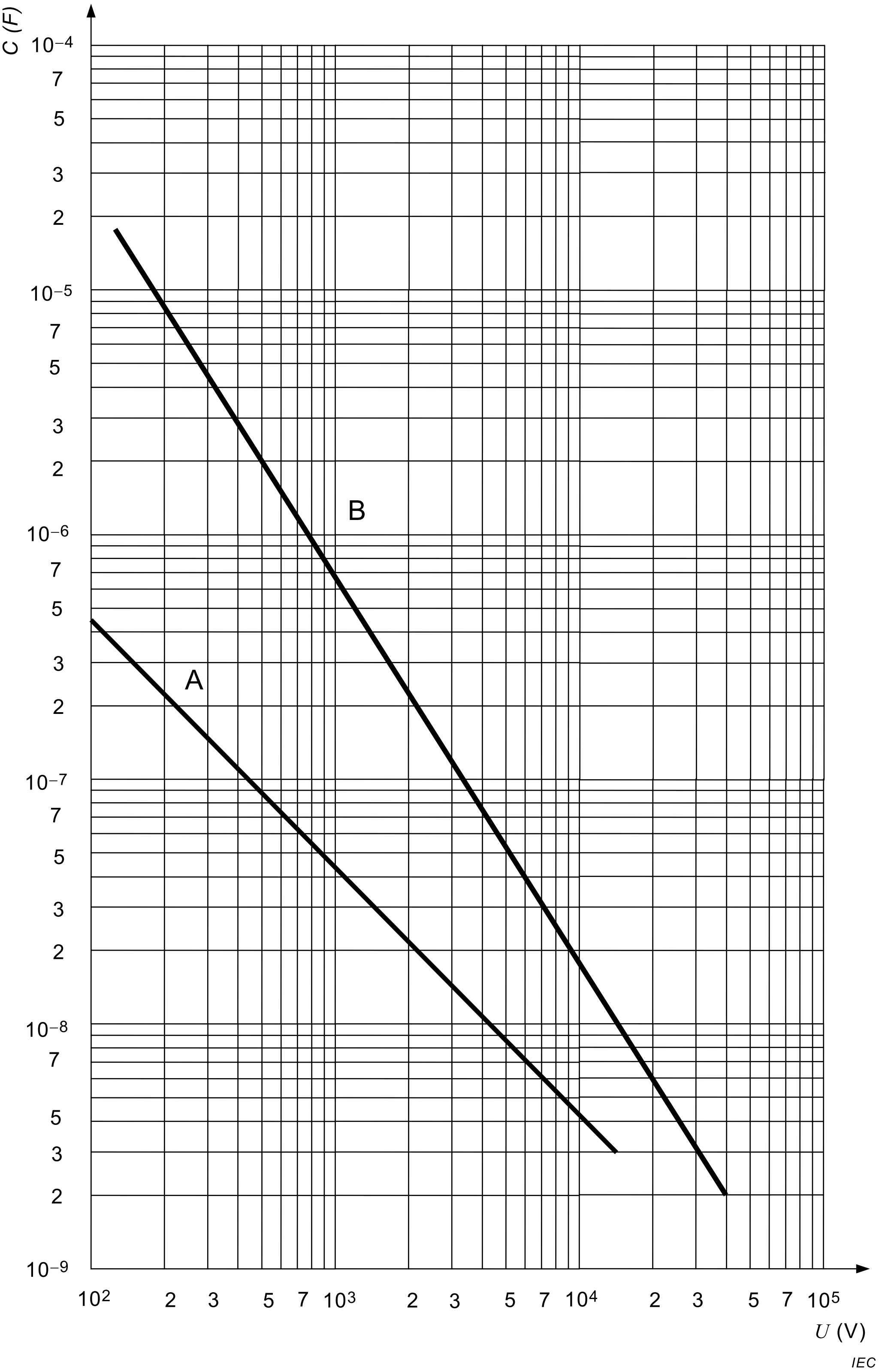
A a.c. voltage level in wet locations

B a.c. voltage level in dry locations

C d.c. voltage level in wet locations

D d.c. voltage level in dry locations

Figure 2 – Maximum duration of short-term accessible voltages in single fault condition (see 6.3.3 a))



Key

A Normal condition

B Single fault condition

V Voltage

C Capacitance

Figure 3 – Capacitance level versus voltage in normal condition and single fault condition (see 6.3.2 c) and 6.3.3 c))

6.4 Primary means of protection (protection against direct contact)

6.4.1 General

NOTE 1 Subclause 6.4 is based on IEC 61010-1:2010, 6.4 (Primary means of protection) and on IEC 60255-27:2013, 5.1.2.

NOTE 2 The following reproduces IEC 61010-1:2010, 6.4.1, except that the term “case” is used instead of enclosures and protective barriers.

Accessible parts shall be prevented from becoming hazardous live by one or more of the following means:

a) the equipment case, see 6.4.2;

b) basic insulation, see 6.4.3; or

c) impedance, see 6.4.4.

Conformity is checked by inspection and as specified in 6.4.2 to 6.4.4.

6.4.2 Equipment case

NOTE This subclause is based on IEC 62052-11:2003, and IEC 61010-1:2010, 6.4.2.

The case of metering equipment shall prevent access to hazardous live parts, such that they are not accessible in normal use. For constructional requirements, see 6.9.4.

If the case provides protection by insulation, then it shall meet the requirements of at least basic insulation.

If enclosures or protective barriers provide protection by limiting access, clearances and creepage distances between accessible parts and hazardous live parts shall meet the requirements of 6.7 and the applicable requirements for basic insulation.

Conformity is checked as specified in 6.7 and 8.2.

6.4.3 Basic insulation

NOTE This subclause reproduces IEC 61010-1:2010, 6.4.3.

Clearances, creepage distances and solid insulation forming basic insulation between accessible parts and hazardous live parts shall meet the requirements of 6.7.

Conformity is checked as specified in 6.7.

6.4.4 Impedance

NOTE This subclause reproduces IEC 61010-1:2010, 6.4.4.

An impedance used for basic protection shall meet all the following requirements:

a) it shall limit the current or voltage to not more than the applicable level of 6.3.3;

b) it shall be rated for the maximum working voltage and for the amount of power that it will dissipate;

c) clearance and creepage distance between terminations of impedances shall meet the applicable requirements of 6.7 for basic insulation.

Conformity is checked by inspection, by measuring the voltage or current to confirm that they do not exceed the levels of 6.3.3 and by measuring clearance and creepage distance as specified in 6.7.

6.5 Additional means of protection in case of single fault conditions (protection against indirect contact)

6.5.1 General

NOTE 1 Fault protection generally corresponds to protection against indirect contact, mainly with regard to failure of basic insulation.

NOTE 2 This subclause reproduces – mutatis mutandis – IEC 61010-1:2010, 6.5.1.

Accessible parts shall be prevented from becoming hazardous live in single fault condition. The primary means of protection (see 6.4) shall be supplemented by one of a), b) c) or d). Alternatively one of the single means of protection e) or f) shall be used. See Figure 4.

a) protective bonding (see 6.5.2);
b) supplementary insulation (see 6.5.3);
c) automatic disconnection of the supply (see 6.5.5);
d) current- or voltage limiting device (see 6.5.6);
e) reinforced insulation (see 6.5.3);
f) protective impedance (see 6.5.4).

Conformity is checked as specified in 6.5.2 to 6.5.6.

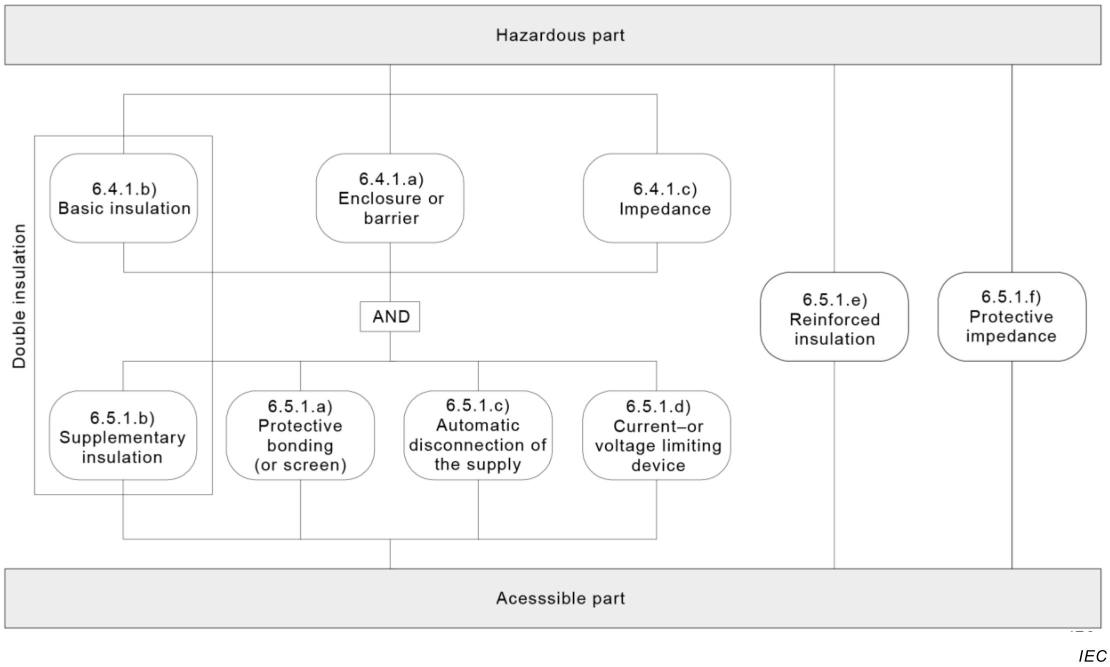


Figure 4 – Acceptable arrangements of protection means against electric shock

6.5.2 Protective bonding

6.5.2.1 General

NOTE This subclause is based on IEC 61010-1:2010, 6.5.2.1 and IEC 60255-27:2013, 5.1.6.2.

Accessible conductive parts shall be bonded to the protective conductor terminal if they could become hazardous live in case of a single fault of the primary means of protection specified in 6.4. Alternatively, accessible conductive parts shall be separated from parts, which are hazardous live, by a conductive protective screen bonded to the protective conductor terminal.

Unearthed accessible conductive parts such as nameplates, screws, suspensions and rivets need not be bonded to the protective conductor terminal if they are separated from all hazardous live parts by double insulation or reinforced insulation.

Conformity is checked as specified in 6.5.2.2 to 6.5.2.5.

6.5.2.2 Integrity of protective bonding

NOTE 1 This subclause reproduces IEC 61010-1:2010, 6.5.2.2.

The integrity of protective bonding shall be assured as specified below:

a) protective bonding shall consist of directly connected structural parts or discrete conductors, or both. It shall withstand all thermal and dynamic stresses to which it could be subjected before the over-current protective means specified in 0 disconnects the equipment from the supply;
b) soldered connections subject to mechanical stress shall be mechanically secured independently from the soldering. Such connections shall not be used for other purposes such as fixing constructional parts;
c) screw connections shall be secured against loosening;
d) if a part of the equipment is removable, the protective bonding for the remainder of the equipment shall not be interrupted (except for a part that also carries the mains input connection to the whole equipment);
e) unless they are specifically designed for electrical inter-connection and meet the requirements of 6.5.2.4, movable conductive connections, for example, hinges, slides, etc., shall not be the sole protective bonding path;
f) the exterior metal braid of cables shall not be regarded as protective bonding, even if connected to the protective conductor terminal;
g) if power from the mains supply is passed through metering equipment of protective class I for use by other equipment, means shall also be provided for passing the protective conductor through the metering equipment to protect the other equipment. The impedance of the protective conductor path through the equipment shall not exceed the values specified in 6.5.2.4.

   However, if metering equipment is of protective class II, then any – auxiliary – equipment powered through this equipment shall be also of protective class II.

   NOTE 2 Item g) concerns only auxiliary equipment to the metering equipment.
h) protective conductors may be bare or insulated. Insulation shall be green-and-yellow, except in the following cases:
   1) for earthing braids, either green-and-yellow or colourless-transparent;
   2) for internal protective conductors, and other conductors connected to the protective conductor terminal in assemblies such as ribbon cables, busbars, flexible printed wiring, etc., any colour may be used provided that no hazard is likely to arise from non-identification of the protective conductor.

Equipment using protective bonding shall be provided with a terminal that is suitable for connection to a protective conductor and meets the requirements of 6.5.2.3.

Conformity is checked by inspection.

6.5.2.3 Protective conductor terminal

NOTE 1 This subclause is based on IEC 61010-1:2010, 6.5.2.3 adapted for metering.

The protective conductor terminal shall meet the following requirements:

a) the contact surfaces shall be metal. Materials of protective bonding systems shall be chosen to minimize electro-chemical corrosion between the terminal and the protective conductor, or any other metal in contact with them;

b) the protective conductor terminal should, if possible, form part of the meter base;

c) the protective conductor terminal should preferably be located adjacent to the terminal block intended for connecting the mains-circuits;

d) in the case of direct connected meters, the current carrying capacity of the protective conductor terminal shall be at least equivalent to the maximum current specified;

e) in the case of transformer connected meters, the current carrying capacity of the protective conductor terminal shall be at least equivalent to 2 times the maximum current specified, or the current carrying capacity of the mains voltage terminals, whichever is larger;

f) in the case of stand-alone time switches and ripple control receivers, the current carrying capacity of the protective conductor terminal shall be at least equivalent to the maximum total current specified;

g) plug-in type protective conductor terminals combined with other terminals and intended to be connected and disconnected without the use of a tool, shall be designed so that the protective conductor connection makes first and breaks last with respect to the other connections;

h) after installation, it shall not be possible to loosen the protective earth terminal without the use of a tool;

i) if the protective conductor terminal is also used for other bonding purposes, the protective conductor shall be applied first and secured independently of other connections. The protective conductor shall be connected in such a way that it is unlikely to be removed during servicing that does not require disconnection of the protective conductor;

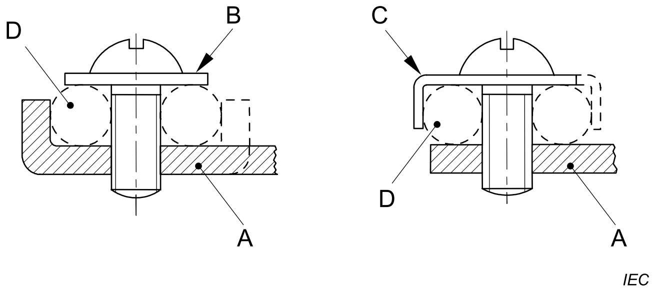
j) it shall be clearly identified by the graphical symbol 6 of Table 3;

k) functional earth terminals (for example, measuring earth terminals) shall allow a connection which is independent from the connection of the protective conductor;

   Equipment may be equipped with functional earth terminals, irrespective of the protective means taken.

l) if the protective conductor terminal is a binding screw assembly (see Figure 5), it shall be of a suitable size for the bond wire, but with a thread size no smaller than 4,0 mm, with at least three turns of the screw engaged;

m) the contact pressure required for a bonding connection shall not be capable of being reduced by deformation of materials forming part of the connection.



Key:

A fixed part

B washer or clamping plate

C anti-spread device

D conductor space

Figure 5 – Examples of binding screw assemblies

Conformity is checked by inspection. Conformity for l) is also checked by the following test:

The binding screw assembly is to be tightened and loosened three times, together with the least favourable conductor to be secured, using the tightening torques specified in Table 4. All parts of the binding screw assembly shall withstand this test without mechanical failure.

Table 4 – Tightening torque for binding screw assemblies

Thread size, mm	4,0	5,0	6,0	8,0	10,0
Tightening torque, Nm	1,2	2,0	3,0	6,0	10,0

6.5.2.4 Impedance of protective bonding of permanently connected equipment

NOTE 1 The following text is based on IEC 61010-1:2010, 6.5.2.5 adapted for metering.

NOTE 2 Metering equipment within the scope of this standard are always permanently connected.

Protective bonding of permanently connected equipment shall be of low impedance.

Conformity is checked by applying a test current for 1 min between the protective conductor terminal and each accessible conductive part for which protective bonding is required. The voltage between them shall not exceed 10 V a.c. r.m.s. or d.c.

a) *in the case of direct connected meters, the test current shall be equal to twice the maximum current of the meter. However, if the equipment*
   - *contains overcurrent protection devices for all hazardous live terminals (except the neutral) or is specified by the manufacturer to be installed with external overcurrent protection devices for all hazardous live terminals (except the neutral);*
   - *and the wiring on the supply side of the overcurrent protection devices cannot become connected to accessible conductive parts in case of a single fault,*

   the test current need not be more than twice the highest rated current of the overcurrent protection devices.
b) *in the case of current transformer or voltage and current transformer operated meters, the test current shall be the greater of:*
   - *the value equal to twice the nominal current of the overcurrent protection in the voltage circuit(s) or other hazardous live circuits as recommended by the manufacturer; or*
   - *25 A;*
c) *in the case of tariff and load control the test current shall be equal to twice the total current.*

6.5.2.5 Transformer protective bonding screen

NOTE 1 This subclause is based on IEC 61010-1:2010, 6.5.2.6.

If a transformer is fitted with a screen for protective bonding purposes that is separated only by basic insulation from a winding that is connected to a hazardous live circuit, the screen shall satisfy the requirements of 6.5.2.2 a) and b), and be of low impedance.

Conformity is checked by inspection and the following tests:

- *a test current specified in 6.5.2.4 is applied for 1 min between the screen and the protective conductor terminal. The voltage between them shall not exceed 10 V a.c. r.m.s. or d.c.*

NOTE 2 A specially prepared sample transformer having an extra lead-out wire from the free end of the screen is used to ensure that the current during the test passes through the screen.

6.5.3 Supplementary insulation and reinforced insulation

NOTE This subclause reproduces IEC 61010-1:2010, 6.5.3.

Clearances, creepage distances and solid insulation forming supplementary insulation or reinforced insulation shall meet the applicable requirements of 6.7.

Conformity is checked as specified in 6.7.

6.5.4 Protective impedance

NOTE This subclause reproduces IEC 61010-1:2010, 6.5.4.

A protective impedance shall limit the current or voltage to the levels of 6.3.2 in normal condition and 6.3.3 in single fault condition.

Insulation between the terminations of the protective impedance shall meet the requirements of 6.7 for double insulation or reinforced insulation.

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

a) an appropriate single component which shall be constructed selected and tested so that safety and reliability for protection against electric shock is assured. In particular, the component shall be:
   1) rated for twice the maximum working voltage;
   2) if a resistor, rated for twice the power dissipation for the maximum working voltage.
b) a combination of components.

A protective impedance shall not be a single electronic device that employs electron conduction in a vacuum, gas or semiconductor.

Conformity is checked by inspection, by measuring the current or voltage to confirm that they do not exceed the applicable levels of 6.3 and by measuring clearance and creepage distance as specified in 6.7. Conformity of a single component is additionally checked by inspection of its ratings.

6.5.5 Automatic disconnection of the supply

NOTE 1 This subclause is based on IEC 61010-1:2010, 6.5.5.

NOTE 2 Automatic disconnection discussed in this subclause concerns any automatic device built in the equipment to clear faults. Such devices are generally not used in metering equipment.

NOTE 3 They are not be confused with the supply control switches that may be controlled locally or remotely to support applications like connection / disconnection of the supply, load limitation, payment metering, etc. Such supply control switches generally do not provide overcurrent protection; if they have such function, then that function is outside the scope of this standard.

An automatic disconnection device shall meet both the following requirements:

a) it shall be rated to disconnect the load within the time specified in Figure 2;
b) it shall be rated for the maximum rated load conditions of the equipment.

Conformity is checked by inspection of the device specification. In case of doubt, the device is tested to check that it disconnects the supply within the required time.

6.5.6 Current- or voltage-limiting device

NOTE This subclause reproduces IEC 61010-1:2010, 6.5.6.

If a current- or voltage-limiting device is used for protection in single fault condition, it shall meet all the following requirements:

a) it shall be rated to limit the current or voltage as specified in 6.3.3;

b) it shall be rated for the maximum working voltage and, if applicable, for the maximum operational current;

c) clearance and creepage distance between the terminations of the current or voltage limiting device shall meet the applicable requirement of 6.7 for supplementary insulation.

Conformity is checked by inspection, by measuring the voltage or current to confirm that they do not exceed the levels of 6.3.3, and by measuring clearance and creepage distance as specified in 6.7.

6.6 Connection to external circuits

6.6.1 General

NOTE 1 Subclause 6.6 is based on IEC 61010-1:2010, 6.6.

In normal condition and in single fault condition, no accessible parts of the equipment and no accessible parts of an external circuit shall become hazardous live as a result of connecting the external circuit to the equipment.

NOTE 2 External circuits are all circuits connected to terminals of the equipment.

The supply and load side terminals of the meter and their external circuits are not considered to be accessible parts. Likewise, the terminals of the load switches and their external circuits are not considered to be accessible parts.

Protection shall be achieved by separation of circuits, unless short-circuiting of the separation could not cause a hazard.

As specified in 5.4.4, the manufacturer's instructions or equipment markings shall include the following information, if applicable, for each external terminal:

a) 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.);

b) 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.

NOTE 3 The type and rating of external circuits connected to the meter are generally under local regulations.

Conformity is checked by:

1) *inspection;*

2) *the determinations of 6.2;*

3) *the measurements of 6.3 and 6.7;*

4) *the dielectric tests of 6.10.4 (without humidity preconditioning) applicable to the type of insulation (see 6.7).*

6.6.2 Terminals for external circuits

NOTE This subclause is based on IEC 61010-1:2010, 6.6.2.

Conductive parts of terminals that are accessible to the user and that receive a charge from an internal capacitor shall not be hazardous live 10 s after removing power from the metering equipment.

Conformity is checked by inspection, and by the determination of accessible conductive parts as specified in 6.2 and in case of doubt by measurement of the remaining voltage or charge.

6.6.3 Terminals for stranded conductors

See 6.9.7.

6.7 Insulation requirements

6.7.1 General – Electrical stresses, overvoltages and overvoltage categories

6.7.1.1 Electric stresses originating from mains

NOTE 1 This subclause is based on IEC 61010-1:2010, 6.7.1.1 and IEC 60364-4-44:2007, adapted to metering.

Electric stresses originating from mains include:

a) working voltage across the insulation. This working voltage is normally the line-to-neutral voltage of the mains supply. In the case of polyphase metering equipment some insulations will be stressed by the line-to-line voltage;

   NOTE 2 An example for the latter is the terminal block of polyphase meters, where line-to-line voltage is present between terminals of the different phases.

b) transient overvoltages that may occasionally appear on the line conductors. The magnitude of the overvoltages depends on the overvoltage category and the line-to-neutral voltage of the mains supply;

c) temporary power frequency overvoltages.

6.7.1.2 Protection against overvoltages of atmospheric origin or due to switching

NOTE This subclause is based on IEC 60364-4-44:2007, 443.1.

Metering equipment shall be protected against transient overvoltages of atmospheric origin transmitted by the supply distribution system and against switching overvoltages.

In general, switching overvoltages are lower than overvoltages of atmospheric origin and therefore the requirements regarding protection against overvoltages of atmospheric origin normally cover protection against switching overvoltages.

6.7.1.3 Classification of impulse withstand voltages (overvoltage categories)

The impulse withstand voltage (overvoltage category, OVC) is used to classify equipment energized directly from the mains.

IEC 60364-4-44:2007, 443.2.2 specifies overvoltage categories I to IV.

For metering equipment, overvoltage category III is taken as a basis for determining clearances. See also 1.4 and Annex K.

NOTE According to IEC 60664-1:2007, 4.3.3.2.2, equipment of overvoltage category III is equipment in fixed installations and for cases where the reliability and the availability of the equipment are subject to special requirements.

6.7.2 The nature of insulation

6.7.2.1 General

NOTE Subclause 6.7.2 is based on IEC 61010-1:2010, 6.7.1.1.

Insulation between circuits and accessible parts (see 6.2) or between separate circuits consists of a combination of clearances, creepage distances and solid insulation. When used to provide protection against a hazard, the insulation needs to withstand the electric stresses that are caused by the voltages that may appear on the mains or in the equipment.

The requirements for insulation depend on:

a) the required level of insulation (basic insulation, supplementary insulation, or reinforced insulation);
b) the maximum transient overvoltage that may appear 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;
c) the maximum working voltage (including steady-state and recurring peak voltages);
d) the pollution degree of the micro-environment;
e) the maximum temporary overvoltage that may occur in a mains-circuit because of a fault in the mains distribution system. See also 6.10.3.2.

6.7.2.2 Clearances

NOTE This subclause reproduces IEC 61010-1:2010, 6.7.1.2, except that for the measurement of clearances the text refers to IEC 60664-1:2007 ,6.2.

Required clearances depend on the factors in 6.7.1.1 a) to c) as well as the rated altitude. If the equipment is rated to operate at an altitude greater than 2 000 m, then the clearances specified in the Tables referenced from the overview Table 6 shall be multiplied by the factors of Table 5.

Table 5 – Multiplication factors for clearance for altitudes up to 5 000 m

Rated operating altitude m	**Multiplication factor**
Up to 2 000	1,00
2 001 to 3 000	1,14
3 001 to 4 000	1,29
4 001 to 5 000	1,48
NOTE 1 The values are taken from IEC 61010-1:2010, Table 3. See also IEC 60664-1:2007, Table A.2. NOTE 2 See also 6.10.2.7, Table 24.	

For measurement of clearances, see IEC 60664-1:2007 ,6.2.

6.7.2.3 Creepage distances

NOTE This subclause reproduces IEC 61010-1:2010, 6.7.1.3, except that for the measurement of creepage distances it refers to IEC 60664-1:2007, 6.2.

Required creepage distances depend on the factors in 6.7.1.1 a) to c) as well the Comparative Tracking Index (CTI) of the insulating material.

Materials are separated into four groups according to their CTI values, as follows:

- material group I: 600 ≤ CTI;
- material group II: 400 ≤ CTI < 600;
- material group IIIa: 175 ≤ CTI < 400;
- material group IIIb: 100 ≤ CTI < 175.

These CTI values refer to values obtained, in accordance with IEC 60112, on samples of the relevant material specifically made for the purpose and tested with solution A. For materials where the CTI value is not known, material group IIIb is assumed.

For glass, ceramics, or other inorganic insulating materials which do not track, there are no requirements for creepage distances.

For measurement of creepage distances, see IEC 60664-1:2007, 6.2.

6.7.2.4 Solid insulation

NOTE This subclause reproduces IEC 61010-1:2010, 6.7.1.4.

The requirements for solid insulation depend on factors in 6.7.1.1 a) to c).

The term "solid insulation" is used to describe many different types of constructions, including monolithic blocks of insulating material, and insulation subsystems composed of multiple insulating materials, organized in layers or otherwise.

The electric strength of a thickness of solid insulation is considerably greater than that of the same thickness of air. The insulating distances through solid insulation are therefore typically smaller than the distances through air. As a result, electric fields in solid insulation are typically higher, and often are less homogeneous.

Solid insulation material may contain gaps or voids. When a solid insulation system is constructed from layers of solid materials, there are also likely to be gaps or voids between the layers. These voids will perturb the electric field so that a disproportionately large part of the electric field is located in the void, potentially causing ionisation within the void, resulting in partial discharge. These partial discharges will influence the adjacent solid insulation and may reduce its service life.

Solid insulation is not a renewable medium: damage is cumulative over the life of the equipment. Solid insulation is also subject to ageing and to degradation from repeated high voltage testing.

6.7.2.5 Requirements for insulation according to type of circuit

NOTE This subclause is based on IEC 61010-1:2010, 6.7.1.5 and Annex K.

Requirements for insulation in particular circuits are specified as follows:

a) in 0 for mains-circuits;
b) in 6.7.4 for non-mains-circuits;
c) in 6.7.5 for circuits that have one or more of the following characteristics:
   1) the maximum possible transient overvoltage is limited by the supply source or within the equipment (see 6.7.6) to a known level below the level assumed for the mains circuit;
   2) the maximum possible transient overvoltage is above the level assumed for the mains circuit;
   3) the working voltage is the sum of voltages from more than one circuit, or is a mixed voltage;

4) the working voltage includes a recurring peak voltage that may include a periodic non-sinusoidal waveform or a non-periodic waveform that occurs with some regularity

5) the working voltage has a frequency above 30 kHz.

Table 6 provides an overview of the clauses specifying the requirements and the tests for insulations. Where no voltage test is specified, conformity is verified by inspection and / or measurement of mechanical dimensions.

Table 6 – Overview of clauses specifying requirements and tests for insulations

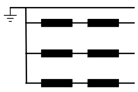
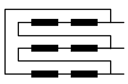
Type of insulation	Requirements		Test clauses			
	Clause	Table / Figure	Impulse voltage	5 s a.c. voltage	1 min a.c. voltage	1 min d.c. voltage
Mains circuits						
Clearance	6.7.3.1 0	Table 7 Table 8	6.10.4.4.2.1	6.10.4.4.2.2 (3 cycles)	–	6.10.4.4.2.3 (2 x3 x10 ms)
Creepage	6.7.3.3	Table 9	–	–	–	–
Solid insulation	6.7.3.4.1	Table 10 Table 11	6.10.4.4.4.2	6.10.4.4.4.3 a)	6.10.4.4.4.4 a)	–
Moulded and potted parts	6.7.3.4.2	Figure 6 Table 12	–	–	–	–
PWBs inner insulating layers	6.7.3.4.3	Figure 7 Table 10 Table 12	–	–	–	–
Thin film insulation	6.7.3.4.4	Figure 8 Table 8 Table 9 Table 10 Table 12	–	–	6.10.4.4.4.4 b)	–
Non-mains circuits						
Clearance	6.7.4.2	Table 13	–	6.10.4.4.3	–	6.10.4.4.3
Creepage	6.7.4.3	Table 14	–	–	–	–
Solid insulation	6.7.4.4.1	Table 13	–	6.10.4.4.4.3 b)	6.10.4.4.4.4 c)	–
Moulded and potted parts	6.7.4.4.2	Figure 6 Table 15	–	–	–	–
PWBs inner insulating layers	0	Figure 7 Table 13 Table 15	–	–	–	–
Thin film insulation	6.7.4.4.4	Figure 8 Table 13 Table 14 Table 15	–	–	6.10.4.4.4.4 d)	6.10.4.4.4.5
Circuits with special overvoltages						
Clearance	6.7.5.2	Table 16 Table 17	6.10.4.4.5	6.10.4.4.5	–	–
Creepage	0 (6.7.4.3)	Table 14	–	–	–	–
Solid insulation	6.7.5.5	Table 17	–	–	–	–
Circuits with recurring peak voltage						
Clearance	6.7.5.3	Table 18	–	–	–	–
Creepage	0 (6.7.4.3)	Table 14	–	–	–	–
Solid insulation	6.7.5.5 (6.7.4.4)	Table 17	–	–	–	–
Circuits above 30 kHz						
Clearance	6.7.5.3	Table 18	–	–	–	–
Creepage	0 (6.7.4.3)	Table 14	–	–	–	–
Solid insulation	6.7.5.5 (6.7.4.4)	Table 17	–	–	–	–

6.7.3 Insulation requirements for mains-circuits

6.7.3.1 Nominal voltages and rated impulse voltages

The rated impulse voltage of the equipment shall be selected from Table 7 corresponding to the nominal/rated voltage of the equipment and the required level of insulation.

Table 7 – Nominal / rated voltages and rated impulse voltages

Nominal voltage of the supply system, V [a]				Voltage line to neutral derived from nominal voltages [c]	Rationalized voltage [d]	Rated impulse voltage, V [b]	
Three-phase four-wire with earthed neutral	Three-phase three-wire not earthed	Single-phase two-wire	Single-phase three-wire			Basic and supple-mentary insulation	Reinforced insulation
							
57,7/100 63,5/110 66,5/115 69/120	66,5			100	100	1 500	2 500
120/208 127/220	115, 120 127	100 110, 120, 127	100-200 120-240	150	160	2 500	4 000
220/380 230/400 240/415 277/480	200, 220, 230, 240 260, 277, 347, 380, 400, 415, 440, 480	230 240	220-440 230-460	300	320	4 000	6 000
347/600 380/660 400/690	500, 577, 600	480	480-960	600	630	6 000	8 000

[a] In some countries, other values may be in use.

[b] Insulation coordination uses a preferred series of values of rated impulse voltage: 330 V, 500 V, 800 V, 1 500 V, 2 500 V, 4 000 V, 6 000 V, 8 000 V, 12 000 V. The values specified in this table correspond to overvoltage category III. For reinforced insulation, the values are one step higher in the preferred series than what is specified for basic insulation. See IEC 60664-1:2007, 5.1.6.

[c] For determining clearances and solid insulation in mains circuits. See IEC 60664-1:2007, Table B.1 and Table F.1.

[d] For determining creepage distances for basic and supplementary insulation in mains circuits. See IEC 60664-1:2007, Clauses F.3a, F.3b and F.4.

Example: For a three-phase four-wire meter with rated voltage of 230/400 V the voltage line-to-neutral derived from nominal voltages is 300 V. The rated impulse voltage for testing clearances for basic insulation is 4 000 V and for reinforced insulation 6 000 V.

The rationalized voltage for insulation line-to-line for all systems used to determine creepage distances for basic and supplementary insulation is 320 V.

6.7.3.2 Clearances for mains-circuits

Clearances for mains-circuits shall meet the values of Table 8. If the equipment is rated to operate at an altitude greater than 2 000 m, the clearance shall be multiplied by the factors of Table 5.

Table 8 – Clearances for mains-circuits

Rated impulse voltage (from Table 7)		**Minimum clearances in air up to 2 000 m above sea level**		
		Pollution degree		
Basic and supplementary insulation	**Reinforced insulation**	**1**	**2 (indoor meter)**	**3 (outdoor meter)**
V		mm		
1 500	–	0,5	0,5	0,8
2 500	2 500	1,5	1,5	1,5
4 000	4 000	3,0	3,0	3,0
6 000	6 000	5,5	5,5	5,5
–	8 000	8,0	8,0	8,0
NOTE 1 The values have been taken from IEC 60664-1:2007, Table F.2, for Case A, inhomogeneous field. NOTE 2 For indoor meters pollution degree 2, for outdoor meters pollution degree 3 has been assumed. NOTE 3 Pollution degree 1 applies if pollution is reduced by coating, potting or moulding. For more information, see IEC 60664-3:2003.				
The purchaser may specify higher rated impulse voltage then the value specified in Table 7. In this case, the values specified should be used. For rated impulse voltages above 8 000 V the required clearances can be found in IEC 60664-1:2007, Table F.2.				

Conformity is checked by inspection, measurement and the test specified in 6.10.4.4.2.

6.7.3.3 Creepage distances for mains-circuits

Creepage distances for mains-circuits for basic insulation and supplementary insulation shall meet the values of Table 9.

Creepage distances of double insulation are the sum of the values of the basic insulation and supplementary insulation, which compose the double insulation system. Creepage distances for reinforced insulation shall be twice those determined for basic insulation from Table 9.

Table 9 – Creepage distances for mains-circuits

Rationalized voltage r.m.s. (from Table 7)	Values for creepage distance							
	Printed wiring board material		Other insulating material					
	Pollution degree							
	1	2	2 (indoor meter)			3 (outdoor meter)		
	Material groups							
	All	I, II or IIIa	I	II	III	I	II	III
V	mm	mm	mm	mm	mm	mm	mm	mm
100	0,10	0,16	0,71	1,0	1,4	1,8	2,0	2,2
160	0,25	0,4	0,8	1,1	1,6	2,0	2,2	2,5
320	0,75	1,6	1,6	2,2	3,2	4,0	4,5	5,0
630	1,8	3,2	3,2	4,5	6,3	8,0	9,0	10

NOTE 1 The values have been taken from IEC 60664-1:2007, Table F.4.

NOTE 2 Pollution degree 1 applies if pollution is reduced by coating, potting or moulding. For more information, see IEC 60664-3:2003.

NOTE The following paragraph is from IEC 60664-1:2007, 5.2.2.6.

In general, a creepage distance cannot be less than the associated clearance so that the shortest creepage distance possible is equal to the required clearance. However, there is no physical relationship, other than this dimensional limitation, between the minimum clearance in air and the minimum acceptable creepage distance.

Conformity is checked by inspection and measurement.

6.7.3.4 Solid insulation for mains-circuits

6.7.3.4.1 General

NOTE 1 Subclause 6.7.3.4 is based on IEC 61010-1:2010, Annex K.1.3.

Solid insulation of mains-circuits shall withstand the electrical and mechanical stresses that may occur in normal use, in all rated environmental conditions (see 1.4), during the intended life of the equipment.

The manufacturer should take the expected life of the equipment into account when selecting insulating materials.

The test voltages are specified for short terms stress in Table 10 and for long term stress in Table 11.

Conformity is checked by both of the following tests:

a) *the impulse voltage test specified in 6.10.4.4.4.2 or the 5 s a.c. voltage test specified in 6.10.4.4.4.3 a);*

b) *the 1 min a.c. voltage test specified in 6.10.4.4.4.4 a).*

NOTE 2 These two different voltage tests are required for these circuits for the following reasons. Test a) checks the effects of transient overvoltages, while test b) checks the effects of long-term stress of solid insulation.

Table 10 – Test voltages for solid insulation in mains-circuits

Voltage line-to-neutral derived from nominal voltages (from Table 7)	Test voltage			
	5 s a.c. voltage test V r.m.s.		Impulse test V peak	
	Basic insulation and supplementary insulation	Reinforced insulation	Basic insulation and supplementary insulation	Reinforced insulation
≤ 150	1 390	2 210	2 500	4 000
> 150 ≤ 300	2 210	3 510	4 000	6 400
> 300 ≤ 600	3 310	5 400	6 000	9 600
NOTE The values are taken form IEC 61010-1:2010, Table K.6.				

Table 11 – Test voltages for testing long-term stress of solid insulation in mains-circuits

Voltage line-to-neutral derived from nominal voltages (from Table 7)	Test voltage			
	1 min a.c. voltage test V r.m.s.		1 min d.c. voltage test V peak	
	Basic insulation and supplementary insulation	Reinforced insulation	Basic insulation and supplementary insulation	Reinforced insulation
≤ 150	1 350	2 700	1 900	3 800
> 150 ≤ 300	1 500	3 000	2 100	4 200
> 300 ≤ 600	1 800	3 600	2 550	5 100
NOTE The values are taken form IEC 61010-1:2010, Table K.8. The test voltages for basic and supplementary insulation are derived using the formula (1 200 V + line-to-neutral voltage) as specified in in IEC 60664-1:2007, 5.3.3.2.3.				

Solid insulation shall also meet the following requirements, as applicable:

1) for solid insulation used as an enclosure or barrier, the requirements of Clause 8, *Resistance to mechanical stresses*, and 10.5, *Resistance to heat*;
2) for moulded and potted parts, the requirements of 6.7.3.4.2;
3) for inner layers of printed wiring boards, the requirements of 6.7.3.4.3;
4) for thin-film insulation, the requirements of 6.7.3.4.4.

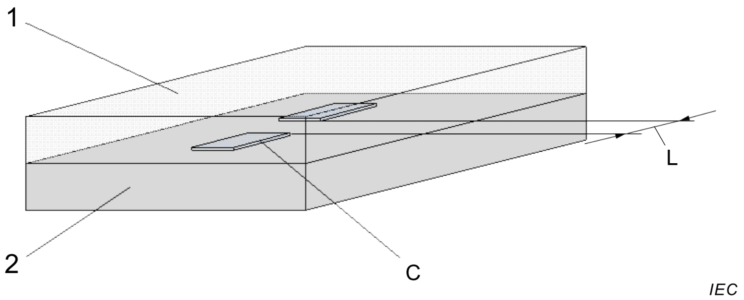
Conformity is checked as specified in 6.7.3.4.2 to 6.7.3.4.4, Clause 8 and subclause 10.5 as applicable.

6.7.3.4.2 Moulded and potted parts

NOTE This subclause reproduces IEC 61010-1:2010, Annex K.1.3.2.

For basic insulation, supplementary insulation and reinforced insulation, conductors located between the same two layers moulded together (see Figure 6, item L) shall be separated by at least the applicable minimum distance of Table 12 after the moulding is completed.

Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.



Key

1 Layer 1

2 Layer 2

C Conductor

L Distance between conductors

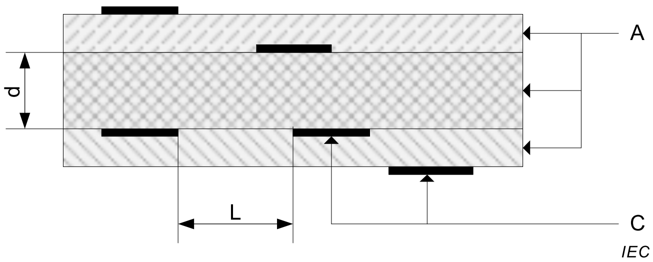
Figure 6 – Distance between conductors on an interface between two layers

6.7.3.4.3 Inner insulating layers of printed wiring boards (PWBs)

NOTE This subclause reproduces IEC 61010-1:2010, Annex K.1.3.3.

For basic insulation, supplementary insulation and reinforced insulation, conductors located between the same two layers (see Figure 7, item L) shall be separated by at least the applicable minimum distance of Table 12.

Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.



Key

L Distance between adjacent conductors

d Thickness of inner insulating layer

A Layers (For minimum thickness, see Table 12)

C Conductors

Figure 7 – Distance between adjacent conductors along an interface of an inner layer

Table 12 – Minimum values for distance or thickness of solid insulation

Voltage line-to-neutral derived from nominal voltages (from Table 7)	Minimum thickness d [a, b] (see Figure 7)	Minimum distance L [a, b] (see Figure 7)
V	mm	mm
≤ 300	0,4	0,75
> 300 ≤ 600	0,6	1,8

[a] These values are independent of the overvoltage category.

[b] These values apply for basic insulation, supplementary insulation and reinforced insulation.

NOTE The values for minimum thickness d are taken from IEC 61010-1:2010, Table K.9. The values for Minimum distance L are taken from Table 9, Printed wiring board material, Pollution degree 1.

Reinforced insulation of inner insulating layers of printed wiring boards shall also have adequate electric strength through the respective layers. One of the following methods shall be used:

a) the thickness through the insulation is at least the value of Table 12;

   Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.

b) the insulation is assembled from at least two separate layers of printed wiring board materials, each of which is rated by the manufacturer of the material for an electric strength of at least the value of the test voltage of Table 10 for basic insulation;

   Conformity is checked by inspection of the manufacturer's specifications.

c) the insulation is assembled from at least two separate layers of printed wiring board materials, and the combination of layers is rated by the manufacturer of the material for an electric strength of at least the value of Table 10 for reinforced insulation.

   Conformity is checked by inspection of the manufacturer's specifications.

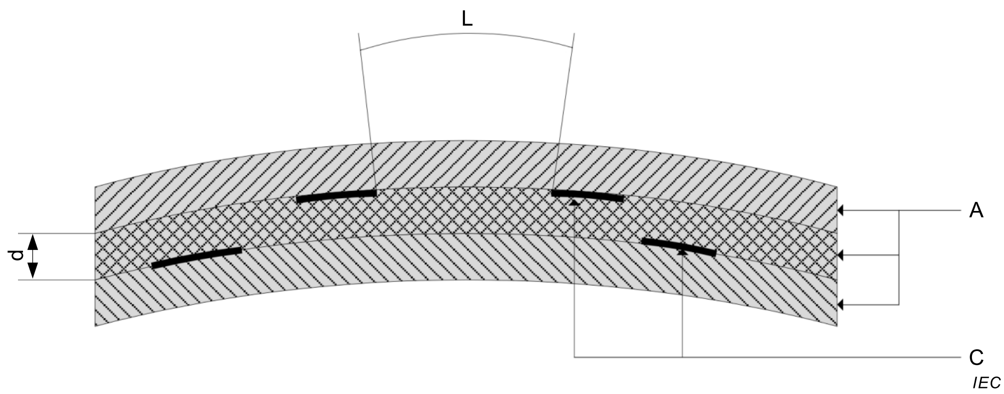
No minimum thickness is specified for basic or supplementary insulation between traces located on the opposite sides of the same layer of a printed wiring board. However, a layer of printed wiring board material used as basic or supplementary insulation shall be rated by the manufacturer of the material for an electric strength of at least the value of the test voltage of Table 7 for basic insulation.

6.7.3.4.4 Thin-film insulation

NOTE 1 This subclause reproduces IEC 61010-1:2010, Annex K.1.3.4.

For basic insulation, supplementary insulation and reinforced insulation, conductors located between the same two layers (see Figure 8, item L) shall be separated by at least the applicable clearance of 0, Table 8 and creepage distance of 6.7.3.3, Table 9.

Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.



Key

L Distance between adjacent conductors

d Thickness of inner insulating layer

A Layers of thin-film material such as tape and polyester film

C Conductors

NOTE There may be air present between the layers.

Figure 8 – Distance between adjacent conductors located between the same two layers

Reinforced insulation through the layers of thin-film insulation shall also have adequate electric strength. One of the following methods shall be used.

a) The thickness through the insulation is at least the value of Table 12;

Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.

b) The insulation consists of at least two separate layers of thin-film materials, each of which is rated by the manufacturer of the material for an electric strength of at least the value of the test voltages from Table 10 for basic insulation.

Conformity is checked by inspection of the manufacturer's specifications.

c) The insulation consists of at least three separate layers of thin-film materials, any two which have been tested to exhibit adequate electric strength of at least the value of the test voltages from Table 10 for reinforced insulation.

Conformity is checked by the a.c. voltage test of 6.10.4.4.4.4 b).

For the purposes of this test a special sample may be assembled with only two layers of the material.

6.7.4 Insulation requirements for non-mains-circuits

6.7.4.1 General

As defined in 3.5.8, non-mains circuits are circuits which are not energized directly from the mains but which are for example isolated by a transformer or supplied by a battery.

NOTE These circuits are assumed to be subjected to lower transient overvoltage levels than the mains-circuit.

6.7.4.2 Clearances for non-mains-circuits

NOTE This subclause is based on IEC 61010-1:2010, K.2.2.

Clearances for non-mains-circuits shall:

a) for basic insulation or supplementary insulation, meet the applicable values of Table 13 or for reinforced insulation meet twice that value; or

b) pass the voltage test of 6.10.4.4.3 using the applicable value of Table 13.

For the application of Table 13 the following applies:

1) values for test voltages for reinforced insulation are 1,6 times the values for basic insulation;
2) if the equipment is rated to operate at an altitude greater than 2 000 m, the values for clearances are multiplied by the applicable factor of Table 5;
3) minimum clearance is 0,2 mm for pollution degree 2 and 0,8 mm for pollution degree 3.

Conformity is checked by inspection and measurement and for b) by the 5 s a.c. voltage test or 1 min d.c. voltage test of 6.10.4.4.3.

Table 13 – Clearances and test voltages for non-mains-circuits derived from mains-circuits of overvoltage category III

Working voltage in non-mains circuit		**Mains voltage ≤ 150 V a.c. r.m.s.**		**Mains voltage 150 V ≤ 300 V a.c. r.m.s.**		**Mains voltage 300 V ≤ 600 V a.c. r.m.s.**	
a.c. r.m.s.	d.c. or a.c. peak	Clearance	Test voltage a.c. r.m.s.	Clearance	Test voltage a.c. r.m.s.	Clearance	Test voltage a.c. r.m.s.
V	V	mm	V	mm	V	mm	V
16	22,6	0,48	1 100	1,5	1 800	2,9	2 820
33	47,3	0,50	1 100	1,5	1 800	3,0	2 900
50	70	0,53	1 120	1,5	1 800	3,0	2 900
100	140	0,61	1 170	1,6	1 880	3,1	2 960
150	210	0,69	1 200	1,6	1 880	3,2	3 020
300	420	0,94	1 360	1,8	2 040	3,4	3 140
600	840	1,6	1 880	2,4	2 440	3,9	3 440
1 000	1 400	2,5	2 500	3,5	3 200	5,0	4 000
1 250	1 750	3,2	3 020	4,2	3 620	5,8	4 480
NOTE The values have been taken from IEC 61010-1:2010, Table K.11. For higher working voltages, see that table.							
Linear interpolation above 16 V is allowed.							

6.7.4.3 Creepage distances for non-mains-circuits

NOTE 1 This subclause is based on IEC 61010-1:2010, K.2.3.

Creepage distances for basic insulation or supplementary insulation for non-mains-circuits shall meet the applicable values of Table 14, based on the working voltage which stresses the insulation. Values for reinforced insulation are twice the values for basic insulation.

Where the non-mains-circuit is derived from the mains circuits, then the creepage distance shall not be less than the clearance as specified in Table 13.

Conformity is checked by inspection and measurement.

Coatings that meet the requirements of Annex H of IEC 61010-1:2010 when applied to the outer surfaces of printed wiring boards reduce the pollution degree of the coated area to pollution degree 1.

Table 14 – Creepage distances for non-mains-circuits

NOTE 2 This table can also be used to determine creepage distances for functional insulation.

Secondary working voltage a.c. r.m.s. or d.c.	Printed wiring board material		Other insulating material					
	Pollution degree							
	1	2	2 (Indoor meters)			3 (Outdoor meters)		
	Material groups							
	All	I, II or IIIa	I	II	III	I	II	III
V	mm	mm	mm	mm	mm	mm	mm	mm
10	0,025	0,04	0,40	0,40	0,40	1,00	1,00	1,00
12,5	0,025	0,04	0,42	0,42	0,42	1,05	1,05	1,05
16	0,025	0,04	0,45	0,45	0,45	1,10	1,10	1,10
20	0,025	0,04	0,48	0,48	0,48	1,20	1,20	1,20
25	0,025	0,04	0,50	0,50	0,50	1,25	1,25	1,25
32	0,025	0,04	0,53	0,53	0,53	1,3	1,3	1,3
40	0,025	0,04	0,56	0,80	1,10	1,4	1,6	1,8
50	0,025	0,04	0,60	0,85	1,20	1,5	1,7	1,9
63	0,040	0,063	0,63	0,90	1,25	1,6	1,8	2,0
80	0,063	0,10	0,67	0,95	1,3	1,7	1,9	2,1
100	0,10	0,16	0,71	1,00	1,4	1,8	2,0	2,2
125	0,16	0,25	0,75	1,05	1,5	1,9	2,1	2,4
160	0,25	0,40	0,80	1,1	1,6	2,0	2,2	2,5
200	0,40	0,63	1,00	1,4	2,0	2,5	2,8	3,2
250	0,56	1,0	1,25	1,8	2,5	3,2	3,6	4,0
320	0,75	1,6	1,6	2,2	3,2	4,0	4,5	5,0
400	1,0	2,0	2,0	2,8	4,0	5,0	5,5	6,3
500	1,3	2,5	2,5	3,6	5,0	6,3	7,1	8,0
630	1,8	3,2	3,2	4,5	6,3	8,0	9,0	10,0
800	2,4	4,0	4,0	5,6	8,0	10,0	11,1	12,5
1 000	3,2	5,0	5,0	7,1	10,0	12,5	14,0	16,0
NOTE 1 The values have been taken from IEC 60664-1:2007, Table F.4. NOTE 2 The values in the shaded lines are the same as in Table 9.								
Linear interpolation is allowed from 10 V up.								

6.7.4.4 Solid insulation for non-mains-circuits

6.7.4.4.1 General

NOTE This subclause 6.7.4.4 is based on IEC 61010-1:2010, K.2.4.

Solid insulation for non-mains circuits shall withstand the electrical and mechanical stresses that may occur in normal use, in all rated environmental conditions (see 1.4), during the intended life of the equipment.

The manufacturer should take the expected life of the equipment into account when selecting insulating materials.

Conformity is checked by both of the following tests:

a) *the 5 s a.c. voltage test specified in 6.10.4.4.4.3 b) using the applicable test voltages from Table 13 for basic insulation and supplementary insulation. For reinforced insulation, the values are multiplied by 1,6;*

b) *additionally, if the working voltage exceeds 300 V, by the 1 min a.c. voltage test specified in 6.10.4.4.4.4 c), with a test voltage of 1,5 times the working voltage for basic insulation and supplementary insulation and twice the working voltage for reinforced insulation.*

Solid insulation shall also meet the following requirements, as applicable:

1) for solid insulation used as an enclosure or barrier, the requirements of Clause 8, *Resistance to mechanical stresses;*
2) for moulded and potted parts, the requirements of 6.7.4.4.2;
3) for inner insulating layers of printed wiring boards, the requirements of 0;
4) for thin-film insulation, the requirements of 6.7.4.4.4.

Conformity is checked as specified in 6.7.4.4.2 to 6.7.4.4.4 and in Clause 8 as applicable.

6.7.4.4.2 Moulded and potted parts

For basic insulation, supplementary insulation and reinforced insulation, conductors located between the same two layers moulded together (see Figure 6, item L) shall be separated by the applicable minimum distance of Table 15 after the moulding is completed.

Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.

Table 15 – Minimum values for distance or thickness (see 6.7.4.4.2 to 6.7.4.4.4)

Peak value of the a.c. or d.c. working voltage or recurring peak voltage V	Minimum value mm
≤ 330	0,01
> 330 ≤ 400	0,02
> 400 ≤ 500	0,04
> 500 ≤ 600	0,06
> 600 ≤ 800	0,10
> 800 ≤ 1 000	0,15
> 1 000 ≤ 1 200	0,2
> 1 200 ≤ 1 500	0,3
> 1 500 ≤ 2 000	0,45
> 2 000 ≤ 2 500	0,6
> 2 500 ≤ 3 000	0,8
> 3 000 ≤ 4 000	1,2
> 4 000 ≤ 5 000	1,5
> 5 000 ≤ 6 000	2
> 6 000 ≤ 8 000	3

NOTE 1 The values have been taken from IEC 60664-3:2003, Table 1, *Minimum spacings for type 2 protection* on which IEC 61010-1:2010, Table K.14 is based. For higher voltages, see that table.

NOTE 2 Type 2 protection is considered to be similar to solid insulation.

6.7.4.4.3 Inner insulating layers of printed wiring boards

For basic insulation, supplementary insulation and reinforced insulation conductors located between the same two layers (see Figure 7, item L) shall be separated by the applicable minimum distance of Table 15.

Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.

Reinforced insulation of inner insulating layers of printed wiring boards shall also have adequate electric strength through the respective layers. One of the following methods shall be used:

a) the thickness of the insulation is at least the applicable minimum distance of Table 15;

   Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.

b) the insulation is assembled from at least two separate layers of printed wiring board materials, each of which is rated by the manufacturer of the material for an electric strength at least the value of the test voltage of Table 13 for basic insulation.

   Conformity is checked by inspection of the manufacturer's specifications.

c) the insulation is assembled from at least two separate layers of printed wiring board materials, and the combination of layers is rated by the manufacturer of the material for an electric strength at least the value of the test voltage of Table 13 multiplied by 1,6 for reinforced insulation.

   Conformity is checked by inspection of the manufacturer's specifications.

6.7.4.4.4 Thin-film insulation

For basic insulation, supplementary insulation and reinforced insulation conductors located between the same two layers (see Figure 8, item L) shall be separated by at least the applicable clearance and creepage distance of 6.7.4.2 and 6.7.4.3.

Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.

Reinforced insulation through the layers of thin-film insulation shall also have adequate electric strength. One of the following methods shall be used:

a) the thickness through the insulation is at least the applicable value of Table 15;

   Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.

b) the insulation consists of at least two separate layers of thin-film materials, each of which is rated by the manufacturer of the material for an electric strength at least the value of the test voltage of Table 13 for basic insulation;

   Conformity is checked by inspection of the manufacturer's specifications.

c) the insulation consists of at least three separate layers of thin-film materials, any two of which have been tested to exhibit adequate electric strength.

   Conformity is checked by the 1 min a.c. voltage test of 6.10.4.4.4.4 d) or – for circuits stressed only by DC – the 1 min d.c. voltage the test of 6.10.4.4.4.5.

   For the purposes of the test for option c), a special sample may be assembled with only two layers of the material.

6.7.5 Insulation in circuits not addressed in 0 or 6.7.4

6.7.5.1 General

NOTE Subclause 6.7.5 is based on IEC 61010-1:2010, Clause K.3.

These circuits have one or more of the following characteristics:

a) the maximum possible transient overvoltage is limited by the supply source or within the equipment (see 6.7.6) to a known level below the level assumed for the mains circuit;

b) the maximum possible transient overvoltage is above the level assumed for the mains circuit;

c) the working voltage is the sum of voltages from more than one circuit, or is a mixed voltage;

d) the working voltage includes a recurring peak voltage that may include a periodic non-sinusoidal waveform or a non-periodic waveform that occurs with some regularity;

e) the working voltage has a frequency above 30 kHz.

In cases a) to c), clearances for basic insulation and supplementary insulation are determined according to 6.7.5.2.

In cases d) and e) clearances are determined according to 6.7.5.3.

In all cases 0 addresses creepage distance and 6.7.5.5 solid insulation.

6.7.5.2 Clearance calculation

NOTE This subclause reproduces IEC 61010-1:2010, K.3.2.

Clearances for basic insulation and supplementary insulation are determined from the following formula:

$$\text{Clearance} = D1 + F \times (D_2 - D_1)$$

where

F is a factor, determined from one of the formulas:

$F = \left(1{,}25 \times \frac{U_w}{U_m}\right) - 0{,}25$ if $U_w/U_m\ 0{,}2$

$F = 0$ if $U_w/U_m\ 0{,}2$

where

$U_m = U_w + U_t$

where

U_w is the maximum peak value of the working voltage;

U_t is the maximum additional transient overvoltage;

D_1 and D_2 are values taken from Table 16 for U_m.

where

- D_1 represents the clearance that would be applicable to a transient overvoltage with the shape of a 1,2 / 50 μs impulse.
- D_2 represents the clearance that would be applicable to the peak working voltage without any transient overvoltage;

Clearances for reinforced insulation are twice the values for basic insulation.

If the equipment is rated to operate at an altitude greater than 2 000 m, the clearances shall be multiplied by the applicable factor of Table 5.

Minimum clearance, for basic insulation, supplementary insulation and reinforced insulation, is 0,2 mm for pollution degree 2 and 0,8 mm for pollution degree 3.

Conformity is checked by inspection and measurement or by the test specified in 6.10.4.4.5.

Table 16 – Clearance values for the calculation of 6.7.5.2

Maximum voltage U_m	Clearance		Maximum voltage U_m	Clearance	
	D_1	D_2		D_1	D_2
V	mm	mm	V	mm	mm
14,1 to 266	0,010	0,010	4 000	2,93	6,05
283	0,010	0,013	4 530	3,53	7,29
330	0,010	0,020	5 660	4,92	10,1
354	0,013	0,025	6 000	5,37	10,8
453	0,027	0,052	7 070	6,86	13,1
500	0,036	0,071	8 000	8,25	15,2
566	0,052	0,10	8 910	9,69	17,2
707	0,081	0,20	11 300	12,9	22,8
800	0,099	0,29	14 100	16,7	29,5
891	0,12	0,41	17 700	21,8	38,5
1 130	0,19	0,83	22 600	29,0	51,2
1 410	0,38	1,27	28 300	37,8	66,7
1 500	0,45	1,40	35 400	49,1	86,7
1 770	0,75	1,79	45 300	65,5	116
2 260	1,25	2,58	56 600	85,0	150
2 500	1,45	3,00	70 700	110	195
2 830	1,74	3,61	89 100	145	255
3 540	2,44	5,04	100 000	165	290
Linear interpolation is allowed from 14,1 V up.					

Table 17 shows test voltages based on clearances.

Table 17 – Test voltages based on clearances

Required clearance	Test voltage	
	Impulse 1,2/50 μs	**a.c. r.m.s. 50/60 Hz**
mm	V peak	V r.m.s
0,010	330	230
0,025	440	310
0,040	520	370
0,063	600	420
0,1	810	500
0,2	1 150	620
0,3	1 310	710
0,5	1 550	840
1,0	1 950	1 060
1,5	2 560	1 390
2,0	3 090	1 680
2,5	3 600	1 960
3,0	4 070	2 210
4,0	4 930	2 680
4,5	5 330	2 900
5,0	5 720	3 110
6,0	6 460	3 510
8,0	7 840	4 260
10,0	9 100	4 950
12,0	10 600	5 780
15,0	12 900	7 000
20	16 400	8 980
25	19 900	10 800
30	23 300	12 700
40	29 800	16 200
50	36 000	19 600
60	42 000	22 800
80	53 700	29 200
100	65 000	35 400
NOTE 1 The values are taken from IEC 61010-1:2010, Table K.16		
Linear interpolation is allowed from 0,010 mm up.		

EXAMPLE 1:

Clearance for reinforced insulation for a working voltage with peak value of 3 500 V and an additional transient voltage of 4 500 V (this can be expected within an electronic switching-circuit):

Maximum voltage $U_{\mathrm{m}} = U_{\mathrm{w}} + U_{\mathrm{t}}$ = (3 500 + 4 500) V = 8 000 V

$U_{\mathrm{w}}/U_{\mathrm{m}}$ = 3 500 / 8 000 = 0,44 $>$ 0,2

thus $F = \left(1{,}25 \times \frac{U_{\mathrm{w}}}{U_{\mathrm{m}}}\right) - 0{,}25$ = 1,25 x 3 500 / 8 000 – 0,25 = 0,297

Values derived from Table 16 at 8 000 V:

D_1 = 8,25 mm, D_2 = 15,2 mm

$Clearance = D1 + F \times (D_2 - D_1)$ = 8,25 + 0,297 × (15,2 – 8,25) = 8,25 + 2,06 = 10,3 mm

For reinforced insulation the value is doubled. Clearance = 20,6 mm.

EXAMPLE 2:

Clearance for basic insulation for a circuit driven from a mains transformer connected to an outlet of the distribution system with a mains voltage of 230 V and overvoltage category II. The circuit includes transient overvoltage limiting devices (see 6.7.6) which limit the maximum voltage (including transients) in the circuit to 1 000 V.

The peak value U_{w} of the voltage in the circuit is 150 V.

The maximum value of the voltage U_m = 1 000 V.

$U_{\mathrm{w}}/U_{\mathrm{m}}$ = 150 / 1 000 = 0,15 < 0,2, thus F = 0.

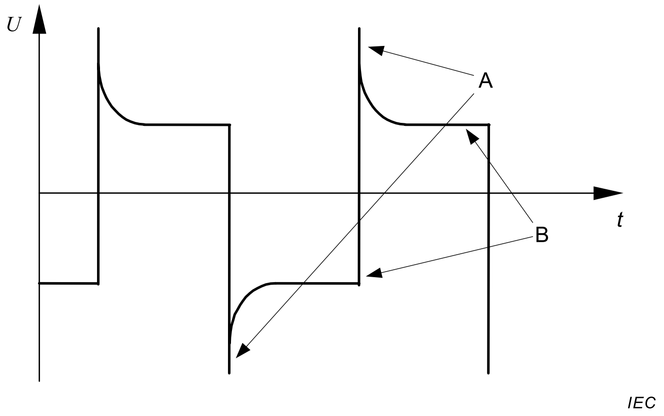
Clearance D_1 = 0,15 mm interpolated from Table 16.

The clearance is then corrected for altitude and checked against pollution degree minimum clearances.

6.7.5.3 Clearances in circuits having recurring peak voltages, or having working voltages with frequencies above 30 kHz

NOTE This subclause reproduces IEC 61010-1:2010, K.3.3.

Clearances for basic insulation and supplementary insulation for circuits having recurring peak voltages but not subjected to frequencies above 30 kHz shall meet the values of the second column of Table 18 using the recurring peak voltage as the index. (See Figure 9 for an example of a recurring peak voltage.)



Key

A Peak value of recurring voltage

B Working voltage value

Figure 9 – Example of recurring peak voltage

Clearances for basic insulation and supplementary insulation for circuits that are subjected to frequencies above 30 kHz shall meet the values of the third column of Table 18 using the peak value of the working voltage as the index.

Clearances for basic insulation and supplementary insulation for circuits that may be subjected to both recurring peak voltages and to frequencies above 30 kHz shall meet the higher of these requirements.

Clearances for reinforced insulation are twice the values for basic insulation.

If the equipment is rated to operate at an altitude greater than 2 000 m, the clearances are multiplied by the applicable factor of Table 5.

The minimum clearance, for basic insulation, supplementary insulation and reinforced insulation, is 0,2 mm for pollution degree 2 and 0,8 mm for pollution degree 3.

Conformity is checked by inspection and measurement.

Table 18 – Clearances for basic insulation in circuits having recurring peak voltages

Voltage	Clearances	
	Frequencies up to 30 kHz	Frequencies above 30 kHz
V peak	mm	mm
0 to 330	0,01	0,02
400	0,02	0,04
500	0,04	0,07
600	0,06	0,11
800	0,13	0,26
1 000	0,26	0,48
1 200	0,42	0,76
1 500	0,76	1,1
2 000	1,27	1,8
2 500	1,8	2,6
3 000	2,4	3,5
4 000	3,8	5,7
5 000	5,7	8
6 000	7,9	10
8 000	11	15
10 000	15,2	20
12 000	19	25
15 000	25	32
20 000	34	44
25 000	44	58
30 000	55	72
40 000	77	100
50 000	100	–
NOTE The values for frequencies up to 30 kHz correspond to IEC 60664-1:2007, Table F.7a, Case A, inhomogeneous field conditions.		
Linear interpolation is allowed from 330 V up.		

6.7.5.4 Creepage distances

NOTE This subclause reproduces IEC 61010-1:2010, K.3.4.

The requirements of 6.7.4.3, creepage distances for non-mains-circuits, apply.

Conformity is checked as specified in 6.7.4.3.

6.7.5.5 Solid insulation

NOTE This subclause reproduces IEC 61010-1:2010, K.3.5.

The requirements of 6.7.4.4 apply except that in 6.7.4.4.1 a), 0 b) and c), and 6.7.4.4.4 b) and c) the values of Table 17 are used in place of the applicable values of Table 13.

To determine the required test voltage from Table 17 the following procedure shall be applied:

a) calculation of the theoretically required clearance according to 6.7.5.2 considering the requirements of 6.7.5.3. Minimum clearances for pollution degrees 2 and 3 do not apply.
b) application of the resulting theoretically required clearance value of Table 17 to determine the required test voltage.

Conformity is checked as specified in 6.7.4.4, using the test voltage determined above in place of the test voltage from Table 13.

6.7.6 Reduction of transient overvoltages by the use of overvoltage limiting devices

NOTE This subclause is based on IEC 61010-1:2010, Clause K.4.

Transient overvoltages in a circuit may be limited by combinations of circuits or components. Components suitable for this purpose include varistors and gas-filled surge arrestors. See also 13.5.

When such components are used, clearances may be reduced to withstand an impulse voltage one step lower in the preferred series of impulse voltages. See Table 7, note b).

EXAMPLE 1 For an indoor meter with nominal voltage 3 x 230 / 400 V, the rated impulse voltage for basic insulation is 4 000 V, see Table 7, and the required clearance is 3,0 mm, see Table 8. If a varistor is used then the clearance may be reduced to 1,5 mm.

EXAMPLE 2 For the same meter, the rated impulse voltage for reinforced insulation is 6 000 V, see Table 7, and the required clearance is 5,5 mm. If a varistor is used then the clearance may be reduced to 3,0 mm.

Conformity is checked by measurement and by performing the impulse voltage test specified in 6.10.3.5 with the test voltages reduced by one step, on a sample from which the varistors have been removed.

6.8 Insulation requirements between circuits and parts

NOTE 1 This subclause is based on IEC 60255-27:2013, Annex A.

This subclause provides guidance on the isolation class and insulation requirements:

- on the one hand between these circuits; and on the other hand
- between these circuits and accessible parts.

Typical examples are provided in Annex B.

The insulation requirements should be used to determine the required clearances, creepage distances and solid insulation from 6.7.

The following mains circuits shall be considered as hazardous live (HLV) circuits:

- voltage and current circuits of direct connected and transformer operated meters;

  NOTE 2 Current circuits of CT operated meters are generally earthed.
- neutral circuits;
- relays / control switches switching mains voltage;
- auxiliary supply circuits intended for connection to the mains.

Non-mains-circuits are classified by their working voltage and isolation class as; see Table 19:

- hazardous live voltage (HLV) circuits (circuits with voltage levels exceeding the values of 6.3.2);
- extra low voltage (ELV) circuits;
- safety extra low voltage (SELV) circuits;
- protective extra low voltage (PELV) circuits;
- protection by equipotential bonding (PEB) circuits.

Table 19 – Isolation classes for non-mains-circuits

Circuit isolation class	**Description**
HLV Hazardous Live Voltage	Non-mains-circuits exceeding 33 V r.m.s. a.c. or 70 V d.c., i.e. ELV voltage limits.
ELV Extra low voltage	Non-mains-circuits complying with the following under normal operational conditions: – not exceeding 33 V r.m.s. a.c. or 70 V d.c. i.e. ELV voltage limits; – separated from HLV circuits by at least basic insulation. See Annex B. ELV circuits should not be accessible under normal operational conditions. Examples are: – non-mains circuits; – analogue/digital inputs and outputs, complying with ELV voltage limits; – connections to ELV terminations of other products.
SELV Safety extra low voltage	Non-mains-circuits complying with ELV voltage limits and the following conditions: – separated from HLV circuits by reinforced/double insulation; – there shall be no provision for an earth connection. See Annex B. SELV circuits may be accessible and are safe to touch under both normal operational and single-fault conditions. Connection of an earth to a SELV circuit is not permitted; for example, connection to an earthed cable screen or earthed communication circuit is not permitted. Where this is required, the circuit definition should change to PELV. An exception could be for a PELV system earthed at one end of a cable run, it would be permissible to connect an SELV system at the other end. Examples are: – analogue/digital inputs and outputs which may be connected directly to unearthed communication networks or circuits; – SELV ports which are suitable for connection to SELV ports of other products.
PELV Protective extra low voltage	Non-mains-circuits complying with ELV voltage limits and the following conditions: – PELV circuits shall be separated from HLV circuits by reinforced/double insulation; – PELV circuits may be connected to functional earth, the protective (earth) conductor, or have provision for an earth connection. See Annex B. PELV circuits may be accessible and are safe to touch under both normal operational and single fault conditions. Examples are: – analogue/digital inputs and outputs which may be connected directly to communication networks or circuits; – PELV ports which are suitable for connection to PELV ports of other products.

Circuit isolation class	Description
PEB Protection by equipotential bonding	Non-mains-circuits complying with ELV voltage limits and the following conditions: – basic protection against electric shock is provided by basic insulation separating HLV circuits from PEB circuits; – for fault protection, PEB circuits and accessible conductive parts, shall be bonded to the protective conductor terminal which will prevent hazardous live voltages in PEB circuits. See Annex B. PEB circuits may be accessible and are safe to touch under both normal operational and single fault conditions. PEB circuits may be considered as protective earthed circuits or earthed accessible parts for the purposes of Table 20. Examples are: – analogue/digital inputs and outputs which may be connected directly to communication networks or circuits; – PEB ports which are suitable for connection to PEB ports of other products.

Table 20 shows the insulation requirements between any two circuits.

Table 20 – Insulation requirements between any two circuits

	HLV mains-circuit 1)	ELV circuit	SELV circuit	PELV circuit	PEB circuit 2)	Protective earthed HLV non-mains-circuit 2), 3)	Unearthed HLV non-mains circuit 3)
HLV mains-circuit 1)	F/B 1) 6) Table 8 Table 9	B Table 8 Table 9	D, R Table 8 Table 9	D, R Table 8 Table 9	B 5) Table 8 Table 9	B Table 8 Table 9	B Table 8 Table 9
ELV circuit	B Table 8 Table 9	F/B 6) Table 13 Table 14	B, S Table 13 Table 14	B, S Table 13 Table 14	F/B 5), 6) Table 13 Table 14	B Table 13 Table 14	B Table 13 Table 14
SELV circuit	D, R Table 8 Table 9	B, S Table 13 Table 14	F/B 6) Table 13 Table 14	F/B 8) Table 13 Table 14	B Table 13 Table 14	D, R Table 13 Table 14	D, R Table 13 Table 14
PELV circuit 2)	D, R Table 8 Table 9	B, S Table 13 Table 14	F/B 8) Table 13 Table 14	F/B 6) Table 13 Table 14	B Table 13 Table 14	D, R Table 13 Table 14	D, R Table 13 Table 14
PEB circuit 2)	B 5) Table 8 Table 9	F/B 5), 6) Table 13 Table 14	B Table 13 Table 14	B Table 13 Table 14	F/B 5) Table 13 Table 14	B Table 13 Table 14	B Table 13 Table 14
Protective earthed HLV non-mains circuit 2), 3)	B Table 8 Table 9	B Table 8 Table 9	D, R Table 8 Table 9	D, R Table 8 Table 9	B Table 8 Table 9	F/B 6) Table 8 Table 9	B Table 8 Table 9
Unearthed HLV non-mains circuit 3)	B Table 13 Table 14	B Table 13 Table 14	D, R Table 13 Table 14	D, R Table 13 Table 14	B Table 13 Table 14	B Table 13 Table 14	F/B 6) Table 13 Table 14
Protective earthed accessible part 2), 7)	B Table 8 Table 9	F/B 6) Table 13 Table 14	B Table 13 Table 14	B Table 13 Table 14	F/B 6) Table 13 Table 14	B Table 13 Table 14	B Table 13 Table 14
Unearthed accessible part 7)	D, R Table 8 Table 9	B Table 13 Table 14	B Table 13 Table 14	F/B 6) Table 13 Table 14	B Table 13 Table 14	D, R Table 13 Table 14	B/D, R 4) Table 13 Table 14

Abbreviations for insulations: B: Basic insulation; S: Supplementary insulation; D: Double insulation, R: Reinforced insulation F: Functional insulation
1) If the functional voltage (not relative to earth/ground) is greater than the rated insulation voltage, the creepage distance for the functional insulation may be greater than that for the basic insulation. An example is a terminal block of a three-phase metering equipment with U_n = 230/400 V, where the functional phase-to-phase voltage is 400 V r.m.s. For an indoor meter with material group III, the creepage distance for basic insulation from Table 9 is 3,2 mm, but the creepage distance for functional insulation from Table 14 is 4,0 mm. 2) Connections to the protective conductor shall comply with 6.5.2.4. Otherwise, this shall be considered to be an unearthed circuit. 3) There shall be at least basic insulation between HLV non-mains circuits and HLV mains circuits. 4) Insulation between an unearthed non-mains circuit at hazardous voltage and an unearthed accessible conductive part shall satisfy the more onerous of the following: – double/reinforced insulation, the working voltage of which is equal to the hazardous voltage; or – supplementary insulation, the working voltage of which is equal to the voltage between the non-mains circuit at hazardous voltage; and • another non-mains circuit at hazardous voltage; or • a mains circuit. 5) See Annex B for the conditional use of basic insulation for PEB. 6) Supplementary or basic insulation shall be used if one of the circuits is an independent circuit or is adjacent to a conductive part which may be earthed when the equipment is installed. 7) A functional earthed circuit shall be treated as an unearthed accessible part. The exception is where the functional earth is bonded to the protective conductor and this meets the relevant requirements, then it may be treated as an earthed accessible part. 8) For a PELV system earthed at one end of a cable run, it would be permissible to connect a SELV system at the other end.
NOTE Reference is made to the respective tables specifying clearances and creepage distances.

Based on this:

- basic insulation is required between the case of a protective class I equipment and the HLV mains-circuits or HLV non-mains-circuits;
- double insulation is required between the case of protective class II equipment and the HLV mains-circuits or HLV non-mains-circuits. See also 6.10.4.3.2 , item b);
- the clearance between the terminal cover, if made of metal, and the upper surface of the terminal screws when screwed down to the maximum applicable conductor fitted shall meet the requirements for basic insulation for protective class I equipment meters and double insulation for protective class II equipment;
- the insulation between:
  – non-mains-circuits and other circuits;
  – non-mains-circuits and the accessible parts;

  shall be dimensioned according to the isolation class of the non-mains-circuit.

Annex B provides some examples.

6.9 Constructional requirements for protection against electric shock

6.9.1 General

NOTE 1 This subclause reproduces IEC 61010-1:2010, 6.9.1.

If a failure could cause a hazard:

a) the security of wiring connections subject to mechanical stresses shall not depend on soldering;
b) screws securing removable covers shall be captive if their length determines a clearance or creepage distance between accessible conductive parts and hazardous live parts;
c) accidental loosening or freeing of the wiring, screws, etc., shall not cause accessible parts to become hazardous live;
d) clearances and creepage distances between the enclosure and hazardous live parts shall not be reduced below the values for basic insulation by loosening of parts or wires.

NOTE 2 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.

Conformity is checked by inspection and measurement of clearances and creepage distances.

6.9.2 Insulating materials

NOTE This subclause reproduces IEC 61010-1:2010, 6.9.2.

The following shall not be used as insulation for safety purposes:

a) materials which can easily be damaged (for example, lacquer, enamel, oxides, anodic films);
b) non-impregnated hygroscopic materials (for example, paper, fibres, fibrous materials).

Conformity is checked by inspection.

6.9.3 Colour coding

NOTE This subclause reproduces IEC 61010-1:2010, 6.9.3.

Green-and-yellow insulation shall not be used except for:

a) protective earth conductors;
b) protective bonding conductors;
c) potential equalization conductors for safety purposes;
d) functional earth conductors.

Conformity is checked by inspection.

6.9.4 Equipment case

Hazardous live parts shall be located within the equipment case.

If the equipment case has removable covers, they shall be firmly secured in place in such a way that:

a) they may only be removed by using a tool;
b) if protected by seals, they cannot be removed without breaking the seals.

NOTE 1 If the covers are fixed by screws these are generally protected by seals so that the covers cannot be removed without breaking the seals first then using a tool to loosen / fasten the screws.

NOTE 2 Some metering equipment is “sealed for life”, so that the case can be only opened by breaking it.

NOTE 3 This requirement does not apply to covers within the meter enclosure.

Terminals that are hazardous live shall be covered by terminal covers, enclosing the actual terminals, the conductor fixing screws and, unless otherwise agreed by the manufacturer and the purchaser, a suitable length of the external conductors and their insulation, so that no hazardous live terminals become accessible without removing the terminal cover. Terminal covers shall be firmly secured in place as specified above.

Panel mounted meters do not have to be equipped with terminal covers, if access to hazardous live terminals in normal operating condition is prevented by an appropriate barrier.

Conformity is checked by inspection and if necessary, the tests specified in 6.2 and 6.3.

Terminal covers covering terminals intended for connecting devices by the user do not need to be protected against removal. Terminals located under terminal covers that can be removed by a user shall be safe to touch (SELV, PELV or PEB). See 6.8.

Terminals may be grouped in connectors to prevent access to the terminals.

It shall not be possible to remove socket-mounted equipment from its specified matching socket without breaking a seal.

The case shall have sufficient mechanical strength, stability and durability to maintain the specified degree of protection and shall meet the rigidity requirements specified in 8.2.

The equipment case, including the covers and terminal covers shall provide a degree of protection as specified in Clause 11.

Conformity is checked by inspection and the tests of 8.2, 10.5.1, 10.5.2 and Clause 11.

6.9.5 Terminal blocks

NOTE This subclause is based on IEC 62052-11:2003, 5.4.

Terminals may be grouped in (a) terminal block(s). Terminal blocks shall have adequate insulating properties and mechanical strength. In order to satisfy such requirements when choosing insulating materials for the terminal block(s), adequate testing of materials shall be taken into account. See also 9.3.2.1.

Conformity is checked with the test specified in 10.5.2.

The holes in the insulating material which form an extension of the terminal holes shall be of sufficient size to also accommodate the insulation of the conductors.

Conformity is checked by inspection.

6.9.6 Insulating materials of supply control and load switches

Insulating parts holding current carrying parts of supply control and load control switches shall have adequate insulating properties and mechanical strength. In order to satisfy such requirements when choosing insulating materials for the switches adequate testing of materials shall be taken into account.

Conformity is checked with the test specified in 10.5.2.

6.9.7 Terminals

NOTE This subclause 6.9.7 is based on IEC 61010-1:2010, 6.6.4 and IEC 62477-1:2012, 4.11.8.

6.9.7.1 General requirements

All parts of terminals which maintain electrical contact and carry current shall be made of metal having adequate mechanical strength.

All metal parts of each terminal shall be such that the risk of corrosion resulting from contact with any other metal part is minimized.

Terminals shall be anchored, fitted or designed so that conductors will not work loose when they are tightened, loosened or when connections are made.

The terminals, the conductor fixing screws, or the external or internal conductors shall not be liable to come into contact with terminal covers made of conducting material.

Conformity is checked by manual test and inspection.

The terminals of current circuits of direct connected meters shall be considered to be at the same potential as the related voltage circuit.

NOTE 1 The terminals of current circuits of current transformer operated meters are generally earthed.

Terminals of one current circuit shall be considered to be at the same potential.

Terminals which are grouped close together shall be protected against accidental short-circuiting that may be detrimental to the operation of equipment and the insulation shall not be reduced below the rated values, even if a strand of a conductor escapes from a terminal.

Protection may be obtained by insulating barriers.

Conformity is checked by inspection and – in case of doubt – by performing the following test:

NOTE 2 The following test is from IEC 60950-1:2005, 3.3.8.

A piece of insulation approximately 8 mm long is removed from the end of a flexible conductor having the appropriate nominal cross-sectional area. One wire of the stranded conductor is left free and the other wires are fully inserted into, and clamped in the terminal.

Without tearing the insulation back, the free wire is bent in every possible direction, but without making sharp bends around the guard.

If the conductor is at hazardous voltage, the free wire shall not touch any conductive part that is accessible or is connected to an accessible conductive part or, in the case of double insulated equipment, any conductive part that is separated from accessible conductive parts by supplementary insulation only.

If the conductor is connected to an earthing terminal, the free wire shall not touch any part at hazardous voltage.

6.9.7.2 Connecting capacity

NOTE 1 This subclause is based on IEC 62477-1:2012, 4.11.8.2.

Terminals shall be capable to accommodate the conductors specified in the installation and maintenance manuals in accordance with the wiring rules applicable at the installation.

NOTE 2 Standard cross-sections are specified in Table 1.

The temperature of the terminals shall meet the requirements of 10.2.

Compliance is checked by inspection.

6.9.7.3 Reliability of screw-type connections

The manner of fixing the conductors to the terminals shall ensure adequate and durable contact such that there is no risk of loosening or undue heating.

Electrical connections shall be designed in a way that contact pressure is not transmitted through insulating material.

Screw connections transmitting contact force and screw fixings that may be loosened and tightened several times during the life of the meter shall screw into a metal nut.

The reliability of the connection shall be checked with the following test (flexion test and pull test):

NOTE This test has been adopted from IEC 60947-1:2007, 8.2.4.3.

The test applies to mains terminals of direct connected meters, the current terminals of current transformer operated meters and to terminals of load control switches, for the connection of round copper conductors, of cross-section and type specified by the manufacturer, and prepared as specified by the manufacturer.

Test methods for aluminium conductors may be made agreed between manufacturer and user.

The test is to be carried out with suitable test equipment, see Annex H.

The test shall be performed on at least two terminals, using both the conductor of minimum and maximum cross section specified by the manufacturer.

The conductor shall be connected to the terminal tested. The length of the test conductors should be 75 mm longer than the height H specified in Table H.1. The clamping screws shall be tightened with a torque specified by the manufacturer.

The conductor is subjected to circular motions according to the following procedure:

- *the end of the conductor under test shall be passed through an appropriate size bushing in a platen positioned at a height H below the equipment terminal, as given in Table H.1. The bushing shall be positioned in the horizontal platen concentric with the conductor;*
- *the bushing shall be moved so that its centreline describes a circle of 75 mm diameter about its centre in the horizontal plane at 10 rpm ± 2 rpm. The distance between the mouth of the terminal and the upper surface of the bushing shall be within 15 mm of the height H in Table H.1. The bushing is to be lubricated to prevent binding, twisting or rotation of the insulated conductor. A mass as specified in Table H.1 is to be suspended from the end of the conductor. The test shall consist of 135 continuous revolutions.*

During the test, the conductor shall neither slip out of the terminal nor break near the clamping unit.

Immediately following the flexion test, the pulling force given in Table H.1 shall be applied to the conductor. The clamping screws shall not be tightened again for this test.

The force shall be applied without jerks for 1 min, in the direction of the axis of the conductor.

During the test, the conductor shall neither slip out of the terminal nor break near the terminal.

6.9.8 Requirements for current circuits

6.9.8.1 Overview

This subclause 6.9.8 specifies requirements for:

a) current circuits of direct connected meters without supply control switches (SCSs), see 6.9.8.3;
b) current circuits of direct connected meters equipped with supply control switches (SCSs) see 6.9.8.4;
c) meters and tariff- and load control equipment equipped with load control switches (LCSs), see 6.9.8.5.

For examples of direct connected meters equipped with the various kinds of switches, see Annex C.

There are no specific safety requirements for auxiliary control switches. Clause 13 nevertheless applies.

For functional and performance requirements for switches, see the relevant standard.

NOTE At the time of the publication of this standard, these are IEC 62052-11:2003, IEC 62054-11:2004, IEC 62054-21:2004 and IEC 62055-31:2005.

6.9.8.2 Characteristics

6.9.8.2.1 General

NOTE The characteristics in 6.9.8.2 are based on IEC 60947-1:2007, Clause 4.

The characteristics specified in this subclause 6.9.8.2 apply to the metering equipment as a complete unit, not to the supply or load control switch as a component.

6.9.8.2.2 Rated operational voltage (U_e)

The rated operational voltage of a switch is a value of voltage which, combined with a rated operational current, determines the application of the switch and to which the relevant tests and the utilization categories are referred.

Unless a different value is marked, the rated operational voltage U_e of a switch is equal to the reference voltage of the meter. In the case of meters with several reference voltages, the rated operational voltage is equal to the highest reference voltage.

6.9.8.2.3 Rated operational current (I_e)

The rated operational current of a switch is stated by the manufacturer and takes into account the rated operation voltage, the rated frequency, the rated duty and the utilization category.

For supply control switches, the rated operational current is the maximum current I_{max} of the meter.

For load control switches, the rated operational current shall be marked. See also Table 22 and Table 23.

6.9.8.2.4 Rated frequency

The supply frequency for which the switch is designed and to which the other characteristic values correspond.

6.9.8.2.5 Rated uninterrupted current (I_u)

The rated uninterrupted current of a switch is a value of current, which the equipment can carry in uninterrupted duty.

6.9.8.2.6 Uninterrupted duty

A duty without any off-load period in which the main contacts of an equipment remain closed, whilst carrying a steady current without interruption for periods of more than 8 h (weeks, months, or even years).

In this kind of service oxides and dirt can accumulate on the contacts and lead to progressive heating. Uninterrupted duty may require special design considerations (e.g. silver contacts).

6.9.8.2.7 Rated making capacity (I_m)

The rated making capacity of a switch is a value of current which the switch can satisfactorily make under specified making conditions.

The making conditions which shall be specified are:

- the applied voltage;
- the characteristics of the test circuit.

The rated making capacity is stated by reference to the rated operational voltage and rated operational current.

For a.c., the rated making capacity is expressed by the r.m.s. value of the symmetrical component of the current, assumed to be constant.

NOTE For a.c., the peak value of the current during the first half-cycles following the closing of the main contacts may be appreciably greater than the peak value of the current under steady-state conditions used in the determination of making capacity, depending on the power factor of the circuit and the instant on the voltage wave when closing occurs.

6.9.8.2.8 Rated breaking capacity (I_c)

The rated breaking capacity of a switch is a value of current, which the equipment can satisfactorily break, under specified breaking conditions.

The breaking conditions which shall be specified are:

- the applied voltage;
- the characteristics of the test circuit.

The rated breaking capacity is stated by reference to the rated operational voltage and rated operational current.

Equipment shall be capable of breaking any value of current up to and including its rated breaking capacity.

For a.c., the rated breaking capacity is expressed by the r.m.s. value of the symmetrical component of the current.

6.9.8.2.9 Rated safe short-time withstand current (I_{ssw})

The rated safe short-time withstand current is the value of current that the current circuit of a direct connected meter and – if fitted – the supply control switch can withstand withut damage under the test conditions specified.

6.9.8.2.10 Rated operational short-time withstand current (I_{osw})

The rated operational short-time withstand current is the value of current that the current circuit of a direct connected meter and – if fitted – the supply control can withstand without damage and the SCS remaining operational, under the test conditions specified.

6.9.8.2.11 Rated short-circuit making capacity (I_{sm})

The rated short-circuit making capacity of a switch is the value of short-circuit making capacity for the rated operational voltage, at rated frequency, and at a specified power-factor for a.c. It is expressed as the maximum prospective peak current, under prescribed conditions.

6.9.8.2.12 Rated conditional safe short-circuit current (I_{cssw})

The rated conditional safe short-circuit current of the switch is the value of prospective current which the switch, protected by a short-circuit protective device specified, can withstand for the operating time of this short-circuit protective device and the switch remaining safe but not necessarily operational, under the test conditions specified.

NOTE For a.c., the rated conditional safe short-circuit current is expressed by the r.m.s. value of the a.c. component.

6.9.8.2.13 Rated conditional operational short-circuit current (I_{cosw})

The rated conditional operational short-circuit current of the switch is the value of prospective current which the switch, protected by a short-circuit protective device specified, can withstand without damage for the operating time of this short-circuit protective device and the switch remaining operational under the test conditions specified.

NOTE For a.c., the rated conditional operational short-circuit current is expressed by the r.m.s. value of the a.c. component.

6.9.8.3 Current circuits of direct connected meters without SCS

The requirements for current circuits of direct connected meters without SCS are summarized in Table 21.

Table 21 – Summary of requirements for current circuits of direct connected meters without SCS

	Requirement	Value			
		Utilization category [a]			
		UC1	UC2	UC3	UC4
1	Rated operational voltage (U_e)	Equal to the reference voltage of the meter [b]			
2	Rated frequency	Equal to the reference frequency of the meter			
3	Rated operational current I_e, equal to the maximum current I_{max} of the meter, [c]	≤ 63 A	≤ 100 A	≤ 125 A	≤ 200 A
4	Duty	N.A.			
5	Rated uninterrupted current (I_u) at 1,15 U_e	Equal to I_e			
6	Endurance / Number of operating cycles [d]	N.A.			
7	Surge voltage withstand across open contacts	N.A.			
8	Rated making capacity (I_m) at 1,15 U_e, *cos φ = 1*	N.A.			
9	Rated breaking capacity (I_c) at 1,15 U_e, *cos φ = 1*	N.A.			
10	Maximum overload current I_{ovl}	As agreed between the manufacturer and the purchaser			
11	Rated safe short-time withstand current (I_{ssw}) [e] at 1,15 U_e	3 000 A	4 500 A	6 000 A	10 000 A
	For detailed requirements and test methods see 6.10.6.6.				
12	Rated operational short-time withstand current (I_{osw}) [d] at 1,15 U_e	N.A.			
13	Rated short-circuit making capacity (I_{sm}) [d] at 1,15 U_e	N.A.			
14	Neutral switching (Optional)	N.A.			
For meters with I_{max} above 200 A the values of test currents shall be agreed between the manufacturer and the purchaser.					

a) The utilization category is subject to the purchase agreement between the supplier and the purchaser. For marking, see 5.3.5.

b) If the meter has several reference voltages, then U_e is equal the highest reference voltage of the meter.

c) Values of rated operating current have been taken from IEC 60898-1:2015, 5.3.2, except the 200 A value.

d) Values for short-time withstand current have been taken from IEC 60898-1:2015, 5.3.4, except the 2 500 A value. For power factor see Table 27.

NOTE For coherence, the structure of this table is the same as that of Table 22.

Compliance to the requirements of Table 21 is verified by the tests specified in 6.10.5.

6.9.8.4 Current circuits of direct connected meters with SCS

The requirements for supply control switches are summarized in Table 22.

Table 22 – Summary of requirements for current circuits of direct connected meters with SCS

Requirement		Value			
		Utilization category [a]			
		UC1	UC2	UC3	UC4
1	Rated operational voltage (U_e)	Equal to the reference voltage of the meter [b]			
2	Rated frequency	Equal to the reference frequency of the meter			
3	Rated operational current I_e, equal to the maximum current I_{max} of the meter, [c]	≤ 63 A	≤ 100 A	≤ 125 A	≤ 200 A
4	Duty	Uninterrupted duty			
5	Rated uninterrupted current (I_u) at 1,15 U_e	Equal to I_e			
6	Endurance / Number of operating cycles [d]	5 000 at U_e, I_e, *cos φ = 1* and then 5 000 at U_e, I_e, *cos φ = 0,5 ind* performed on the same switch			
	For detailed requirements and test methods see 6.10.6.4.				
7	Surge voltage withstand across open contacts	max. 12 000 V			
	For detailed requirements and test methods see 6.10.6.5.				
8	Rated making capacity (I_m) at 1,15 U_e, *cos φ = 1*	Equal to I_e			
9	Rated breaking capacity (I_c) at 1,15 U_e, *cos φ = 1*	Equal to I_e			
10	Maximum overload current I_{ovl}	As agreed between the manufacturer and the purchaser			
11	Rated safe short-time withstand current (I_{ssw}) [e] at 1,15 U_e	3 000 A	4 500 A	6 000 A	10 000 A
	For detailed requirements and test methods see 6.10.6.6.				
12	Rated operational short-time withstand current (I_{osw}) [d] at 1,15 U_e	1 500 A	2 500 A	3 000 A	4 500 A
	For detailed requirements and test methods see 6.10.6.7.				
13	Rated short-circuit making capacity (I_{sm}) [d] at 1,15 U_e	1 500 A	2 500 A	3 000 A	4 500 A
	For detailed requirements and test methods see 6.10.6.8.				
14	Neutral switching (Optional)	UC equal to UC of phase switches.			
	For detailed requirements and test methods see 6.10.6.3.				
For meters with I_{max} above 200 A the values of test currents shall be agreed between the manufacturer and the purchaser.					

a) The utilization category is subject to the purchase agreement between the supplier and the purchaser. For marking, see 5.3.5.

b) If the meter has several reference voltages, then U_e is equal the highest reference voltage of the meter.

c) Values of rated operating current have been taken from IEC 60898-1:2015, 5.3.2, except the 200 A value.

d) Values for short-time withstand current and short-circuit making capacity have been taken from IEC 60898-1:2015, 5.3.4, except the 2 500 A value. For power factor see Table 27.

Compliance to the requirements of Table 22 is verified by the tests specified in 6.10.6.

A direct connected meter may have zero or more supply control switches, intended to control supply to the premises. Supply control switches shall be able to:

- carry, make and break currents up to and including I_{max} of the meter;
- carry, make and break negligible currents: the starting current of the meter;
- carry, make and break overload currents;

  NOTE This condition occurs occasionally when the supply side protection does not trip immediately.

- carry and make short-circuit currents.

A supply control switch may have additional functions like circuit breaker, contactor, isolator, earth leakage detector, under / over voltage detector and raised neutral detector. Requirements and tests of such functions are out of the Scope of this standard.

A supply control switch shall be designed for uninterrupted duty.

A supply control switch is intended for infrequent use: up to 3 operating cycles per day.

The current circuit of the meter, including the supply control switch(s) is protected by the upstream (supply side) protection of the installation.

Supply control switches may be part not only of meters but of other equipment constituting the installation. However, this standard applies only to supply control switches being part of meters.

6.9.8.5 Load control switches

The requirements for load control switches are summarized in Table 23.

Meters, tariff and load control devices may have zero or more load control switches. When built into meters, load control switches may be connected in series with (a) current circuit(s) or may have independent terminals. The rated operational current of a load switch may be lower than the maximum current of the meter. Load control switches shall be able to:

- carry, make and break currents up to their rated operational current $I_{e;}$
- carry short circuit currents.

NOTE A load control switch is not intended to provide isolation function.

A load control switch shall be designed for uninterrupted duty.

A load control switch is intended for infrequent use: up to 1 operating cycle per hour.

In all applications, load control switches are protected by the downstream (load side) protection of the installation.

Short circuits may occur on the wires – rated to carry the current of the load control switch(s) – between the load control switch and the downstream protection, although the probability of such an event is very low. Such faults are cleared then by the supply side protection.

Table 23 – Summary of requirements for load control switches

Requirement		Value								
1	Rated operational voltage (U_e)	Equal to the reference voltage of the meter or tariff and load control device [a]								
2	Rated frequency	Equal to the reference frequency of the meter or tariff and load control device								
3 a	Rated operational current I_e, A [b] at cos φ = 1	2	10	16	25	32	40	63	80	100
3 b	Rated operational current I_e, A [b] at cos φ = 0,4	1	5	8	10	10	10	10	10	10
4	Duty	Uninterrupted duty								
5	Rated uninterrupted current (I_u)	Equal to I_e								
6	Endurance / Number of operating cycles [c] at U_e, I_e, *cos φ = 1* at U_e, reduced I_e, (see above), *cos φ = 0,4* No load	30 000 on sample 1 30 000 on sample 2 75 000 on sample 3 NOTE See also Figure 10.								
	For detailed requirements and test methods see 6.10.7.3.									
7	Rated making capacity (I_m) at 1,15 U_e, cos φ = 1	Equal to I_e								
8	Rated breaking capacity (I_c) at 1,15 U_e, cos φ = 1	Equal to I_e								
9	Rated conditional safe short-circuit current (I_{cssw}) [c]	7 000 A								
	For detailed requirements and test methods see 6.10.7.4.									
10	Rated conditional operational short-circuit current (I_{cosw}) [c]	3 000 A								
	For detailed requirements and test methods see 6.10.7.5.									

a) For load control switches with independent terminals, other voltages may be specified.

b) Values of rated operating current have been taken from IEC 60898-1:2015, 5.3.2, except the 2 A value. Other values may be agreed on by the manufacturer and the supplier.

c) These values are appropriate for installations where supply control switches UC1 to UC3 are appropriate. Special consideration is required for selection of the protection device when the meter contains a UC4 rated supply control switch. For power factor see Table 27.

Compliance to the requirements of Table 23 is verified by the tests specified in 6.10.7.

6.10 Safety related electrical tests

6.10.1 Overview

Safety related electrical test procedures are specified for:

a) testing of voltage circuits, see 6.10.3;

b) testing on dielectrics on complete equipment, see 6.10.4.3;

c) testing of dielectrics on sub-assemblies, see 6.10.4.4;

d) testing of current circuits of direct connected meters without SCSs, see 6.10.5;

e) testing of current circuits of direct connected meters with SCSs, see 6.10.6;

f) testing of load control switches see 6.10.7.

Unless otherwise specified, the tests specified below apply to type testing and shall be performed on newly manufactured equipment. Since deterioration of the test specimen may occur, further use of the test specimen may not be appropriate.

If for any reason the impulse voltage or surge tests have to be repeated, they may be performed on a new specimen.

The test procedure is shown in Figure 10.

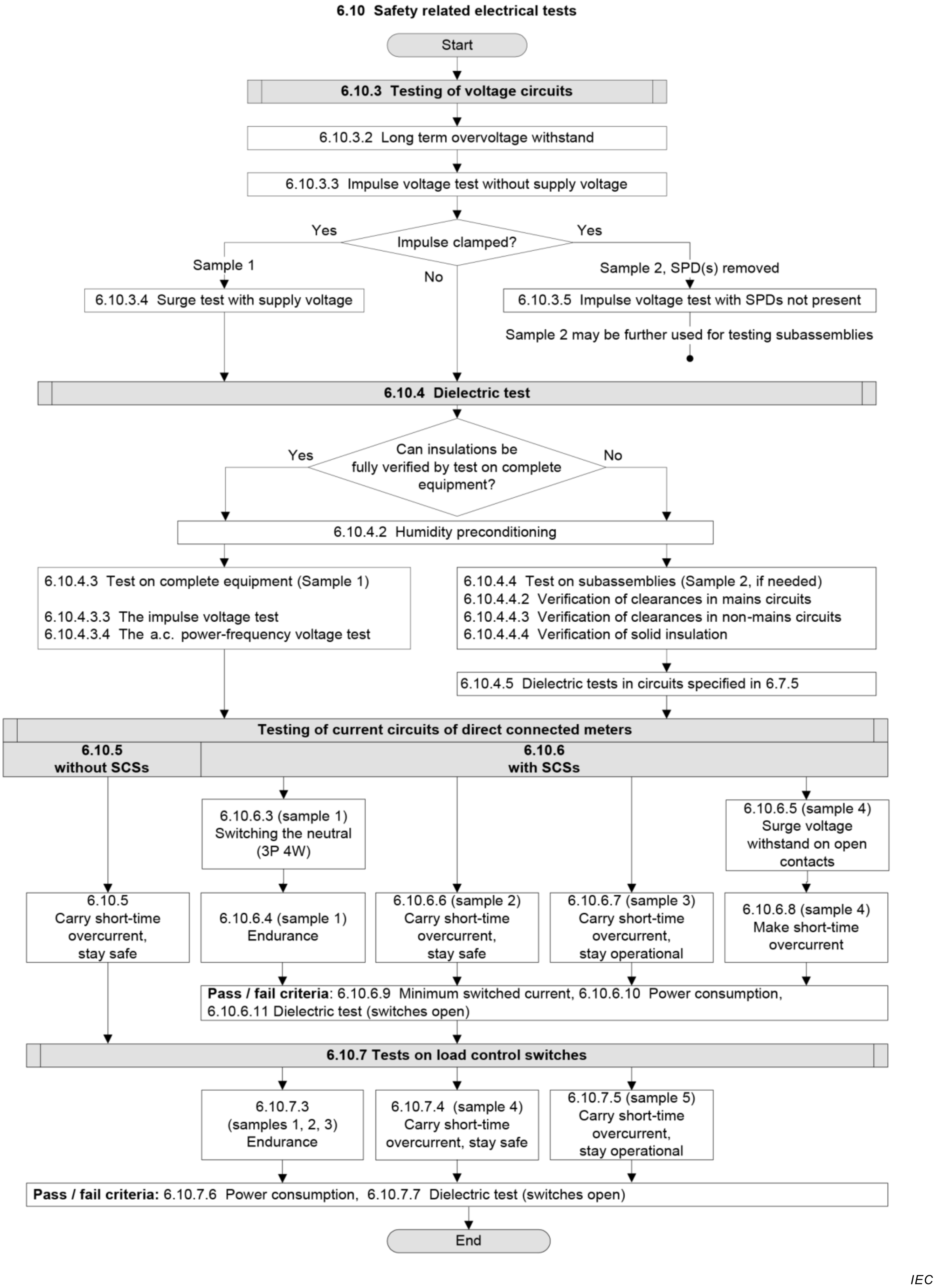


Figure 10 – Flowchart of safety related electrical tests

6.10.2 Test methods

6.10.2.1 Atmospheric conditions

Safety related electrical tests shall be made in normal atmospheric conditions of use. See 4.3.1. During the test, the quality of the insulation shall not be impaired by dust or abnormal humidity.

6.10.2.2 Test leads

The length and the cross-section of the test cable shall be as specified in 4.3.2.11.

6.10.2.3 Impulse voltage test

NOTE 1 This subclause is based on IEC 61180-1:1992, 6.2.

The standard impulse shall be a full impulse having a virtual front time of 1,2 μs and a time to half-value of 50 μs. It is described as a 1,2 / 50 impulse.

The following differences are accepted between specified values for the standard impulse and those actually recorded:

- *peak value ± 3 %;*
- *front time ± 30 %;*
- *time to half-value ± 20 %.*

Where high capacitive loading does not allow the impulse waveshape to be obtained within the specified tolerances, it may be necessary to perform a d.c. voltage test as an alternative (see 6.10.2.6).

Unless otherwise specified:

- *the conventional output impedance of the generator shall be 500 Ω ± 10 %.*

The calibration of the measuring system shall be verified in accordance with the requirements of IEC 61180-2.

The test voltage shall be as specified in the relevant subclauses.

Unless otherwise specified, the impulse voltage is applied for ten times with one polarity and then repeated with the other polarity. The minimum time between the impulses shall be 3 s.

The waveshape of each impulse shall be recorded.

It is permissible for an impulse voltage waveform applied across test points connected to surge suppression devices, inductive devices or potential dividers, to be attenuated or distorted if this is not due to electrical breakdown.

The waveform applied to test points not connected to such devices, will not be noticeably distorted or attenuated unless the insulation does not withstand the impulse voltage test.

Pass / fail criteria: Unless otherwise specified, the requirements of the test are satisfied if no disruptive discharge (sparkover, flashover or puncture) occurs on the test object.

6.10.2.4 Surge test

NOTE 1 This subclause is based on IEC 61000-4-5:2014, 6.1.

NOTE 2 The surge test specified in this subclause is intended to verify the correct operation of the surge protective devices (SPDs) inside the product for safety purposes and it is not to be considered as an EMC test.

The generator is intended to generate a surge having:

- *an open-circuit voltage front time of 1,2 μs;*
- *an open-circuit voltage duration of 50 μs;*
- *a short-circuit current front time of 8 μs; and*
- *a short-circuit current time duration of 20 μs.*

For convenience, the ratio of peak open-circuit output voltage to peak short-circuit current of a combination wave generator may be considered the effective output impedance. For this generator, the ratio defines an effective output impedance of 2 Ω.

The waveform of the voltage and current is a function of the EUT input impedance. This impedance may change during surges to equipment due either to proper operation of the installed protection devices, or to flash over or component breakdown if the protection devices are absent or inoperative. Therefore, the 1,2/50 μs voltage and the 8/20 μs current waves have to be available from the same generator output as required by the load.

Characteristics and performance of the generator:

- *Open-circuit voltage:*
  - *Front time: 1,2 μs ± 30 %;*
  - *Time to half value: 50 μs ± 20 %.*
  - *Peak voltage tolerance: ± 10 %.*
- *Short-circuit current:*
  - *Front time: 8 μs ± 20 %;*
  - *Time to half value 20 μs ± 20 %;*
  - *Peak current tolerance: ± 10 %.*

The test voltage may be applied with – using suitable coupling/decoupling networks – or without mains as specified in the relevant clauses (6.10.3.4 and 6.10.6.5).

The test levels, the polarity and the position of the surges relative to the mains voltage, the number and the repetition rate of the surges shall be as specified in the relevant clauses.

Pass / fail criteria: as specified in the relevant clauses.

6.10.2.5 AC power-frequency voltage test

NOTE 1 The following is based on IEC 61180-1:1992, 5.2.

The alternating test voltage, as applied to the test object, shall have a frequency in the range 45 Hz to 65 Hz, normally referred to as power-frequency test voltage.

The voltage shape shall approximate to a sinusoid with both half-cycles closely alike. This requirement is considered met if the ratio of peak to r.m.s. values is equal to √2 ± 5 %.

The test voltage shall be as specified in the relevant clauses. A tolerance of ± 3 % is acceptable between the specified and the measured test voltage values when connected to the EUT.

The voltage in the test circuit should be stable enough to be practically unaffected by varying leakage currents.

At the test voltage, the prospective short-circuit current at the test object shall be at least 200 mA r.m.s.

For test voltages exceeding 3 000 V, it is sufficient that the rated power of the test equipment is equal to or greater than 600 VA.

If capacitors with high capacitance are parallel to the parts between which the test voltage needs to be applied, it may be difficult, or even impossible, to perform the a.c. voltage test because the charging current would exceed the capacity of the high voltage tester (200 mA). In the latter case, those parallel capacitors should be disconnected before testing. If this is also impossible, d.c. voltage testing can be taken into consideration (see 6.10.2.6).

The characteristics of the generator shall be verified in accordance with the requirements of IEC 61180-2.

The tripping current of the generator shall be adjusted to a tripping current of 10 mA or for test voltages above 6 000 V to the highest possible value.

NOTE 2 The tripping current is calculated from the leakage current multiplied by 2 times the ratio between the test voltage and the nominal voltage. The leakage current is specified in 6.3.2.

EXAMPLE For a meter with U_n = 230 V, when the test is made at 2 000 V, then the tripping current shall be set to 2 0,5 mA * 2 000 / 230 = 8,6 mA —> 10 mA. When the test is made at 4 000 V, then the tripping current shall be set to 20 mA.*

If the generator trips, it is not necessarily due to an insulation failure. The root-cause of the tripping shall be investigated.

The voltage shall be applied to the test object starting at a value sufficiently low to prevent any effect of overvoltages due to switching transients. It shall be raised sufficiently slowly as to permit accurate reading of the measuring instrument but not so slowly as to cause unnecessary prolongation of the stressing of the test object near to the test voltage.

These requirements are, in general, met if the rate of the rise is about 5 % of the estimated final test voltage per second, when the applied voltage is above 75 % of this voltage. It shall be maintained for the specified time and then rapidly decreased, but not suddenly interrupted, as this may generate switching transients which could cause damage or erratic test results.

The test duration shall be as specified in the relevant clauses and should be independent of the frequency in the range from 45 Hz to 65 Hz.

Pass / fail criteria: Unless otherwise specified, the requirements of the test are satisfied if no disruptive discharge (sparkover, flashover or puncture) occurs on the test object.

6.10.2.6 DC voltage test

NOTE The following is based on IEC 61180-1:1992, 4.2.

The test voltage, as applied to the test object, shall be a direct voltage with not more than 3 % ripple factor. Note that the ripple factor may be affected by the presence of the test object and by the test conditions.

The test voltage shall be as specified in the relevant clauses. A tolerance of ±3 % is acceptable between the specified and the measured test voltage values when connected to the EUT.

The characteristics of the test voltage source and the calibration of the measuring system shall be verified in accordance with the requirements of *IEC 61180-2*.

The voltage shall be applied to the test object starting at a value sufficiently low to prevent any effect of overvoltage due to switching transients. It should be raised sufficiently slowly as to permit reading of the instruments, but not so slowly as to cause unnecessary prolongation of stressing of the test object near to the test voltage. These requirements are, in general, met if the rate of rise is about 5 % of the estimated final voltage per second when the applied voltage is above 75 % of this voltage. It shall be maintained for the specified time and then reduced by discharging the smoothing capacitor and the test object through a suitable resistor.

The test duration shall be as specified in the relevant clauses taking into consideration that the time to reach the steady state voltage distribution depends on the resistances and capacitances of the test object components.

Unless otherwise specified, the requirements of the test are satisfied if no disruptive discharge (sparkover, flashover or puncture) occurs on the test object.

6.10.2.7 Altitude correction for testing clearances

NOTE This subclause is from IEC 61010-1:2010, 6.8.1.

When verifying clearances, the values for test voltages given in 6.7 apply to tests performed at 2 000 m. For other test site altitudes, the corrections of Table 24 are applied for clearances but not for tests of solid insulation.

Table 24 – Correction factors according to test site altitude for test voltages for clearances

	Correction factors			
Test voltage peak	**≥327 V < 600 V**	**≥600 V < 3 500 V**	**≥3 500 V < 25 kV**	**≥25 kV**
Test voltage r.m.s.	**≥231 V < 424 V**	**≥424 V < 2 475 V**	**≥2 475 V < 17,7 kV**	**≥17,7 kV**
Test site altitude m				
0	1,08	1,16	1,22	1,24
500	1,06	1,12	1,16	1,17
1 000	1,04	1,08	1,11	1,12
2 000	1,00	1,00	1,00	1,00
3 000	0,96	0,92	0,89	0,88
4 000	0,92	0,85	0,80	0,79
5 000	0,88	0,78	0,71	0,70
Linear interpolation is allowed.				

6.10.3 Testing of voltage circuits

6.10.3.1 Overview

Testing of voltage circuits comprises four tests:

a) testing of long term overvoltage withstand, see 6.10.3.2;
b) impulse voltage test without supply voltage – see 6.10.3.3 – and depending on the result:
c) surge test, superimposed on supply voltage, see 6.10.3.4; and
d) impulse voltage test without supply voltage, one step lower, see 6.10.3.5.

6.10.3.2 Long term overvoltage withstand

Meters and tariff and load control equipment shall withstand the maximum withstand voltage, 1,9 U_n applied as follows:

NOTE U_n is the nominal voltage between a line and the neutral.

- *for single-phase two-wire meters, the maximum withstand voltage shall be applied between the line and neutral terminals;*
- *for single-phase two-wire multi-element meters the maximum withstand voltage shall be applied on all the elements simultaneously, between the line and neutral terminals;*
- *for three-phase four-wire polyphase types, the maximum withstand voltage shall be applied to any two phases and neutral with a phase angle of 60° between the two phase voltages. A total of three test runs is required to cover the pairs of phases, with a cooling period of 1 h between each run;*
- *for three-phase three-wire meters this requirement does not apply.*
- *when the current circuit (of a direct connected meter) contains supply control switches, then these switches shall be in the open position and the load side terminals shall be connected so that the maximum test voltage appears across the open supply control switch;*
- *for tariff-and load control equipment, the maximum withstand voltage shall be applied between the line and neutral terminals.*

The test circuit diagram is shown in Annex D.

In every configuration (test run) described above, the maximum withstand voltage of 1,9 U_n shall be applied for 4 h, with a cooling period of 1 h between the test runs.

During the test, the EUT may be damaged, but no hazardous live parts shall be exposed, no fire shall occur, or if it occurs, it shall be contained in the meter. When more than one test run is required, all of them have to be passed.

6.10.3.3 Impulse voltage test without supply voltage

This test does not have to be carried out if it can be ascertained from the circuit diagram that SPDs are present in the voltage circuit. In that case the tests specified in 6.10.3.4 and 6.10.3.5 have to be performed.

The impulse voltage test specified in 6.10.2.3 shall be applied:

a) to voltage circuit(s):

   1) When the voltage and the current circuits of a measuring element are connected together in normal use (for example direct connected meters) the test shall be made on the whole measuring element. The impulse voltage shall be applied between this common point and earth, with the other terminal of the voltage circuit connected to the earth and the other end of the current circuit left open. If there is a supply control switch present, then it shall be closed. All other terminals shall be connected to earth. When the meter has several measuring elements the impulse voltage shall be applied to each measuring element one by one.

   2) When the voltage and the current circuits of a measuring element are separated and appropriately insulated in normal use (for example transformer operated meters) the test shall be made on the voltage circuit only. The impulse voltage shall be applied between one terminal of the voltage circuit and earth, with the other terminal of the voltage circuit and all other terminals connected to earth. When the meter has several measuring elements the impulse voltage shall be applied to each voltage circuit one by one.

b) to auxiliary supply circuit(s) with a reference voltage above 33 V a.c. or 70 V d.c. between the supply terminals.

The test voltage shall be as specified in Table 7 for basic insulation. For examples of test arrangements see Annex F.

If during the test the impulse voltage is not clamped and the other pass / fail criteria of 6.10.2.3 are met, the test is passed.

If the impulse voltage is clamped – that is the test voltage is reduced by more than 15 % – then the tests specified in 6.10.3.4 and 6.10.3.5 have to be performed as well.

6.10.3.4 Surge test with supply voltage

The surge test specified in 6.10.2.4 shall be applied as follows:

- *this test shall be carried out with a supply side overcurrent protection present in each phase to protect the coupling network. The characteristics of the protection shall be agreed between the manufacturer and the purchaser and shall be included in the test report;*
- *the surges shall be applied to the same points as specified in 6.10.3.3;*
- *the test voltage shall be as specified in Table 7 for basic insulation;*
- *5 positive and 5 negative surges shall be applied;*
- *the surges shall be superimposed on the peak of the sine wave;*
- *the waveshape shall be recorded.*

The requirements of the test are satisfied if no disruptive discharge (sparkover, flashover or puncture) occurs on the test object and no SPD failure occurs.

If the surge voltage is still clamped, then the manufacturer and the test house shall agree if further tests are required.

6.10.3.5 Impulse voltage test with SPDs not present

In the case where surge protective devices (SPDs) are used inside a meter to reduce the overvoltage levels below the rated impulse voltage values specified in Table 7, the impulse voltage test shall be also performed on a specially prepared sample with SPDs removed.

The test shall be performed as specified in 6.10.3.3, but the value of the impulse test voltage shall be one step lower, as specified in 6.7.6.

NOTE The purpose of this test is to verify that clearances meet the requirements for reduced impulse voltages.

The pass / fail criteria of 6.10.2.3 apply.

6.10.4 Dielectric tests

6.10.4.1 Testing complete equipment vs. sub-assemblies

Dielectric tests on complete equipment is the preferred method.

NOTE 1 The reason for this is that with some designs, metering equipment is sealed for life and all parts of the meter case eventually have functions in fulfilling the requirements for clearances and creepage distances.

NOTE 2 Verification of clearances and creepage distances by measurement as specified in 6.7 is performed on disassembled metering equipment.

In some designs, applying test voltages for double or reinforced insulation between mains circuits and PELV / SELV circuits may overstress certain insulations or circuits that are not required to withstand these voltages, or some sensitive components may be damaged. In such cases insulation tests shall be carried out on sub-assemblies. See explanations to the figures in Annex B.

6.10.4.2 Humidity preconditioning

NOTE The following is based on IEC 61010-1:2010, 6.8.2.

The equipment is subjected to humidity preconditioning before the dielectric tests. The equipment is not energized during preconditioning.

When testing sub-assemblies, this treatment need not be applied to parts that are clearly unlikely to be influenced by humidity and temperature.

Preconditioning is carried out as specified in IEC 60068-2-78, in a humidity chamber containing air with a humidity of (93 ± 3) % RH. The temperature of the air in the chamber is maintained at (40 ± 2) °C.

Before applying humidity, the equipment is brought to a temperature of 40 °C ± 2 °C, normally by keeping it at this temperature for at least 4 h before the humidity preconditioning.

The air in the chamber is stirred and the chamber is designed so that condensation will not precipitate on the equipment.

The equipment remains in the chamber for 48 h, after which it is removed and allowed a recovery period of 2 h under the environmental conditions of 4.3.1, with the covers of non-ventilated equipment removed if this is possible.

The tests are performed and completed within 1 h of the end of the recovery period after humidity preconditioning.

6.10.4.3 Dielectric test on complete equipment

6.10.4.3.1 Test methods

This subclause specifies test methods for testing complete equipment using:

a) impulse voltage test specified in 6.10.4.3.3; and

b) a.c. power-frequency voltage test specified in 6.10.4.3.4.

The impulse voltage test shall be performed first, followed by the a.c. voltage test.

The results of the insulation tests are considered to be valid only for the terminal arrangement of the metering equipment, which has undergone the tests. When the terminal arrangements differ, all the insulation tests shall be carried out for each arrangement.

6.10.4.3.2 Preparation of the metering equipment for testing

NOTE This subclause is based on IEC 62052-11:2003, 7.3.1.

Unless otherwise specified, the tests shall be carried out on complete metering equipment, with its cover (except when indicated otherwise) and terminal cover in place, the terminal screws being screwed down to touch the conductors of the maximum size that can be accommodated by the terminals.

To create a continuous circuit for the voltage tests, terminals and open contacts of switches shall be bridged where necessary. Before testing, semiconductor devices and other vulnerable components within a circuit may be disconnected and/or their terminals bridged to avoid damage occurring to them during the test. The modifications to be performed shall be agreed on by the manufacturer and the test laboratory and shall be documented in the test report.

For the purpose of these tests, the term "earth" has the following meaning:

a) when the case of the metering equipment is made of metal, the “earth” is the case itself, placed on a flat conducting surface;

b) when the meter case or only a part of it is made of insulating material, the “earth” is a conductive foil wrapped around the meter touching all accessible conductive parts and connected to the flat conducting surface on which the meter base is placed.

A gap of 2 cm shall be left between the earth and the terminals to avoid flashover to the terminals.

During the tests, circuits which are not under test shall be connected together and to the earth.

For payment meters, the following special conditions apply: Where a physical token carrier acceptor is fitted, the meter shall withstand the tests with a metallic token in the token carrier acceptor or, if the metallic token cannot be retained, with a suitable electrical connection to the physical token carrier interface. Such metallic tokens or electrical connections shall then be connected to the earth for the purposes of these tests.

6.10.4.3.3 The impulse voltage test

The impulse voltage test method specified in 6.10.2.3 is used.

The altitude correction factors specified in 6.10.2.7 apply.

The test voltage shall be applied:

a) between all the HLV terminals connected together and earth. The test voltage shall be as specified in Table 7, taken from the column “Basic and supplementary insulation” for metering equipment of protective class I and the column “Reinforced insulation” for metering equipment of protective class II.

b) between each independent (group of) HLV circuit(s). The test voltage shall be as specified in Table 7, taken from the column “Basic and supplementary insulation”. When testing the current circuits of transformer operated meters, the test voltage shall be selected based on the nominal voltage of the corresponding voltage circuit.

For examples of test arrangements see Annex F.

6.10.4.3.4 The AC power-frequency voltage test

NOTE This subclause is based on IEC 60060-1:2010, Clause 5, IEC 62052-21:2004, 7.3.2.3, IEC 62053-11:2003, 7.4 and IEC 62053-21:2003, 7.4.

The a.c. power-frequency voltage test method specified in 6.10.2.5 is used. The test voltage shall be applied for 1 min.

Capacitors interfering with the a.c. voltage testing may be disconnected, or d.c. voltage testing can be considered. If capacitors are removed, this shall be documented in the test report.

The test shall be performed as specified in Table 25. Circuits not involved in the test shall be connected together and to the earth. The test voltage shall be applied directly to the terminals. For examples of test arrangements see Annex F.

Table 25 – AC voltage test

Points of application of the test voltage	AC test voltage V r.m.s.	
	Protective class I	**Protective class II**
a) Between, on the one hand, all mains circuits connected together, and, on the other hand, earth	The values of Table 11 for basic insulation apply.	The values of Table 11 for reinforced insulation apply.
b) Between mains circuits not intended to be connected together in service	The values of Table 11 for basic insulation apply.	

For electromechanical meters, additional tests are specified in Annex G.

For performing AC voltage test as routine test, see Annex I.

6.10.4.4 Dielectric tests on sub-assemblies

6.10.4.4.1 Overview

NOTE 1 The following is based on IEC 60664-1:2007, 6.1.1 and 6.1.2.

If full verification of insulation through testing on complete equipment is not possible, additional verification of individual clearances and solid insulations may be necessary; see 6.10.4.1.

Clearances and solid insulation in mains circuits are verified by the impulse voltage test, simulating the stresses caused by transient overvoltages. The impulse voltage test may be substituted by an a.c. voltage test or a d.c. voltage test.

Clearances and solid insulation in non-mains-circuits are verified by an a.c. voltage test or a d.c. voltage test.

While tests with a.c. or d.c. voltages of the same peak value as the impulse test voltage specified can be used to verify the withstand capability of clearances, they more highly stress solid insulation because the voltage is applied for longer duration. They can overload and damage certain solid insulations. Therefore, these test methods shall be used with caution.

When verifying insulation within equipment by a voltage test, it is necessary to ensure that the specified test voltage appears at the tested insulation. Protective impedance and voltage-limiting devices in parallel with the insulation to be tested shall be disconnected. Such modifications of the EUT shall be properly documented.

6.10.4.4.2 Verification of clearances in mains circuits

6.10.4.4.2.1 Impulse voltage test

The purpose of this test is to verify that clearances will withstand specified transient overvoltages. The impulse voltage test is intended to simulate overvoltages of atmospheric origin and covers overvoltages due to switching of low-voltage equipment.

The impulse voltage test method specified in 6.10.2.3 is used.

The test voltage shall be as specified in Table 7.

The altitude correction factors specified in 6.10.2.7 apply.

The supplier and the purchaser may agree on higher test values.

NOTE When testing clearances, associated solid insulation will be subjected to the test voltage. As the impulse test voltage is increased for higher altitudes, solid insulation will have to be designed accordingly. This results in an increased impulse withstand capability of the solid insulation.

6.10.4.4.2.2 AC power-frequency voltage test

Alternatively, clearances may be verified using the a.c. power-frequency voltage test method specified in 6.10.2.5. The peak value of the a.c. voltage shall be equal to the impulse test voltage as specified in Table 7 and shall be applied for three cycles of the a.c. test voltage.

The altitude correction factors specified in 6.10.2.7 apply.

6.10.4.4.2.3 DC voltage test

Alternatively, clearances may be verified using d.c. voltage test method specified in 6.10.2.6.

The average value of the d.c. voltage shall be equal to the impulse test voltage as specified in Table 7 and applied three times for 10 ms in each polarity.

The altitude correction factors specified in 6.10.2.7 apply.

6.10.4.4.3 Verification of clearances in non-mains-circuits

Clearances in non-mains-circuits – see 6.7.4.2 – shall be verified using the a.c. power-frequency voltage test method specified in 6.10.2.5.

The test voltages shall be as specified Table 13. The duration of the test shall be 5 s.

Alternatively, the test may be performed using the d.c. voltage test method specified in 6.10.2.6. The test voltages shall be as specified in Table 13 but multiplied by $\sqrt{2}$. The duration of the test shall be 1 min.

The altitude correction factors specified in 6.10.2.7 apply.

6.10.4.4.4 Verification of solid insulation

6.10.4.4.4.1 General

Solid insulation in mains circuits shall be verified by:

a) the impulse voltage test specified in 6.10.4.4.4.2; and / or

b) the 5 s a.c. voltage test as specified in 6.10.4.4.4.3; and / or

c) the 1 min a.c. voltage test as specified in 6.10.4.4.4.4; and / or

d) the 1 min d.c. voltage test as specified in 6.10.4.4.4.5.

The kind of test used and the test voltages shall be as specified for the relevant situation.

6.10.4.4.4.2 Impulse voltage test

The impulse voltage test method specified in 6.10.2.3 is used to verify the capability of the solid insulation to withstand the rated impulse voltage.

For verifying solid insulation in mains circuits – see 6.7.3.4.1 – the test voltages shall be as specified in Table 10. Altitude correction factors specified in 6.10.2.7 do not apply.

The supplier and the purchaser may agree on higher test values.

The test shall be conducted for ten impulses of each polarity with an interval of at least 1 s between impulses.

6.10.4.4.4.3 The 5 s a.c. power-frequency voltage test

The a.c. power-frequency voltage test method specified in 6.10.2.5 is used with a duration of 5 s.

a) *for verifying solid insulation in mains circuits – see 6.7.3.4.1 – the test voltages shall be as specified in Table 10;*

b) *for verifying solid insulation in non-mains circuits – see 6.7.4.4.1 – the test voltage shall be as specified in Table 13 for basic insulation and supplementary insulation. For reinforced insulation, the values are multiplied by 1,6. Additionally, if the working voltage exceeds 300 V, then the test specified in 6.10.4.4.4.4 c) shall be performed.*

6.10.4.4.4.4 The 1 min a.c. voltage test

The a.c. power-frequency voltage test method specified in 6.10.2.5 is used for a duration of 1 min.

a) *for verifying solid insulation in mains circuits – see 6.7.3.4.1 –, the test voltages shall be as specified in Table 11;*

   If the 1 min a.c. voltage test is performed with the test voltages specified in Table 10, there is no need to repeat the test with the voltages specified in Table 11.

b) *for verifying reinforced thin film insulation in mains circuits – see 6.7.3.4.4 – the test voltages shall be as specified in Table 10 for reinforced insulation and applied to two of the three layers;*

c) *for verifying solid insulation in non-mains circuits – see 6.7.4.4.1 – when the working voltage exceeds 300 V, the test voltage shall be 1,5 times the working voltage for basic insulation and supplementary insulation and twice the working voltage for reinforced insulation;*

d) *for verifying reinforced thin film insulation in non-mains circuits – see 6.7.4.4.4 – the test voltages shall be as specified in Table 13 multiplied by 1,6 for reinforced insulation and applied to two of the three layers.*

6.10.4.4.4.5 The 1 min d.c. voltage test

NOTE The following is based on IEC 60664-1:2007, 6.1.3.6.

In some cases the 1 min a.c. voltage test needs to be substituted by a 1 min d.c. voltage test of a value equal to the peak value of the a.c. voltage, however this test will be less stringent than the a.c. voltage test.

The d.c. voltage test with a test voltage equal to the peak value of the a.c. voltage is not fully equivalent to the a.c. voltage test due to the different withstand characteristics of solid insulation for these types of voltages. However in the case of a pure d.c. voltage stress, the d.c. voltage test is appropriate.

The d.c. voltage test method specified in 6.10.2.6 is used.

For verifying reinforced thin film insulation in non-mains circuits – see 6.7.4.4.4 – stressed only by d.c. voltage, the test voltages shall be as specified in Table 13 multiplied by 1,6 for reinforced insulation and applied to two of the three layers.

6.10.4.4.4.6 Pass / fail criteria

NOTE 1 This subclause is based on IEC 60664-1:2007, 6.1.3.3.2.

No puncture or partial breakdown of solid insulation shall occur during the test, but partial discharges are allowed. Partial breakdown will be indicated by a step in the resulting *waveshape which will occur earlier in successive impulses. Breakdown on the first impulse may either indicate a complete failure of the insulation system or the operation of overvoltage limiting devices in the equipment.*

If overvoltage limiting devices are included in the equipment, care should be taken to examine the waveshape to ensure that their operation is not taken to indicate insulation failure. Distortions of the impulse voltage which do not change from impulse to impulse may be caused by operation of such overvoltage limiting device and do not indicate a (partial) breakdown of solid insulation.

NOTE 2 Partial discharges in voids can lead to partial notches of extremely short durations which may be repeated in the course of an impulse.

6.10.4.4.5 Dielectric tests in circuits specified in 6.7.5 – Verification of clearances in circuits with special overvoltage values

For verification of clearances in circuits described in 6.7.5.1 a) to c) the impulse voltage test method specified in 6.10.2.3 or the a.c. voltage test method specified in 6.10.2.5 with a duration of at least 5 s shall be used using the applicable voltage from Table 17 for the required clearance. The altitude correction specified in 6.10.2.7 applies.

6.10.5 Electrical tests on current circuits of direct connected meters without supply control switches (SCSs)

Current circuits of direct connected meters shall withstand simulated short-circuit currents – as may be experienced under short-circuit conditions in metering installations – and stay safe.

Conformity is checked by the following test.

Test conditions:

- *test circuit as shown in Annex E, comprising the following elements in series:*
  - *a voltage source with a voltage of 1,15 U_e and with reference frequency;*
  - *the metering equipment under test and;*
  - *load to produce the required test current;*
- *prospective test current as specified in Table 22, line 11. The power factor shall be as specified in Table 27;*
- *test voltage tolerance +5 % …–5 %;*
- *test current tolerance +5 % …–0 %.*

Test method:

- *the test switch shall be closed at the zero voltage crossover and opened at the first subsequent zero voltage crossover, thus remaining in the closed position for one half cycle of the supply voltage;*
- *repeat the test 3 times on the same specimen with an interval of at least 1 min between each test;*
- *for polyphase meters, the test may be performed phase by phase.*

Pass / fail criteria:

- *it is permissible that the current circuit may be damaged but no hazardous live parts shall be exposed, no fire shall occur, or if it occurs, it shall be contained in the meter.*

6.10.6 Electrical tests on current circuits of direct connected meters with SCSs

6.10.6.1 Test sequence and sample plan

This subclause 6.10.6 further details the requirements specified in 6.9.8.4 and specifies test methods to verify conformity. Table 26 summarizes the test sequence and sample plan.

For the purposes of the tests given in this subclause 6.10.6, the supply control switch(es) shall be considered as an integral part of the meter equipment and each test shall be performed on the metering equipment as a complete unit. Polyphase supply control switches constructed as a single unit shall be tested as a single unit. The supply side input terminals and the load side output terminals of the meter shall be taken to be the effective terminals of the supply control switches. Example diagrams of meters with switches are given in Annex C.

In the case of a polyphase meter, the tests and test values given shall apply to each phase.

Table 26 – Test sequence and sample plan for supply control switches

Test number	Test clause		SCS Sample			
			1	2	3	4
1	0	Pre-conditioning	*	*	*	*
2	6.10.6.3	Switching the neutral by the supply control switch	*			
3	6.10.6.4	Endurance / Number of operating cycles	*			
4	6.10.6.5	Surge voltage withstand across open contacts				*
5	6.10.6.6	Verification of the ability to carry the rated safe short-time withstand current (I_{ssw})		*		
6	6.10.6.7	Verification of the ability to carry the rated operational short-time withstand current (I_{osw})			*	
7	6.10.6.8	Verification of the ability to make the rated short-circuit current (I_{sm})				*
8	6.10.6.9	Minimum switched current (pass / fail criterion)	*	*	*	*
9	6.10.6.10	Power consumption (pass / fail criterion)	*	*	*	*
10	6.10.6.11	Dielectric test (pass / fail criterion)	*	*	*	*

The * in the table indicates that the particular test should be performed on the particular sample, but the sequence of the tests shall always follow the same order as the test number sequence. For example: SCS sample 1 shall be subjected to test numbers 1, 2, 3, 8, 9 and 10, in that specific order.

SCS sample 3 might not be required, depending on the result of test 5 on SCS sample 2. Test 8, 9 and 10 on SCS sample 2 has to be carried out only if the switch remains operational after test 5.

6.10.6.2 Pre-conditioning

NOTE This subclause is based on IEC 62055-31:2005.

This test shall be carried out as pre-conditioning before the short-circuit current tests to "settle" the switch contacts. It shall also be carried out after the endurance test to establish if the EUT passed the test or not.

The test shall be performed as follows:

- *configure the EUT so that the contact tested is in the closed position;*
- *set voltage and current in the supply control circuit to U_n, I_{max} and PF = 1,0;*
- *apply conditions that lead to the contact to be opened. The conditions for opening – and closing – depend on the function of the switch and should be specified by the manufacturer;*

- *verify that the switch opens at the first attempt;*
- *apply conditions that lead to the contact closed;*
- *verify that the switch closes at the first attempt;*
- *there shall be no evidence of sticking of the contacts;*
- *repeat the test 3 times.*

Where a switch has a mechanical actuating lever then test for trip-free operation by repeating the test as follows:

- *push the lever in the direction for closing of the contacts, then hold it at the nearest point where the supply control switch contacts have just made contact. Cause the switch to open. Repeat the test three times.*

The test is passed if the switch trips for the first attempt each time.

6.10.6.3 Switching the neutral by the supply control switch

Switching the neutral of a three-phase-four wire direct connected meter by the supply control switch is an optional requirement. When the neutral is switched:

- when the switch is opening, the contacts switching the live circuits shall break first and the contacts switching the neutral shall break last;
- when the switch is closing, the contacts switching the neutral shall make first and the contacts switching the live circuits shall make after;
- all other requirements are the same as for the poles switching the phases.

Conformity is checked by inspection.

6.10.6.4 Endurance / number of operating cycles

NOTE 1 This test strictly speaking is not a safety test, as the supply control switch is expected to remain operable at the end of the test. However, the ability to switch minimum current and keeping specified power consumption limits after performing the endurance test have safety implications. For this reason this test is specified here.

Each supply control switch shall be capable of carrying out the number of operations specified in Table 22.

In the case of a polyphase meter, each phase has to be tested. This can be performed on the same sample phase-by-phase one after the other or on different samples separately.

Conformity is checked by the following test carried out on a new test specimen (SCS sample 1, see Table 26). The method for actuating the switch shall be specified by the manufacturer. For this test, other triggers controlling the switch under test shall be disabled.

- *the test circuit essentially comprises the supply source, an overcurrent protective device, the metering equipment under test and a loading impedance;*
- *the voltage shall be set to U_e;*

  NOTE 2 This is a reduced requirement compared to what is specified in IEC 62055-31:2005, Clause C.3.

- *the current shall be set to I_e, and the power factor shall be set to 1,0;*
- *number of operating cycles shall be as specified in Table 22, line 6, with 10 s make and 20 s break time;*
- *the test shall be repeated using the same sample, except that the power factor shall be set to 0,5.*

This test implicitly tests the rated making and breaking capacity.

The test is passed if during the test the switch shows no signs of malfunction, sticking of contacts or reluctance to latch and after the test:

- *the switch is not damaged and no live parts are exposed;*
- *the switch operates normally as specified in 0;*
- *the switch is capable to switch the minimum switched current as specified in 6.10.6.9;*
- *the power consumption does not exceed the limits specified in 6.10.6.10;*
- *the switch passes the dielectric test specified in 6.10.6.11.*

In the case of multi-pole (e.g. three-phase) switches, the conditions shall be met by each pole.

6.10.6.5 Surge voltage withstand across open contacts

Meters equipped with (a) supply control switch(es) shall withstand simulated lightning-induced common mode and differential mode voltage surges as might be expected in residential installations, while the supply control switch contacts are in the open position.

NOTE 1 This test is specifically designed for the case where there is internal electrical coupling of circuits between the input and output terminals of the meter when the supply control switch contacts are in the open condition. The test stresses these coupling elements.

Conformity is checked by the surge test specified in 6.10.2.4, carried out on a new test specimen (SCS sample 4, see Table 26) as follows:

For this test, all triggers controlling the switch under test shall be disabled.

- *meter in non-operating mode, with the contacts of the supply control switch in open position;*
- *the test voltage shall be applied across the terminals of the current circuit which contains the supply control switch. All other terminals shall be connected to earth;*
- *if there is more than one supply control switch, the test shall be applied to each in sequence;*
- *repetition rate not faster than 1 impulse per minute;*
- *test level increased from zero in 1 000 V steps until contact tips flash over, but not more than 12 000 V;*
- *number of surges at each test level: five positive and five negative pulses each;*
- *the voltage at which the contact tips flash over shall be recorded.*

  NOTE 2 Flash-over can be detected by observation and by a collapse of the waveform.

In the case when the neutral is switched, additional common mode voltage tests in addition to the surge voltage test across the open contacts may be agreed between the supplier and the purchaser.

Pass / fail criteria: there shall be no permanent damage to any part of the meter including the components connected across the poles of the switch and if after the test:

- *the switch is capable to switch the minimum switched current as specified in 6.10.6.9;*
- *the power consumption does not exceed the limits specified in 6.10.6.10;*
- *the switch passes the dielectric test specified in 6.10.6.11.*

  NOTE 3 Integrity of the components connected across the poles of the switch can be established by inspection or by a functional test as specified by the manufacturer.

6.10.6.6 Verification of the ability to carry the rated safe short-time withstand current

Meters equipped with (a) supply control switch(es) shall withstand simulated short-circuit currents – as may be experienced under short-circuit conditions in metering installations – and stay safe.

Conformity is checked by the following test carried out on a new test specimen (SCS sample 2, see Table 26).

Test conditions:

- *test circuit as shown in Annex E, comprising the following elements in series:*
  - *a voltage source with a voltage of 1,15 U_e and with reference frequency;*
  - *the metering equipment under test with the supply control switch in closed position;*
  - *load to produce the required test current; and*
  - *a test switch;*
- *prospective test current as specified in Table 22, line 11. The power factor shall be as specified in Table 27;*
- *test voltage tolerance +5 % …–5 %;*
- *test current tolerance +5 % …–0 %.*

Table 27 – Power factor ranges of the test circuit

Test current A	**Corresponding power factor range**
$I \leq 1\,500$	0,93 to 0,98
$1\,500 < I \leq 3\,000$	0,85 to 0,90
$3\,000 < I \leq 4\,500$	0,75 to 0,80
$4\,500 < I \leq 6\,000$	0,65 to 0,70
$6\,000 < I \leq 10\,000$	0,45 to 0,50
NOTE 1 These values are from IEC 60898-1:2015, Table 17. NOTE 2 The phase shift is caused by a combination of resistors and reactors.	

The test shall be performed as follows:

- *the test switch shall be closing at zero voltage crossover and opening at the first subsequent zero voltage crossover, thus remaining in the closed position for one half cycle of the supply voltage;*
- *repeat the test 3 times on the same specimen with an interval of at least 1 min between each test;*
- *plot a graph of the voltage and the test current waveform during each test and verify that the test was executed as is required. The graphs shall be attached to the test report.*

Acceptance conditions: it is permissible that the contacts may weld or burn away but no hazardous live parts shall be exposed, no fire shall occur, or if it occurs, it shall be contained in the meter.

If the switch remained operational, and if after the test:

- *it meets the acceptance conditions of 6.10.6.9, Minimum switched current;*
- *it meets the acceptance conditions of 6.10.6.10, Power consumption;*

- *it meets the acceptance conditions of 6.10.6.11, Dielectric test*

the tests specified in 6.10.6.7 do not need to be performed.

6.10.6.7 Verification of the ability to carry the rated operational short-time withstand current

Meters equipped with (a) supply control switch(es) shall withstand simulated short-circuit currents – as may be experienced under short-circuit conditions in metering installations – and stay operational.

If the test "stay safe" test is passed and the requirements for "stay operational" are also met, then the "stay operational" test need not be performed.

Conformity is checked by the same test as specified in 6.10.6.6, but the prospective test current test shall be as specified in Table 22, line 12, and the test shall be carried out only once, on a new test specimen (SCS sample 3, see Table 26).

Acceptance conditions:

- *during the test the supply control switch shall not open;*
- *after the test the supply control switch shall show no signs of malfunction, sticking or welding of contacts or reluctance to latch;*
- *after the test it shall meet the requirements of 6.10.6.9, Minimum switched current;*
- *after the test it shall meet the requirements of 6.10.6.10, Power consumption;*
- *it shall pass the dielectric test specified in 6.10.6.11.*

NOTE For additional functional and accuracy requirements, see the relevant standards.

6.10.6.8 Verification of the ability to make the rated short-circuit current

Meters equipped with (a) supply control switch(es) shall withstand making into simulated short-circuit currents – as may be experienced under short-circuit conditions in metering installations – and stay safe and operational.

Conformity is checked with the following test, carried out on a new test specimen (SCS sample 4, see Table 26).

Test conditions:

- *test circuit as shown in Annex E, comprising the following elements in series:*
  - *a voltage source voltage with a voltage of 1,15 U_e and with reference frequency;*
  - *the metering equipment under test with the supply control switch in open position;*
  - *load to produce the required test current;*
  - *and a test switch;*
- *prospective test current as specified in Table 22, line 13, power factor as specified in Table 27;*
- *test voltage tolerance +5 % …–5 %;*
- *test current tolerance +5 % …–0 %.*

The test shall be performed as follows:

- *close the switch under test to close into the prospective test current. The switch should remain in the closed position.*

It is not permitted to allow the supply control switch to be activated under the control of the external test equipment, because it could possibly negate special techniques that the meter application process may employ, such as zero point switching. The load switch contacts thus have to be caused to close under the direct control of the EUT itself.

- *the test current shall be maintained to flow up to the first zero point crossing of the current, at which point the test equipment shall disconnect the voltage source;*
- *after the test, the switch shall be opened;*
- *repeat the test 3 times on the same sample with a min. delay of 1 min between each test;*
- *plot a graph of the voltage and the test current waveform during each test and verify that the test was executed as is required.*

During and after the test the following requirements shall be met:

- *contacts shall open on the first attempt after each make operation;*
- *the supply control switch shall show no signs of malfunction, sticking or welding of contacts or reluctance to latch;*
- *after the test the switch shall meet the requirements of 6.10.6.9, Minimum switched current;*
- *after the test the switch shall meet the requirements of 6.10.6.10, Power consumption;*
- *after the test the switch shall pass the dielectric test specified in 6.10.6.11.*

It is recognised that there may be significant statistical variance in the result of this test. A more exact method is under consideration.

6.10.6.9 Minimum switched current (pass / fail criterion)

As part of the pass / fail criteria of the tests specified above (see Table 26), it shall be verified that the supply control switch that have been tested is capable to switch the minimum current.

Compliance is verified with the following test:

- *metering equipment in normal operating condition;*
- *test voltage at U_e;*
- *test current equal to the starting current of the meter, and cos φ= 1;*
- *10 operating cycles at approximately 10 s closed and 20 s open.*

NOTE One operating cycle of the supply control switch is one make followed by one break action.

For the purpose of this test, the manufacturer may provide an external means, which allows for the opening and closing of the supply control switch to be under the control of the test equipment.

Acceptance conditions:

- *the supply control switch shall successfully conduct the test current each time the contacts are in the closed position;*
- *the supply control switch shall successfully break the test current each time the contacts are in the open position.*

6.10.6.10 Power consumption (pass / fail criterion)

As part of the pass / fail criteria of the tests specified above (see Table 26), it shall be verified that the power consumption of the current circuit that comprises the supply control switch that have been tested does not exceed the values specified here.

If the neutral is also switched, the test also applies to the neutral circuit.

NOTE This subclause is based on IEC 62055-31:2005, 7.3.2.

Compliance is verified with the following test:

The current circuit shall be loaded with the rated operational voltage and maximum current of the meter, cos φ= 1 at reference frequency and temperature, for a duration of 10 min.

Acceptance conditions: The apparent power taken shall not exceed a value in VA equivalent to 0,08 % of U_n in volts multiplied by 100 % of I_{max} in amperes.

EXAMPLE 230 V and 60 A gives 11,0 VA; 230 V and 100 A gives 18,4 VA.

6.10.6.11 Dielectric test (pass / fail criterion)

As part of the pass / fail criteria of the tests specified above (see Table 26), it shall be verified that the open contacts of the load switch can withstand an impulse voltage test of 2 kV and an a.c. test voltage of 1 kV r.m.s. for 1 min.

The test shall be performed as follows:

- *in the case where the neutral line is not switched, the supply side current circuit terminals on the one hand as well as the load side current circuit terminals on the other hand are connected together. All other terminals are connected to earth;*
- *in the case where the neutral line is switched, the supply side current circuit and neutral terminals on the one hand as well as the load side current circuit and the neutral terminals are connected together. All other terminals are connected to earth;*
- *the meter shall be in non-operating condition;*
- *the supply control switch shall be in the open position;*
- *the impulse voltage test as specified in 6.10.2.3 shall be performed with a voltage of 2 kV applied between the two groups of terminals;*
- *the a.c. voltage test as specified in 6.10.2.5 shall be performed with a voltage of 1 kV applied between the two groups of terminals for 1 min;*
- *the leakage current shall be recorded.*

6.10.7 Electrical tests on load control switches (LCSs)

6.10.7.1 Test sequence and sample plan

This subclause 6.10.7 further details the requirements specified in 6.9.8.5 and specifies test methods to verify conformity. Table 28 summarizes the test sequence and sample plan.

Table 28 – Test sequence and sample plan for load control switches

Test number	Test clause		LCS Sample 1	2	3	4	5
1	6.10.7.2	Pre-conditioning	*	*	*	*	*
2 / 1	6.10.7.3	Endurance / Number of operating cycles Test 2/1	*				
2 / 2	6.10.7.3	Endurance / Number of operating cycles Test 2/2		*			
2 / 3	6.10.7.3	Endurance / Number of operating cycles Test 2/3			*		
3	6.10.7.4	Verification of the ability to carry the rated conditional safe short-circuit current (I_{cssw})				*	
4	6.10.7.5	Verification of the ability to carry the rated conditional operational short-circuit current (I_{cosw})					*
5	6.10.7.6	Power consumption (pass / fail criterion)	*	*	*	*	*
6	6.10.7.7	Dielectric test (pass / fail criterion)	*	*	*	*	*

The * in the table indicates that the particular test should be performed on the particular LCS sample.

LCS sample 5 might not be required, depending on the result of test 3 on LCS sample 4. Test 5 and 6 on LCS sample 4 has to be carried out only if the switch remains operational after test 3.

For the purposes of the tests given in this subclause 6.10.7, the load control switch(es) shall be considered as an integral part of the metering equipment and each test shall be performed on the metering equipment as a complete unit. Polyphase load control switches constructed as a single unit shall be tested as a single unit. The terminals of the metering equipment shall be taken to be the effective terminals of the load control switches. Example diagrams of meters with load control switches are given in Annex C.

6.10.7.2 Pre-conditioning

Subclause 0 applies.

6.10.7.3 Endurance / number of operating cycles

NOTE This test strictly speaking is not a safety test, as the load control switch is expected to remain operable at the end of the test. However, the ability to keep specified power consumption limits after performing the endurance test has safety implications. For this reason this test is specified here.

Load control switches shall be capable of carrying out the number of operations specified in Table 23.

Conformity is checked by the following tests carried out on a new test specimen. For this test three load switches and therefore, possibly more than one metering equipment are required. The method for actuating the switch shall be specified by the manufacturer. For this test, other triggers controlling the switch under test shall be disabled.

- *the test circuit essentially comprises the supply source, an overcurrent protective device, the metering equipment under test and a loading impedance;*
- *the voltage shall be set to U_e;*
- *number of operating cycles shall be as specified in Table 23 line 6. Number of switching operation per minute shall not exceed 6 per minute;*
- *test 2/1 shall be performed on LCS sample 1, with a test current set to I_e, as shown in Table 23 line 3a, and power factor shall be set to 1,0. This test implicitly tests the rated making and breaking capacity;*
- *test 2/2 shall be performed on LCS sample 2 with a reduced current as shown in Table 23 line 3b and the power factor set to 0,4. The loading impedance consists of a resistance and inductance in series (if an air-core inductor is used a resistor passing at least 0,6 % of the coil current shall be connected in parallel with it);*

- *test 2/3 shall be performed on LCS sample 3 without current.*

The test is passed if during the test the switch shows no signs of malfunction, sticking of contacts or reluctance to latch and after the test:

- *the switch is not damaged and no live parts are exposed;*
- *the switch operates normally as specified in 6.10.7.2;*
- *the power consumption does not exceed the limits specified in 6.10.7.6;*
- *the switch passes the dielectric test specified in 6.10.7.7.*

6.10.7.4 Verification of the ability to carry the rated conditional safe short-circuit current (I_{cssw})

Load control switches shall withstand simulated short-circuit currents – as may be experienced under short-circuit conditions in metering installations – and stay safe.

Conformity is checked by the following test carried out on a new test specimen (LCS sample 4, see Table 28).

Test conditions:

- *test circuit comprising the following elements connected in series:*
  - *a voltage source voltage U_e, with reference frequency;*
  - *a fuse, conforming to IEC 60269-3, with a rated current equal to, or immediately above, the rated operational current (at power factor = 1) of the switch. The characteristics of the fuse shall be agreed between the manufacturer and the purchaser and shall be included in the test report;*
  - *the metering equipment under test, with the load switch in closed position;*
  - *load to produce the required test current; and*
  - *a test switch.*
- *prospective test current as specified in Table 23 line 9. The power factor shall be as specified in Table 27;*
- *test voltage tolerance +5 % …–5 %;*
- *test current tolerance +5 % …–0 %.*

The test shall be performed as follows:

- *the test switch shall be closing at zero voltage crossover and opening at the first subsequent zero voltage crossover, thus remaining in the closed position for one half cycle of the supply voltage;*
- *repeat the test 3 times on the same specimen with an interval of at least 1 min between each test;*
- *plot a graph of the voltage and the test current waveform during each test and verify that the test was executed as is required. The graphs shall be attached to the test report.*

Acceptance conditions: it is permissible that the contacts may weld or burn away but no hazardous live parts shall be exposed, no fire shall occur, or if it occurs, it shall be contained in the meter.

If the switch remained operational, and after the test:

- *it meets the requirements of 6.10.7.6, Power consumption;*
- *it passes the dielectric test specified in 6.10.7.7*

the tests specified in 6.10.6.6 do not need to be performed.

6.10.7.5 Verification of the ability to carry the rated conditional operational short-circuit current (I_{cosw})

Load control switches shall withstand simulated short-circuit currents – as may be experienced under short-circuit conditions in metering installations – and stay operational.

If the test “stay safe” test is passed and the requirements for “stay operational” are also met, then the “stay operational” test need not be performed.

Conformity is checked by the same test as specified in 6.10.6.5, but with prospective test current as specified in Table 23, line 10, and the test shall be carried out a new test specimen (LCS sample 5, see Table 28).

Acceptance conditions:

- *during the test the supply control switch shall show no signs of malfunction, sticking or welding of contacts or reluctance to latch;*
- *it shall meet the requirements of 6.10.7.6, Power consumption;*
- *it shall pass the dielectric test specified in 6.10.7.7.*

6.10.7.6 Power consumption (pass / fail criterion)

As part of the pass / fail criteria of the tests specified above (see Table 28), it shall be verified that the power loss of the output elements under rated operational current does not exceed 3 W or the voltage drop across the input and output terminals does not exceed 1 V.

6.10.7.7 Dielectric test (pass / fail criterion)

As part of the pass / fail criteria of the tests specified above (see Table 28), it shall be verified that the open contacts of the load switch can withstand an a.c. test voltage of 1 000 V r.m.s. for 1 min.

The test shall be performed as follows:

- *the metering equipment shall be in non-operating condition;*
- *the load control switch shall be in the open position;*
- *the a.c. voltage test as specified in 6.10.2.5 shall be performed with a voltage of 1 kV applied between the input and output terminals of the load switch for 1 min;*
- *the leakage current shall be recorded.*

7 Protection against mechanical hazards

7.1 General

NOTE This subclause is based on IEC 61010-1:2010, 7.1.

The equipment shall not cause a mechanical hazard in normal use, or cause a hazard in a single fault condition that might not be easily noticed. Mechanical hazards include, but are not limited to, the following:

a) sharp edges which could cause cuts (see 7.2);

b) falling equipment, resulting from breakage of the carrying device (see 7.3).

Conformity is checked as specified in 7.2 and 7.3.

7.2 Sharp edges

NOTE 1 This subclause reproduces IEC 61010-1:2010, 7.2.

All easily touched parts of the equipment shall be smooth and rounded so as not to cause injury during normal use of the equipment.

Unless the fault presents an obvious hazard, easily-touched parts of the equipment shall not cause an injury in single fault condition.

Conformity is checked by inspection and, if necessary, by application of an object that represents a finger in size, shape and hardness, to check for abrasions or cuts.

NOTE 2 An acceptable procedure is outlined in UL 1439.

7.3 Provisions for lifting and carrying

NOTE This subclause is based on IEC 61010-1:2010, 7.5. It is relevant only to carrying handles used before installation of metering equipment.

If a carrying handle is fitted with the metering equipment or supplied with it, it shall be capable of withstanding a force of four times the weight of the equipment in normal use and in single fault condition.

Conformity is checked by inspection and by the following test.

The carrying handle is subjected to a force corresponding to four times the weight of the equipment. Unless the handle mounting screws (if any) are secured against loosening, one screw is removed before performing these tests. The force is applied uniformly over a 70 mm width at the centre of the handle or grip, without clamping. The force is steadily increased so that the test value is attained after 10 s and maintained for a period of 1 min.

The carrying handle shall not have broken loose from the equipment and there shall not be any permanent distortion, cracking or other evidence of failure which could cause a hazard.

8 Resistance to mechanical stresses

8.1 General

Equipment shall not cause a hazard when subjected to mechanical stresses likely to occur in normal use.

Conformity is checked by performing the following tests on the enclosure.

8.2 Spring hammer test

NOTE This subclause is based on IEC 62052-11:2003, 5.2.2.1.

The mechanical strength of the meter case shall be tested with a spring hammer (test Ehb, see IEC 60068-2-75:2014, Clause 6).

The meter shall be mounted in its normal working position and the spring hammer shall act on the outer surfaces of the meter cover (including windows) and on the terminal cover with a kinetic energy of 0,2 J. The number of impacts shall be three per location.

The result of the test is satisfactory if the meter case and terminal cover(s) do not sustain damage which would make hazardous live parts accessible. Slight damage which does not impair the protection against indirect contact or the penetration of solid objects, dust and water is acceptable.

9 Protection against spread of fire

9.1 General

NOTE 1 Clause 9 is based on IEC 61010-1:2010 Clause 9 and IEC 62052-11:2003, 5.8.

There shall be no spread of fire outside the equipment in normal condition or in single fault condition. Figure 11 is a flow chart showing methods of conformity verification.

See also 0, Overcurrent protection.

Conformity is checked by at least one of the following methods.

a) Testing in the single fault conditions (see 4.4) that could cause the spread of fire outside the equipment. The conformity criteria of 4.4.4.3 shall be met.

b) Verifying elimination or reduction of the sources of ignition within the equipment as specified in 9.2.

c) Verifying as specified in 9.3 that if a fire occurs it will be contained within the equipment.

These alternative methods can be applied throughout the equipment or individually for different sources of hazards or for different areas of the equipment.

NOTE 2 Methods b) and c) are based on fulfilling specified design criteria, in contrast to method a) which relies entirely on testing in specified single fault conditions.

NOTE 3 See 12 concerning protection against fire caused by batteries.

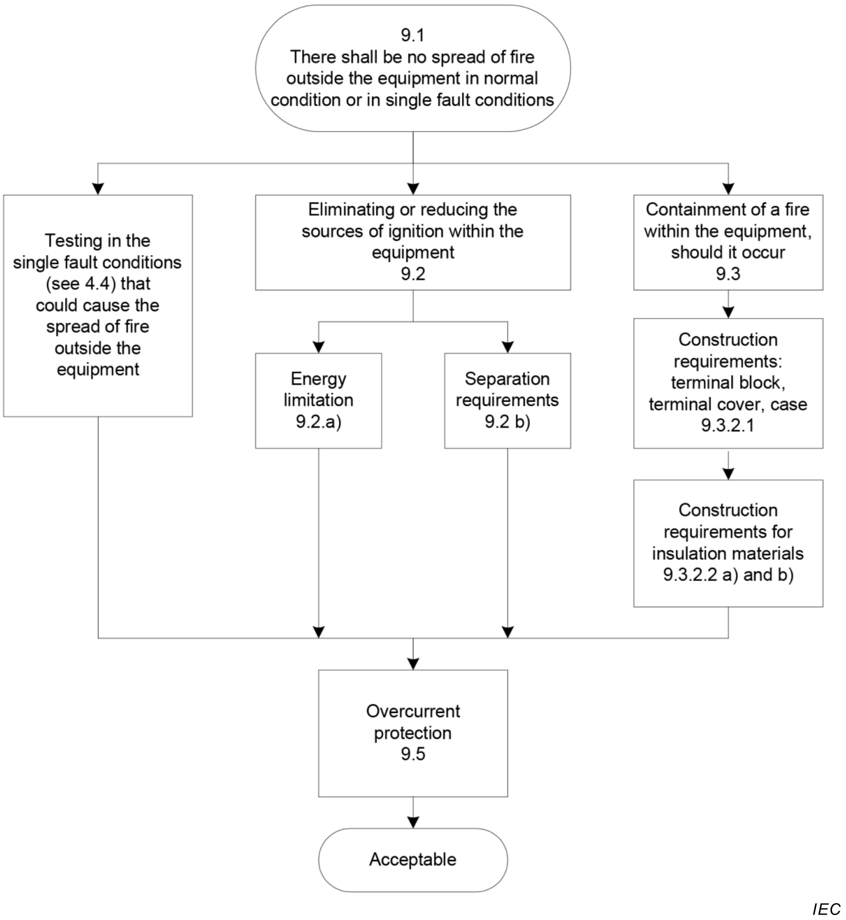


Figure 11 – Flow chart to explain the requirements for protection against the spread of fire

9.2 Eliminating or reducing the sources of ignition within the equipment

NOTE This subclause is based on IEC 61010-1:2010, 9.2.

The possibility of ignition and occurrence of fire is considered to be reduced to a tolerable level if the following requirements are met:

a) the voltage, current and power available to the circuit or part of equipment are limited as specified in 9.4.

   Conformity is checked by measurement of limited-energy values as specified in 9.4.

b) insulation between parts at different potentials meets the requirements for basic insulation, or it can be demonstrated that bridging the insulation will not cause ignition.

   Conformity is checked by inspection and in the case of doubt by test.

9.3 Containment of fire within the equipment, should it occur

9.3.1 General

The possibility of the spread of fire outside the equipment is considered to be reduced to a tolerable level if the equipment and the equipment enclosure conform to the constructional requirements of 9.3.2.

Conformity is checked by inspection and as specified in 9.3.2.

9.3.2 Constructional requirements

9.3.2.1 Terminal block, terminal cover, case

NOTE This subclause is based on IEC 62052-11:2003, 5.8 and IEC 62055-31:2005, 5.8.

The terminal block(s), insulating material retaining the main contacts of supply and load control switches, the terminal cover(s) and the meter case shall ensure reasonable safety against spread of fire. In particular, they should not be ignited by thermal overload of live parts in contact with them.

Conformity is checked by inspection of data on materials, and in case of doubt by performing the glow-wire test specified in IEC 60695-2-11, with the following temperatures:

- *terminal block and insulating material retaining the main contacts of supply and load control switches in position: 960* °C *± 15* °C*;*
- *terminal cover and meter case: 650* °C *± 10* °C*;*
- *duration of application: 30 s ± 1 s.*

The contact with the glow-wire may occur at any random location. If the terminal block is integral with the meter base, it is sufficient to carry out the test only on the terminal block.

9.3.2.2 Connectors and insulation materials on which components are mounted

NOTE 1 This subclause reproduces IEC 61010-1:2010, 9.3.2.

NOTE 2 This subclause does not apply to the terminal block accommodating the terminals of the mains circuits.

The following constructional requirements shall be met:

a) Connectors and insulating material on which components are mounted shall have a flammability classification V-2, or better, of IEC 60695-11-10. See also 13.3 for requirements for printed wiring boards.

   NOTE 3 V-0 is better than V-1, which is better than V-2.

   Conformity is checked by inspection of data on materials, and in case of doubt by performing the vertical burning test of IEC 60695-11-10 on samples used in the relevant parts.

b) Insulated wires shall retard flame propagation.

   NOTE 4 Wire with a flammability rating of UL 2556 VW-1 or equivalent is considered to meet this requirement.

   Conformity is checked by inspection of data on materials, and in case of doubt by performing whichever of the following tests is applicable:

   1) *for wires with overall cross-sectional area of the conductors exceeding 0,5 mm^2, the test of IEC 60332-1-2:2004;*
   2) *for wires with overall cross-sectional area of the conductors of 0,5 mm^2 or less, the test of IEC 60332-2-2:2004.*

9.4 Limited-energy circuit

NOTE This subclause reproduces IEC 61010-1:2010, 9.4.

A limited-energy circuit is a circuit that meets all the following criteria.

a) The voltage appearing in the circuit is not more than 30 V r.m.s., 42,4 V peak, or 60 V d.c.
b) The current that can appear in the circuit is limited by one of the following means:

1) the maximum available current is limited inherently or by impedance so that it cannot exceed the applicable value of Table 29;

2) current is limited by an overcurrent protection device so that it cannot exceed the applicable values of Table 30;

3) a regulating network limits the maximum available current so that it cannot exceed the relevant value of Table 29 in normal condition or as a result of a fault in the regulating network.

c) It is separated by at least basic insulation from other circuits having energy values exceeding criteria a) and b) above.

If an overcurrent protection device is used, it shall be a fuse or a non-adjustable non-self-resetting electromechanical device.

Conformity is checked by inspection and by measuring the potentials appearing in the circuit and the maximum available current, under the following conditions:

i) the potentials appearing in the circuit are measured in the load condition that maximizes the voltage;

ii) output current is measured after 60 s of operation, with the resistive load (including short circuit) which produces the highest value of current.

Table 29 – Limits of maximum available current

Open-circuit output voltage (U or $\hat{U}$)			**Maximum available current**
V			A
a.c. r.m.s.	d.c.	Peak [a]	a.c. r.m.s. or d.c.
$U \leq 2$	$U \leq 2$	$\hat{U} \leq 2,8$	50
$2 < U \leq 12,5$	$2 < U \leq 12,5$	$2,8 < \hat{U} \leq 17,6$	100 / U
$12,5 < U \leq 18,7$	$12,5 < U \leq 18,7$	$17,6 < \hat{U} \leq 26,4$	8
$18,7 < U \leq 30$	$18,7 < U \leq 60$	$26,4 < \hat{U} \leq 42,4$	150 / U

[a] The peak value ($\hat{U}$) applies to non-sinusoidal a.c. and to d.c. with ripple exceeding 10 %, and is provided for convenience. The r.m.s. value of the maximum available current shall be determined as that value is related to heating.

Table 30 – Values for overcurrent protection devices

Potential appearing in the circuit (U or $\hat{U}$)			**Current that the device breaks after not more than 120 s [b, c]**
V			A
a.c. r.m.s.	d.c.	Peak [a]	a.c. r.m.s. or d.c.
$U \leq 2$	$U \leq 2$	$\hat{U} \leq 2,8$	62,5
$2 < U \leq 12,5$	$2 < U \leq 12,5$	$2,8 < \hat{U} \leq 17,6$	125 / U
$12,5 < U \leq 18,7$	$12,5 < U \leq 18,7$	$17,6 < \hat{U} \leq 26,4$	10
$18,7 < U \leq 30$	$18,7 < U \leq 60$	$26,4 < \hat{U} \leq 42,4$	200 / U

[a] The peak value ($\hat{U}$) applies to non-sinusoidal a.c. and to d.c. with ripple exceeding 10 %, and is provided for convenience. The r.m.s. value of the maximum available current shall be determined as that value is related to heating.

[b] The evaluation is based on the specified time-current breaking characteristic of the device, which is different from the rated breaking current. (For example, an ANSI/UL 248-14 5 A fuse is specified to break 10 A at 120 s or less and an IEC 60127 T-type 4 A fuse is specified to break at 8,4 A at 120 s or less.)

[c] The breaking current of fuses is dependent on temperature, and this has to be taken into account if the temperature immediately around the fuse is significantly higher than the room temperature.

9.5 Overcurrent protection

NOTE 1 This subclause is based on IEC 61010-1:2010, 9.6.2.

As this standard applies only to permanently connected metering equipment, the use of internal overcurrent protection elements such as fuses is optional.

NOTE 2 For functional reasons, they are generally not used.

Overcurrent protection of metering equipment is provided by the overcurrent protection of the installation. See also 5.4.5.2.

10 Equipment temperature limits and resistance to heat

10.1 Surface temperature limits for protection against burns

NOTE This subclause is based on IEC 61010-1:2010, 10.1.

At an ambient temperature of 40 °C, the temperature of easily touched surfaces shall not exceed:

a) the values of Table 31 in normal condition; and
b) 105 °C in single fault condition, or when the EUT is exposed to the maximum overload current I_{ovl} as agreed by the manufacturer and the purchaser.

At ambient temperatures exceeding 40 °C, easily touched surfaces of equipment rated for a maximum ambient temperature above 40 °C are permitted to exceed:

c) the values of Table 31 in normal condition; and
d) 105 °C in single fault condition, or when the EUT is exposed to the maximum overload current I_{ovl} as agreed by the manufacturer and the purchaser,

by not more than the amount by which the maximum rated ambient temperature exceeds 40 °C.

Example: If the maximum rated temperature of equipment is 55 °C, then the surface temperature limit of easily touched plastic parts in normal condition is:

a) 85 °C at an ambient temperature of 40 °C, from Table 31;

b) 85 °C + (55 °C – 40 °C) = 100 °C at an ambient temperature of 55 °C.

Surfaces of the terminal blocks covered by terminal covers or, in the case of panel mounted meters, protected by a barrier are not considered to be easily touched surfaces.

Table 31 – Surface temperature limits in normal condition

Part	Limit °C
1) Outer surface of enclosure (unintentional contact)	
a) metal, uncoated or anodized	65
b) metal, coated (paint, non-metallic)	80
c) plastics	85
d) glass and ceramics	80
e) small areas (<2 cm^2) that are not likely to be touched in normal use	100
2) Knobs and handles (normal use contact)	
a) metal	55
b) plastics	70
c) glass and ceramics	65
d) non-metallic parts that in normal use are held only for short periods (1 s – 4 s)	70
NOTE 1 EN 563 and CENELEC Guide 29 provide information about the effect of the duration of contact.	
NOTE 2 For an example of evaluating test results, see 10.4.	

Conformity is checked by measurement as specified in 10.4.

10.2 Temperature limits for terminals

At an ambient temperature of 40 °C the temperature of terminals shall not exceed:

a) the values of Table 32 in normal condition; and

b) 135 °C in single fault condition, or when the EUT is exposed to the maximum overload current I_{ovl} as agreed by the manufacturer and the purchaser.

At ambient temperatures exceeding 40 °C, the temperature of terminals is permitted to exceed:

c) the values of Table 32 in normal condition; and

d) 135 °C in single fault condition, or when the EUT is exposed to the maximum overload current I_{ovl} as agreed by the manufacturer and the purchaser,

by not more than the amount by which the maximum rated ambient temperature exceeds 40 °C.

Example: If the maximum rated temperature is 55 °C, then the temperature limit of bare copper terminals is:

a) 100 °C at an ambient temperature of 40 °C from Table 32;

b) 100 °C + (55 °C – 40 °C) = 115 °C at an ambient temperature of 55 °C.

Table 32 – Temperature limits for terminals

Terminal material	Temperature limits °C [a]
Bare copper	100
Bare brass	105
Tin plated copper or brass	105
Silver plated or nickel plated copper or brass	110
Other metals	[b]

[a] The use in service of connected conductors significantly smaller than those listed in Table 1 could result in higher terminals and internal part temperatures and such conductors should not be used without the manufacturer's consent since higher temperatures could lead to equipment failure.

[b] Temperature limits to be based on service experience or life tests but not to exceed 105 °C.

NOTE This table is based on IEC 60947-1:2007, Table 2, by adding 40 °C to the temperature rise limits specified in that table.

Conformity is checked by measurement as specified in 10.4.

10.3 Temperatures of internal parts

NOTE This subclause is based on IEC 62477-1:2012, 4.6.4.1.

The components, parts and materials of the equipment shall not attain temperatures in excess of those in Table 33 when the equipment is operated in accordance with its ratings.

The equipment shall be is tested in worst case conditions, applying the maximum current I_{max} or, when agreed by the manufacturer and the purchaser the maximum overload current I_{ovl} and the maximum rated voltage, with all optional accessories attached.

The maximum measured temperatures shall be corrected by adding the difference between the ambient temperature during the test and the rated maximum ambient temperature of the equipment.

Compliance is checked by the test of subclause 10.4.

Table 33 – Maximum measured total temperatures for internal materials and components

Materials and components		Thermocouple method °C		Rise of resistance method °C	
1	Rubber- or thermoplastic-insulated conductors [a]	75			
2	Copper bus bars and connecting straps	[b]			
3	Insulation systems on magnetic components (windings) [c]	[d]		[d]	
	Class of insulation (See IEC 60085)	Normal condition	Single fault condition	Normal condition	Single fault condition
	Class A (105)	90	135	100	145
	Class E (120)	105	150	115	160
	Class B (130)	110	155	120	165
	Class F (155)	130	165	140	175
	Class H (180)	155	185	165	195
4	Phenolic composition [a]	165			
5	On bare resistor material	415			
6	Capacitor	[e]			
7	Power electronic devices	[f]			
8	PWBs	[g]			
9	Components bridging at least basic protection	[e]			
10	Batteries	[e]			

[a] The limitation on rubber and thermoplastic insulation and phenolic composition does not apply to compounds which have been investigated and found to meet the requirements for a higher temperature.

[b] The maximum permitted temperature is determined by the temperature limit of support materials or insulation of connecting wires or other components. A maximum temperature of 140 °C is recommended.

[c] The maximum temperatures on insulation of magnetic components assume thermocouples are applied on the surface of coils, and are therefore not located on hot-spots. Rise of resistance method results in a measurement of the average temperature of the winding.

[d] These limits are extracted from the group safety standards IEC 61558-1 and IEC 61558-2-16 (Safety of power transformers, power supplies, reactors and similar products).

[e] For a component, the maximum temperature specified by the manufacturer should not be exceeded.

[f] The maximum temperature on the case should be the maximum case temperature for the applied power dissipation specified by the manufacturer of power electronic devices.

[g] The maximum operating temperature of the PWB shall not be exceeded.

To determine the temperature rise of a winding by the change of resistance method the following formula shall be used.

$$\Delta t = \frac{R_2 - R_1}{R_1}(k + t_1) - (t_2 - t_1)$$

where:

Δt is the temperature rise above t_2 so that the maximum temperature equals to $\Delta t + t_2$;

R_2 is the resistance at the end of the test, in Ω;

R_1 is the resistance at the beginning of the test, in Ω;

t_1 is the ambient temperature at the beginning of the test, in ºC;

t_2 is the ambient temperature at the end of the test, in ºC;

k is 234,5 for copper, 225,0 for electrical conductor grade (EC) aluminium. Values of the constant for other conductors shall be determined.

10.4 Temperature test

NOTE This subclause is based on IEC 62477-1:2012, 5.2.3.10 as well as on IEC 62052-11:2003, 7.2 and IEC 62052-21:2004, 7.2.

The test is intended to ensure that accessible surfaces and parts of the metering equipment do not exceed the temperature limits specified in subclauses 10.1, 10.2 and 10.3 and that the manufacturer's temperature limits of safety-relevant parts are not exceeded.

It is allowed to use a new metering equipment for the test.

Equipment shall be tested built in as specified in the installation instructions, using walls of plywood painted matt black, approximately 10 mm thick when representing the walls of a cabinet, approximately 20 mm thick when representing the walls of a building. The connecting cables shall be as specified in 4.3.2.11.

The test shall be performed under reference conditions specified in 4.3.1, with ambient temperature 23 °C ± 2 °C at the start of the test with each voltage circuit (and with those auxiliary voltage circuits which are energized for periods of longer duration than their thermal time constants) carrying 1,15 times the reference voltage and:

a) *in the case of single phase two-wire meters, both the phase and the neutral conductor carrying rated maximum current;*
b) *in the case of single-phase three-wire meters:*
   1) *each current circuit carrying rated maximum current with the neutral conductor not carrying current;*
   2) *one phase and the neutral conductor carrying rated maximum current;*
c) *in the case of three-phase three-wire meters each current circuit carrying rated maximum current;*
d) *in the case of three-phase four-wire meters:*
   1) *each current circuit carrying rated maximum current with the neutral conductor not carrying current;*
   2) *the current circuit closest to the neutral terminal and the neutral terminal carrying rated maximum current;*
e) *in the case of tariff and load control equipment, energized with 1,15 times the reference voltage and carrying maximum total current.*

For test with polyphase currents, current shall be balanced in each phase within ±5 % and the average of these currents shall be not less than the appropriate test current.

The test shall be maintained until thermal stabilization has been reached. That is, when three successive readings, taken at intervals of 10 % of the previously elapsed duration of the test and not less than 10 min intervals, indicate no change in temperature, defined as ± 1 °C between any of the three successive readings, with respect to the ambient temperature.

If a heat source could cause the failure of insulation at a certain point leading to a hazard, the temperature of the electrical insulation (other than that of windings) is measured on the surface of the insulation at the closest point to the heat source.

If temperatures of windings are measured by the thermocouple method, the thermocouple shall be located on the surface of the winding located at the hottest part due to surrounding heat emitting components. See also notes in Table 33.

The maximum temperature attained shall be corrected to the rated maximum ambient temperature of the metering equipment by adding the difference between the ambient temperature attained during the test and the rated maximum ambient temperature.

No corrected temperature shall exceed the rated temperature of the material or component measured.

EXAMPLE 1

The rated maximum ambient temperature is 40 °C. The meter case is made of plastic. The ambient temperature attained during the test is 32 °C. The maximum temperature measured on the meter case is 64 °C. The corrected temperature is 64 + (40-32) = 72 °C. This is below 85 °C, the limit specified in Table 31. The meter passed.

EXAMPLE 2

The rated maximum ambient temperature is 55 °C. The meter case is made of plastic. The ambient temperature attained during the test is 32 °C. The maximum temperature measured on the meter case is 64 °C. The corrected temperature is 64 + (55-32) = 87 °C.

The temperature limit based on Table 31 scaled to the maximum rated temperature is 85+(55-40) = 100 °C. The meter passed.

EXAMPLE 3

The rated maximum ambient temperature is 55 °C. The meter case is made of plastic. The ambient temperature attained during the test is 32 °C. The maximum temperature measured on the meter case is 79 °C. The corrected temperature is 79 + (55-32) = 102 °C.

The temperature limit based on Table 31 scaled to the maximum rated temperature is 85+(55-40) = 100 °C. The meter failed.

When the manufacturer and the purchaser agreed that the meter may be exposed to the maximum overload current I_{ovl}*, see 3.3.11, the test shall also be carried out on a new test specimen, with the meter carrying the maximum overload current agreed instead of the maximum current. The test duration shall be 2 h. All other conditions shall be the same as during the test with the maximum current.*

The maximum temperature attained shall be corrected to the rated maximum ambient temperature of the metering equipment by adding the difference between the ambient temperature attained during the test and the rated maximum ambient temperature.

The corrected temperature of easily touched surface shall not exceed 105 °C, the temperature of terminals shall not exceed 135 °C and the temperature of internal materials and components shall not exceed the values specified in Table 33.

10.5 Resistance to heat

10.5.1 Non-metallic enclosures

NOTE This subclause is based in IEC 61010-1:2010, 10.5.2.

Enclosures of non-metallic material shall be resistant to elevated temperatures.

Conformity is checked by test, after one of the following treatments.

a) *A non-operative treatment, in which the equipment, not energized, is stored for 7 h at 70 °C ± 2 °C, or at 10 °C ± 2 °C above the temperature measured during the test of 10.4, whichever is higher. If the equipment contains components that might be damaged by this treatment, an empty enclosure may be treated, followed by assembly of the equipment at the end of the treatment.*
b) *An operative treatment, in which the equipment is operated under the reference test conditions of 4.3, except that the ambient temperature is 20 °C ± 2 °C above 40 °C, or above the maximum rated ambient temperature if higher than 40 °C, and loaded as specified in 10.4.*

Within 10 min of the end of treatment the equipment shall be subjected to the stress specified in 8.2, and meet the pass criteria of 8.1.

10.5.2 Insulating materials

NOTE 1 This subclause is based on IEC 61010-1:2010, 10.5.3 and IEC 62052-11:2003, 5.4, with alternative test methods added.

Insulating materials supporting the mains terminals and the contacts of supply and/or load control switches shall have adequate resistance to heat.

Conformity is checked by inspection of data on materials, and in case of doubt by performing one of the following tests.

a) *The deflection temperature test (ISO 75-2)*

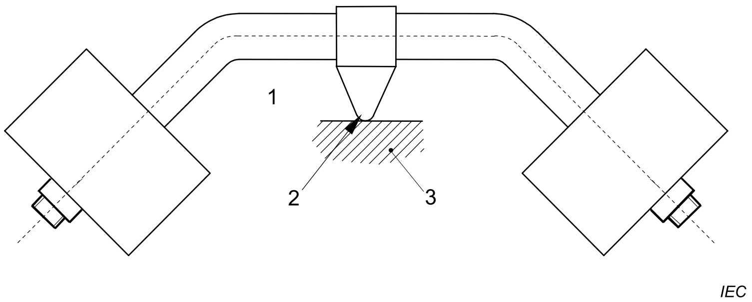
   The insulating material shall be capable of passing the test given in ISO 75-2 for a temperature of 124 °C and a pressure of 1,8 MPa (method A).

b) *The ball pressure test (IEC 60695-10-2)*

   A sample of the insulating material, at least 2,5 mm thick, is subjected to a ball-pressure test using the test apparatus shown in Figure 12. The test is made at 125 °C ± 2 °C. The part to be tested is supported so that its upper surface is horizontal, and the spherical part of the apparatus is pressed against this surface with a force of 20 N. After 1 h the apparatus is removed and the sample is cooled within 10 s to approximately room temperature by immersion in cold water. The diameter of the impression caused by the ball shall not exceed 2 mm.

NOTE 2 If necessary, the required thickness may be obtained by using two or more sections of the part.

NOTE 3 For supply and load control switches, only those parts that support or retain the contacts in position are subjected to the test.



Key

1 Part to be tested

2 Spherical part of the apparatus (diameter 5 mm)

3 Support

Figure 12 – Ball-pressure test apparatus

c) *The Vicat softening test (*ISO 306*)*

   Method A120 using a force of 10 N and a heating rate of 120 °C/h. The Vicat softening temperature shall be at least 130 °C.

11 Protection against penetration of dust and water

NOTE 1 This subclause is based on IEC 62052-11:2003, 5.9.

Metering equipment shall conform to the following degree of protection given in IEC 60529:1989:

- indoor meters IP51;

NOTE 2 Meters equipped with physical payment token carriers acceptors are for indoor use only, unless otherwise specified by the manufacturer.

- outdoor meter: IP54.

For panel mounted meters, where the panel provides IP protection, the IP ratings apply to the meter parts exposed in front of (outside of) the electrical panel.

NOTE 3 Meter parts behind the panel may have lower IP rating, e.g. IP30.

The enclosure shall be treated as:

- category 2 in the case of indoor meters;

NOTE 4 Category 2 enclosures are enclosures where no pressure difference relative to the surrounding air is present.

- category 2 or category 1 in the case of outdoor meters according to the documentation provided by the manufacturer.

NOTE 5 Category 1 enclosures are enclosures where the normal working cycle of the equipment causes reductions in air pressure within the enclosure below that of the surrounding air, for example, due to thermal cycling effects.

Conformity is checked with the following tests:

a) Dust test for first characteristic numeral 5, according to IEC 60529:1989, 13.4:

  - *meter in non-operating condition and installed according to the manufacturer's instructions, including all terminal covers provided;*
  - *with sample lengths of cable (exposed ends sealed) of the type specified by the manufacturer and with the terminal cover(s) in place;*
  - *meters equipped with physical payment token acceptors shall be tested without any token carrier in place in the token carrier acceptor;*
  - *metering equipment with category 2 enclosures shall not be connected to a vacuum pump.*

The protection is satisfactory if, on inspection, talcum powder has not accumulated in a quantity or location such that, as with any other kind of dust, it could interfere with the correct operation of the equipment or impair safety. No dust shall deposit where it could lead to tracking along the creepage distances.

Care should be taken during the inspection to avoid accidental transfer of the talcum powder to locations where its accumulation could be interpreted as a test failure.

b) Protection against penetration of water

  - *meter in the same conditions as for test a)*
  - *test for second characteristic numeral 1 (IPX1) for indoor meters as specified in IEC 60529:1989, 14.2.1 with drip box;*
  - *test for second characteristic numeral 4 (IPX4) for outdoor meters as specified in IEC 60529:1989, 14.2.4, with oscillating tube.*

After testing the enclosure shall be inspected for ingress of water. If any water has entered, it shall not:

- *be sufficient to interfere with the correct operation of the equipment or impair safety;*
- *deposit on insulation parts where it could lead to tracking along the creepage distances;*
- *reach live parts or windings not designed to operate when wet;*
- *accumulate near the cable ends or enter the cables.*

In addition, the AC power-frequency voltage test as specified in 6.10.4.3.4 shall be passed.

12 Protection against liberated gases and substances explosion and implosion – Batteries and battery charging

NOTE This clause is based on IEC 61010-1:2010, 11.5 and 13.2.2 as well as on IEC 60255-27:2013, 8.7.2.2.

Batteries shall be so mounted that safety cannot be impaired by leakage of their electrolyte.

Conformity is checked by inspection.

Batteries shall not cause explosion or produce a fire hazard as a result of excessive charge or discharge, or if a battery is installed with incorrect polarity. If necessary, protection shall be incorporated in the equipment, unless the manufacturer's instructions specify that it is for use only with batteries which have built-in protection. See Annex J for examples of battery protection.

If an explosion or fire hazard could occur through fitting a battery of the wrong type (for example, if a battery with built-in protection is specified) there shall be a warning marking (see 5.2.1) on or near the battery compartment or mounting, and a warning in the manufacturer's instructions. An acceptable marking is symbol 14 of Table 3. See also 5.4.8.

If equipment has means for charging rechargeable batteries, and if non-rechargeable cells could be fitted and connected in the battery compartment, there shall be a warning marking (see 5.2.1) in or near the compartment. The marking shall warn against the charging of non-rechargeable batteries and indicate the type of rechargeable battery that can be used with the recharging circuit. An acceptable marking is symbol 14 of Table 3.

Non-rechargeable batteries used in the equipment should be protected against accidental charging in normal and single fault conditions.

The battery compartment shall be designed so that there is no possibility of explosion or fire caused by build-up of flammable gases.

For batteries intended to be replaced by the user, if an attempt is made to install a battery with its polarity reversed, no hazard shall arise.

Conformity is checked by inspection, including inspection of battery data, to establish that failure of a single component cannot lead to an explosion or fire hazard. If necessary, a short circuit and an open circuit is made on any single component (except the battery itself) whose failure could lead to such a hazard.

For batteries intended to be replaced by an operator, an attempt is made to install a battery with its polarity reversed. No hazard shall arise.

13 Components and sub-assemblies

13.1 General

NOTE 1 This subclause reproduces – mutatis mutandis – IEC 61010-1:2010, 14.1.

Connection of any accessories or modules, such as communication modules, input/output modules, external measuring transformers, etc., shall not reduce the safety of the equipment. Components, sub-assemblies, accessories or modules which are essential to the safety of the equipment, shall conform to one of the following:

a) applicable safety requirements of a relevant IEC standard. Conformity with other requirements of the component standard is not required. If necessary for the application, components shall be subjected to the tests of this standard, except that it is not necessary to carry out identical or equivalent tests already performed to check conformity with the component standard;

NOTE 2 For example if components meet the safety requirements of IEC 60950-1:2005 but are rated for a less severe environment than the applicable environment of 1.4, they also need to meet relevant additional requirements of this standard.

b) the requirements of this standard and, where necessary for the application, any additional applicable safety requirements of the relevant IEC component standard;

c) if there is no relevant IEC standard, the requirements of this standard;

d) applicable safety requirements of a non-IEC standard which are at least as high as those of the relevant IEC standard, provided that the component has been approved to the non-IEC standard by a recognized testing authority.

NOTE 3 Tests performed by a recognized testing authority which confirm conformity with applicable safety requirements need not be repeated even if the tests were performed using a non-IEC standard.

Figure 13 is a flow chart showing methods of conformity verification.

Conformity is checked by inspection and, if necessary, by test.

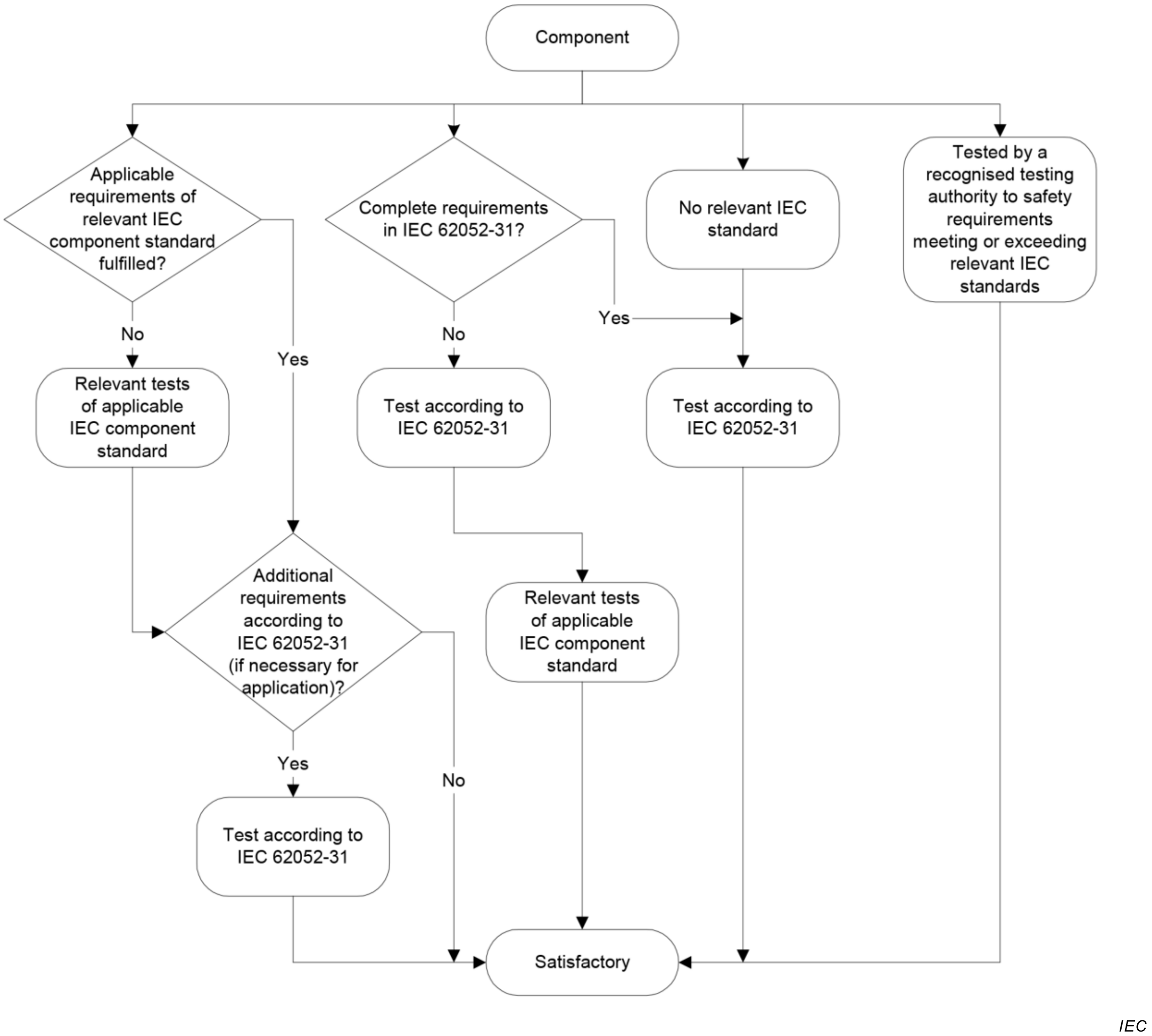


Figure 13 – Flow chart for conformity options 13.1 a), b), c) and d)

13.2 Mains transformers tested outside equipment

NOTE This subclause reproduces – mutatis mutandis – IEC 61010-1:2010, 14.6.

If environmental conditions could affect the test results, transformers tested outside the equipment (see 4.4.2.4) shall be tested in the same conditions as exist inside the equipment.

Conformity is checked by the relevant tests specified in 4.4.2.4.2, 4.4.2.4.3, 4.4.2.4.4, and followed by the test of 4.4.4.1 b) and c). If there is any doubt whether a transformer would pass the other tests specified in 4.4.4 and 10.2 when installed in the equipment, the tests are repeated with the transformer installed in the equipment.

13.3 Printed wiring boards

NOTE This subclause reproduces IEC 61010-1:2010, 14.7.

Printed wiring boards shall be made of material with a flammability classification of V-1 of IEC 60695-11-10 or better.

This requirement does not apply to printed wiring boards which contain only limited-energy circuits meeting the requirements of 9.4.

Conformity of the flammability rating is checked by inspection of data on the materials. Alternatively, conformity is checked by performing the vertical burn tests of IEC 60695-11-10 on three samples of the relevant parts. The samples may be complete boards, sections of the boards or specimens as specified in IEC 60695-11-10.

13.4 Components bridging insulation

NOTE This subclause has been taken from IEC 62477-1:2012, 4.4.7.1.7.

Components bridging insulation shall comply with the requirements of the level of insulation (e.g. basic, reinforced or double) they are bridging.

13.5 Circuits or components used as transient overvoltage limiting devices

NOTE 1 This subclause is based on IEC 61010-1:2010, Clause K.4.

Transient overvoltages in a circuit may be limited by combinations of circuits or components. Components suitable for this purpose include varistors and gas-filled surge arrestors.

NOTE 2 IEC 61643-12 provides information on the selection and application principles of surge protective devices.

If the overvoltage limiting device or circuit is intended to reduce transient overvoltages so that the circuit following it may have reduced clearances, a risk assessment (see Clause 15) shall be performed, taking into account both of the following aspects:

a) No hazard shall arise in the event that the component ruptures or overheats during the test. If a rupture occurs, no part of the component shall bridge safety-relevant insulation. If the component overheats, it shall not heat other materials to their self-ignition points. Tripping of the protection during the test specified in 6.10.3.4 is an indication of failure.
b) the circuit shall operate as intended even after withstanding repeated transient overvoltages.

Conformity is checked by evaluation of the risk assessment documentation to ensure that the risks have been eliminated or that only tolerable risks remain.

14 Hazards resulting from application – Reasonably foreseeable misuse

NOTE This clause reproduces IEC 61010-1:2010, 16.1.

No hazards shall arise if adjustments, knobs, or other controls are set in a way not intended, and not described in the instructions. Other possible cases of reasonably foreseeable misuse that are not addressed by specific requirements in this standard shall be addressed by risk assessment (see Clause 15).

Conformity is checked by inspection and by evaluation of the RISK assessment documentation.

15 Risk assessment

NOTE 1 This clause reproduces IEC 61010-1:2010 Clause 17.

If examination of the equipment shows that hazards not fully addressed in Clauses 6 to 14 (see 1.2.1) might arise, then risk assessment is required. It shall be carried out and documented to achieve at least a tolerable risk by an iterative process covering the following.

a) Risk analysis

   Risk analysis is the process to identify hazards and to estimate the risk based on the use of available information.

b) Risk evaluation

   Each risk analysis requires a plan to evaluate the estimated severity and likelihood of a risk, and to judge the acceptability of the resulting risk level.

c) Risk reduction

   If the initial risk level is not acceptable, steps shall be taken to reduce the risk. The process of risk analysis and risk evaluation shall then be repeated, including checking that no new risks have been introduced.

Risks remaining after a risk assessment shall be identified in the instructions for the installer, operator, user and service personnel. Adequate information about how to mitigate these risks shall be given.

In selecting the most appropriate methods of risk reduction, the manufacturer shall apply the following principles, in the order given:

1) eliminate or reduce risks as far as possible (an inherently safe design and construction);
2) take the necessary protective measures in relation to risks that cannot be eliminated;
3) inform users of the residual risks due to any shortcomings of the protective measures adopted, indicate whether any particular training is required, and specify any need to provide personal protective equipment.

NOTE 2 One risk assessment procedure is outlined in Annex J of IEC 61010-1:2010. Other risk assessment procedures are contained in ISO 14971, SEMI S10-1296, IEC 61508, ISO 14121-1, and ANSI B11.TR3. Other established procedures which implement similar steps can also be used.

Conformity is checked by evaluation of the risk assessment documentation to ensure that the risks have been eliminated or that only tolerable risks remain.

Annex A
(normative)

Measuring circuits for touch current

A.1 Measuring circuit for a.c. with frequencies up to 1 MHz and for d.c.

NOTE 1 This Annex A reproduces IEC 61010-1:2010, Annex A.

NOTE 2 It is based on IEC 60990, which specifies procedures for measuring touch-current, and also specifies the characteristics for test voltmeters.

NOTE 3 Frequency dependence of electric shocks is being investigated by TC 64 and depending on the result changes in this area may be required.

The current is measured using the circuit of Figure A.1. The current is calculated from:

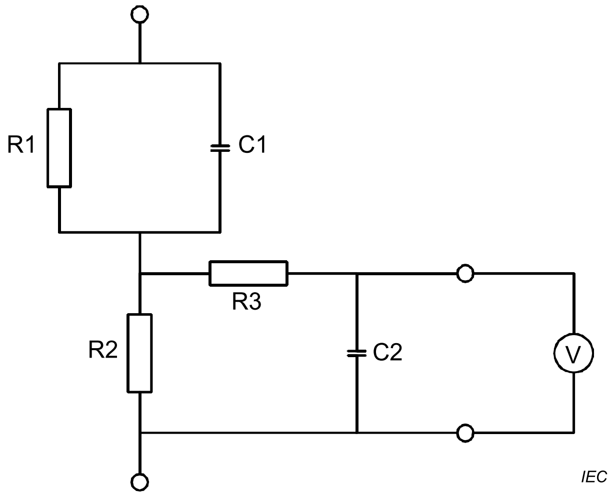
$$I = \frac{U}{500}$$

where

I is the current, in A;

U is the voltage, in V, indicated by the voltmeter.

This circuit represents the impedance of the body and compensates for the change of physiological response of the body with frequency.



Key

R1 = 1 500 Ω with a relative tolerance of ±5 %

R2 = 500 Ω with a relative tolerance of ±5 %

R3 = 10 kΩ with a relative tolerance of ±5 %

C1 = 0,22 μF with a relative tolerance of ±10 %

C2 = 0,022 μF with a relative tolerance of ±10 %

Figure A.1 – Measuring circuit for a.c. with frequencies up to 1 MHz and for d.c.

A.2 Measuring circuits for sinusoidal a.c. with frequencies up to 100 Hz and for d.c.

If the frequency does not exceed 100 Hz, the current may be measured using either of the circuits of Figure A.2. When using the voltmeter, the current is calculated from:

$$I = \frac{U}{2000}$$

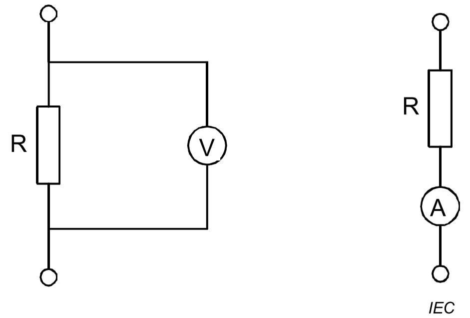
where

I is the current, in A;

U is the voltage, in V, indicated by the voltmeter.

The circuit represents the impedance of the body for frequencies not exceeding 100 Hz.

NOTE The value 2 000 Ω includes the impedance of the measuring instrument.



Key

R = 2 000 Ω with a relative tolerance of ±5 %

Figure A.2 – Measuring circuits for sinusoidal a.c. with frequencies up to 100 Hz and for d.c.

A.3 Current measuring circuit for electrical burns at high frequencies

The current is measured using the circuit of Figure A.3 . The current is calculated from:

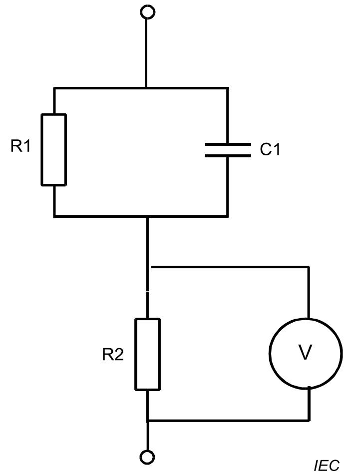
$$I = \frac{U}{500}$$

where

I is the current, in A;

U is the voltage, in V, indicated by the voltmeter.

This circuit compensates for the effects of high frequency on the physiological response of the body.



Key

R1 = 1 500 Ω with a relative tolerance of ±5 %

R2 = 500 Ω with a relative tolerance of ±5 %

C1 = 0,22 μF with a relative tolerance of ±10 %

Figure A.3 – Current measuring circuit for electrical burns

A.4 Current measuring circuit for wet location

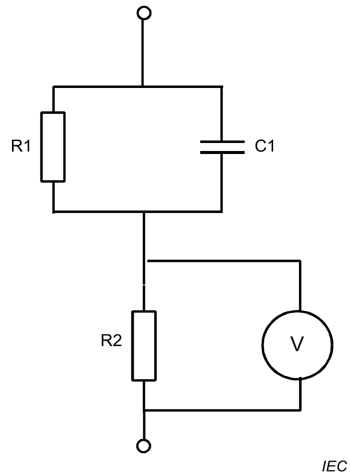
For wet location the current is measured using the circuit of Figure A.4. The current is calculated from:

$$I = \frac{U}{500}$$

where

I is the current, in A;

U is the voltage, in V, indicated by the voltmeter.



Key

R1 = 375 Ω with a relative tolerance of ±5 %

R2 = 500 Ω with a relative tolerance of ±5 %

C1 = 0,22 μF with a relative tolerance of ±10 %

Figure A.4 – Current measuring circuit for wet contact

Annex B
(informative)

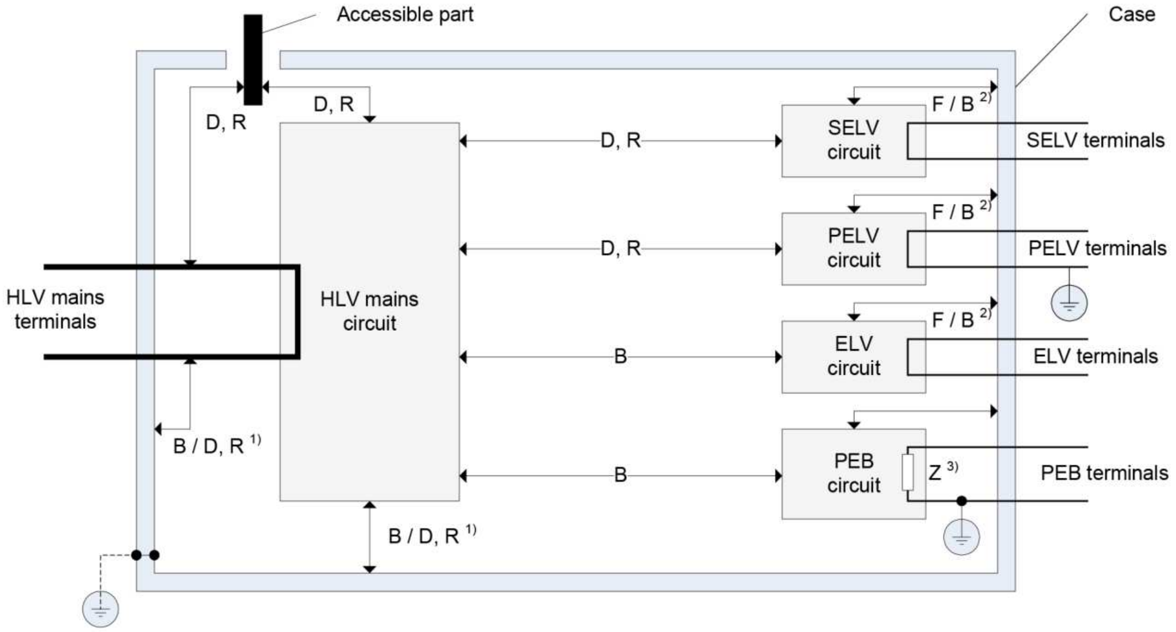
Examples for insulation between parts

B.1 Insulation between parts – Example 1

Figure B.1 shows a meter with the HLV mains terminals – the voltage and current terminals – connected directly to the HLV mains circuit.

Double or reinforced insulation is applied between the HLV mains circuit and the SELV circuit as well as between the HLV mains circuit and the PELV circuit.

Basic insulation is applied between the HLV mains circuit and the ELV circuit as well as between the HLV mains circuit and the PEB circuit with one pole of the PEB terminals connected to protective earth.



1) If the case / accessible parts are conductive and they are connected to the protective conductor terminal, only basic insulation is required between these and the mains terminals / mains circuit. Otherwise, double or reinforced insulation is required.

2) If the case is conductive, basic insulation is required between it and the non-mains circuit, SELV, PELV, ELV and PEB circuits. Otherwise, functional insulation may be used.

3) The connection path of the PEB circuit to the protective conductor terminal, including impedance Z, shall comply with 6.5.2.4. Then, if under a single fault condition, an HLV conductor was shorted to the PEB circuit, the PEB circuit would not become hazardous live.

Figure B.1 – Insulation between parts – Example 1

To verify this design a test voltage for double / reinforced insulation has to be applied between the HLV mains terminals and the SELV and PELV terminals.

If a reinforced insulation is used this design can be verified in both normal and single fault conditions using the black box test method, provided that the full test voltage appears across the insulation under test.

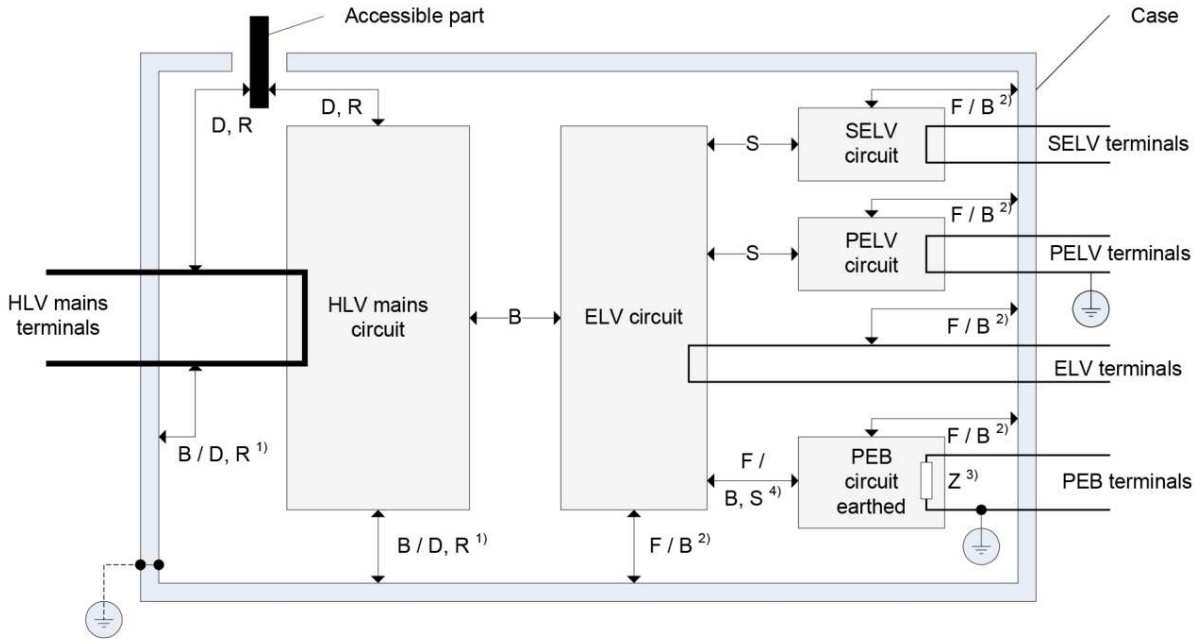
If a double insulation is used, this design can be verified only in normal condition using the black box test method provided that the full test voltage appears across the insulation under test. However, design verification in single fault condition is not possible with the black box test method. The double insulation consists of a layer of basic insulation and a layer of supplementary insulation. In single fault conditions each of these layers should be subjected to fault (shorted), one at a time, and it should be verified that the remaining intact insulation layer still provides at least basic protection.

B.2 Insulation between parts – Example 2

Figure B.2 shows a meter with the HLV mains terminals – the voltage and current terminals – connected directly to the HLV mains circuit.

Basic insulation is applied between the HLV mains circuit and the ELV circuit.

Supplementary insulation is applied between the ELV circuit and the SELV circuit as well as between the ELV circuit and the PELV circuit. With this, double insulation between the HLV mains circuits and the SELV / PELV circuits is assured.



1) If the case / accessible parts are conductive and they are connected to the protective conductor terminal, only basic insulation is required between these and the HLV mains terminals / mains circuit. Otherwise, double or reinforced insulation is required.

2) If the case is conductive, basic insulation is required between it and the SELV, PELV, ELV and PEB circuits. Otherwise, functional insulation may be used.

3) The connection path of the PEB circuit to the protective conductor terminal, including impedance Z, shall comply with 6.5.2.4. Then, if under a single fault condition, an HLV conductor was shorted to the PEB circuit, the PEB circuit would not become hazardous live.

4) Functional insulation is required between the ELV circuit and the PEB circuit, unless the circuits have to be independent in which case basic or supplementary insulation shall be used.

Figure B.2 – Insulation between parts – Example 2

To verify this design, a test voltage for double or reinforced insulation has to be applied between the HLV mains terminals and the SELV and PELV terminals.

Verification of the basic insulation between the HLV mains circuit and the ELV circuit on the one hand, and verification of the supplementary insulation between the ELV circuit and the

PELV/SELV circuits on the other hand is not possible using a black box test method as it is not possible to ensure that the correct test voltage will be applied to each insulation layer.

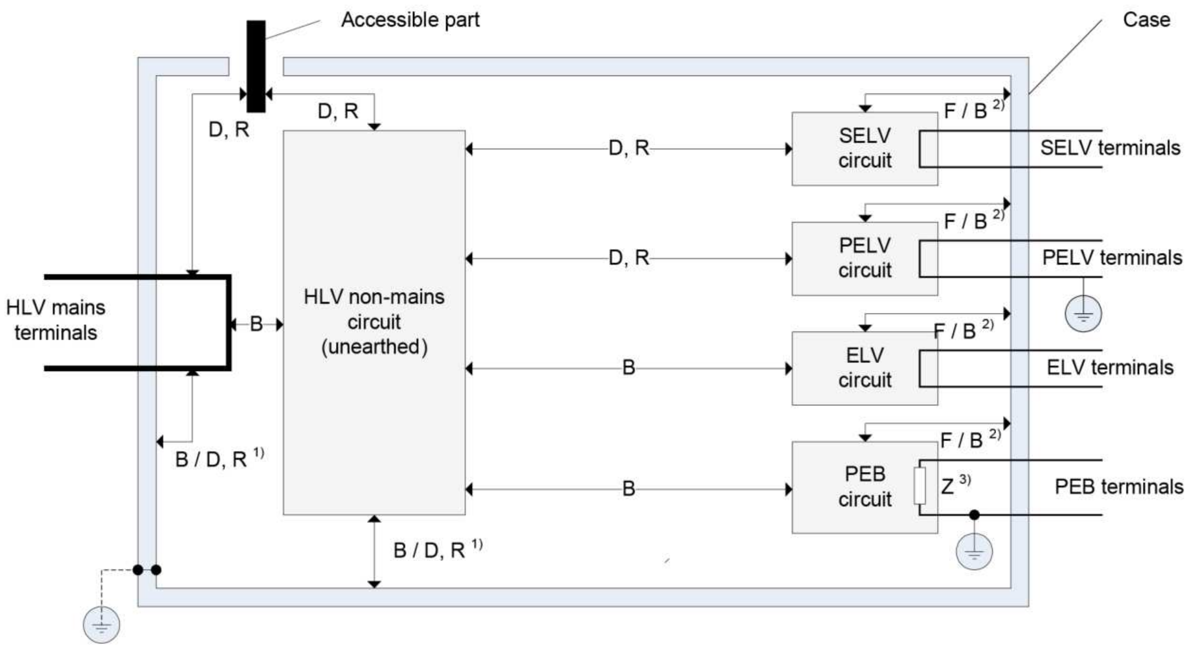
Design verification in single fault condition is not possible either with the black box test method. The double insulation consists of a layer of basic insulation and a layer of supplementary insulation (in this example equivalent to basic insulation). In single fault conditions each of these layers should be subjected to fault (shorted), one at a time, and it should be verified that the remaining, intact insulation layer still provides at least basic protection.

B.3 Insulation between parts – Example 3

Figure B.3 shows a meter with HLV mains terminals – the voltage and current terminals – insulated from the HLV non-mains circuit by basic insulation.

Double or reinforced insulation is applied between the HLV non-mains circuit and the SELV circuit as well as between the HLV non-mains circuit and the PELV circuit. With this, double insulation between the HLV mains terminals and the SELV / PELV circuits is assured.

Basic insulation is applied between the HLV non-mains circuit and the ELV circuit as well as between the HLV non-mains circuit and the PEB circuit with one pole of the PEB terminals connected to protective earth.



1) If the case / accessible parts are conductive and they are connected to the protective conductor terminal, only basic insulation is required between these and the HLV mains terminals / mains circuit. Otherwise, double or reinforced insulation is required.

2) If the case is conductive, basic insulation is required between it and the non-mains circuit, the SELV, and PELV circuits. Otherwise, functional insulation may be used.

3) The connection path of the PEB circuit to the protective conductor terminal, including impedance Z, shall comply with 6.5.2.4. Then, if under a single fault condition, an HLV conductor was shorted to the PEB circuit, the PEB circuit would not become hazardous live.

Figure B.3 – Insulation between parts – Example 3

To verify this design, a test voltage for double or reinforced insulation has to be applied between the HLV mains terminals and the SELV and PELV terminals.

If a reinforced insulation is used this design can be verified in both normal and single fault conditions using the black box test method, provided that the full test voltage appears across the insulation under test.

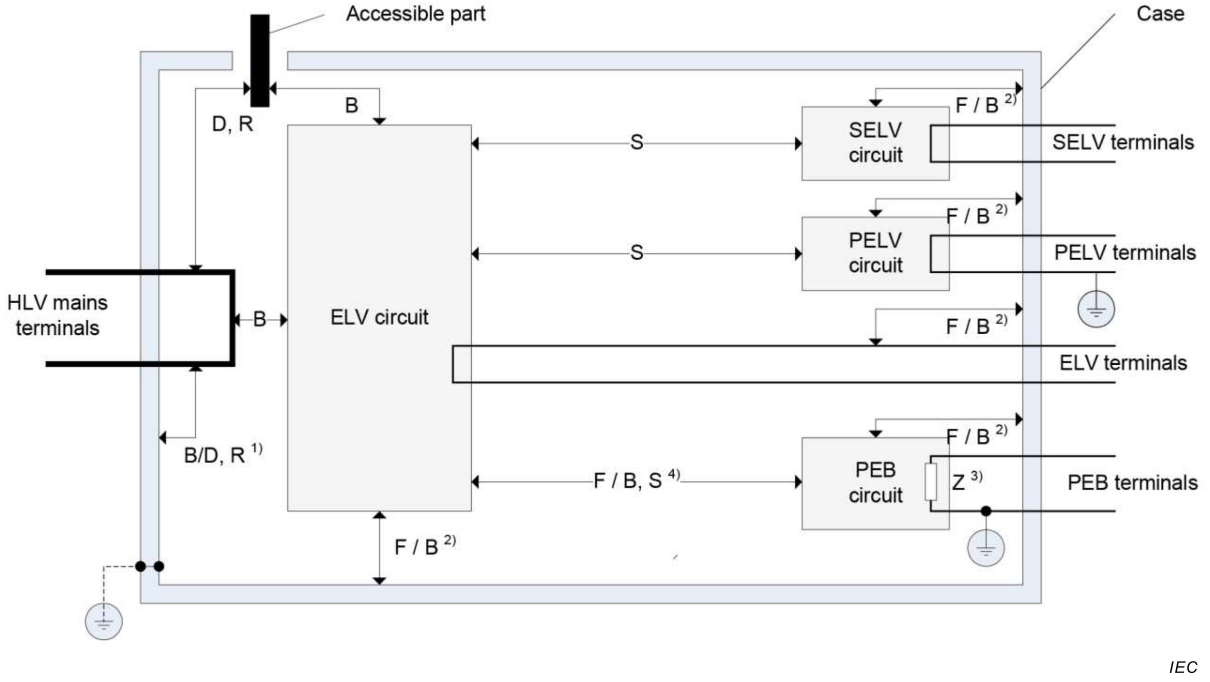
If a double insulation is used, this design can be verified only in normal condition using the black box test method provided that the full test voltage appears across the insulation under test. However, design verification in single fault condition is not possible with the black box test method. The double insulation consists of a layer of basic insulation and a layer of supplementary insulation. In single fault conditions each of these layers should be subjected to fault (shorted), one at a time, and it should be verified that the remaining intact insulation layer still provides at least basic protection.

B.4 Insulation between parts – Example 4

Figure B.4 shows a meter with HLV mains terminals – the voltage and current terminals – insulated from the ELV circuit by basic insulation.

Supplementary insulation is applied between the ELV circuit and the SELV circuit as well as between the ELV circuit and the PELV circuit. With this, double insulation between the HLV mains terminals and the SELV / PELV circuits is assured.

The PEB circuit is connected directly to the mains circuit with one pole of the PEB terminals connected to protective earth.



1) If the case / accessible parts are conductive and they are connected to the protective conductor terminal, only basic insulation is required between these and the HLV mains terminals. Otherwise, double or reinforced insulation is required.

2) If the case is conductive, basic insulation is required between it and the non-mains circuit, SELV, PELV, ELV and PEB terminals. Otherwise, functional insulation may be used.

3) The connection path of the PEB terminals to the protective conductor terminal, including impedance Z, shall comply with 6.5.2.4. Then, if under a single fault condition, an HLV conductor was shorted to the PEB terminals, the PEB terminals would not become hazardous live.

4) Functional insulation is required between the ELV circuit and the PEB circuit, unless the circuits have to be independent in which case basic or supplementary insulation shall be used.

Figure B.4 – Insulation between parts – Example 4

To verify this design a test voltage for double / reinforced insulation test has to be applied between the HLV mains terminals and the SELV and PELV terminals.

Verification of the basic insulation between the HLV mains terminals and the ELV circuit on the one hand, and verification of the supplementary insulation between the ELV circuit and the PELV/SELV circuits on the other hand is not possible using a black box test method as it is not possible to ensure that the correct test voltage will be applied to each insulation layer.

Design verification in single fault condition is not possible either with the black box test method. The double insulation consists of a layer of basic insulation and a layer of supplementary insulation (in this example equivalent to basic insulation). In single fault conditions each of these layers should be subjected to fault (shorted), one at a time, and it should be verified that the remaining, intact insulation layer still provides at least basic protection.

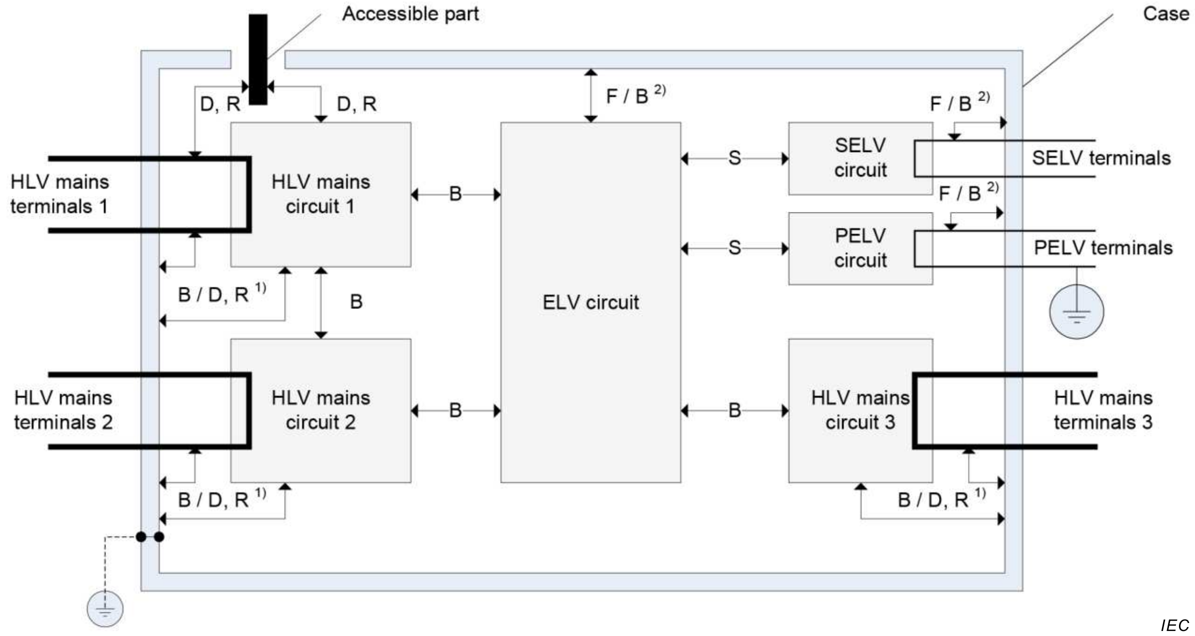
B.5 Insulation between parts – Example 5

Figure B.5 shows a meter with three independent mains circuits:

- The HLV mains terminals 1 are the voltage and current terminals connected directly to mains circuit 1.
- The HLV mains terminals 2 are auxiliary supply terminals connected directly to mains circuit 2.
- The HLV mains terminals 3 are the terminals of a load switch with independent terminals, connected directly to mains circuit 3.

Basic insulation is applied between each mains circuit and the ELV circuit.

Supplementary insulation is applied between the ELV circuit and the SELV circuit as well as between the ELV circuit and the PELV circuit. With this, double insulation between the HLV mains circuits and the SELV / PELV circuits is assured.



1) If the case / accessible parts are conductive and they are connected to the protective conductor terminal, only basic insulation is required between these and the HLV mains terminals. Otherwise, double or reinforced insulation is required.

2) If the case is conductive, basic insulation is required between it and the non-mains circuit, SELV, PELV, ELV and PEB terminals. Otherwise, functional insulation may be used.

Figure B.5 – Insulation between parts – Example 5

To verify this design, a test voltage for double or reinforced insulation has to be applied between the HLV mains terminals and the SELV and PELV terminals.

Verification of the basic insulation between the HLV mains circuits and the ELV circuit on the one hand, and verification of the supplementary insulation between the ELV circuit and the PELV/SELV circuits on the other hand is not possible using a black box test method as it is not possible to ensure that the correct test voltage will be applied to each insulation layer.

Design verification in single fault condition is not possible either with the black box test method. The double insulation consists of a layer of basic insulation and a layer of supplementary insulation (in this example equivalent to basic insulation). In single fault conditions each of these layers should be subjected to fault (shorted), one at a time, and it should be verified that the remaining, intact insulation layer still provides at least basic / supplementary protection.

Annex C
(informative)

Examples for direct connected meters equipped with supply control and load control switches

Figure C.1 shows a single phase two wire meter with an UC2 supply control switch (SCS) and a 25A load control switch (LCS).

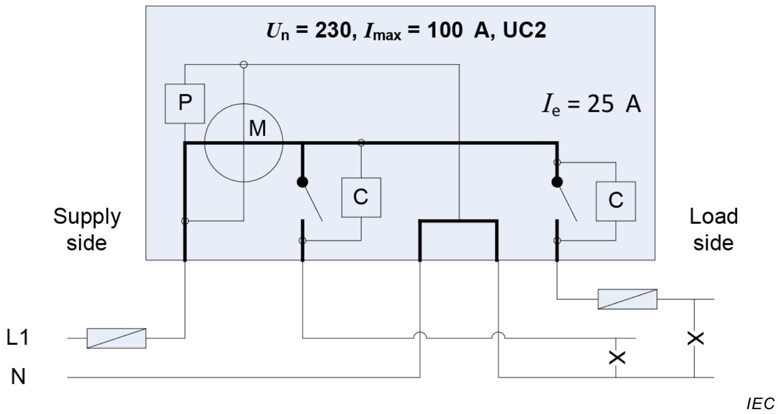
For marking of switches, see 5.3.5.

The SCS may be controlled by a payment metering function, a limiter function and/or remotely. The meter and the SCS are protected by the upstream – supply side – protection.

The LCS controls part of the load, and may be controlled by a time switch function and/or remotely. It is protected by the downstream – load side – protection.

The protection network P is a component or network of components on the supply side of the meter power supply, supply voltage input and/or PLC coupling circuit, for the purpose of protecting such circuits from severe differential mode surges. Typical devices are voltage operated surge arrestors with unspecified operating voltage and surge capacity.

The coupling network C is a component or network of components connected in parallel with the terminals of a supply control switch, for the purpose of providing functionality when the switch is in the open position. Typical functionality is load side voltage sensing and PLC signal coupling. In its simplest form, the coupling network C is the dielectric of the load switch housing which must withstand severe common and differential mode surges.



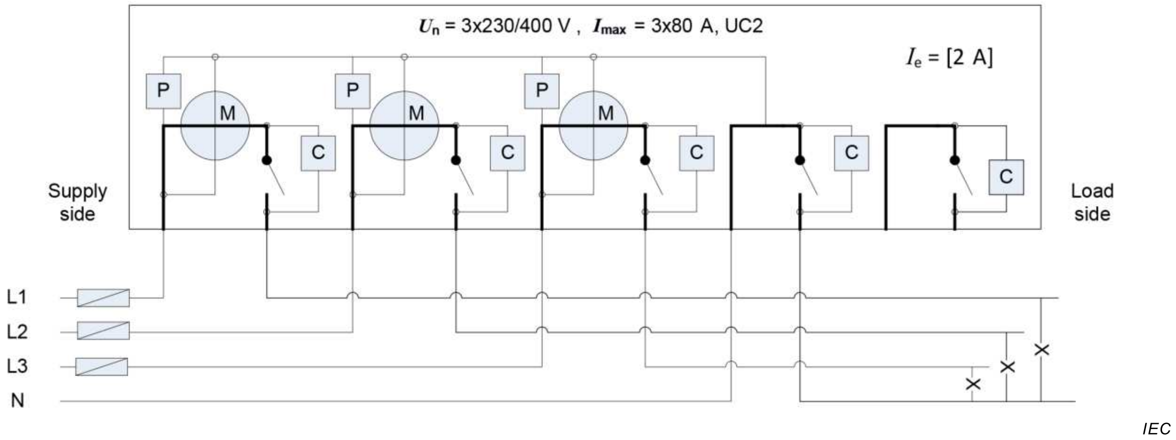
Key
C coupling network
M measuring element
P protection network

Figure C.1 – Single phase two wire meter with UC2 SCS and 25A LCS

Figure C.2 shows a three phase four wire meter with an UC2 supply control switch (SCS), also switching the neutral, and a 2A auxiliary control switch (ACS) with independent terminals.

The SCS may be controlled by a payment metering function, a limiter function and/or remotely. The meter and the SCS are protected by the upstream – supply side – protection.

The ACS controls part of the load, eventually through a contactor – and may be controlled by a time switch function and/or remotely. The contactor and the downstream protection of the ACS are not shown.



Key

C coupling network
M measuring element
P protection network

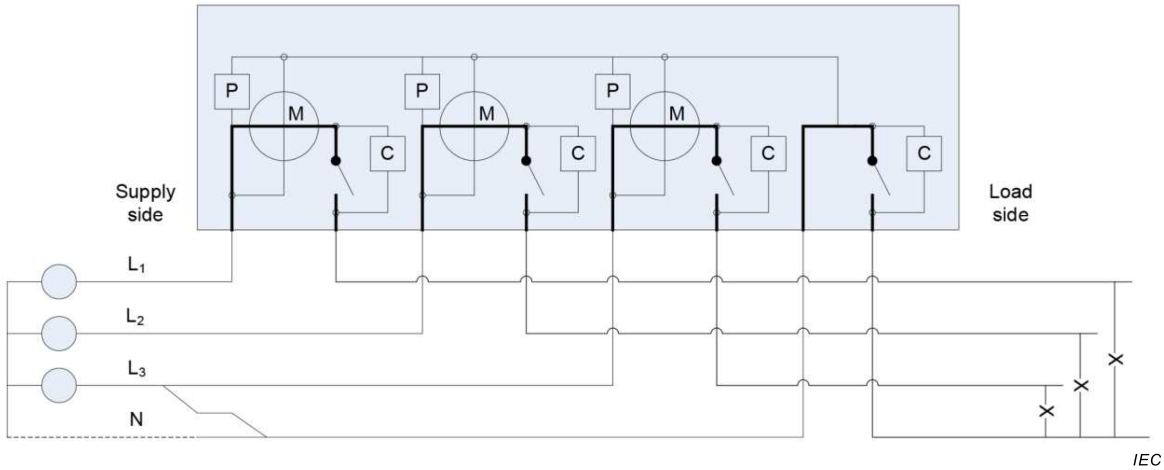
Figure C.2 – Three phase four wire meter with UC2 SCS and 2A auxiliary control switch

Annex D
(normative)

Test circuit diagram for the test of long term overvoltage withstand

Figure D.1 shows the test circuit diagram, for the long term overvoltage withstand test specified in 6.10.3.2 in the case of testing a three-phase four wire meter.

Figure D.2 shows the voltages that appear at the terminals of the EUT during the test.



Key

C coupling network

M measuring element

P protection network

Figure D.1 – Circuit for three-phase four-wire meters to simulate long term overvoltage, voltage moved to L3

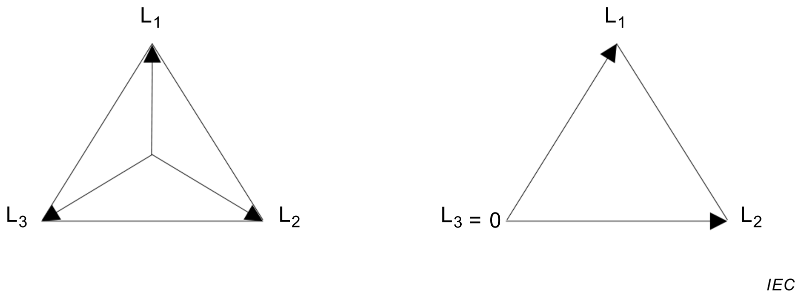


Figure D.2 – Voltages at the meter under test

Annex E
(normative)

Test circuit diagram for short current test on the current circuit of direct connected meters

Figure E.1 shows the principal test circuit diagram for short current tests on the current circuit of direct connected meters equipped or not with a supply control switch, specified in 6.10.5, 6.10.6.6 6.10.6.7 and 6.10.6.8.

NOTE 1 Figure E.1 is based on Figure 9 of IEC 60947-1:2007.

For the verification of the ability to carry the rated safe short-time withstand current – see 6.10.6.6 – and for the verification of the ability to carry the rated operational short-time withstand current – see 6.10.6.7 – the switch under test shall be closed.

For the verification of the ability to make the rated short-circuit current – see 6.10.6.8 – the switch under test is open before the test and it closes during the test.

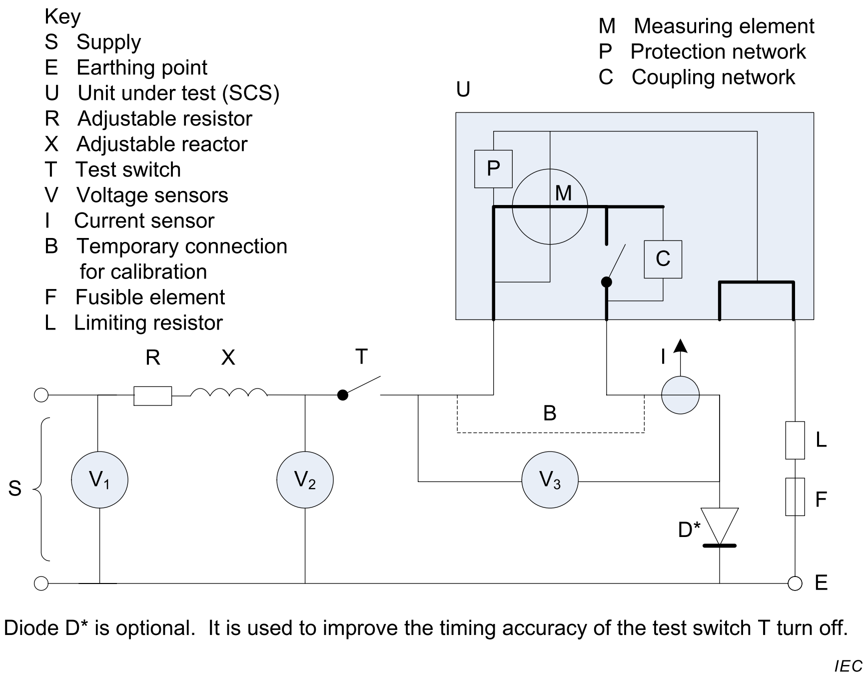
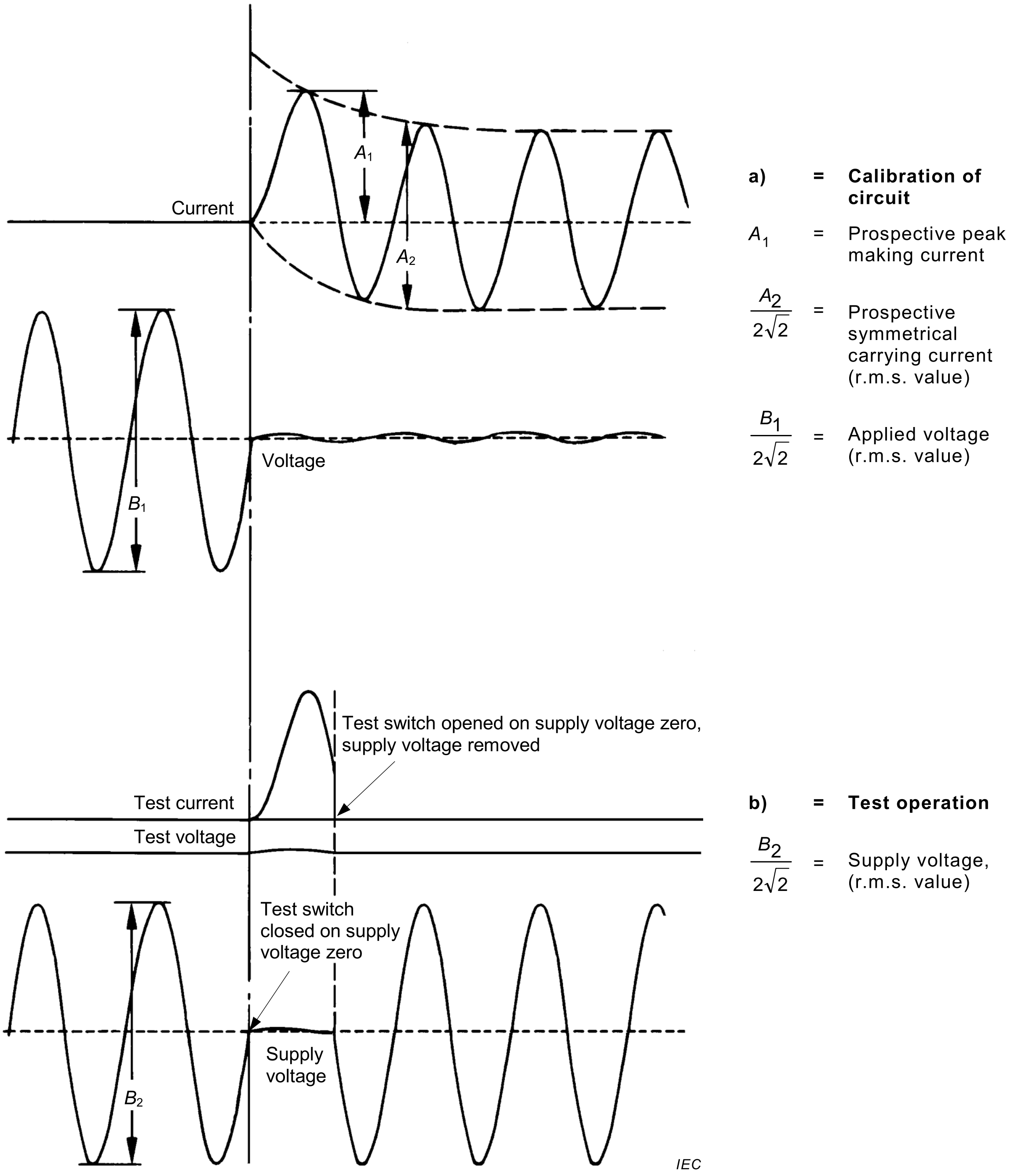


Figure E.1 – Test circuit for verification of short-time withstand current test on current circuits with and without supply control switches

Figure E.2 shows the voltage and current waveforms during calibration and test operation.

NOTE 2 Figure E.2 is based on Figure 13 of IEC 60947-1:2007.



NOTE 1 The amplitude of the voltage trace, after initiation of the test current, varies according to the relative positions of the closing device, the adjustable impedances, the voltage sensors and according to the test circuit diagram.

NOTE 2 The supply voltage is removed when the test switch is opened, which simulates the operation of a supply side protection device after one half cycle.

Figure E.2 – Example of short-circuit carrying test record in the case of a single-pole equipment on single-phase a.c.

Annex F
(informative)

Examples for voltage tests

Figure F.1 shows the test arrangement for voltage tests in the case of a 3 phase 4 wire direct connected meter with supply control and load control switches.

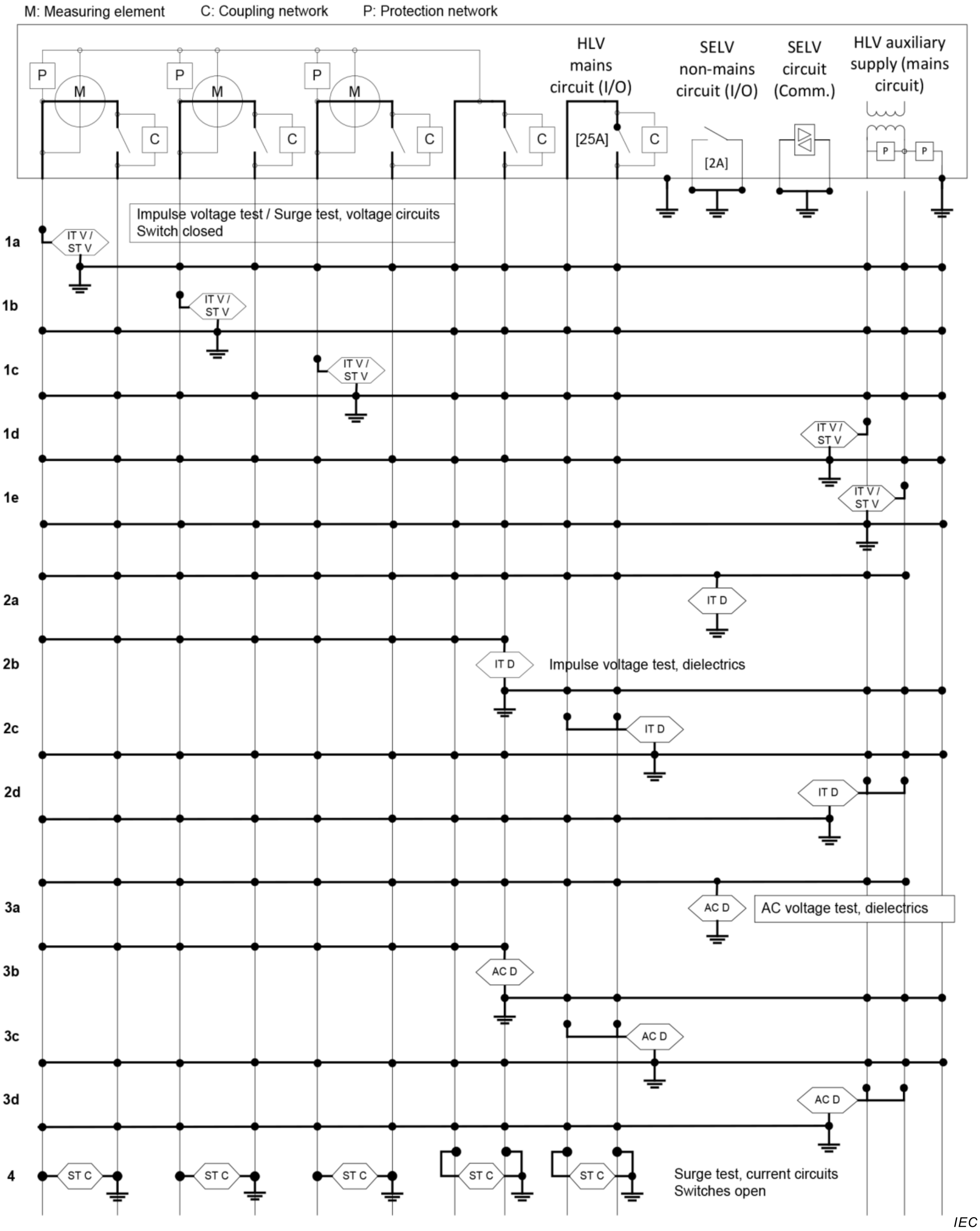


Figure F.1 – Test arrangement for voltage tests: 3 phase 4 wire direct connected meter with supply control and load control switches

The tests are the following:

1) Testing of voltage circuits with impulse voltage / surge, see 6.10.3.3 and 6.10.3.4:
   - 1a – on phase L1 (supply control switch closed);
   - 1b – on phase L2 (supply control switch closed);
   - 1c – on phase L3 (supply control switch closed);
   - 1d, 1e – on auxiliary supply.
2) Impulse voltage test:
   - 2a – between all HLV terminals and earth, see 6.10.4.3.3 a);
   - 2b – between the terminals of all voltage and current circuits and all other HLV terminals, see 6.10.4.3.3 b);
   - 2c – between HLV I/O terminals and all other HLV terminals, see 6.10.4.3.3 b);
   - 2d – between HLV auxiliary supply terminals and all other HLV terminals, see 6.10.4.3.3 b);
3) AC voltage test:
   - 3a – between all HLV terminals and earth, see 6.10.4.3.4, Table 25 a);
   - 3b – between the terminals of all voltage and current circuits and all other HLV terminals, see 6.10.4.3.4, Table 25 b);
   - 3c – between HLV I/O terminals and all other HLV terminals, see 6.10.4.3.4, Table 25 b);
   - 3d – between HLV auxiliary supply terminals and all other HLV terminals, see 6.10.4.3.4, Table 25 b);
4) Surge voltage test across open contacts of supply control switches, see 6.10.6.5.

Figure F.2 shows the test arrangement for voltage tests in the case of a 3 phase 4 wire transformer connected meter.

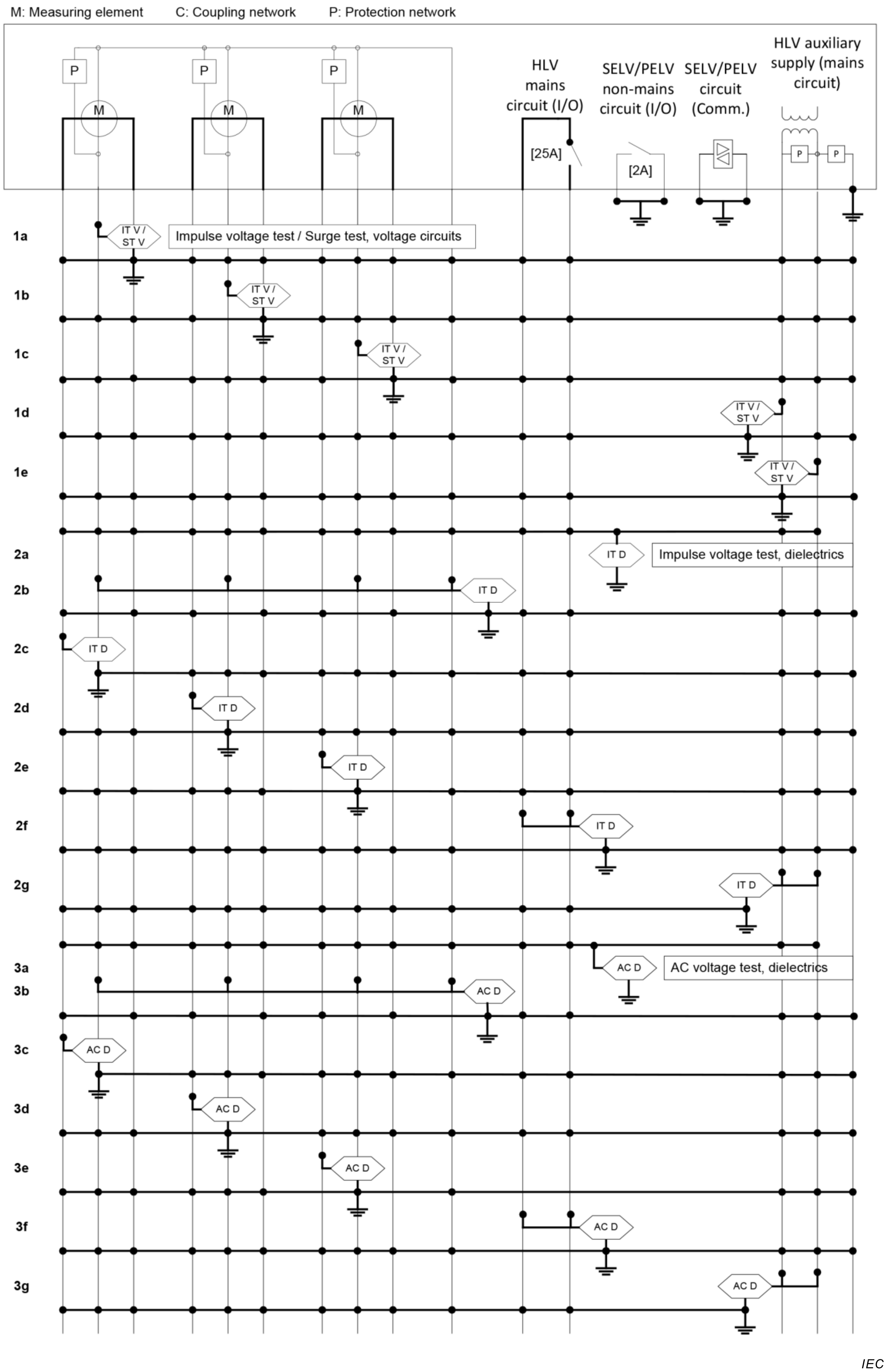


Figure F.2 – Test arrangement for voltage tests: 3 phase 4 wire transformer connected meter

The tests are the following:

1) Testing of voltage circuits with impulse voltage / surge, see 6.10.3.3 and 6.10.3.4:
   - 1a – on phase L1 voltage measurement circuit;
   - 1b – on phase L2 voltage measurement circuit;
   - 1c – on phase L3 voltage measurement circuit;
   - 1d, 1e – on auxiliary supply.
2) Impulse voltage test:
   - 2a – between all HLV terminals and earth, see 6.10.4.3.3 a);
   - 2b – between the terminals of all voltage circuits and all other HLV terminals, see 6.10.4.3.3 b);
   - 2c – between the terminals of phase L1 current circuits and all other HLV terminals, see 6.10.4.3.3 b);
   - 2d – between the terminals of phase L2 current circuits and all other HLV terminals, see 6.10.4.3.3 b);
   - 2e – between the terminals of phase L3 current circuits and all other HLV terminals, see 6.10.4.3.3 b);
   - 2f – between HLV I/O terminals and all other HLV terminals, see 6.10.4.3.3 b);
   - 2g – between HLV auxiliary supply terminals and all other HLV terminals, see 6.10.4.3.3 b);
3) AC voltage test, see 6.10.4.3.4:
   - 3a – between all HLV terminals and earth, see 6.10.4.3.4, Table 25 a);
   - 3b – between the terminals of all voltage circuits and all other HLV terminals, see 6.10.4.3.4, Table 25 b);
   - 3c – between the terminals of phase L1 current circuits and all other HLV terminals see 6.10.4.3.4, Table 25 b);
   - 3d – between the terminals of phase L2 current circuits and all other HLV terminals, see 6.10.4.3.4, Table 25 b);
   - 3e – between the terminals of phase L3 current circuits and all other HLV terminals, see 6.10.4.3.4, Table 25 b);
   - 3f – between HLV I/O terminals and all other HLV terminals, see 6.10.4.3.4, Table 25 b);
   - 3g – between HLV auxiliary supply terminals and all other HLV terminals, see 6.10.4.3.4, Table 25 b).

Annex G
(normative)

Additional a.c. voltage tests for electromechanical meters

The purpose of this test is to verify that the frame holding the driving elements is suitably insulated from the HLV circuits and – in the case of meters of protective class II – from the accessible surfaces.

The test shall be carried out in accordance with Table G.1. Where these levels exceed the levels in Table 25, the levels in Table G.1 shall apply.

Table G.1 – AC voltage tests of electromechanical meters

Points of application of the test voltage	**AC test voltage V r.m.s.**	
	Protective class I	**Protective class II**
A) *Tests to be carried out with the cover and terminal cover removed, between, on the one hand, the* frame *and, on the other hand:* a) each current circuit which, in normal service, is separated and suitably insulated from the other circuits [1]; b) each voltage circuit, or set of voltage circuits having a common point which, in normal service, is separated and suitably insulated from the other circuits [1]; c) each HLV auxiliary circuit or a set of auxiliary circuits having a common point; d) each assembly of current-voltage windings of one and the same driving element which, in normal service, are connected together but separated and suitably insulated from the other circuits [2];	2 000	2 000
e) each auxiliary circuit with a voltage level equal or below the value specified in 6.3.2.	500	500
B) *Tests which may be carried out with the terminal cover removed, but with the cover in place when it is made of metal:* a) between the current circuit and the voltage circuit of each driving element, normally connected together, this connection being temporarily broken for the purpose of the test [3].	600 [4]	600 [4]
C) *Additional test for insulating enclosed meters of protective class II* a) between the *frame* and earth;	–	2 000
b) between, on the one hand, all conductive parts inside the meter case connected together and, on the other hand, all conductive parts, outside the meter case that are accessible with the test finger, connected together.	–	40

[1] The simple breaking of the connection, which is normally included between current and voltage windings, is not generally sufficient to ensure suitable insulation, which can withstand a test voltage of 2 000 V.

Tests in part A) Items a) and b) generally apply to meters operated from instrument transformers and also to certain special meters having separate current and voltage windings.

[2] Circuits, which have been subjected to tests in part A) Items a) and b) are not subjected to the test in Item d). When the voltage circuits of a polyphase meter have a common point in normal service, this common point shall be maintained for the test and, in this case, all the circuits of the driving elements are subjected to a single test.

[3] It is not, strictly speaking, a dielectric strength test, but a means of verifying that the insulation distances are sufficient when the connecting device is open.

[4] or twice the voltage applied to the voltage windings under reference conditions, when this voltage is greater than 300 V (the higher value).

During this test no flashover, disruptive discharge or puncture shall occur.

Annex H
(normative)

Test equipment for cable flexion and pull test

Figure H.1 shows the test equipment for the cable flexion and pull test. The distance of the platen from the clamping unit, the diameter of the bushing, the mass to be applied during the flexion test and the pull force to be applied after the flexion test is shown in Table H.1.

Dimensions in millimetres

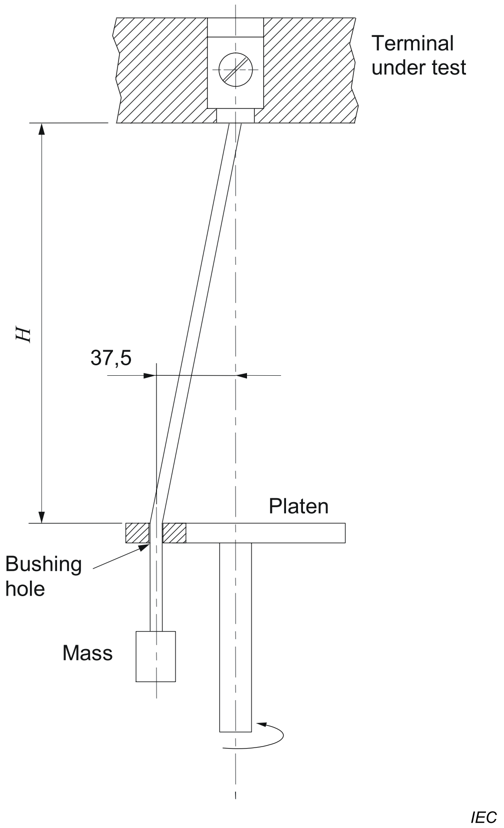


Figure H.1 – Test equipment for cable flexion and pull test (see 6.9.7.3)

Table H.1 – Test values for flexion and pull-out tests for round copper conductors

Conductor cross-section	Diameter of bushing hole [a, b]	Height H [a]	Mass	Pulling force
mm^2	mm	mm	kg	N
1,0	6,5	260	0,4	35
1,5	6,5	260	0,4	40
2,5	9,5	280	0,7	50
4,0	9,5	280	0,9	60
6,0	9,5	280	1,4	80
10,0	9,4	280	2,0	90
16,0	13,0	300	2,9	100
25,0	13,0	300	4,5	135
35,0	14,5	320	6,8	190
50,0	15,9	343	9,5	236

a Tolerances: for height H ± 15 mm, for diameter of the bushing hole ±2 mm.

b If the bushing hole diameter is not large enough to accommodate the conductor without binding, a bushing having the next larger hole size may be used.

NOTE The values have been taken from IEC 60947-1:2007, Table 5.

Annex I
(informative)

Routine tests

I.1 General

NOTE This Annex is based on IEC 61010-1:2010, Annex F.

The manufacturer should perform the tests of I.2 to I.4 on equipment produced, which has both hazardous live parts and accessible conductive parts.

As specified in IEC 62058-11:2008, 100 % inspection may be performed or lot-by-lot inspection by attributes, with acceptance number 0.

Unless it can be clearly shown that the result of the tests cannot be invalidated by subsequent manufacturing stages, tests should be made with equipment fully assembled. Components should not be unwired, modified or disassembled for the test. The equipment does not need to be energized during the tests.

Wrapping the equipment in foil is not required. Humidity preconditioning is not required.

Test site altitude correction of the test voltage is not required.

The voltage test equipment should be able to maintain the required voltage for the specified period of time. No other requirements apply.

Conformity is checked by inspection.

I.2 Protective earth

A continuity test is made between the protective conductor terminal on the one side, and all accessible conductive parts which are required by 6.5.2 to be connected to the protective conductor terminal on the other side.

NOTE No value is specified for the test current.

I.3 AC power-frequency high-voltage test for mains-circuits

The test method specified in 6.10.2.5 shall be used:

- the test voltage shall be selected from Table 10 for basic insulation;
- the test duration shall be reduced to 2 s;
- the rise time and the fall time of the test voltage shall be $>$ 2 s.

I.4 Mains-circuits with voltage limiting devices

For mains-circuits with voltage limiting devices the test specified can be carried out using a test voltage of 0,9 times the working voltage of the voltage limiting device but not less than twice the working voltage of the mains-circuit.

Annex J
(informative)

Examples of battery protection

NOTE This Annex is based on IEC 60255-27:2013, Annex F.

This annex gives typical examples of battery protection to reduce overheating or explosion risk under a single-fault condition (see Figures J.1 and J.2).

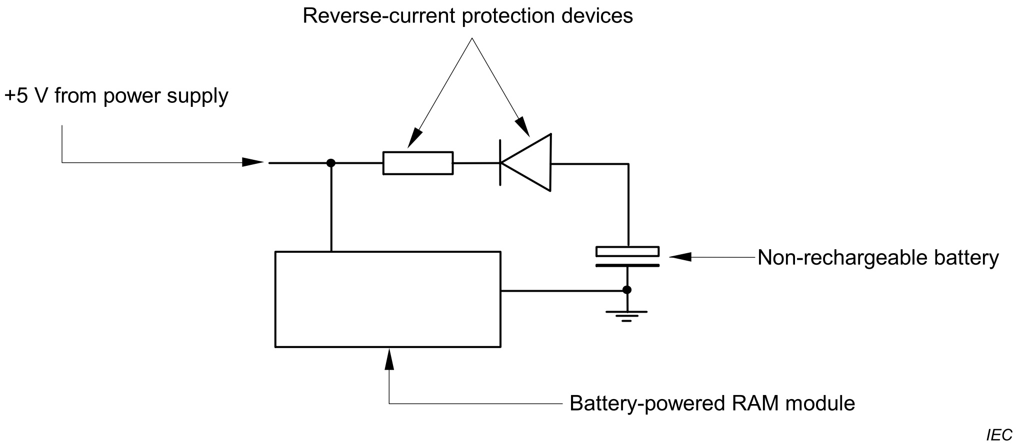


Figure J.1 – Non-rechargeable battery protection

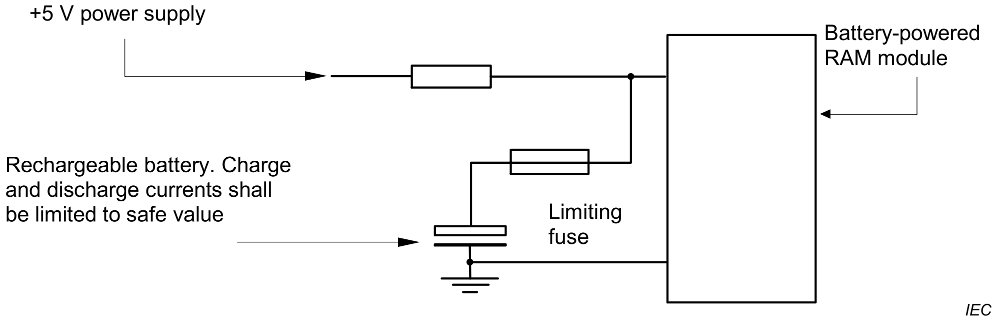


Figure J.2 – Rechargeable battery protection

Annex K
(informative)

Rationale for specifying overvoltage category III

K.1 Transient overvoltage requirements in TC 13 standards

Standards established by IEC TC 13 related to metering equipment have evolved over time and although their prime focus is on measurement accuracy, they have adopted and augmented requirements, test methods and test conditions related to safety through their various editions.

IEC 62052-31 is the latest stage in this process and it aligns the safety requirements, test methods and test conditions of electrical energy meters with that of other electrical and electronic products used in domestic, commercial and industrial environments.

The standards published by IEC TC 13 so far did not mention overvoltage categories; this evolution is introduced with IEC 62052-31.

The specified values of clearances, creepage distances and impulse withstand voltages used in the previously published standards correspond to overvoltage category III, and have been used to design and test electrical energy meters for the past 20 years. The specified values have been proven through practical experience and extensive use in the field.

Electricity meters are sometimes used in environments normally classified as overvoltage category IV, e.g. substations and transformer stations, but only with appropriate additional protection such as fuses or external overvoltage protection elements. Also for these applications of electricity meters, the design requirements for clearances, creepage distances and impulse test voltages given in this standard, according to the overvoltage category III, are considered to be appropriate by TC 13. See also 1.4.1.

Subclause 1.4.2 allows the supplier and the manufacturer to agree on specifying impulse withstand voltages higher than what is required for overvoltage category III, or even overvoltage category IV where it would be appropriate, but recognises that in the majority of applications, overvoltage category III is sufficient.

K.2 Electricity meters mentioned in basic safety publications and group safety publications

K.2.1 IEC 60664-1

Electricity meters are common and recognisable devices and as such they are mentioned in the horizontal safety standard IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests.*

The following subclause of IEC 60664-1:2007 defines the use of overvoltage categories III and IV as follows:

Subclause 4.3.3.2.2: *Equipment energized directly from the supply mains* specifies this:

> Technical committees shall specify the overvoltage category as based on the following general explanation of overvoltage categories (see also 443 of IEC 60364-4-44:2007):
>
> – Equipment of overvoltage category IV is for use at the origin of the installation.
>
> NOTE 1 Examples of such equipment are electricity meters and primary overcurrent protection equipment.

– Equipment of overvoltage category III is equipment in fixed installations and for cases where the reliability and the availability of the equipment are subject to special requirements.

  NOTE 2 Examples of such equipment are switches in the fixed installation and equipment for industrial use with permanent connection to the fixed installation.

A note is only a general information. Electricity meters are mentioned as an example; IEC 60664-1, being ahorizontal safety standard, neither asks for applying category IV to electricity meters nor gives any special requirements covering electricity meters.

K.2.2 IEC 60364-4-44

IEC 60664-1:2007,4.3.3.2.2 also refers to 443 of IEC 60364-4-44:2007, *Low-voltage electrical installations – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances.*

Subclause 443.2.2: *Relationship between impulse withstand voltages of equipment and overvoltage categories* states this:

> Equipment with an impulse withstand voltage corresponding to overvoltage category IV is suitable for use at, or in the proximity of, the origin of the installation, for example upstream of the main distribution board. Equipment of category IV has a very high impulse withstand capability providing the required high degree of reliability.
>
> NOTE Examples of such equipment are electricity meters, primary overcurrent protection devices and ripple control units.
>
> Equipment with an impulse withstand voltage corresponding to overvoltage category III is for use in the fixed installation downstream of, and including the main distribution board, providing a high degree of availability.

Again, electricity meters are mentioned in the Note as an *example* under overvoltage category IV.

As electricity meters are typically installed on distributions boards, overvoltage category III is therefore considered to be appropriate.

The definitions above both relate to fixed installations, and since an electricity meter forms part of a fixed installation, both categories may be applicable.

K.2.3 IEC 61010-1

IEC 61010-1:2010, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements.* Annex K.1 also mentions electricity meters as an example: “may include”.

> OVERVOLTAGE CATEGORY III is for equipment intended to form part of a building wiring installation. Such equipment includes socket outlets, fuse panels, and some MAINS installation control equipment. Manufacturers may also design equipment for OVERVOLTAGE CATEGORY IV when a higher degree of reliability and availability is desired.
>
> OVERVOLTAGE CATEGORY IV is for equipment installed at or near the origin of the electrical supply to a building, between the building entrance and the main distribution board. Such equipment may include electricity tariff meters and primary overcurrent protection devices.

The description of the OVC IV mentions electricity meters as an example, but this cannot be interpreted as a requirement.

K.3 Conclusion

From the above it is clear that the choice of TC 13 to use clearances, creepage distances and impulse withstand voltages corresponding to Overvoltage Category III, while allowing the use of higher impulse withstand voltages as agreed by the manufacturer and the purchaser, is technically and procedurally correct.

Annex L
(informative)

Overview of safety aspects covered

The following Table L.1 provides an overview of the safety aspects covered in this standard.

The first two columns contain the Contents of this document.

The third column references clauses/subclauses in horizontal / group / other product safety standards on which the given clause is based:

- IEC 60255-27:2013;
- IEC 60364-1:2005;
- IEC 60664-1:2007;
- IEC 60947-1:2007;
- IEC 61000-4-5:2014;
- IEC 61010-1:2010;
- IEC 61180-1:1992;
- IEC 62477-1:2012.

The fourth column references safety clauses/subclauses of current TC 13 type test standards, which are replaced by this standard.

Table L.1 – Overview of safety aspects

Clause	Title	Source from horizontal / group other product safety standards	Source from TC 13 type test standards: IEC 62052-11: 2003 IEC 62052-21:2004 IEC 62055-31:2005	Remark
	Introduction	IEC Guide 104 ISO / IEC Guide 51	–	–
1	Scope and object	–	–	–
1.1	Scope	–	IEC 62052-11:2003, Clause 1 IEC 62052-21:2004, Clause 1	–
1.2	Object	IEC 61010-1:2010, 1.2		Modified
1.2.1	Aspects included in scope	IEC 61010-1:2010, 1.2.1		
1.2.2	Aspects excluded from scope	IEC 61010-1:2010, 1.2.1		
1.3	Verification	IEC 61010-1:2010, 1.3		
1.4	Environmental conditions	IEC 61010-1:2010, 1.4	IEC 62052-11:2003, 6.1, 6.2 IEC 62052-21:2004, 6.1, 6.2	Modified
1.4.1	Normal environmental conditions			
1.4.2	Extended environmental conditions			

Clause	Title	Source from horizontal / group other product safety standards	Source from TC 13 type test standards: IEC 62052-11: 2003 IEC 62052-21:2004 IEC 62055-31:2005	Remark
1.4.3	Extreme environmental conditions	IEC 60721-3-0:1984, 5.2	–	
2	Normative references	IEC 61010-1:2010, Clause 2	IEC 62052-11:2003, Clause 2 IEC 62052-21:2004, Clause 2	
3	Terms and definitions	IEC 60050	IEC 62052-11:2003 Clause 3 IEC 62052-21:2004, Clause 3	Modified
3.1	Equipment and states of equipment	IEC 61010-1:2010, 3.1		Modified
3.2	Parts and accessories	IEC 61010-1:2010, 3.2	IEC 62052-11:2003 Clause 3 IEC 62052-21:2004, Clause 3 IEC 62055-31:2005, Clause 3	Modified
3.3	Quantities	IEC 61010-1:2010, 3.3		Modified
3.4	Tests	IEC 61010-1:2010, 3.4		Modified
3.5	Safety terms	IEC 61010-1:2010, 3.5	IEC 62052-11:2003, 3.3	Modified
3.6	Insulation	IEC 61010-1:2010, 3.6 IEC 60255-27:2013, 3	IEC 62052-11:2003, 3.4 IEC 62052-21:2004, 3.4	Modified
3.7	Terms related to switches of metering equipment	IEC 60050-441:1984 IEC 60947-1:2007	IEC 62052-21:2004, 3.5	
4	Tests	IEC 61010-1:2010, Clause 4		
4.1	General	IEC 61010-1:2010, 4.1		Modified
4.2	Type test – sequence of tests	IEC 61010-1:2010, 4.2	IEC 62052-11:2003, Annex F IEC 62052-21:2004, Annex E	Modified
4.3	Reference test conditions	IEC 61010-1:2010, 4.2	IEC 62052-11:2003, Clause 6 IEC 62052-21:2004, Clause 6	Modified
4.3.1	Atmospheric conditions	IEC 60068-1:2013	IEC 62052-11:2003 7.3.1 IEC 62052-21:2004, 7.3.2.1	
4.3.2	State of the equipment	IEC 61010-1:2010, 4.3.2		Modified

Clause	Title	Source from horizontal / group other product safety standards	Source from TC 13 type test standards: IEC 62052-11: 2003 IEC 62052-21:2004 IEC 62055-31:2005	Remark
4.3.2.1	General	IEC 61010-1:2010, 4.3.2.1		Modified to cover modification / opening of the DUT
4.3.2.2	Position of equipment	IEC 61010-1:2010, 4.3.2.2		Modified to include matching socket
4.3.2.3	Plug-in modules	IEC 61010-1:2010, 4.3.2.3		Communication modules etc.
4.3.2.4	Covers and removable parts	IEC 61010-1:2010, 4.3.2.4		
4.3.2.5	Connection of the voltage and current circuits	IEC 61010-1:2010, 4.3.2.5		Modified for metering
4.3.2.6	Supply and load control switches	–		Specific for metering
4.3.2.7	Connection of the auxiliary circuits	–		Specific for metering
4.3.2.8	Connection of batteries	–		
4.3.2.9	Protective conductor terminals	IEC 61010-1:2010, 4.3.2.7		
4.3.2.10	Physical token carriers	–		Specific for metering
4.3.2.11	Test cables	IEC 60947-1:2007, 8.3.3.3.4	–	
4.3.2.12	Information on tests	IEC 60255-27:2013, 10.4	–	
4.4	Testing in single fault condition	IEC 61010-1:2010, 4.4	–	Modified for metering. Parts not relevant for metering omitted.
4.4.1	General	IEC 61010-1:2010, 4.4.1	–	
4.4.2	Application of fault conditions	IEC 61010-1:2010, 4.4.2	–	
4.4.2.1	General	IEC 61010-1:2010, 4.4.2.1	–	
4.4.2.2	Protective impedance	IEC 61010-1:2010, 4.4.2.2	–	
4.4.2.3	Equipment or parts for short-term or intermittent operation	IEC 61010-1:2010, 4.4.2.4	–	
4.4.2.4	Transformers	IEC 61010-1:2010, 4.4.2.7	–	
4.4.2.4.1	General	IEC 61010-1:2010, 4.4.2.7.1	–	
4.4.2.4.2	Short circuit test for voltage transformers	IEC 61010-1:2010, 4.4.2.7.2	–	
4.4.2.4.3	Overload	IEC 61010-1:2010, 4.4.2.7.3	–	
4.4.2.4.4	Open circuit of current transformers	–	–	Specific for metering

Clause	Title	Source from horizontal / group other product safety standards	Source from TC 13 type test standards: IEC 62052-11: 2003 IEC 62052-21:2004 IEC 62055-31:2005	Remark
4.4.2.5	Equipment with auxiliary supply	IEC 61010-1:2010, 4.4.2.9	–	
4.4.2.6	Mains-circuits and hazardous voltage non-mains-circuits	IEC 60255-27:2013, 5.2.2.6	–	
4.4.2.7	Overloads	IEC 60255-27:2013, 5.2.2.7	–	
4.4.2.8	Intermittently rated resistors	IEC 60255-27:2013, 5.2.2.8	–	
4.4.2.9	Double insulation			
4.4.3	Duration of tests	IEC 61010-1:2010, 4.4.3.1.	–	
4.4.4	Conformity after application of fault conditions	IEC 61010-1:2010, 4.4.4	–	
4.4.4.1	General	IEC 61010-1:2010, 4.4.4.1	–	
4.4.4.2	Temperature	IEC 61010-1:2010, 4.4.4.2	–	
4.4.4.3	Spread of fire	IEC 61010-1:2010, 4.4.4.3	–	
4.4.4.4	Other hazards	IEC 61010-1:2010, 4.4.4.4	–	
5	Information and marking requirements	IEC 61010-1:2010, Clause 5 IEC 62477-1:2012, Clause 6	IEC 62052-11:2003, 5.12 IEC 62052-21:2004, 5.12 IEC 62055-31:2005, 5.13	
5.1	General	IEC 62477-1:2012, 6.1		Marked items specific for metering
0	Labels, signs and signals			
5.2.1	General	IEC 62477-1:2012, 6.4.3.1		
5.2.2	Durability of markings	IEC 61010-1:2010, 5.3		Modified
5.3	Information for selection	IEC 62477-1:2012, 6.2		Modified for metering
5.3.1	General			
5.3.2	General information			
5.3.3	Information related to meters / metering elements			
5.3.4	Information related to stand-alone tariff-and load control equipment			
5.3.5	Information related to supply control and load control switches		IEC 62052-21:2004, 5.12 IEC 62055-31:2005, Annex C	
5.4	Information for installation and commissioning	IEC 62477-1:2012, 6.3		Modified for metering

Clause	Title	Source from horizontal / group other product safety standards	Source from TC 13 type test standards: IEC 62052-11: 2003 IEC 62052-21:2004 IEC 62055-31:2005	Remark
5.4.1	General			
5.4.2	Handling and mounting	IEC 62477-1:2012, 6.3.4		
5.4.3	Enclosure	IEC 62477-1:2012, 6.3.5		Modified for metering
5.4.4	Connection	IEC 62477-1:2012, 6.3.6		Modified for metering
5.4.4.1	General	IEC 62477-1:2012, 6.3.6.1		Modified for metering
5.4.4.2	Connection diagrams	IEC 62477-1:2012, 6.3.6.2		Modified for metering
5.4.4.3	Mains terminals			
5.4.4.4	Auxiliary terminals			
5.4.4.5	Connecting cables	IEC 62477-1:2012, 6.3.6.3		Modified for metering
5.4.4.6	Isolation from the supply	IEC 62477-1:2012, 6.5.5		Modified for metering
5.4.5	Protection	IEC 62477-1:2012, 6.3.7		Modified for metering
5.4.5.1	Protective class and earthing	–		
5.4.5.2	External protection devices	–		Specific for metering
5.4.6	Auxiliary power supply	–		
5.4.7	Supply for external devices	–		Specific for metering
5.4.8	Batteries	IEC 60255-27:2013, 9.1.8.1.		
5.4.9	Self-consumption	–		
5.4.10	Commissioning	IEC 61010-1:2010, 5.4.6 IEC 60364-1:2005, 131.7		Modified for metering
5.5	Information for use	IEC 62477-1:2012, 6.4		Modified for metering
5.5.1	General			
5.5.2	Display, push buttons and other controls			
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5.5.4	Connection to user's equipment			
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5.5.6	Cleaning			
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6	Protection against electrical shock	IEC 61010-1:2010, 6.1.1 IEC 60255-27:2013, 5.1		

Clause	Title	Source from horizontal / group other product safety standards	Source from TC 13 type test standards: IEC 62052-11: 2003 IEC 62052-21:2004 IEC 62055-31:2005	Remark
6.1	General requirements	IEC 61010-1:2010, 6.1.1 IEC 60255-27:2013, 5.1	IEC 62052-11:2003, 5.1 IEC 62052-21:2004, 5.1	Modified for metering
6.2	Determination of accessible parts	IEC 61010-1:2010, 6.2		
6.2.1	General	IEC 61010-1:2010, 6.2.1 IEC 60255-27:2013, 5.1.5.1		Modified for metering
6.2.2	Examination	IEC 61010-1:2010, 6.2.2		References made to IEC 61032:1997
6.2.3	Openings above parts that are hazardous live	IEC 61010-1:2010, 6.2.3		
6.2.4	Openings for pre-set controls	IEC 61010-1:2010, 6.2.4		
6.2.5	Wiring terminals	IEC 60255-27:2013, 5.1.5.2.6		Modified for metering
6.3	Limit values for accessible parts	IEC 61010-1:2010, 6.3		
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6.3.2	Levels in normal condition	IEC 61010-1:2010, 6.3.1		
6.3.3	Levels in single fault condition	IEC 61010-1:2010, 6.3.2,.		
6.4	Primary means of protection (protection against direct contact)	IEC 61010-1:2010, 6.4 IEC 60255-27:2013, 5.1.2		
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6.4.2	Equipment case	IEC 61010-1:2010, 6.4.2	IEC 62052-11:2003, 5.2.1 IEC 62052-21:2004, 5.2.1	
6.4.3	Basic insulation	IEC 61010-1:2010, 6.4.3		
6.4.4	Impedance	IEC 61010-1:2010, 6.4.4		
6.5	Additional means of protection in case of single fault conditions (protection against indirect contact)	IEC 61010-1:2010, 6.5		
6.5.1	General	IEC 61010-1:2010, 6.5.1		
6.5.2	Protective bonding	IEC 61010-1:2010, 6.5.2	IEC 62052-11:2003, 5.4 IEC 62052-21:2004, 5.4	

Clause	Title	Source from horizontal / group other product safety standards	Source from TC 13 type test standards: IEC 62052-11: 2003 IEC 62052-21:2004 IEC 62055-31:2005	Remark
6.5.2.1	General	IEC 61010-1, 6.5.2.1 IEC 60255-27:2013, 5.1.6.2		
6.5.2.2	Integrity of protective bonding	IEC 61010-1:2010, 6.5.2.2		Modified for metering
6.5.2.3	Protective conductor terminal	IEC 61010-1:2010, 6.5.2.3		Modified for metering
6.5.2.4	Impedance of protective bonding of permanently connected equipment	IEC 61010-1:2010, 6.5.2.5		Modified for metering
6.5.2.5	Transformer protective bonding screen	IEC 61010-1:2010, 6.5.2.6		
6.5.3	Supplementary insulation and reinforced insulation	IEC 61010-1:2010, 6.5.3		
6.5.4	Protective impedance	IEC 61010-1:2010, 6.5.4		
6.5.5	Automatic disconnection of the supply	IEC 61010-1:2010, 6.5.5		Modified for metering
6.5.6	Current- or voltage-limiting device	IEC 61010-1:2010, 6.5.6		
6.6	Connection to external circuits			
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6.6.2	Terminals for external circuits	IEC 61010-1:2010, 6.6.2		Modified for metering
6.6.3	Terminals for stranded conductors			See 6.9.7
6.7	Insulation requirements			
6.7.1	General – Electrical stresses, overvoltages and overvoltage categories			
6.7.1.1	Electric stresses originating from mains	IEC 61010-1:2010, 6.7.1.1 IEC 60364-4-44:2007		Modified for metering: broken neutral
6.7.1.2	Protection against overvoltages of atmospheric origin or due to switching	IEC 60364-4-44:2007 443.1.		
6.7.1.3	Classification of impulse withstand voltages (overvoltage categories)	IEC 60364-4-44:2007, 443.2.2		
6.7.2	The nature of insulation			
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6.7.2.2	Clearances	IEC 61010-1:2010, 6.7.1.2		
6.7.2.3	Creepage distances	IEC 61010-1:2010, 6.7.1.3		
6.7.2.4	Solid insulation	IEC 61010-1:2010, 6.7.1.4		

Clause	Title	Source from horizontal / group other product safety standards	Source from TC 13 type test standards: IEC 62052-11: 2003 IEC 62052-21:2004 IEC 62055-31:2005	Remark
6.7.2.5	Requirements for insulation according to type of circuit	IEC 61010-1:2010, 6.7.1.5 and Annex K		With Table 6 added providing an overview
0	Insulation requirements for mains-circuits			
6.7.3.1	Nominal voltages and rated impulse voltages			Specific for metering
0	Clearances for mains-circuits	IEC 60664-1:2007, Table F.2	IEC 62052-11:2003, 5.6 IEC 62052-21:2004, 5.6	Table driven by rated impulse voltage
6.7.3.3	Creepage distances for mains-circuits	IEC 60664-1:2007, Table F.4		Table driven by rationalized voltage
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6.7.3.4.2	Moulded and potted parts	IEC 61010-1:2010, K.1.3.2		
6.7.3.4.3	Inner insulating layers of printed wiring boards (PWBs)	IEC 61010-1:2010, K.1.3.3.		
6.7.3.4.4	Thin-film insulation	IEC 61010-1:2010, K.1.3.4.		
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6.7.4.2	Clearances for non-mains-circuits	IEC 61010-1:2010, K.2.2		
6.7.4.3	Creepage distances for non-mains-circuits	IEC 61010-1:2010, K.2.3		
6.7.4.4	Solid insulation for non-mains-circuits	IEC 61010-1:2010, K.2.4		
6.7.4.4.1	General	IEC 61010-1:2010, K.2.4.1		
6.7.4.4.2	Moulded and potted parts	IEC 61010-1:2010, K.2.4.2		
0	Inner insulating layers of printed wiring boards	IEC 61010-1:2010, K.2.4.3		
6.7.4.4.4	Thin-film insulation	IEC 61010-1:2010, K.2.4.4		
6.7.5	Insulation in circuits not addressed in 0 or 6.7.4	IEC 61010-1:2010, Clause K.3		
6.7.5.1	General	IEC 61010-1:2010, K.3.1		
6.7.5.2	Clearance calculation	IEC 61010-1:2010, K.3.2		
6.7.5.3	Clearances in circuits having recurring peak voltages, or having working voltages with frequencies above 30 kHz	IEC 61010-1:2010, K.3.3		

Clause	Title	Source from horizontal / group other product safety standards	Source from TC 13 type test standards: IEC 62052-11: 2003 IEC 62052-21:2004 IEC 62055-31:2005	Remark
0	Creepage distances	IEC 61010-1:2010, K.3.4		
6.7.5.5	Solid insulation	IEC 61010-1:2010, K.3.5		
6.7.6	Reduction of transient overvoltages by the use of overvoltage limiting devices	IEC 61010-1:2010, Clause K.4		Modified for metering
6.8	Insulation requirements between circuits and parts	IEC 60255-27:2013, Annex A		
6.9	Constructional requirements for protection against electric shock	IEC 61010-1:2010, 6.9		Annex B provides meter specific examples
6.9.1	General	IEC 61010-1:2010, 6.9.1		
6.9.2	Insulating materials	IEC 61010-1:2010, 6.9.2	IEC 62052-11:2003, 5.7 IEC 62052-21:2004, 5.7	
6.9.3	Colour coding	IEC 61010-1:2010, 6.9.3		
6.9.4	Equipment case		IEC 62052-11:2003, 5.2.1 IEC 62052-21:2004, 5.2.1	Modified for metering
6.9.5	Terminal blocks			Modified for metering
6.9.6	Insulating materials of supply control and load switches		IEC 62052-11:2003, 5.4 IEC 62052-21:2004, 5.4.	
6.9.7	Terminals	IEC 61010-1:2010, 6.6.4 IEC 62477-1:2012, 4.11.8.		
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6.9.7.2	Connecting capacity	IEC 62477-1:2012, 4.11.8.2		
6.9.7.3	Reliability of screw-type connections	IEC 60947-1:2007, 8.2.4.3		
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6.9.8.2.3	Rated operational current (Ie)	IEC 60947-1:2007, 4.3.2.3		Modified for metering
6.9.8.2.4	Rated frequency	IEC 60947-1:2007, 4.3.3		
6.9.8.2.5	Rated uninterrupted current (Iu)	IEC 60947-1:2007, 4.3.2.4		
6.9.8.2.6	Uninterrupted duty	IEC 60947-1:2007, 4.3.4.2		

Clause	Title	Source from horizontal / group other product safety standards	Source from TC 13 type test standards: IEC 62052-11: 2003 IEC 62052-21:2004 IEC 62055-31:2005	Remark
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6.9.8.2.8	Rated breaking capacity (*Ic*)	IEC 60947-1:2007, 4.3.5.3		Modified for metering
6.9.8.2.9	Rated safe short-time withstand current (*Issw*)	IEC 60947-1:2007, 4.3.6.1		Modified for metering
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6.9.8.2.12	Rated conditional safe short-circuit current (*Icssw*)	IEC 60947-1:2007, 4.3.6.4		Modified for metering
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6.10.2.2	Test leads			See 4.3.2.11.
6.10.2.3	Impulse voltage test	IEC 61180-1:1992, 6.2		
6.10.2.4	Surge test	IEC 61000-4-5:2014, Clause 8		
6.10.2.5	AC power-frequency voltage test	IEC 61180-1:1992, 5.2		
6.10.2.6	DC voltage test	IEC 61180-1:1992, 4.2		
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Clause	Title	Source from horizontal / group other product safety standards	Source from TC 13 type test standards: IEC 62052-11: 2003 IEC 62052-21:2004 IEC 62055-31:2005	Remark
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6.10.4.3.2	Preparation of the metering equipment for testing	IEC 61010-1:2010, 6.8.1	IEC 62052-11:2003, 7.3.1 IEC 62052-21:2004, 7.3.1	Modified for metering
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6.10.4.4.4.6	Pass / fail criteria	IEC 60664-1:2007, 6.1.3.3.2		

Clause	Title	Source from horizontal / group other product safety standards	Source from TC 13 type test standards: IEC 62052-11: 2003 IEC 62052-21:2004 IEC 62055-31:2005	Remark
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Clause	Title	Source from horizontal / group other product safety standards	Source from TC 13 type test standards: IEC 62052-11: 2003 IEC 62052-21:2004 IEC 62055-31:2005	Remark
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9.2	Eliminating or reducing the sources of ignition within the equipment	IEC 61010-1:2010, 9.2		Modified for metering
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9.3.2.2	Connectors and insulation materials on which components are mounted	IEC 61010-1:2010, 9.3.2		
9.4	Limited-energy circuit	IEC 61010-1:2010, 9.4		
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Clause	Title	Source from horizontal / group other product safety standards	Source from TC 13 type test standards: IEC 62052-11: 2003 IEC 62052-21:2004 IEC 62055-31:2005	Remark
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12	Protection against liberated gases and substances explosion and implosion – Batteries and battery charging	IEC 61010-1:2010, 11.5, 13.2.2 IEC 60255-27:2013, 8.7.2.2		
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13.2	Mains transformers tested outside equipment	IEC 61010-1:2010, 14.6		
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13.5	Circuits or components used as transient overvoltage limiting devices	IEC 61010-1:2010, Clause K.4.		
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Clause	Title	Source from horizontal / group other product safety standards	Source from TC 13 type test standards: IEC 62052-11: 2003 IEC 62052-21:2004 IEC 62055-31:2005	Remark
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Annex M
(informative)

Index of defined terms

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