भारतीय मानक **IS/IEC 60309-1: 2021**

Indian Standard

औद्योगिक प्रोयोजनो के लिए प्लग, फिक्स्ड या पोर्टेबल सॉकेट-आउटलेट और उपकरण इनलेट

भाग 1 सामान्य अपेक्षाएँ

(दूसरा पुनरीक्षण)

Plugs, Fixed or Portable Socket-Outlets and Appliance Inlets for Industrial Purposes

Part 1 General Requirements

(Second Revision)

29.120.30

भारतीय मानक ब्यूरो
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August 2023 **Price Group 18**

Electrical Wiring Accessories Sectional Committee, ETD 14

NATIONAL FOREWORD

This Indian Standard (Part-1) (Second Revision) which is identical with IEC 60309-1 : 2021 'Plugs, fixed or portable socket-outlets and appliance inlets for industrial purposes — Part 1: General requirements' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Electrical Wiring Accessories Sectional Committee and approval of the Electrotechnical Division Council.

This standard was published in 1966 and subsequently revised in year 2002 to bring it in line with latest IEC 60309-1 to make pace with the latest developments that have taken place at international level.

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

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'; and

b) Comma (,) has been used as a decimal marker, while in Indian Standards the current practice is to use a point (.) as the decimal marker.

In this standard, reference appears to International Standards for which Indian Standards also exists. The corresponding Indian Standards, which are to be substituted, are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding IndianStandard*	*Degree of Equivalence*
ISO 1456 Metallic and other inorganic coatings — Electrodeposited coatings of nickel, nickel plus chromium, copper plus nickel and of copper plus nickel plus chromium	IS 1068 : 1993 Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium — Specification (*third revision*)	Technical Equivalent
ISO 2093 Electroplated coatings of tin — Specification and test methods	IS 1359 : 1992 Electroplated coatings of tin — Specification (*third revision*)	Technical Equivalent
IEC 60068-2-14 Environmental testing — Part 2-14: Tests — Test N: Change of temperature	IS/IEC 60068-2-14 : 2009 Environmental testing Part 2: Tests, Section 14 Test N: Change of temperature	Identical
IEC 60068-2-78 Environmental testing — Part 2-78: Tests — Test Cab: Damp heat, steady state	IS 9000 (Part 4) : 2020/IEC 60068-2-78 : 2012 Environmental testing: Part 4 Tests — Test Cab: Damp heat, steady state (*second revision*)	Identical
IEC 60112 Method for the determination of the proof and the comparative tracking indices of solid insulating materials	IS 2824 : 2007/IEC 60112 : 2003 Method for the determination of the proof and the comparative tracking indices of solid insulating materials (*second revision)*	Identical

International Standard	*Corresponding IndianStandard*	*Degree of Equivalence*
IEC 60228 : 2004 Conductors of insulated cables	IS 8130 : 2013/IEC 60228 : 2004 Conductors for insulated electric cables and flexible cords — Specification (*second revision*)	Identical
IEC 60269-1 Low-voltage fuses — Part 1: General requirements	IS/IEC 60269-1 : 2014 Low-voltage fuses: Part 1 General requirements	Identical
IEC 60269-2 Low-voltage fuses — Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) — Examples of standardized systems of fuses A to K	IS/IEC 60269-2 : 2016 Low-voltage fuses: Part 2 Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) — examples of standardized systems of fuses A to K	Identical
IEC 60320 (all parts) Appliance couplers for household and similar general purposes	IS/IEC 60320 (all parts) Appliance couplers for household and similar general purposes	Identical
IEC 60529 : 1989 Degrees of protection provided by enclosures (IP code)	IS/IEC 60529 : 2001 Degrees of protection provided by enclosures (IP Code)	Identical
IEC 60664-3 Insulation coordination for equipment within low-voltage systems — Part 3: Use of coating, potting or moulding for protection against pollution	IS 15382 (Part 3) : 2019/IEC 60664-3 : 2003 Insulation coordination for equipment within low-voltage systems: Part 3 Use of coating potting or moulding for protection against pollution	Identical
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)	IS/IEC 60695-2-11 : 2014 Fire hazard testing: Part 2-11 Glowing/hot-wire based test methods glow-wire flammability test method for end-products (GWEPT)	Identical
IEC 60695-10-2 Fire hazard testing – Part 10-2: Abnormal heat — Ball pressure test method	IS/IEC 60695-10-2 : 2014 Fire hazard testing: Part 10 Abnormal heat, Section 2 Ball pressure test method	Identical
IEC 61000-6-2 Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity standard for industrial environments	IS 14700 (Part 6/Sec 2) : 2019/IEC 61000-6-2 : 2016 Electromagnetic compatibility (EMC): Part 6 Generic standards, Section 2 Immunity standard for industrial environments (*first revision*)	Identical

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 61000-6-3 Electromagnetic compatibility (EMC) — Part 6-3: Generic standards — Emission standard for equipment in residential environments	IS 14700 (Part 6/Sec 3) : 2018/ IEC 61000-6-3 : 2018 Electromagnetic compatibility (EMC): Part 6 Generic standards, Section 3 Emission standards for residential, commercial and light-industrial environments (*first revision*)	Identical
IEC 61032 Protection of persons and equipment by enclosures — Probes for verification	IS 1401 : 2008/IEC 61032 : 1997 Protection of persons and equipment by enclosures — Probes for verification (*second revision*)	Identical

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

International Standard	*Title*
ISO 2081	Metallic and other inorganic coatings — Electroplated coatings of zinc with supplementary treatments on iron or steel
IEC TR 60083	Plugs and socket-outlets for domestic and similar general use standardized in member countries of IEC
IEC 60227 (all parts)	Polyvinyl chloride insulated cables of rated voltages up to and including450/750 V
IEC 60245-4 : 2011	Rubber insulated cables — Rated voltages up to and including 450/750 V — Part 4: Cords and flexible cables
IEC 60309-4 : 2021	Plugs, fixed or portable socket-outlets and appliance inlets for industrial purposes — Part 4: Switched socket-outlets with or without interlock
IEC 60417	Graphical symbols for use on equipment
IEC 60664-1 : 2020	Insulation coordination for equipment within low-voltage supply systems — Part 1: Principles, requirements and tests

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

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

CONTENTS

Indian Standard

PLUGS, FIXED OR PORTABLE SOCKET-OUTLETS AND APPLIANCE INLETS FOR INDUSTRIAL PURPOSES
PART 1 GENERAL REQUIREMENTS
(Second Revision)

1 Scope

This document applies to plugs, fixed or portable socket-outlets and appliance inlets hereinafter referred to as accessories, with a rated operating voltage not exceeding 1 000 V DC or 1 000 V AC with a frequency not exceeding 500 Hz and a rated current not exceeding 800 A, primarily intended for industrial use, either indoors or outdoors.

These accessories are intended to be installed by instructed persons or skilled persons only.

The list of preferred ratings is not intended to exclude other ratings.

This document applies to accessories for use when the ambient temperature is normally within the range of −25 °C to +40 °C.

These accessories are intended to be connected to cables of copper or copper alloy only.

This document applies to accessories with screwless-type terminals or insulation piercing terminals, with a rated current up to and including 32 A for series I and 30 A for series II.

The use of these accessories on building sites and for agricultural, commercial and domestic applications is not precluded.

Fixed socket-outlets or appliance inlets incorporated in or fixed to electrical equipment are within the scope of this document. This document also applies to accessories intended to be used in extra-low voltage installations.

This document does not apply to accessories primarily intended for domestic and similar general purposes.

This document does not cover single-pole accessories.

In locations where special conditions prevail, for example on board ship or where explosions are liable to occur, additional requirements can be necessary.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-14, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

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

IEC TR 60083, *Plugs and socket-outlets for domestic and similar general use standardized in member countries of IEC*

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

IEC 60227 (all parts), *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V*

IEC 60228:2004, *Conductors of insulated cables*

IEC 60245-4:2011, *Rubber insulated cables – Rated voltages up to and including 450/750 V – Part 4: Cords and flexible cables*

IEC 60269-1, *Low-voltage fuses – Part 1: General requirements*

IEC 60269-2, *Low-voltage fuses – Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) – Examples of standardized systems of fuses A to K*

IEC 60309-4:2021, *Plugs, fixed or portable socket-outlets and appliance inlets for industrial purposes – Part 4: Switched socket-outlets with or without interlock*

IEC 60320 (all parts), *Appliance couplers for household and similar general purposes*

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

IEC 60529:1989, *Degrees of protection provided by enclosures (IP code)*
IEC 60529:1989/AMD1:1999
IEC 60529:1989/AMD2:2013

IEC 60664-1:2020, *Insulation coordination for equipment within low-voltage supply systems – Part 1: Principles, requirements and tests*

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

IEC 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 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments*

IEC 61000-6-3, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for equipment in residential environments*

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

ISO 1456, *Metallic and other inorganic coatings – Electrodeposited coatings of nickel, nickel plus chromium, copper plus nickel and of copper plus nickel plus chromium*

ISO 2081, *Metallic and other inorganic coatings – Electroplated coatings of zinc with supplementary treatments on iron or steel*

ISO 2093, *Electroplated coatings of tin – Specification and test methods*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

NOTE Where the terms "voltage" and "current" are used, they refer to the DC or the AC root mean square (RMS) values.

The application of accessories is shown in Figure 1.

3.1
fixed socket-outlet
part intended to be installed with the fixed wiring or incorporated in equipment

Note 1 to entry: A fixed socket-outlet may also be incorporated in the output circuit of an isolating transformer.

Note 2 to entry: In some countries fixed socket-outlets are called "receptacles".

Note 3 to entry: When the term "socket-outlet" is used alone, it covers both fixed and portable socket-outlets.

3.2
plug
part integral with or intended to be attached directly to one flexible cable connected to the equipment or to a portable socket-outlet

Note 1 to entry: In French, the resulting assembly when a plug is inserted into a socket-outlet is called "prise de courant".

3.3
portable socket-outlet
part integral with or intended to be attached to one flexible cable connected to the supply

Note 1 to entry: In general, a portable socket-outlet has the same contact arrangement as a fixed socket-outlet.

Note 2 to entry: The resulting assembly when a plug is inserted into a portable socket outlet is called a "cable coupler".

3.4
appliance inlet
part incorporated in, or fixed to, the equipment or intended to be fixed to it

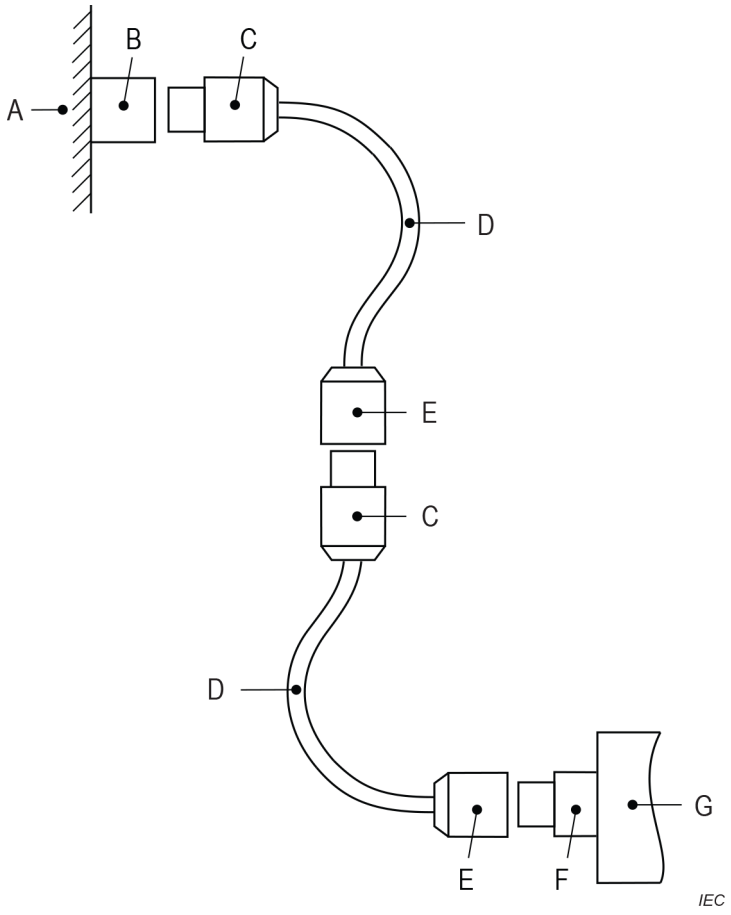
Note 1 to entry: In general, an appliance inlet has the same contact arrangement as a plug.

Note 2 to entry: The resulting assembly when a portable socket outlet is inserted into an appliance is called an "appliance coupler".

3.5
main part
part of an accessory carrying the contacts

3.6
rewireable accessory
accessory so constructed that the flexible cable can be replaced

3.7
non-rewireable accessory
accessory so constructed that the flexible cable cannot be separated from the accessory without making it permanently useless



Key

A supply
B fixed socket-outlet
C plug
D flexible cable
E portable socket-outlet
F appliance inlet
G appliance

Figure 1 – Diagram showing the use of the accessories

3.8
interlock
device, either electrical or mechanical, which prevents the contacts of a plug from becoming live before it is in proper engagement with a socket-outlet, and which either prevents the plug from being withdrawn while its contacts are live or makes the contacts dead before separation

3.9
retaining device
mechanical arrangement which holds a plug or portable socket-outlet in position when it is in proper engagement, and prevents its unintentional withdrawal

3.10
rated current
current assigned to the accessory by the manufacturer

3.11
insulation voltage
voltage assigned to the accessory by the manufacturer and to which dielectric tests, clearances and creepage distances are referred

3.12
rated operating voltage
nominal voltage of the supply for which the accessory is intended to be used

Note 1 to entry: An accessory may have a rated operating voltage range.

Note 2 to entry: An accessory may have more than one rated operating voltage.

3.13
basic insulation
insulation necessary for the proper functioning of the accessory and for basic protection against electric shock

3.14
supplementary insulation
protective insulation
independent insulation provided in addition to the basic insulation, in order to ensure protection against electric shock in the event of a failure of the basic insulation

3.15
double insulation
insulation comprising both basic insulation and supplementary insulation

3.16
reinforced insulation
improved basic insulation with such mechanical and electrical qualities that it provides the same degree of protection against electric shock as double insulation

3.17
terminal
conductive part provided for the connection of a conductor to an accessory

3.17.1
pillar terminal
terminal in which the conductor is inserted into a hole or cavity, where it is clamped under the shank of the screw or screws

Note 1 to entry: The clamping pressure may be applied directly by the shank of the screw or through an intermediate clamping member to which pressure is applied by the shank of the screw (see Figure 2).

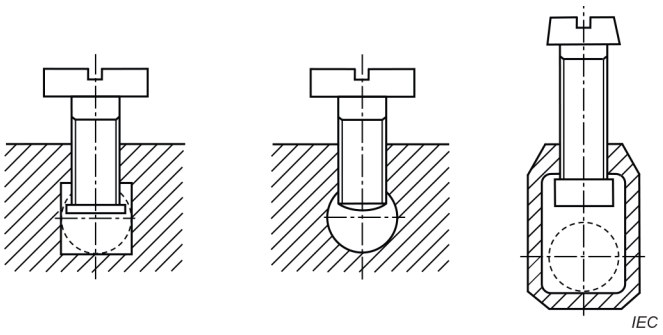


Figure 2 – Pillar terminals

3.17.2
screw terminal
terminal in which the conductor is clamped under the head of the screw

Note 1 to entry: The clamping pressure may be applied directly by the head of the screw or through an intermediate part, such as a washer, clamping plate or anti-spread device (see Figure 3).

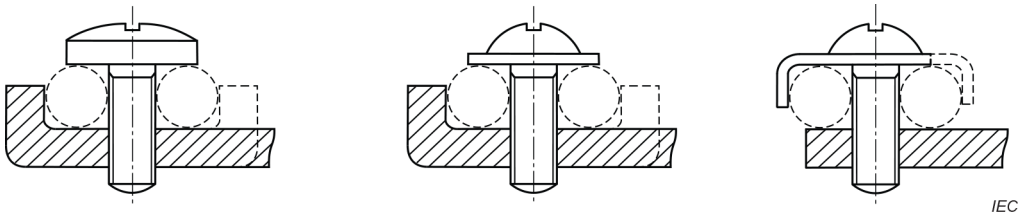


Figure 3 – Screw terminals

3.17.3
stud terminal
terminal in which the conductor is clamped under a nut

Note 1 to entry: The clamping pressure may be applied directly by a suitably shaped nut or through an intermediate part, such as a washer, clamping plate or anti-spread device (see Figure 4).

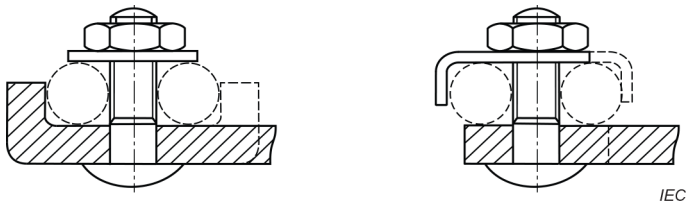


Figure 4 – Stud terminals

3.17.4
saddle terminal
terminal in which the conductor is clamped under a saddle by means of two or more screws or nuts

SEE: Figure 5

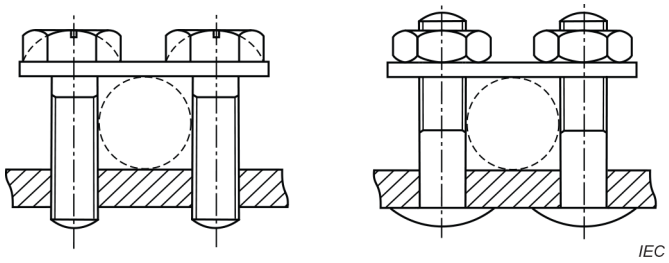


Figure 5 – Saddle terminals

3.17.5
lug terminal
screw terminal or a stud terminal, designed for clamping a cable lug or bar by means of a screw or nut

SEE: Figure 6

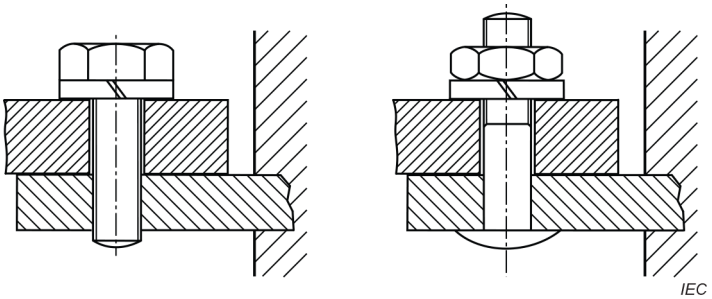


Figure 6 – Lug terminals

3.17.6
mantle terminal
terminal in which the conductor is clamped against the base of a slot in a threaded stud by means of a nut

Note 1 to entry: The conductor is clamped against the base of the slot by a suitably shaped washer under the nut, by a central peg if the nut is a cap nut, or by equally effective means for transmitting the pressure from the nut to the conductor within the slot (see Figure 7).

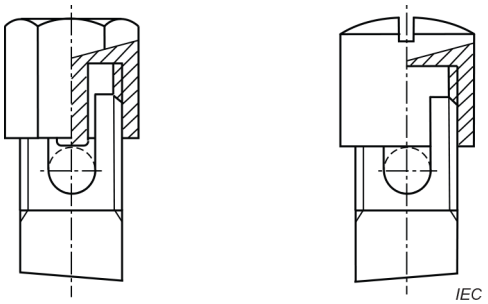


Figure 7 – Mantle terminals

3.17.7
screwless type terminal
terminal for the connection and subsequent disconnection of one or more conductors, the connection being made, directly or indirectly, by means other than screws

Note 1 to entry: Examples of screwless type terminals are given in Figure 8.

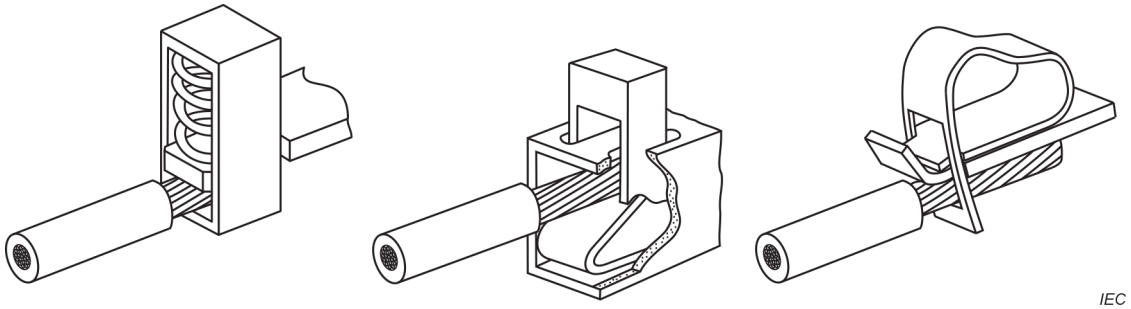
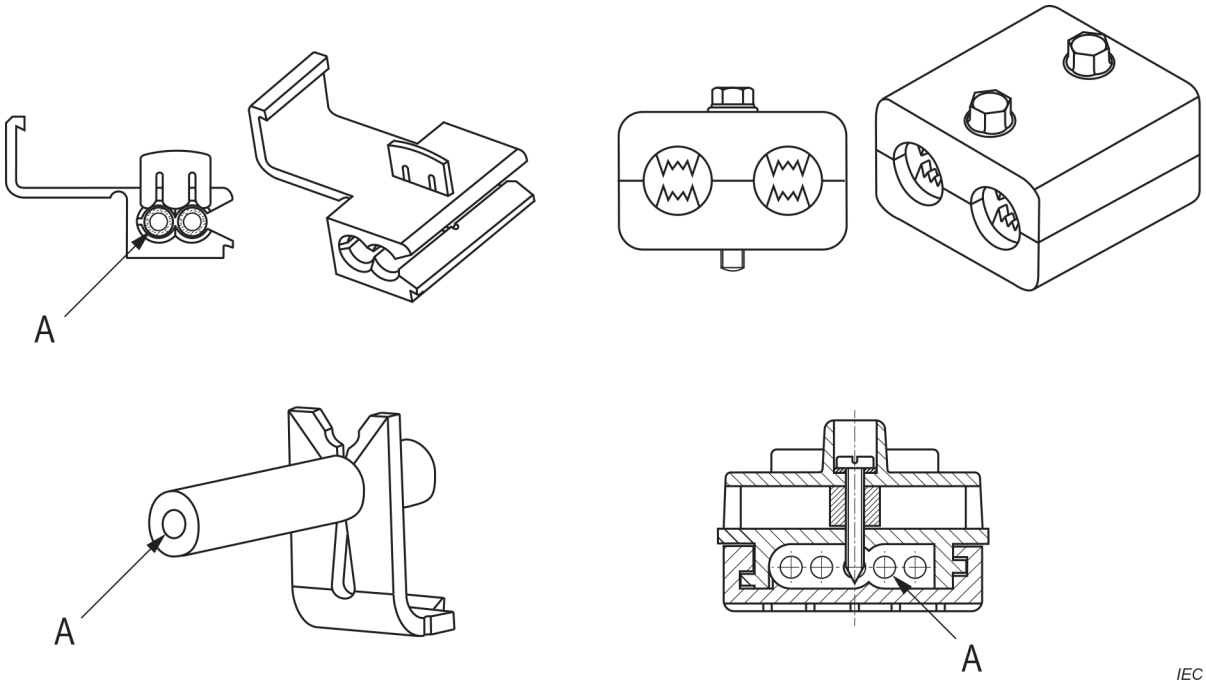


Figure 8 – Screwless terminals

3.17.8
insulation piercing terminal
IPT
terminal for the connection and subsequent disconnection of one or more conductors, the connection being made by piercing, boring through, cutting through, displacing or making ineffective in some other manner the insulation of the conductor(s) without previous stripping

Note 1 to entry: The removal of the outer sheath of the cable, if necessary, is not considered as a previous stripping.

Note 2 to entry: Examples of IPT are given in Figure 9.



Key

A Conductor

Figure 9 – Insulation piercing terminals

3.18
clamping unit
part(s) of a terminal necessary for the mechanical clamping and the electrical connection of the conductor(s), including the parts which are necessary to ensure correct contact pressure

3.19
conditional short-circuit current
prospective current that an accessory, protected by a specified short-circuit protective device, can satisfactorily withstand for the total operating time of that device under specified conditions of use and behaviour

Note 1 to entry: This definition differs from that of IEC 60050-441:2000, 441-17-20 by broadening the concept of current-limiting device to a short-circuit protective device, the function of which is not only to limit the current.

3.20
cap
part separated or attached, which may be used to provide the degree of protection of a plug or appliance inlet when it is not engaged with a socket-outlet

3.21
lid
means, attached, to ensure the degree of protection on a socket-outlet when it is not engaged with a plug or an appliance inlet

3.22
shutter
movable part(s) incorporated into an accessory arranged to automatically shield at least the live contacts when the accessory is withdrawn from the complementary accessory

[SOURCE: IEC 60884-1:2002 and IEC 60884-1:2002:AMD2:2013, 3.27, modified – "socket-outlet" and "plug" have been replaced by "accessory", and the words "from the complementary accessory" have been added.]

3.23
insulated end cap
part made of insulating material, located at the tip of a contact, ensuring a protection against access to hazardous parts with a standard test finger (IPXXB)

3.24
contact
conductive element of an accessory intended to make an electric contact with the corresponding contact of a mating accessory

[SOURCE: IEC 60050-151:2001, 151-12-16, modified – a preferred term "contact member" has been omitted, and "of an accessory" and "with the corresponding contact of a mating accessory" have been added to the definition.]

3.25
pilot contact
auxiliary electric contact for use in a control, signalling, monitoring or interlock function

Note 1 to entry: Pilot contact is not considered to be a pole.

[SOURCE: IEC 60309-4:2006, 2.108, modified – "signalling" has been added.]

3.26
compatibility
compatible
ability of accessories to join together and be functional

Note 1 to entry: Non-compatible accessories may physically join together, but not be functional.

3.27
instructed person
person adequately advised or supervised by electrically skilled persons to enable him or her to perceive risks and to avoid hazards which electricity can create

[SOURCE: IEC 60050-195:1998, 195-04-02, modified – "(electrically)" has been omitted from the term.]

3.28
skilled person
person with relevant education and experience to enable him or her to perceive risks and to avoid hazards which electricity can create

[SOURCE: IEC 60050-195:1998, 195-04-01, modified – "(electrically)" has been omitted from the term.]

4 General

4.1 General requirements

Accessories shall be so designed and constructed that in normal use their performance is reliable and safety is achieved by reducing risk to a tolerable level, as defined in ISO/IEC Guide 51.

Unless otherwise stated, the normal use environment in which the devices complying with this document are normally used is pollution degree 3 according to IEC 60664-1.

If other pollution degrees are needed, clearances and creepage distances shall be in accordance with IEC 60664-1. The comparative tracking index (CTI) value shall be evaluated in accordance with IEC 60112. Tests and requirements are set out in 26.1.3.

Accessories shall have a minimum degree of protection IP23 according to IEC 60529.

Combinations of plugs, appliance inlets, socket-outlets that are intended for use together shall comply with the requirements of this document and with the relevant standard sheets, if any.

In general, compliance is checked by carrying out all the tests specified.

4.2 General notes on tests

4.2.1 Tests according to this document are type tests. If a part of an accessory has previously passed tests for a given degree of severity, the relevant type tests shall not be repeated if the severity is not greater. When a part or a component is incorporated in a device or accessory according to this document and if this part or component meets an appropriate IEC International Standard, then no further test(s) or requirement(s) shall be required for this part or component, unless it is being used in a way significantly different from the intent of its own standard.

4.2.2 Unless otherwise specified, the samples are tested as delivered and under normal conditions of use, at an ambient temperature of (20 ± 5) °C; the tests are made at rated frequency.

4.2.3 Unless otherwise specified, the tests are carried out in the order of the clauses of this document.

4.2.4 Three samples are subjected to all the tests, except if necessary for the tests of 11.1.4 and Clause 29 where, for each of these two tests, one new set of samples is tested. If, however, the tests of Clause 20, Clause 21 and Clause 22 have to be made with both DC and AC, the tests with AC are made on three additional samples.

4.2.5 Accessories are deemed to comply with this document if no sample fails in the complete series of appropriate tests. If one sample fails in a test, that test and those preceding which may have influenced the test result are repeated on another set of three samples, all of which shall then pass the repeated tests.

In general, it will only be necessary to repeat the test which caused the failure, unless the sample fails in one of the tests of Clause 21 and Clause 22, in which case the tests are repeated from Clause 20 onwards.

The applicant may submit, together with the first set of samples, the additional set which may be wanted should one sample fail. The testing station will then, without further request, test the additional samples and will reject only if a further failure occurs. If the additional set of samples is not submitted at the same time, the failure of one sample will entail a rejection.

4.2.6 When the tests are carried out with conductors, they shall be copper and comply with IEC 60227 (all parts), IEC 60228:2004 [Clause 2, solid (class 1), stranded (class 2), flexible (class 5)] and IEC 60245-4, as accessories according to this document are intended to be connected to cables with copper or copper-alloy conductors only.

5 Standard ratings

5.1 The rated operating voltage or voltage range are those declared by the manufacturer.

5.2 Preferred rated currents are given in Table 1.

Table 1 – Preferred rated currents

Series I A	**Series II** A
16 32 63 125 250 315 400 630 800	20 30 60 100 200 300 350 500 600
NOTE 1 Ratings referred to as "Other ratings" in this document are given for test purposes only, when the manufacturer has not used the preferred ratings. NOTE 2 This Table 1 does not provide correspondence between series I and series II values. It is only a list of preferred ratings.	

6 Classification of accessories

6.1 According to purpose:

- plugs,
- fixed socket-outlets,
- portable socket-outlets,
- appliance inlets.

6.2 According to degrees of protection in accordance with IEC 60529 (with a minimum IP23, see 4.1).

6.3 According to earthing facilities:

- accessories without earthing contact;
- accessories with earthing contact.

6.4 According to the method of connecting the cable:

- rewireable plugs and rewireable portable socket-outlets;
- non-rewireable plugs and non-rewireable portable socket-outlets.

6.5 According to interlocking facilities:

- accessories without interlock, with or without integral switching device;
- accessories with mechanical interlock;

– accessories with electrical interlock.

6.6 According to the type of terminals:

– with screw type terminals;
– with screwless type terminals;
– with insulation piercing terminals.

6.7 According to the type of conductors for screwless type and insulation piercing terminals:

– for solid conductors only;
– for rigid (both solid and stranded) conductors only;
– for flexible conductors only;
– for rigid (both solid and stranded) and flexible conductors.

6.8 According to accessibility to live parts:

– accessories providing for IPXXB;
– accessories providing for IP2X;
– accessories providing for IPXXD;
– accessories providing for IP4X.

6.9 According to the presence of shutter:

– without shutters;
– with shutters.

6.10 According to presence of insulating end caps:

– accessories without insulating end caps;
– accessories with insulating end caps.

7 Marking

7.1 Accessories shall be marked with:

a) rated current(s) in amperes;
b) rated operating voltage(s) or range(s) in volts;
c) symbol for the nature of supply, if the accessory is not intended for both AC and DC, or is intended for AC with frequencies other than 50 Hz or 60 Hz, or if the rating is different for AC and DC;
d) rated frequency if exceeding 60 Hz;
e) either the name or trade mark of the manufacturer or of the responsible vendor;
f) type reference, which may be a catalogue number;
g) degree of protection;
h) symbol indicating the position of the earthing contact or the means used for ensuring compatibility, if any.

Optionally, the insulation voltage may be marked.

Compliance is checked by inspection.

7.2 When symbols are used, they shall be as follows:

A	.....	amperes	
V	.....	volts	
Hz	.....	hertz	
~	.....	alternating current	IEC 60417-5032 (2002-10)
AC	.....	alternating current	
⎓	.....	direct current	IEC 60417-5031 (2002-10)
DC	.....	direct current	
⏚	(preferred)	protective earth	IEC 60417-5019 (2006-08)
or ⏚	.....	earth	IEC 60417-5017 (2006-08)
IPXX	(relevant numerals)	degree of protection according to IEC 60529	

For IP codes, the two characteristic numerals (XX) shall be specified.

Marking of degree(s) of protection on plugs and appliance inlets is only valid when those plugs and appliance inlets are in engagement with a complementary accessory or with an attached cap, if any.

For the marking of rated current(s) and rated operating voltage(s) or range(s), values may be used alone.

The value for DC rated operating voltage, if any, shall then be placed before the figure for the AC rated operating voltage, and separated from it by a line or a dash.

Compliance is checked by inspection.

7.3 For fixed socket-outlets and appliance inlets, the marking a), c) and e) of 7.1 shall be on the main part, on the outside of the enclosure, or on the lid, if any, if the latter cannot be removed without the aid of a tool.

Except for flush-type fixed socket-outlets and appliance inlets, marking for a), c) and e) of 7.1 shall be easily discernible when the accessory is mounted and wired as in normal use, if necessary after it has been removed from the enclosure. The marking, if any, for the insulation voltage shall be on the main part; it shall not be visible when the accessory is mounted and wired as in normal use.

The marking for b), f), g) and h), if any, of 7.1, shall be on a place which is visible after installation of the accessory, on the outside of enclosure or on the lid, if any, if the latter cannot be removed without the aid of a tool.

With the exception of marking f) of 7.1, these markings shall be easily discernible when the accessory is mounted and wired as in normal use.

Compliance is checked by inspection.

The marking for f) of 7.1 may be on the main part.

The marking for a), b), c) and e) of 7.1, may be repeated on the lid, if any.

7.4 For plugs and portable socket-outlets, the marking specified in 7.1, with the exception of the marking for insulation voltage, if any, shall be easily discernible when the accessory is wired ready for use.

The marking for insulation voltage, if any, shall be on the main part; it shall not be visible when the accessory is mounted and wired as in normal use.

NOTE The term "ready for use" does not imply that the plug or portable socket-outlet is in engagement with its complementary accessory.

Compliance is checked by inspection.

7.5 For rewireable accessories, the contacts shall be indicated by the following symbols:

– for three-phase, the symbols L1, L2, L3, or 1, 2, 3 for the phases, N for neutral, if any, and the symbol  or  for earth;
– for two-pole, which may be used for both AC and DC, one symbol for one of the live poles and the symbol  or  for earth, if any.

These symbols shall be placed close to the relevant terminals; they shall not be placed on screws, removable washers or other removable parts.

Additional marking to indicate neutral terminal and/or earthing terminal may be used as follows:

– letter W and/or white colour for neutral;
– letter G and/or green colour for earthing.

The terminals for pilot conductors are not required to be marked. In the event that they are marked, it is recommended to use the marking P or PILOT.

The numerals used with the letters may be written as an index. It is recommended that where practicable the symbol  should be used.

Compliance is checked by inspection.

7.6 Marking shall be easily legible.

Compliance is checked by inspection, using normal or corrected vision, without additional magnification.

Marking shall be durable and indelible.

Compliance is checked by the following test, to be performed after the humidity treatment of Clause 14.

Laser marking directly on the product and marking made by moulding, pressing or engraving are considered to be durable and indelible and they are not subjected to this test.

The test is made by rubbing the marking for 15 s with a piece of cotton cloth soaked with water and again for 15 s with a piece of cotton cloth soaked with n-hexane 95 % (Chemical Abstracts Service Registry Number, CAS RN, 110-54-3).

NOTE n-hexane 95 % (Chemical Abstracts Service Registry Number, CAS RN, 110-54-3) is available from a variety of chemical suppliers as a high pressure liquid chromatography (HPLC) solvent.

When using the liquid specified for the test, precautions as stated in the relative material safety datasheet provided by the chemical supplier shall be taken to safeguard the laboratory technicians.

The marking surface to be tested shall be dried after the test with water.

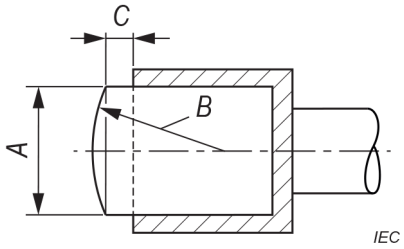
Rubbing shall commence immediately after soaking the piece of cotton, applying compression force of (5 ± 1) N at a rate of about one cycle per second (a cycle comprising forward and backward movement along the length of the marking). For markings longer than 20 mm, rubbing can be limited to a part of the marking, over a path of at least 20 mm length.

The compression force is applied by means of a test piston which is wrapped with cotton comprising cotton wool covered by a piece of cotton medical gauze.

The test piston shall have the dimensions specified in Figure 10 and shall be made of an elastic material which is inert against the test liquids and has a Shore-A hardness of 47 ± 5 (for example synthetic rubber).

When it is not possible to carry out the test on the specimens due to the shape/size of the product, a suitable piece having the same characteristics as the product can be submitted to the test.

Dimensions in millimetres



$A\ ^{+2}_{0}$	B ±0,5	$C\ ^{+1}_{0}$
20	20	2

Figure 10 – Test piston

7.7 If, in addition to the marking specified, the rated operating voltage and frequencies are indicated by means of a colour, the colour code shall be as shown in Table 2. An indicating colour, if different from that of the enclosure, shall be used only if it can be easily distinguished.

Table 2 – Colour coding

Rated operating voltage V	Colour [a) b)]
20 to 25	Violet
40 to 50	White
100 to 130	Yellow
200 to 250	Blue
380 to 480	Red
500 to 1 000	Black

a) For frequencies over 60 Hz up to and including 500 Hz, the colour green may be used, if necessary, in combination with the colour for the rated operating voltage.

b) In countries where accessories of series II current ratings are used, the colour orange is reserved for 125/250 V AC and the colour grey is reserved for 277 V AC accessories.

Compliance is checked by inspection.

7.8 Accessories with screwless type terminals shall be marked with the length of insulation to be removed before insertion of the conductor into the terminal.

7.9 Terminals according to 6.7 shall be marked as follows:

– with the letter(s) "s" or "sol" for terminals declared for solid conductors only;
– with the letter "r" for terminals declared for rigid conductors only (both solid and stranded);
– with the letter "f" for terminals declared for flexible conductors only;
– terminals declared for rigid (both solid and stranded) and flexible conductors need not be marked.

This marking shall appear on the accessory. It may also appear on the accompanying instruction sheet, the smallest package unit or in the manufacturer's documentation, if any.

7.10 For terminals, the connection and disconnection procedures shall, if necessary, be indicated on the product, on the smallest package unit or in the manufacturer's documentation.

8 Dimensions

8.1 Accessories shall comply with the appropriate standard sheets, if any. When standard sheets do not exist, accessories shall comply with manufacturer's specifications.

8.2 It shall not be possible to engage plugs or portable socket-outlets with socket-outlets or appliance inlets having different ratings, or having contact combinations allowing improper connection.

In addition, the design shall be such that improper connections shall not be possible between:

– the earth and/or pilot contact of the plug and a live contact of the socket-outlet, or a live contact of the plug and the earth and/or pilot contact of the socket-outlet;
– the phase contacts of the plug and the neutral contact of the socket-outlet, if any;
– the neutral contact of the plug and a phase contact of the socket-outlet.

Connection of single-phase or three-phase plugs into three-phase with neutral socket-outlets is permitted where the above conditions are met.

Compliance is checked by inspection.

8.3 It shall not be possible to make single-pole connections between plugs and socket-outlets, or between appliance inlets and socket-outlets.

Plugs and appliance inlets shall not allow improper connections with socket-outlets complying with IEC TR 60083 or with connectors complying with IEC 60320 (all parts).

Socket-outlets shall not allow improper connections with plugs complying with IEC TR 60083 or with appliance inlets complying with IEC 60320 (all parts).

Improper connections include single-pole connections and other connections which do not comply with the requirements for protection against electric shock.

Compliance is checked by inspection.

9 Protection against electric shock

9.1 Accessories shall be so designed that live parts of socket-outlets, when they are wired as in normal use, and live parts of plugs and appliance inlets, when they are in partial or complete engagement with the complementary accessories, are not accessible.

In addition, it shall not be possible to make contact between a contact of a plug or appliance inlet and a contact of a socket-outlet while any contact is accessible.

Compliance is checked by inspection and, if necessary, by a test on the sample wired as in normal use.

The standard test finger according to IEC 61032, Probe B is applied in every possible position, an electrical indicator, with a voltage not less than 40 V, being used to show contact with the relevant part.

The neutral contact and pilot contacts of socket-outlets are deemed to be live parts.

9.2 Accessories with earthing contact shall be so designed that:

– when inserting the plug or portable socket-outlet, the earth connection is made before the phase connections and neutral, if any, are made;
– when withdrawing the plug or portable socket-outlet, the phase connections and neutral, if any, are broken before the earth connection is broken.

Compliance is checked by inspection.

9.3 It shall not be possible to inadvertently assemble the part carrying contacts of the plug into the enclosure of a socket-outlet.

Compliance is checked by manual test.

9.4 For accessories provided with shutters, the shutters shall be so constructed that live parts are not accessible without a plug in engagement, with the gauges shown in Figure 11 and Figure 12.

The gauges are applied to the entry holes corresponding to the live contacts and to any other opening of the engagement surface. The gauges shall not touch any live part.

For the purpose of this test, neutral contacts of socket-outlets are deemed to be live parts and pilot contacts, signal, data earth, and earth contacts are not considered live parts.

To ensure this degree of protection, accessories shall be so constructed that live contacts are automatically screened when complementary accessories are withdrawn.

The means for achieving this shall be such that they cannot easily be operated by anything other than complementary accessories and shall not depend upon parts which are liable to be lost.

An electrical indicator with a voltage between 40 V and 50 V is used to show contact with the relevant part.

Compliance is checked by inspection and for socket-outlets with a plug completely withdrawn by applying the above gauges as follows.

The gauge according to Figure 11 is applied to the entry holes corresponding to the live contacts and to any other opening of the engagement surface with a force of 20 N.

The gauge is applied to the shutters in the most unfavourable position, successively in three directions, to the same place for approximately 5 s in each of the three directions.

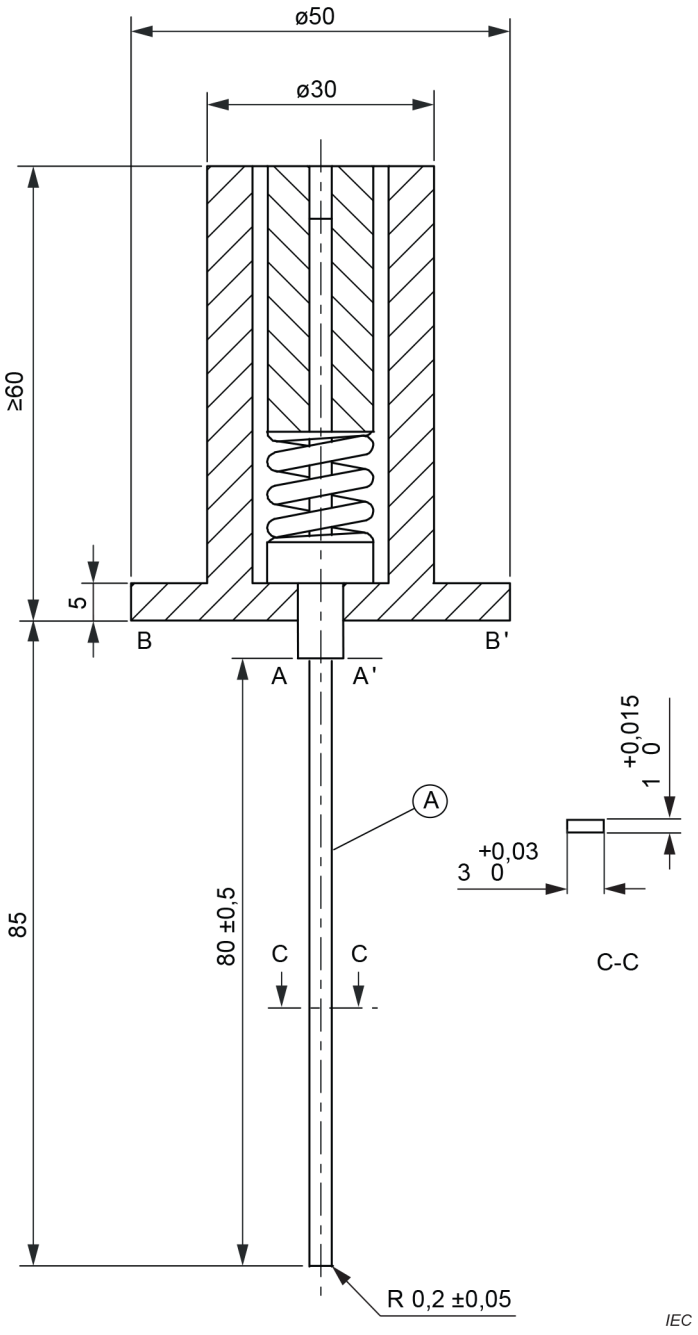
During each application the gauge shall not be rotated and it shall be applied in such a way that the 20 N force is maintained. When moving the gauge from one direction to the next, no force is applied but the gauge shall not be withdrawn.

A steel gauge, according to Figure 12, is then applied with a force of 1 N and in three directions, for approximately 5 s in each direction, with independent movements, withdrawing the gauge after each movement.

For socket-outlets and appliance inlets with enclosures or bodies of thermoplastic material, the test is made at an ambient temperature of (35 ± 2) °C, both the socket-outlets and the gauge being at this temperature.

This test shall be repeated after the tests of Clause 21.

Dimensions in millimetres



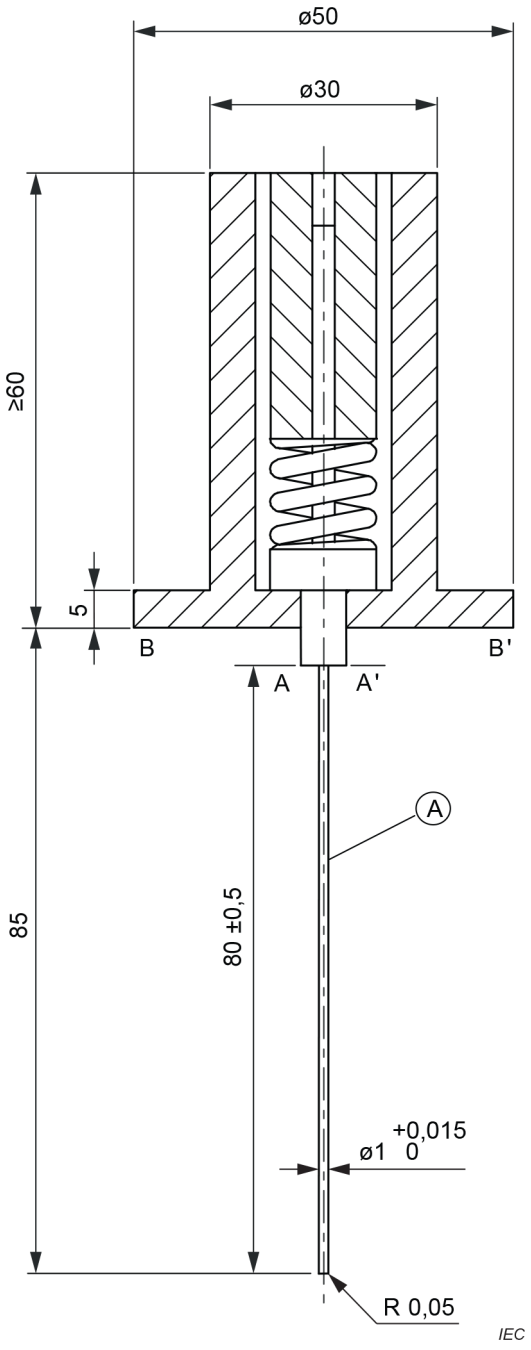
Key

A Rigid steel wire

To calibrate the gauge, a push force of 20 N is applied on the steel rigid wire in the direction of its axis: the characteristics of the gauge internal spring shall be such that the suface A-A' is brought practically to the same level as the surface B-B' when this force is applied.

Figure 11 – Gauge "A" for checking shutters

Dimensions in millimetres



Key

A Rigid steel wire

To calibrate the gauge, a push force of 1 N is applied on the steel rigid wire in the direction of its axis: the characteristics of the gauge internal spring shall be such that the suface A-A' is brought practically to the same level as the surface B-B' when this force is applied.

Figure 12 – Gauge "B" for checking shutters

10 Provision for earthing

10.1 Accessories with earthing contact shall be provided with an earthing terminal. Metal-clad fixed accessories with an internal earthing terminal can, in addition, be provided with an external earthing terminal, which, except for flush type fixed socket-outlets, shall be visible from the outside.

Earthing contacts shall be directly and reliably connected to the earthing terminals.

Compliance is checked by inspection.

10.2 Accessible metal parts of accessories with earthing contact, which may become live in the event of an insulation fault, shall be reliably connected to the internal earthing terminal(s) by construction.

NOTE For the purpose of this requirement, screws for fixing bases, covers and the like are not deemed to be accessible parts which can become live in the event of an insulation fault.

If accessible metal parts are screened from live parts by metal parts which are connected to an earthing terminal or earthing contact, or if they are separated from live parts by double insulation or reinforced insulation, they are not, for the purpose of this requirement, regarded as likely to become live in the event of an insulation fault.

Compliance is checked by inspection and by the following test:

A current of 25 A derived from an AC source having a no-load voltage not exceeding 12 V is passed between the earthing terminal and each of the accessible metal parts in turn.

The voltage drop between the earthing terminal and the accessible metal part is measured, and the resistance calculated from the current and this voltage drop.

In no case shall the resistance exceed 0,05 Ω.

Care should be taken that the contact resistance between the tip of the measuring probe and the metal part under test does not influence the test results.

10.3 Earthing contacts shall be capable of carrying a current equal to that specified for the phase contacts without overheating.

Compliance is checked by the test of Clause 22.

10.4 Earthing contacts shall be so shrouded or guarded that they are protected against mechanical damage.

This requirement precludes the use of side earthing contacts.

Compliance is checked by inspection.

11 Terminals and terminations

11.1 Common requirements for terminals and terminations

11.1.1 Rewireable accessories shall be provided with terminals.

Rewireable plugs and portable socket-outlets shall be provided with terminals that accept flexible conductors.

Compliance is checked by inspection.

11.1.2 Non-rewireable accessories shall be provided with soldered, welded, crimped or equally effective permanent connections (terminations).

Connections made by crimping a pre-soldered flexible conductor are not permitted, unless the soldered area is outside the crimping area.

Compliance is checked by inspection.

11.1.3 Terminals shall allow the conductor to be connected without special preparation.

This requirement is not applicable to lug terminals.

NOTE The term "special preparation" covers soldering of the wires of the conductor, use of terminal ends, etc., but not the reshaping of the conductor before introduction into the terminal or the twisting of a flexible conductor to consolidate the end.

Compliance is checked by inspection.

11.1.4 Parts of terminals and terminations other than screws, nuts, washers, stirrups, clamping plates and the like, shall be of a metal having, under conditions occurring in the equipment, mechanical strength, electrical conductivity and resistance to corrosion adequate for the intended use.

Suitable metals, when used within a permissible temperature range and under normal conditions of chemical pollution, are:

– copper;
– an alloy containing at least 58 % copper for parts that are worked cold or at least 50 % copper for other parts;
– stainless steel containing at least 13 % chromium and not more than 0,09 % carbon;
– steel provided with an electroplated coating of zinc according to ISO 2081, the coating having a thickness of at least:
  - 8 µm (ISO service condition 2) for IP ≤ X4 accessories;
  - 12 µm (ISO service condition 3) for IP ≥ X5 accessories;
– steel provided with an electroplated coating of nickel and chromium according to ISO 1456, the coating having a thickness of at least:
  - 20 µm (ISO service condition 2) for IP < X4 accessories;
  - 30 µm (ISO service condition 3) for IP > X5 accessories;
– steel provided with an electroplated coating of tin according to ISO 2093, the coating having a thickness equal to at least that specified for:
  - 20 µm (ISO service condition 2) for IP < X4 accessories;
  - 30 µm (ISO service condition 3) for IP > X5 accessories.

NOTE Given values are nominal values.

Other metal no less resistant to corrosion than copper and having mechanical properties no less suitable shall be the subject of investigation.

Parts of terminals and terminations other than screws, nuts, washers, stirrups, clamping plates and the like, which may be subjected to mechanical wear, shall not be made of steel provided with an electroplated coating.

Compliance is checked by inspection and by chemical analysis.

11.1.5 If the body of an earthing terminal is not part of the metal frame or housing of the accessory, the body shall be of material as specified in 11.1.4 for parts of terminals. If the body is part of the metal frame or housing, the clamping means shall be the material of the body.

If the body of an earthing terminal is part of a frame or housing made of aluminium or aluminium alloy, precautions shall be taken to avoid the risk of corrosion resulting from contact between copper and aluminium or its alloys.

NOTE The requirement regarding the avoidance of the risk of corrosion does not preclude the use of adequately coated metal screws or nuts.

Compliance is checked by inspection and by chemical analysis.

11.1.6 Terminals and terminations shall be properly fixed to the accessory and shall not loosen when connecting and disconnecting the conductors.

Terminals and terminations shall be protected against rotation.

Clamping means shall not serve to fix any other component.

The clamping means for the conductor may be used to stop rotation or displacement.

Compliance is checked by inspection and, if necessary, by test of 25.1.

NOTE These requirements do not preclude terminals that are floating or terminals so designed that rotation or displacement of the terminal is prevented by the clamping screw or nut, provided that their movement is appropriately limited and does not impair the correct operation of the accessory.

Terminals may be prevented from working loose by fixing with two screws, by fixing with one screw in a recess such that there is no appreciable play, or by other suitable means.

Covering with sealing compound without other means of locking is not deemed to be sufficient. Self-hardening resins may, however, be used to lock terminals or terminations which are not subject to torsion in normal use.

11.1.7 Each terminal shall be located in proximity to the other terminals, as well as to the internal earthing terminal, if any, unless there is a sound technical reason to the contrary.

Compliance is checked by inspection.

11.1.8 Terminals or terminations shall be so located or shielded that:

– screws or other parts becoming loose from the terminals cannot establish any electrical connection between live parts and metal parts connected to the earthing terminal;
– conductors becoming detached from live terminals or terminations cannot touch metal parts connected to the earthing terminal;
– conductors becoming detached from the earthing terminal or terminations cannot touch live parts.

This requirement applies also to terminals or terminations for pilot conductors.

Compliance is checked by inspection and by manual test.

11.1.9 When the conductors have been correctly fitted, there shall be no risk of accidental contact between live parts of different polarity or between such parts and accessible metal parts, and, should a wire of a stranded conductor escape from a terminal or termination, there shall be no risk that such a wire emerges from the enclosure.

The requirement with regard to the risk of accidental contact between live parts and accessible metal parts does not apply to accessories having rated operating voltages not exceeding 50 V.

Compliance is checked by inspection and, where the risk of accidental contact between live parts and other metal parts is concerned, by the following test:

An 8 mm length of insulation is removed from the end of a flexible conductor having a cross-sectional area in the middle of the range specified in Table 3. One wire of the stranded conductor is left free and the other wires are fully inserted and clamped into the terminal or termination. The free wire is bent back, without tearing the insulation, in every possible direction, but without making sharp bends around barriers.

The free wire of a conductor connected to a live terminal or termination shall neither touch any metal part which is not a live part nor emerge from the enclosure. The free wire of a conductor connected to the earthing terminal or termination shall not touch any live part.

If necessary, the test is repeated with the free wire in another position.

Table 3 – Size for connectable conductors

Rating of the accessory				**Internal connection[a) e)]**				**External earthing connection if any**	
Rated operating voltage	**Current** A			**Flexible cables for plugs and portable socket-outlets** **Solid or stranded cables for appliance inlets[b)]**		**Solid or stranded cables for fixed socket-outlets [b) f)]**			
V	**Series I**	**Series II**	**Other ratings**	**Series I** mm^2	**Series II** AWG/MCM [c)]	**Series I** mm^2	**Series II** AWG/MCM [c)]	**Series I** mm^2	**Series II** AWG/MCM [c)]
Not exceeding 50	16	20		4 to 10	12 to 8	4 to 10	12 to 8		
	32	30		4 to 10	12 to 8	4 to 10	12 to 8		
Exceeding 50			6	0,75 to 1	18 to –	0,75 to 1,5	18 to 16	2,5	14
			10	1 to 1,5	– to 16	1 to 1,5	– to 16	2,5	14
	16	20		1 to 2,5	16 to 12	1,5 to 4	16 to 12	6	10
			25	1,5 to 4	16 to 12	2,5 to 6	14 to 10	6	10
	32	30		2,5 to 6	14 to 10	2,5 to 10	14 to 8	10	8
			40	4 to 10	12 to 8	4 to 16	12 to 6	10	8
			50	4 to 10	12 to 8	4 to 16	12 to 6	16	6
	63	60		6 to 16	10 to 6	6 to 25	10 to 4	25	4
			80	10 to 25	8 to 4	16 to 35	6 to 2	25	4
			90	10 to 25	8 to 4	16 to 35	6 to 2	25	4
	125	100		16 to 50	6 to 0	25 to 70	4 to 00	25	4
			150	25 to 70	4 to 00	35 to 95	2 to 000	25	4
			160	25 to 70	4 to 00	35 to 95	2 to 000	25	4
	250	200		70 to 150	00 to 0000	70 to 185[d)]	00 to 250	25	4
	315	300		95 to 150	000 to 300	120 to 185	250 to 350	25	4
		350		120 to 185	250 to 350	150 to 240	300 to 500	35	3
	400			150 to 240	300 to 500	185 to 300	350 to 600	35	3
		500		185 to 300	350 to 600	240 to 400	500 to 800	35	2
	630	600		240 to 400	500 to 800	300 to 500	600 to 1 000	50	1
	800			300 to 500	600 to 1 000	400 to 630	800 to 1 250	50	0

a)	Terminal or terminations for pilot conductors, if any, shall allow the connection of conductors having a cross-sectional area of at least 1 mm^2.
b)	Classification of conductors: according to IEC 60228.
c)	The nominal cross-sectional areas of conductors are given in square millimetres (mm^2). AWG/MCM values are considered as equivalent to mm^2 for the purpose of this document. AWG: American Wire Gauge is a system of identifying wires in which the diameters are in geometric progression between size 36 and size 0000. MCM: Mille Circular Mils denotes circle surface area. 1 MCM = 0,506 7 mm^2.
d)	150 mm^2 for 200 A accessories of series II.
e)	For ratings other than those above, the cross-sectional area(s) of the conductors may be that specified by the manufacturer.
f)	For fixed socket-outlets declared for flexible conductors only, these values apply.

11.2 Screw type terminals

11.2.1 Screw type terminals shall allow the proper connection of copper or copper-alloy conductors having nominal cross-sectional areas as shown in Table 3.

For terminals other than lug terminals, compliance is checked by the following test and by tests of 11.5.

Gauges as specified in Figure 13, having a measuring section for testing the insertability of the maximum specified cross-sectional area of Table 3, shall be able to penetrate into the terminal aperture, down to the designated depth of the terminal, under their own weight.

Screw type terminals that cannot be checked with the gauges specified in Figure 13, shall be tested by suitably shaped gauges, having the same cross-section as those of the appropriate gauges given in Figure 13.

For pillar terminals in which the end of a conductor is not visible, the hole to accommodate the conductor shall have a depth such that the distance between the bottom of the hole and the last screw will be equal to at least half the diameter of the screw, and in any case not less than 1,5 mm.

Compliance is checked by inspection.

For terminals complying with Figure 6, the lug shall accept conductors having nominal cross-sectional areas within the appropriate range specified in Table 3.

Compliance is checked by inspection.

11.2.2 Screw type terminals shall have appropriate mechanical strength.

Screws and nuts for clamping shall have an ISO thread or a thread comparable in pitch and mechanical strength.

NOTE SI, BA and UN threads are considered as being comparable in pitch and mechanical strength.

Compliance is checked by inspection, measurement and the test of 25.1. In addition to the requirements of 25.1, the terminals shall not have undergone changes after the test that would adversely affect their future use.

11.2.3 Screw type terminals shall be so designed that they clamp the conductor between metal surfaces with sufficient contact pressure and without damaging the conductor.

Compliance is checked by inspection and by the type tests of 11.5.

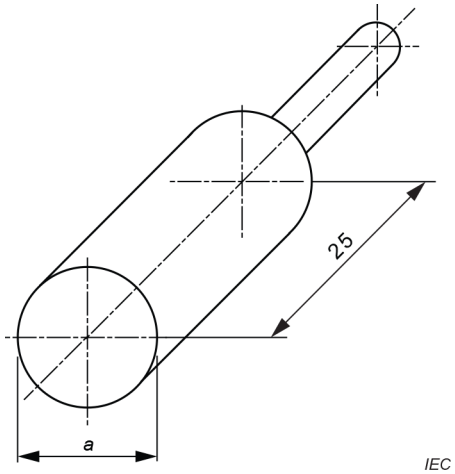
11.2.4 Lug terminals shall be used only for accessories having a rated current of at least 60 A; if such terminals are provided, they shall be fitted with spring washers or equally effective locking means.

Compliance is checked by inspection.

11.2.5 Clamping screws or nuts of earthing terminals shall be adequately locked against accidental loosening, and it shall not be possible to loosen them without the aid of a tool.

Compliance is checked by inspection, by manual test and by the relevant test of Clause 11.

Dimensions in millimetres



Flexible mm^2	**Rigid (solid or stranded)** mm^2	**Diameter** *a* mm	**Tolerances for** *a* mm
1	1	1,6	0 -0,05
1,5	1,5	1,9	0 -0,05
2,5	4	2,8	0 -0,05
4	6	3,4	0 -0,06
6	10	4,3	0 -0,06
10	16	5,4	0 -0,06
16	25	6,7	0 -0,07
25	35	8,0	0 -0,07
35	50	10,0	0 -0,07
50	70	12,0	0 -0,08
70	95	14,0	0 -0,08
95	120	16,0	0 -0,08
120	150	18,0	0 -0,08
150	185	20,0	0 -0,08
185	240	25,0	0 -0,08
240	300	28,0	0 -0,08
300	400	28,5	0 -0,08
400	500	33,0	0 -0,08
500	630	37,0	0 -0,08
630	800	41,0	0 -0,08

Maximum cross-section of conductors and corresponding gauges.

Material: steel

Figure 13 – Gauges for testing insertability of round unprepared conductors having the maximum specified cross-section

11.3 Screwless type terminals

11.3.1 Screwless type terminals shall allow the proper connection of copper or copper-alloy conductors having nominal cross-sectional areas as shown in Table 3.

Gauges as specified in Figure 13, having a measuring section for testing the insertability of the maximum specified cross-sectional area of Table 3, shall be able to penetrate into the terminal aperture to the designated depth of the terminal.

Screwless type terminals that cannot be checked with the gauges specified in Figure 13, shall be tested by suitably shaped gauges, having the same cross-section as those of the appropriate gauges given in Figure 13.

Compliance is checked by inspection.

11.3.2 Screwless type terminals shall be so designed that they clamp the conductor(s) between metal surfaces, with sufficient contact pressure and without damaging the conductor(s).

Compliance is checked by inspection and the type tests of 11.5 and 11.6.

11.3.3 Screwless type terminals shall have appropriate mechanical strength.

Compliance is checked by the following test:

Five insertions and disconnections are made with each type of conductor for which the terminal is intended to be used, with conductors having the largest diameter according to Table 3 and Table 13.

The insertion and disconnection of the conductors shall be made in accordance with manufacturer's instructions.

New conductors are used each time, except for the fifth time, when the conductor used for the fourth insertion is clamped at the same place. For each insertion, the conductors are either pushed as far as possible into the clamping unit or are inserted so that adequate connection is obvious. After each insertion the conductor is twisted through 90° and subsequently disconnected.

After these tests, the terminals shall not be damaged in such a way as to impair their further use with the smallest and the largest conductors.

11.3.4 The connection or disconnection of conductors shall be made:

– either by the use of a general purpose tool or a convenient integrated device in the terminal, to open it and to assist the insertion or the withdrawal of the conductor(s);
– or by simple insertion.

Disconnecting a conductor shall require an operation, other than a pull only on the conductor, such that it can, in normal use, be effected manually, with or without the help of a tool.

Compliance is checked by inspection.

11.3.5 Opening for a tool intended to assist the insertion or disconnection of the conductors, if needed, shall be clearly distinguishable from the opening intended for the conductor.

Compliance is checked by inspection.

11.3.6 Terminals shall be so designed and constructed that:

– each conductor is clamped individually in a separate independent clamping unit (not necessarily in separate holes);
– during the connection or disconnection, the conductors can be connected or disconnected either at the same time or separately.

It shall be possible to clamp securely any number of conductors up to the maximum provided for.

Compliance is checked by inspection and by tests of 11.5.

11.3.7 Terminals shall be so designed and constructed that inadequate insertion of the conductor is avoided.

Compliance is checked by inspection.

11.3.8 Screwless terminals shall be so designed that the connected conductor remains clamped, even if it has been bent during normal installation.

NOTE This test is intended to simulate the bending forces on the conductor being transferred to the terminal during installation.

Compliance is checked by the following test:

For the bending test, three new samples shall be used.

The test apparatus, the principle of which is shown in Figure 14, shall be constructed so that:

– the test conductor, properly inserted into a clamping unit of the connecting devices, shall be allowed to be bent (deflected) in any of the 12 directions differing from each other by 30° ± 5°;
– the starting point can be varied by 10° and 20° from the original point.

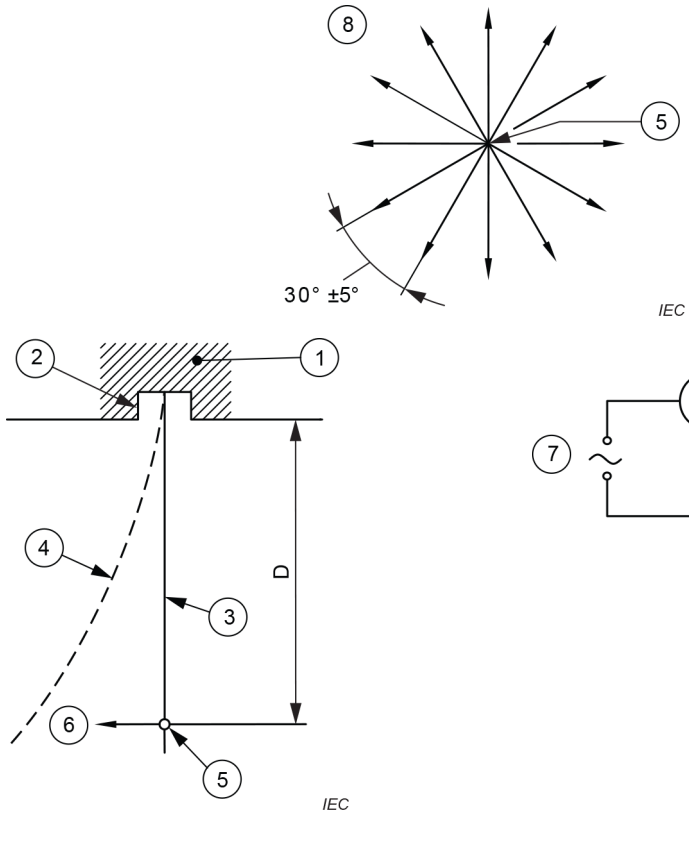
NOTE A reference direction and starting point is not specified.

The bending of the conductor from its straight position to the testing positions shall be effected by means of a suitable device applying a force as specified in Table 4 to the conductor, at a certain distance from the clamping unit of the connecting device.

The bending apparatus shall be so designed that:

– the force is applied in the direction perpendicular to the conductor;
– the bending is attained without rotation of the conductor within the clamping unit;
– the force remains applied while the specified voltage drop measurement is made.

The force for bending the conductor is specified in Table 4. The distance "D" shall be measured from the extremity of the connecting device, including the guidance for the conductor, if any, to the point of application of the force to the conductor.



a) Principle of the test apparatus for bending tests on screwless terminals

b) Example of test arrangement to measure the voltage drop during bending test on screwless terminals

Key

A Amperemeter
mV Millivoltmeter
S Switch
D Distance (Table 4)
1 Specimen
2 Terminal
3 Test conductor
4 Test conductor, bent
5 Point of application of the force for bending the conductor
6 Bending force (perpendicular to the straight conductor)
7 Supply
8 Directions of application of the forces

Figure 14 – Information for the bending test

Table 4 – Deflection test forces

Nominal cross-sectional area of test conductor		Deflection test force [a]	Distance D
Mm^2	AWG	N	mm
1,0	--	0,25 [b]	100
1,5	16	0,5 [b]	100
2,5	14	1,0 [b]	100
4	12	2,0 [b]	100
6	10	3,5 [c]	100
10	8	7,0 [c]	100

[a] The forces are chosen so that they stress the conductors close to the limit of elasticity.

[b] These values are based on IEC 60998-2-2.

[c] These values are based on IEC 60352-7.

Provisions shall be made so that the voltage drop across the clamping units under test can be measured when the conductor is connected, as shown for example in Figure 14 b).

The sample is mounted on the fixed part of the test apparatus in such a way that the test conductor can be freely bent.

The surface of the test conductor shall be free of detrimental contamination or corrosion.

A clamping terminal is fitted, as for normal use, with a rigid solid copper conductor having the smallest cross-sectional area specified in Table 3 and is submitted to a first test sequence; the same clamping terminal is submitted to a second test sequence using the conductor having the largest cross-sectional area, unless the first test sequence has failed.

The test shall be made with the current flowing (i.e. the current is not switched on and off during the test). A suitable power supply shall be used so that the current variations are kept with ±5 %.

A tenth of the test current assigned to the connected conductor, according to Table 7, shall flow through the connecting devices. A bending force shall be applied as shown in Figure 14 a), in one of the 12 directions and the voltage drop across this clamping unit shall be measured.

The force shall then be applied successively on each one of the remaining 11 directions shown in Figure 14 a) following the same test procedure.

If at any of the 12 test directions the voltage drop is greater than 2,5 mV, the force shall be maintained in this direction until the voltage drop is reduced to a value below 2,5 mV, but for not more than 1 min. After the voltage drop has reached a value below 2,5 mV, the force shall be maintained in the same direction for a further period of 30 s during which period the voltage drop shall not have increased.

The other two samples of the test set shall be tested according to the same test procedure, but moving the 12 directions of the force, so that they differ by approximately 10° for each sample.

If one sample fails in one of the directions of application of the test force, the tests shall be repeated on another set of samples, all of which shall comply with the repeated tests.

11.4 Insulation piercing terminals (IPT)

11.4.1 Insulation piercing terminals shall allow the proper connection of copper or copper-alloy conductors having nominal cross-sectional areas as shown in Table 3.

Compliance is checked by inspection and by introducing the largest insulated conductor according to Table 3 and Table 13.

11.4.2 Insulation piercing terminals shall be so designed that they clamp the conductor between metal surfaces with sufficient contact pressure and without damaging the conductor.

Compliance is checked by inspection and by the tests of 11.5 and 11.6.

Alternatively insulation piercing terminals are allowed to clamp the conductor between a metal part and a part of insulating material provided the insultation piercing terminals comply with test of 11.7.

Compliance is checked by inspection and tests of 11.5 and 11.7.

11.4.3 Insulation piercing terminals shall have appropriate mechanical strength.

Compliance is checked by the following test:

Five insertions and disconnections are made with each type of conductor for which the terminal is intended to be used with conductors having the largest diameter according to Table 3 and Table 13.

The insertion and disconnection of the conductors shall be made in accordance with the manufacturer's instructions.

If insulation piercing terminals use screws for wire connection, the torque value of Table 19 shall be used. Higher values of torque may be used if so stated by the manufacturer in its technical documentation.

New conductors are used each time, except for the fifth time, when the conductor used for the fourth insertion is clamped at the same place. For each insertion, the conductors are either pushed as far as possible into the clamping unit or are inserted so that adequate connection is obvious. After each insertion the conductor is twisted through 90° and subsequently disconnected.

After these tests, the terminals shall not be damaged in such a way as to impair their further use with the smallest and the largest conductor cross-sections.

11.4.4 The connection or disconnection of conductors shall be made by the use of a general purpose tool or a convenient integrated device in the terminal to assist the insertion or the withdrawal of the conductors.

The disconnection of a conductor shall require an operation other than a pull on the conductor only. It shall be necessary to take a deliberate action to disconnect it by hand or with a suitable tool.

Compliance is checked by inspection.

11.4.5 The opening for a tool intended to assist the insertion or disconnection of the conductors, if needed, shall be clearly distinguishable from the opening intended for the conductor.

Compliance is checked by inspection.

11.4.6 Terminals shall be so designed and constructed that:

– each conductor is clamped individually in a separate independent clamping unit (not necessarily in separate holes);
– during the connection or disconnection, the conductors can be connected or disconnected either at the same time or separately.

It shall be possible to clamp securely any number of conductors up to the maximum provided for.

Compliance is checked by inspection and by the tests of 11.5.

11.5 Mechanical tests on terminals

11.5.1 New terminals are fitted with new conductors of the minimum and the maximum cross-sectional areas and are tested with the apparatus shown in Figure 15.

The test is carried out on six samples: three with the smallest conductor cross-sectional area and three with the largest conductor cross-sectional area.

The length of the test conductor shall be 75 mm longer than the height H specified in Table 5.

Clamping screws, if any, are tightened with the torque according to Table 19. Otherwise the terminals are connected according to the manufacturer's instructions.

Where there is a means of guidance for the conductor at the clamping unit the terminal shall be tested while installed in the accessory.

Each conductor is subjected to the following test.

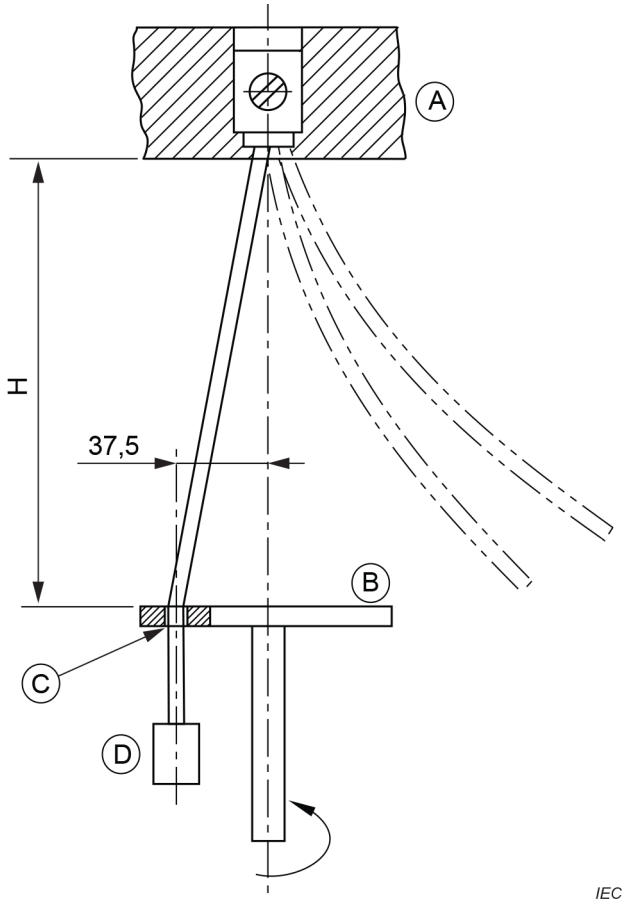
The end of the conductor is passed through an appropriate-sized bushing in a platen, positioned at a height H below the equipment, as given in Table 5. The bushing is positioned in a horizontal plane, such that its centre line describes a circle of 75 mm diameter, concentric with the centre of the clamping unit in the horizontal plane. The platen is then rotated at a rate of (10 ± 2) r/min.

The distance between the mouth of the clamping unit and the upper surface of the bushing shall be within 15 mm of the height in Table 5. The bushing may be lubricated to prevent binding, twisting or rotation of the insulated conductor. A mass, as specified in Table 5, is suspended from the end of the conductor. The duration of the test is 15 min.

During the test, the conductor shall neither slip out of the clamping unit nor break near the clamping unit.

Terminals shall not, during this test, damage the conductor in such a way as to render it unfit for further use.

Dimensions in millimetres



Key

A Clamping unit

B Platen

C Bushing hole

D Mass

Figure 15 – Test arrangement for terminals

Table 5 – Pulling test values on terminals

Nominal cross-sectional area mm^2	Diameter of bushing mm	Height[a)] mm	Mass kg
1,0	6,5	260	0,4
1,5	6,5	260	0,4
2,5	9,5	280	0,7
4,0	9,5	280	0,9
6,0	9,5	280	1,4
10,0	9,5	280	2,0
16,0	13,0	300	2,9
25,0	13,0	300	4,5
35,0	14,5	300	6,8
50,0	15,9	343	9,5
70,0	19,1	368	10,4
95,0	19,1	368	14,0
120,0	22,2	406	14,0
150,0	22,2	406	15,0
185,0	25,4	432	16,8
240,0	28,6	464	20,0
300,0	28,6	464	22,7
400,0	31,8	495	50,0
500,0	38,1	572	50,0
630,0	44,5	660	70,3

a) Tolerance for height *H:* ±15 mm.

NOTE If a bushing with the given hole diameter is not adequate to accommodate the conductor without binding, a bushing having the next largest hole can be used.

11.5.2 Verification is made successively with conductors of the largest and smallest cross-sectional areas specified in Table 3, using class 1 or class 2 conductors for terminals of fixed socket-outlets or appliance inlets, and class 5 conductors for terminals of plugs or portable socket-outlets.

For fixed socket-outlets or appliance inlets with screwless type terminal or insulation piercing terminals that accept only flexible conductors according to 6.7, the verification is made with class 5 conductors.

The conductors shall be connected to the clamping unit, and the clamping screws or nuts tightened to two-thirds of the torque indicated in Table 19, unless the torque is specified by the manufacturer on the product or in an instruction sheet.

Each conductor is subjected to a pull according to the value in Table 6, exerted in the opposite direction to that in which the conductor was inserted. The pull is applied without jerks for 1 min. The maximum length of the test conductor shall be 1 m.

During the test, the conductor shall not slip out of the terminal nor shall it break at, or in, the clamping unit.

Table 6 – Pulling force

Nominal cross-sectional area mm^2	Pulling force N
1	35
1,5	40
2,5	50
4	60
6	80
10	90
16	100
25	135
35	190
50	236
70	285
95	351
120	427
150	427
185	503
240	578
300	578
400	690
500	778
630	965

11.6 Voltage drop test for screwless type terminals and for insulation piercing terminals

The following test is made on new samples which have not been used for any other test.

The test is made with new copper conductors having the minimum and maximum cross-sectional areas according to Table 3 and Table 13.

The number of samples according to the type of conductors is:

– for terminals which can accept solid types of conductors only: 6 samples;
– for terminals which can accept rigid types of conductors only: 6 samples;
– for terminals which can accept flexible conductors only: 6 samples;
– for terminals which can accept all types of conductors: 12 samples.

Conductors having the smallest cross-sectional area are connected, as in normal use, to each of three terminals. Conductors having the largest cross-sectional area are connected, as in normal use, to each of the other three terminals. Each set of three terminals is connected in series.

For a terminal which can accept all types of conductors, this test shall be performed twice, once with rigid conductors and once with flexible conductors (12 terminals in total).

The clamping screws or nuts, if any, are tightened with the torque according to Table 19, unless the torque is specified by the manufacturer on the product or in an instruction sheet.

The use of AC is preferable but DC is acceptable.

After this test an inspection by the naked eye, with normal or corrected vision, without additional magnification, shall show no changes obviously impairing further use, such as cracks, deformations or the like.

The whole test arrangement including the conductors is placed in a heating cabinet which is initially kept at a temperature of 20 °C ± 2 °C.

Except during the cooling period, the test current, as defined in Table 7, is applied through the series circuit. The test current shall be applied for the initial 30 min of each cycle.

The terminals are then subjected to 192 temperature cycles, each cycle having a duration of approximately 1 h, as follows:

The air temperature in the cabinet is raised in approximately 20 min to 40 °C.

It is maintained within ±5 °C of this value for approximately 10 min. The terminals are then allowed to cool down for approximately 20 min, to a temperature of approximately 30 °C, forced cooling being allowed. They are kept at this temperature for approximately 10 min and, if necessary, for measuring the voltage drop, then allowed to cool down further to a temperature of 20 °C ± 2 °C.

During the ageing test, the voltage-drop measurement is made in the ambient cool condition to ensure stability.

The voltage drop in the terminals is measured and recorded after the completion of the 24th *and 192*nd *cycle.*

The maximum allowable voltage drop of each clamping unit, measured with the current as specified in Table 7, shall not exceed the smaller of the two following values:

– either 22,5 mV, or

– 1,5 times the value measured after the 24th cycle.

The measuring points shall be as close as possible to the clamping unit of the terminal. If this is not possible, the measured value shall be reduced by the value of the voltage drop in the conductor between the two measuring points.

The temperature in the heating cabinet shall be measured at a distance of at least 50 mm from the samples.

Table 7 – Test current

Nominal cross-sectional area mm^2	Test current[a)] A
1,0	13,5
1,5	17,5
2,5	24,0
4,0	32,0
6,0	41,0
10,0	57,0
a) Test current is only acceptable if it is the same or less than the test current of Table 11 for the accessory.	

11.7 Tests for insulation piercing terminals transmitting contact pressure via insulating parts

11.7.1 Temperature-cycling test

The test procedure is the same as described in 11.6 except as follows:

– the number of cycles is increased from 192 to 384;

– the voltage drop in each insulation piercing terminal is measured after the 48th and the 384th cycle, each time at a temperature for the insulation piercing terminal of 20 °C ± 2 °C. The voltage drop measurement shall not exceed the smaller of the two following values:

  a) either 22,5 mV, or

  b) 1,5 times the value measured after the 48th cycle.

11.7.2 Short-time withstand current test

Three new samples are fitted with new rigid (solid or stranded) or flexible conductors with the maximum cross-sectional area. If the terminal can be used for rigid (solid or stranded) and flexible conductors, then flexible conductors shall be used.

Screws, if any, are tightened with two thirds of torques as stated in Table 19.

The terminal shall withstand a current, of 120 A/mm^2 of the cross-sectional area of the connected conductor, for 1 s. The test is performed once.

The voltage drop is measured after the terminal has attained normal ambient temperature. The voltage drop shall not exceed 1,5 times the voltage value measured before the test.

In order to limit additional heating, the current for measuring the voltage drop before and after the test shall be one-tenth of the value shown in Table 7.

After this test an inspection by the naked eye, with normal or corrected vision, without additional magnification, shall show no change obviously impairing further use, such as cracks, deformations or the like.

12 Interlocks

Accessories with a rated current above 250 A or accessories not intended to make and break under load shall be provided with an interlock according to IEC 60309-4 or with the provision for an interlock to be used according to IEC 60309-4.

Requirements for interlocks are given in IEC 60309-4.

Compliance is checked by inspection and by the tests of IEC 60309-4.

13 Resistance to ageing of rubber and thermoplastic material

Accessories with enclosures of rubber or thermoplastic material, and parts of elastomeric such as sealing rings and gaskets, shall be sufficiently resistant to ageing.

Compliance is checked by an accelerated ageing test made in an atmosphere having the composition and pressure of the ambient air.

The samples are suspended freely in a heating cabinet, ventilated by natural circulation. The temperature in the cabinet and the duration of the ageing test are:

– *(70 ± 2) °C and 10 days (240 h), for rubber;*

– *(80 ± 2) °C and 7 days (168 h), for thermoplastic material.*

Based on agreement between manufacturer and test house, a combined test of rubber and thermoplastic is allowed at the following test condition:

– *(80 ± 2) °C and 10 days (240 h).*

After the samples have been allowed to attain approximately room temperature, they are examined and shall show no crack visible with normal or corrected vision, without additional magnification.

After the test, the samples shall show no damage which would lead to non-compliance with this document.

The use of an electrically heated cabinet is recommended. Natural circulation may be provided by holes in the walls of the cabinet.

14 Construction

14.1 General construction

14.1.1 Accessible surfaces of accessories shall be free from burrs, flashes and similar sharp edges.

Compliance is checked by inspection.

14.1.2 Screws or other means for fixing the part carrying the contacts of the socket-outlet or the part carrying the contacts of the plug or of the appliance inlet to its mounting surface, in a box or in an enclosure, shall be easily accessible.

These fixings and those which fix the enclosure shall not serve any other purpose except in the case whereby an internal earthing connection is established automatically and in a reliable way by such a fixing.

Compliance is checked by inspection.

14.1.3 It shall not be possible for the user to alter the position of the earthing contact, or of the neutral contact, if any, in relation to the means for ensuring compatibility of the socket-outlet, or in relation to the means for ensuring compatibility of the plug or appliance inlet.

Compliance is checked by manual test to ensure that only one mounting position is possible.

14.1.4 Socket-outlets when mounted as in normal use and without a plug in position shall ensure the degree of protection specified on its marking.

In addition, when a plug or appliance inlet is fully engaged with the socket-outlet, the lower degree of protection of the two accessories shall be ensured.

Compliance is checked by inspection.

14.2 Construction of contacts

14.2.1 Contacts of socket-outlets and contacts of plugs shall be so designed as to ensure adequate contact pressure when the socket-outlet and plug are completely engaged.

Contacts of appliance inlets shall be so designed as to ensure adequate contact pressure when the appliance inlet is completely engaged with the portable socket-outlets.

Contacts of portable socket-outlets shall be so designed as to ensure adequate contact pressure when the portable socket-outlet is completely engaged with a plug or an appliance inlet.

Compliance is checked by the temperature-rise test of Clause 22.

14.2.2 The pressure exerted between the contacts of a socket-outlet and the contacts of a plug shall not be so great as to make insertion and withdrawal of the plug difficult. Proper connection shall be maintained during normal use.

The pressure exerted between the contacts of a portable socket-outlet and the contacts of the plug or the contacts of an appliance inlet shall not be so great as to make difficult the insertion and withdrawal of the portable socket-outlet from the plug or appliance inlet. Proper connection shall be maintained during normal use.

Compliance is checked by inspection.

14.2.3 Contacts shall not be removable without dismantling the accessory.

Contacts may be either floating or fixed.

Compliance is checked by inspection.

14.2.4 Contacts providing the contact pressure shall be self-adjusting so as to ensure adequate contact pressure.

Compliance is checked by inspection.

15 Construction of fixed socket-outlets

15.1 Fixed socket-outlets shall be so constructed as to permit:

– the conductors to be easily introduced into the terminals and secured therein;
– the correct positioning of the conductors, without their insulation coming into contact with live parts of a polarity different from that of the conductor;
– the covers or enclosures to be fixed easily after connection of the conductors.

Compliance is checked by inspection and by an installation test with conductors of the largest cross-sectional area specified in Table 3.

15.2 Enclosures and parts of a fixed socket-outlet providing protection against electric shock shall have adequate mechanical strength; they shall be securely fixed in such a way that they will not work loose in normal use. It shall not be possible to remove these parts without the aid of a tool.

Compliance is checked by inspection and by the tests of 18.2 and Clause 24.

15.3 Cable entries shall allow the introduction of the conduit or the protective covering of the cable so as to afford complete mechanical protection.

Compliance is checked by inspection and by an installation test with conductors of the largest cross-sectional area specified in Table 3.

15.4 Insulating linings, barriers and the like shall have adequate mechanical strength and shall be fixed to the metal casing or the body in such a way that either they cannot be removed without being seriously damaged or be so designed that they cannot be replaced in an incorrect position.

The use of self-setting varnish is allowed for fixing insulating linings.

Compliance is checked by inspection and by the tests of 18.2 and Clause 24.

15.5 When a plug is not engaged, fixed socket-outlets shall be totally enclosed and shall incorporate means for ensuring the marked degree of protection when fitted with screwed conduits, or sheathed cables. Polyvinyl chloride sheathed cables are not excluded. The means for achieving total enclosure and that for ensuring the marked degree of protection, if any, shall be securely fixed to the fixed socket-outlet.

When a plug is completely engaged, the fixed socket-outlet shall incorporate means for ensuring the marked degree of protection.

Lid springs, if any, shall be of corrosion-resistant material such as bronze, stainless steel or other suitable material adequately protected against corrosion.

Fixed socket-outlets, up to and including IPX4 designed for only one mounting position may have provision for opening a drain-hole at least 5 mm in diameter or 20 mm^2 in area with a width of at least 3 mm which is effective when the fixed socket-outlet is in the mounting position.

The total enclosure and the marked degree of protection may be achieved by means of a cover.

A drain-hole in the back of the enclosure of a fixed socket-outlet, up to and including IPX3 or IPX4 intended to be mounted on a vertical wall is deemed to be effective only if the design of the enclosure ensures a clearance of at least 5 mm from the wall, or provides a drainage channel of at least the size specified.

Compliance is checked by inspection, by measurement and by the tests of Clause 18, Clause 19 and Clause 21.

15.6 Fixed socket-outlets having a rated operating voltage exceeding 50 V AC or 120 V DC shall be provided with an earthing contact.

Compliance is checked by inspection.

16 Construction of plugs and portable socket-outlets

16.1 The enclosure of plugs and portable socket-outlets shall completely enclose the terminals and the ends of the flexible cable.

The construction of rewireable plugs and rewireable portable socket-outlets shall be such that the conductors can be properly connected and the cores kept in place so that there is no risk of contact between them from the point of separation of the cores to the terminals.

Accessories shall be so designed that they can only be reassembled so as to ensure the correct relationship between the components as originally assembled.

Compliance is checked by inspection and, if necessary, by manual test.

16.2 The various parts of a plug or portable socket-outlet shall be reliably fixed to one another in such a way that they will not work loose in normal use. It shall not be possible to dismantle plugs or portable socket-outlets without the aid of a tool.

Compliance is checked by manual test and by the test of 24.3.

16.3 If an insulating lining is provided, it shall have adequate mechanical strength and shall be secured to the enclosure in such a way that either it cannot be removed without being seriously damaged, or it is so designed that it cannot be replaced in an incorrect position.

The use of self-setting varnish is allowed for fixing insulating linings.

Compliance is checked by inspection and by the tests of 18.2 and 24.3.

16.4 Plugs shall incorporate means for ensuring the marked degree of protection when in complete engagement with the complementary accessory and fitted with a flexible cable as in normal use.

Where there is an attached cap which cannot be removed without the aid of a tool, then the plug shall also meet this requirement when that cap is correctly fitted.

It shall not be possible to dismantle these means without the aid of a tool.

Compliance is checked by inspection and by the tests of Clause 18 and Clause 19.

16.5 When not in engagement with a complementary accessory, portable socket-outlets, fitted with a flexible cable as in normal use, shall be totally enclosed and shall incorporate means for ensuring the marked degree of protection.

When in complete engagement with the complementary accessory, portable socket-outlets, fitted with a flexible cable as in normal use, shall incorporate means for ensuring the marked degree of protection.

The marked degree of protection against humidity when the complementary accessory is not in position may be achieved by means of a lid or cover.

The means for ensuring the marked degree of protection shall be securely fixed to the portable socket-outlet.

Lid springs shall be of corrosion-resistant material, such as bronze, stainless steel or other suitable materials adequately protected against corrosion.

Compliance is checked by inspection and by the tests of Clause 18, Clause 19 and Clause 21.

16.6 Plugs and portable socket-outlets having a rated operating voltage exceeding 50 V AC or 120 V DC shall be provided with an earthing contact.

Compliance is checked by inspection.

16.7 Plugs and portable socket-outlets shall not have specific means to allow the wiring of more than one cable assembly. Plugs shall not have specific means to allow the plug to be wired to more than one socket-outlet. Portable socket-outlets shall not have specific means to allow the wiring of more than one plug or appliance inlet.

Compliance is checked by inspection.

NOTE This document does not cover adapters.

17 Construction of appliance inlets

17.1 Appliance inlets shall incorporate means for ensuring the marked degree of protection when in complete engagement with the complementary accessory.

Where there is an attached cap which cannot be removed without the aid of a tool, then the appliance inlets shall also meet this requirement when that cap is correctly fitted.

It shall not be possible to dismantle these means without the aid of a tool.

Compliance is checked by inspection and by the tests of Clause 18 and Clause 19.

17.2 Appliance inlets having a rated operating voltage exceeding 50 V AC or 120 V DC shall be provided with an earthing contact.

Compliance is checked by inspection.

18 Degrees of protection

18.1 Accessories shall comply with requirements for the degrees of protection marked on the products.

Compliance is checked by the appropriate tests mentioned in 18.2 and 18.3.

The tests are made on accessories fitted with the cables or conduits for which they are designed, screwed glands and fixing screws of enclosures and covers being tightened with a torque equal to two-thirds of that applied in the tests of 24.5 or 25.1, as appropriate.

Screwed caps or lids, if any, are tightened as in normal use.

Fixed socket-outlets are mounted on a vertical surface so that the open drain-hole, if any, is in the lowest position and remains open.

Portable socket-outlets are placed in the most unfavourable position and the drain-hole, if any, remains open.

Socket-outlets are tested with and also without the complementary accessory in engagement, the means for ensuring the required degree of protection against moisture being positioned as in normal use.

Plugs and appliance inlets are tested as described in 16.4 or 17.1.

18.2 Accessories shall be tested in accordance with 18.1, and with IEC 60529. When the first characteristic numeral is 5, category 2 shall apply.

When the first characteristic numeral is 3 or 4, and for degrees of protection up to and including IPX4, where a drain hole is provided, the protection is satisfactory if the full diameter of the probe does not pass through any opening other than through drain holes, in which case the probe shall not touch live parts within the enclosure.

For IPX4, the oscillating tube according to 14.2.4 a) of IEC 60529:1989 shall be used.

Immediately after the tests, the samples shall withstand the dielectric strength test specified in 19.5, and inspection shall show that water has not entered the samples to any appreciable extent and has not reached live parts.

18.3 All accessories shall withstand humid conditions which may occur in normal use.

Compliance is checked by the humidity treatment described in this Subclause 18.3, followed immediately by the measurement of the insulation resistance and by the dielectric strength test specified in Clause 19. Cable entries, if any, are left open; if knock-outs are provided, one of them is opened.

Covers which can be removed without the aid of a tool are removed and subjected to the humidity treatment with the main part; spring lids are open during this treatment.

The humidity treatment is carried out in a humidity cabinet containing air with a relative humidity maintained between 91 % and 95 %. The temperature of the air, at all places where samples can be located, is maintained within 1 °C of any convenient value T between 20 °C and 30 °C.

Before being placed in the humidity cabinet, the samples are brought to a temperature between T and T + 4 °C.

In most cases, the samples may be brought to the temperature specified by keeping them at this temperature for at least 4 h before the humidity treatment.

The test is performed according to IEC 60068-2-78 with parameters specified by this document.

The samples are kept in the cabinet for 7 days (168 h).

After this treatment, the samples shall show no damage within the meaning of this document.

19 Insulation resistance and dielectric strength

19.1 The insulation resistance and the dielectric strength of accessories shall be adequate.

Compliance is checked by the tests of 19.2 and 19.5, which are made immediately after the test of 18.3 in the humidity cabinet or in the room in which the samples were brought to the specified temperature, after reassembly of covers which may have been removed.

Accessories with enclosures of thermoplastic material are subjected to the additional test of 19.6.

For the purpose of these tests, the neutral contact and the pilot contact are each considered as a pole.

19.2 *The insulation resistance is measured with a DC voltage of approximately 500 V applied, the measurement being made 1 min after application of the voltage*.

The insulation resistance shall be not less than 5 MΩ.

19.3 *For socket-outlets, the insulation resistance is measured consecutively:*

a) between all poles connected together and the body, the measurement being made with and also without a plug-in engagement;

b) between each pole in turn and all others, these being connected to the body, with a plug-in engagement;

c) between any metal enclosure and metal foil in contact with the inner surface of its insulating lining, if any, a gap of approximately 4 mm being left between the metal foil and the edge of the lining.

NOTE The term "body" includes all accessible metal parts, metal foil in contact with the outer surface of external parts of insulating material, other than the engagement face of portable socket-outlets and plugs, fixing screws of bases, enclosures and covers, external assembly screws and earthing terminals, if any.

19.4 *For plugs and appliance inlets, the insulation resistance is measured consecutively:*

a) between all poles connected together and the body;

b) between each pole in turn and all others, these being connected to the body;

c) between any metal enclosure and metal foil in contact with the inner surface of its insulating lining, if any, a gap of approximately 4 mm being left between the metal foil and the edge of the lining.

19.5 *A voltage of substantially sine-wave form, having a frequency of 50 Hz/60 Hz and the value shown in Table 8, is applied for 1 min between the parts indicated in 19.3 and 19.4.*

Table 8 – Dielectric strength test

Insulation voltage of the accessory[a)] V	**Test voltage** V
Up to and including 50 over 50 up to and including 415 over 415 up to and including 500 over 500	500 2 000[b)] 2 500 3 000
[a)] The insulation voltage is at least equal to the highest rated operating voltage. [b)] This value is increased to 2 500 V for metal enclosures lined with insulating material.	

Initially, no more than half the specified voltage is applied, then it is raised rapidly to the full value.

No flashover or breakdown shall occur during the test.

NOTE Glow discharges without drop in voltage are neglected.

19.6 Immediately after the test of 19.5, it shall be verified that, for accessories with enclosures of thermoplastic material, the means for ensuring compatibility have not been impaired.

20 Breaking capacity

Accessories without interlock shall have adequate breaking capacity.

Compliance is checked by testing any accessory with a new complementary accessory that complies with the relevant standard.

The test position shall be horizontal or, if not possible, as in normal use.

Any accessory having an integral switching device operated by the plug or appliance inlet shall be mounted as in normal use.

The plug or portable socket-outlet is inserted into and withdrawn from the fixed socket-outlet or appliance inlet at a rate of 7,5 strokes per minute.

A stroke is:

- *an insertion or a withdrawal of a plug from a socket-outlet, or*
- *an insertion or a withdrawal of a portable socket-outlet from an appliance inlet.*

A cycle is composed of two strokes, one for insertion and one for withdrawal.

The speed of insertion and separation of the plug or portable socket-outlet shall be (0,8 ± 0,1) m/s.

The speed of insertion may be reduced according to manufacturer's recommendation.

The measurement of speed is made by recording the interval of time between insertion or separation of the main contacts and the insertion or separation of the earthing contact, relative to the distance.

Electrical contact and current flowing shall be maintained for (3 ± 1) s. The two accessories shall be separated at least by 50 mm.

The number of cycles is specified in Table 9.

The samples are tested at 1,1 times the rated operating voltage and 1,25 times the rated current.

Accessories for AC only are tested with AC in a circuit with cos φ as defined in Table 9.

Accessories for DC only are tested with a non-inductive load.

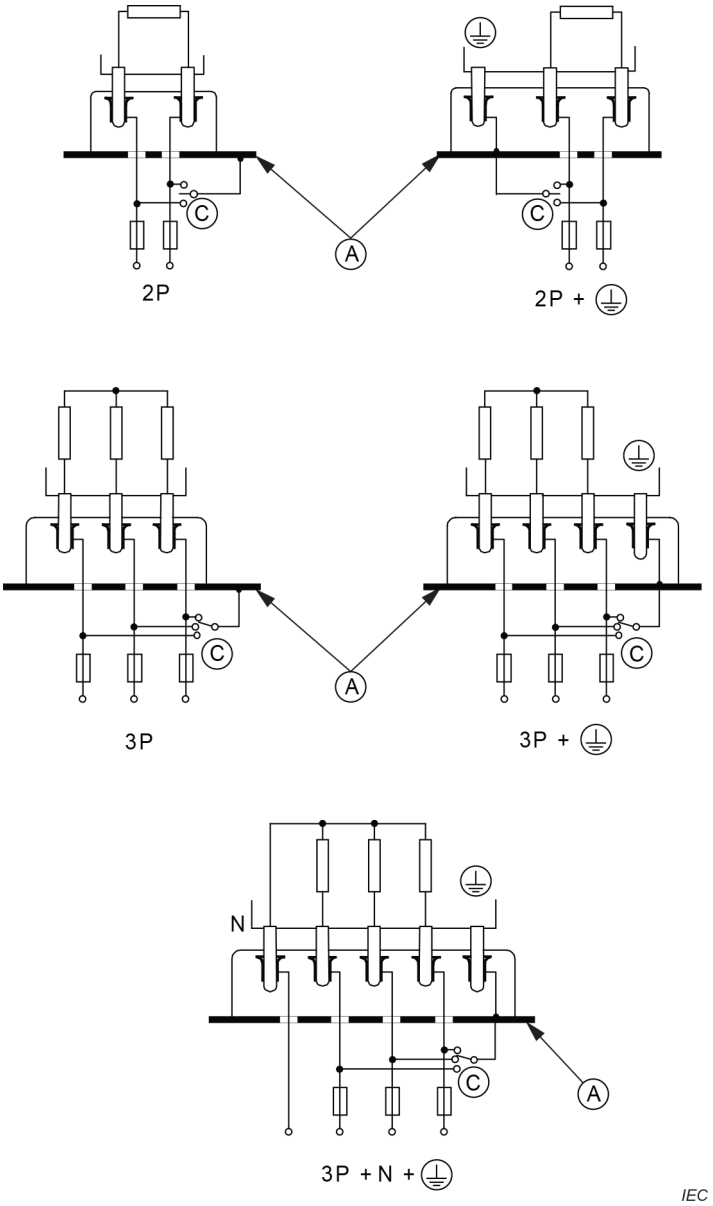
Accessories having a rated operating voltage or rated current for AC and for DC are tested both for AC and DC according to their rating.

The test is made using the connections shown in Figure 16. For two-pole accessories the selector switch C, connecting the metal support and the accessible metal parts to one of the poles of the supply, is operated after half the number of strokes; for three-pole and three-pole plus neutral accessories, the selector switch C is operated after one-third of the number of strokes, and again after two-thirds of the number of strokes, so as to connect each pole in turn.

Resistors and inductors are not connected in parallel, except that, if an air-core inductor is used, a resistor taking approximately 1 % of the current through the inductor is connected in parallel with it. Iron-core inductors may be used, provided the current has substantially sine-wave form. For the tests on three-pole accessories, three-core inductors are used.

During the test, no sustained arcing shall occur.

After the test, the samples shall show no damage impairing their further use and the entry holes for the contacts of the plug shall not show any serious damage.



Key

A Metal support

Figure 16 – Circuit diagrams for breaking capacity and normal operation tests

Table 9 – Breaking capacity

Rated current A			Number of cycles		
Preferred ratings		Other ratings	AC		DC
Series I	Series II	Range	cos φ ± 0,05	on load	on load
16	20	up to 29	0,6	50	50
32	30	from 30 to 59	0,6	50	50
63	60	from 60 to 99	0,6	20	20
125	100	from 100 to 199	0,7	20	20
250	200	from 200 to 250	0,8	10	10
315	300 350				
400	500	from 251 to 800	NA	NA	NA
630	600				
800					

21 Normal operation

Accessories shall withstand, without excessive wear or other harmful effect, the mechanical, electrical and thermal stresses occurring in normal use.

Compliance is checked by testing any accessory with a new complementary accessory that complies with the relevant standard.

This test is carried out by the same means as in Clause 20 used in the manner indicated in that clause.

The test position is as specified in Clause 20.

The test is made using the connections indicated in Clause 20, the selector switch C being operated as specified in that clause.

The plug or portable socket-outlet is inserted into and withdrawn from the fixed socket-outlet or appliance inlet at a rate of 7,5 strokes per minute.

Accessories are submitted alternately to cycles with and without current flowing except those rated at 16/20 A which are only tested under load.

The samples are tested at a rated operating voltage and rated current.

After each set of 250 cycles, the contacts of the plug are wiped with a piece of dry cloth or the equivalent dry cleaning maintenance operation is performed, as stated in the manufacturer's instructions.

During the test, the contacts of the accessories shall not be adjusted, lubricated or otherwise conditioned.

Accessories without interlock which have been subjected to the tests of Clause 20 are tested with a number of cycles specified in Table 10.

Accessories for AC only are tested with AC in a circuit with cos φ as specified in Table 10.

Accessories for DC only are tested with a non-inductive load.

Accessories having a rated operating voltage or rated current for AC and for DC are tested both for AC and DC according to their rating.

Accessories with interlock are tested without current flowing, the interlock being locked and unlocked after each complete insertion of the plug.

The number of cycles is the sum of the on and off load of Table 10.

During the test, no sustained arcing shall occur.

After the test, the samples shall show:

- *no wear impairing the further use of the accessory or of its interlock, if any;*
- *no deterioration of enclosures or barriers;*
- *no damage to the entry holes for the contacts of the plug that might impair proper working;*
- *no loosening of electrical or mechanical connections;*
- *no seepage of sealing compound.*

The samples shall then withstand a dielectric strength test made in accordance with 19.5, the test voltage, however, being decreased by 500 V for accessories having an insulation voltage exceeding 50 V.

The humidity treatment is not repeated before the dielectric strength test of the paragraph above.

Lid springs, if any, are tested by completely opening and closing the lid, the number of times the lid is opened being the same as the number of insertions of the plug specified in Table 10.

The test for lid spring may be combined with the test for the accessories.

Table 10 – Normal operation

Rated current A			**Number of cycles**				
Preferred rating		**Other rating**	**AC**			**DC**	
Series I	**Series II**	**Range**	**cos φ ± 0,05**	**on load**	**off load**	**on load**	**off load**
16	20	up to 29	0,6	5 000	–	5 000	–
32	30	30 to 59	0,6	1 000	1 000	1 000	1 000
63	60	60 to 99	0,6	1 000	1 000	500	500
125	100	100 to 199	0,7	250	250	250	250
250	200	200 to 250	0,8	125	125	125	125
315	300						
–	350						
400	–	251 to 800	NA	NA	125	NA	125
–	500						
630	600						
800							

22 Temperature rise

Accessories shall be so constructed that the temperature rise in normal use is not excessive.

Compliance is checked by testing any accessory with a new complementary accessory that complies with the relevant standards.

The test current is an alternating current of the value shown in Table 11.

Rewireable accessories are fitted with conductors of a cross-sectional area as specified in Table 11, the terminal screws or nuts being tightened with a torque specified on the product or in the instruction sheets by the manufacturer or equal to two-thirds of that specified in Table 19.

For the purpose of this test, a length of at least 2 m of the cable is connected to the terminals.

Non-rewireable accessories are tested as delivered.

For accessories having three or more poles, the test current during the test shall be passed through the phase contacts. If there is a neutral contact, a separate test shall be carried out passing the test current through the neutral contact and the nearest phase contact.

A further separate test shall be carried out passing the test current through the earthing contact and the nearest phase contact.

A current of 2 A shall be passed through the pilot contact, if any, during any of these tests.

Table 11 – Temperature rise test

Nominal current A			**Test current** A	**Nominal cross-sectional area(s) of the test conductors[c)]**	
Preferred rated current		**Other ratings**		**Plugs, appliance inlets Portable socket-outlets**	**Fixed socket-outlets**
Series I	**Series II**			mm^2	mm^2
		6	8,5	1	1
		10	14	1,5	1,5
16	20		22	2,5 [a)]	4 [a)]
		25	32	4 [a)]	6 [a)]
32	30		42	6 [a)]	10
		40	42	10	16
		50	rated current	10	16
63	60		rated current	16	25
		80	rated current	25	35
		90	rated current	25	35
125	100		rated current	50	70
		150	rated current	70	95
		160	rated current	70	95
250	200		rated current	150	185 [b)]
315	300		rated current	150	185
	350		rated current	185	240
400			rated current	240	300
	500		rated current	300	400
630	600		rated current	400	500
800			rated current	500	630

[a)] For accessories having a rated operating voltage not exceeding 50 V, the values are increased to 10 A.

[b)] 150 mm^2 for 200 A accessories of series II.

[c)] For ratings other than those above, the cross-sectional area(s) of the conductors may be that specified by the manufacturer.

The duration of the test is:

– 1 h for accessories having a rated current not exceeding 32 A;
– 2 h for accessories having a rated current exceeding 32 A but not exceeding 125 A;
– 3 h for accessories having a rated current exceeding 125 A but not exceeding 250 A.

For accessories having a rated current exceeding 250 A, the test shall continue until thermal stabilization is attained. Thermal stabilization is considered to have occurred when three successive readings, taken at intervals of not less than 10 min, show no further increases of more than 1 K.

The temperature rise of terminals shall not exceed 50 K.

23 Flexible cables and their connection

23.1 Cable anchorage

Plugs and portable socket-outlets shall be provided with a cable anchorage such that the conductors are relieved from strain, including twisting, where they are connected to the terminals or terminations, and that their covering is protected from abrasion.

Cable anchorages shall be so designed that the cable cannot touch accessible metal parts or internal metal parts, for example cable anchorage screws, if these are electrically connected to accessible metal parts, unless the accessible metal parts are connected to the internal earth terminal.

Compliance is checked by inspection.

23.2 Requirements for plugs and portable socket-outlets

23.2.1 Non-rewireable plugs and portable socket-outlets

Accessories shall be provided with a flexible cable complying with IEC 60245-4 of one of the types specified in Table 12, the nominal cross-sectional area being not less than the value shown.

Table 12 – Types of cables

Nominal current A			Type of cable IEC 60245-4	Nominal cross-section[e] mm^2
Preferred rated currents		Other ratings		
Series I	Series II			
		6	53 [b], 57 [b], 66	1
		10	53 [b], 57 [b], 66	1,5
16	20		53 [b], 57 [b], 66	2,5 [a]
		25	66	4
32	30		66	6
		40	66	10
		50	66	10
63	60		66	16
		80	66	25
		90	66	25
125	100		66 [c]	50
		150	66 [c]	70
		160	66 [c]	70
250	200		66 [d]	150
315	300		Under consideration	150
	350		Under consideration	185
400			Under consideration	240
	500		Under consideration	300
630	600		Under consideration	400
800			Under consideration	500

a) Value increased to 4 for accessories having a rated operating voltage not exceeding 50 V.

b) Not applicable to accessories having a rated operating voltage exceeding 415 V.

c) Only applicable for 3 P + E or 2 P + N + E and 2 P + E or 1 P + N + E.

d) Only applicable for 3 P + E or 2 P + N + E.

e) For ratings other than those above, the cross-sectional area(s) of the conductors may be that specified by the manufacturer.

Flexible cables having nominal cross-sections other than those specified in Table 12 may be used if the load is known.

The core connected to the earthing terminal shall be identified by the colour combination green/yellow. The nominal cross-sectional area of the earthing conductor and of the neutral conductor, if any, shall be at least equal to that of the phase conductors.

The pilot conductor, if any, shall have a nominal cross-sectional area of at least 1,5 mm^2.

Compliance is checked by inspection and by the test of 23.3.

23.2.2 Rewireable plugs and portable socket-outlets

– It shall be clear how the relief from strain and the prevention of twisting is intended to be effected. If any one of the components is not in position in the accessory as provided, an instruction sheet shall be provided to identify the necessary parts and the method of assembly.
– The design of the cable anchorage shall be such that the anchorage or its components are properly positioned relative to the accessory when assembled.
– Cable anchorages shall present no sharp edges to the cable and shall be so designed that the anchorages or their components are not likely to be lost when the enclosure of the accessory and not the cable anchorage is being opened.
– Makeshift methods, such as tying the cable into a knot or tying the ends with string, shall not be used.
– Cable anchorages and cable inlets shall be suitable for the different types of flexible cable which may be connected.

If a cable inlet is provided with a sleeve to prevent damage to the cable, this sleeve shall be of insulating material and shall be smooth and free from burrs.

If a bell-mouthed opening is provided, the diameter at the end shall be at least 1,5 times the diameter of the cable with the largest cross-sectional area to be connected.

Helical metal springs, whether bare or covered with insulating material, are not allowed as cable sleeves.

Compliance is checked by inspection and by the test of 23.3.

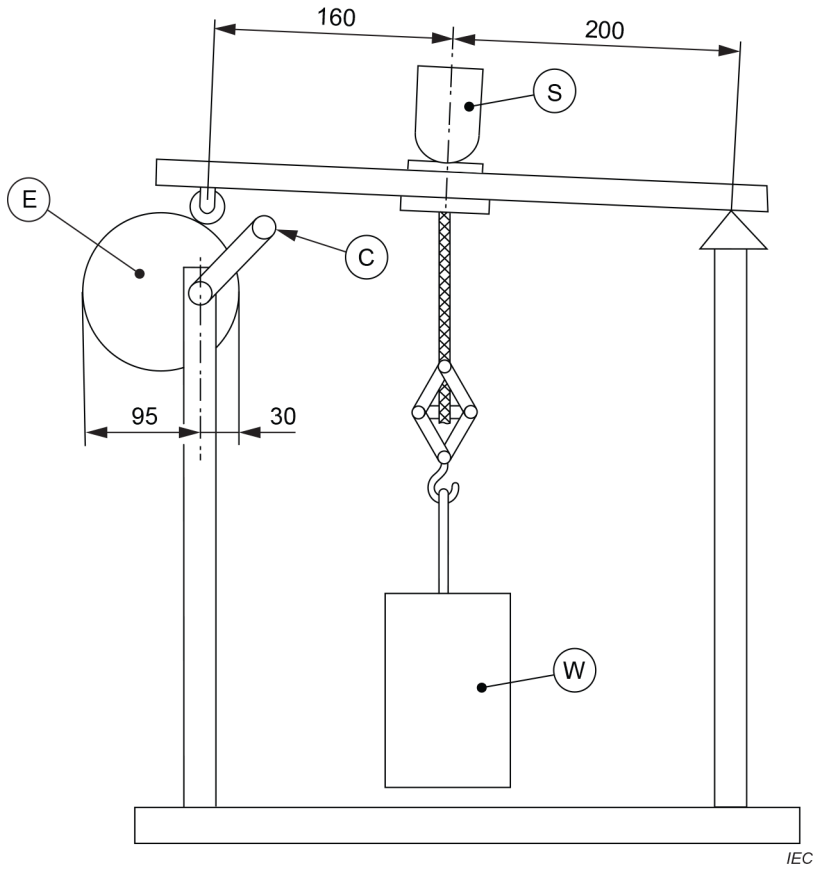
23.3 Pull test

Plugs and portable socket-outlets provided with a flexible cable are subjected to a pull test in apparatus similar to that shown in Figure 17, followed by a torque test.

Non-rewireable accessories are tested as delivered.

Rewireable accessories are tested first with one and then with the other type of cable, complying with IEC 60245-4, as specified in Table 13.

Dimensions in millimetres



Key

S Sample
W Weight
E Eccentric
C Crank

Figure 17 – Apparatus for testing the cable anchorage

Table 13 – Dimensions of cables

Rated operating voltage V	Nominal current A			Type of cable	Nominal cross-section	Approximate external diameter of the cable[a)]				
	Preferred rated current		Other ratings			Type of accessory				
	Series I	Series II		IEC 60245-4	mm^2	2 P	3 P	1 P + N + E 2 P + E	2 P + N + E 3 P+ E	3 P + N + E
Not exceeding 50	16	20		66	4	13,5	14,5	–	–	–
				66	10	21,3	22,8	–	–	–
	32	30		66	4	13,5	14,5	–	–	–
				66	10	21,3	22,8	–	–	–
Over 50			6	57	0,75	–	–	7,2	7,8	8,8
				66	1	–	–	9,5	10,6	11,7
			10	57	1	–	–	7,5	8,2	9,2
				66	1,5	–	–	10,6	11,7	12,8
	16	20		57	1	–	–	7,5	8,2	9,2
				66	2,5	–	–	12,6	13,8	15,2
			25	57	1,5	–	–	9,2	10,3	11,3
				66	4	–	–	14,5	16,0	17,8
	32	30		57	2,5	–	–	11,0	12,3	13,6
				66	6	–	–	16,1	17,9	19,9
			40	66	4	–	–	14,5	16,3	17,8
				66	10	–	–	22,8	24,8	27,3
			50	66	4	–	–	14,5	16,3	17,8
				66	10	–	–	22,8	24,8	27,3
	63	60		66	6	–	–	16,1	17,9	19,9
				66	16	–	–	24,7	27,0	29,9
			80	66	10	–	–	22,8	24,8	27,3
				66	25	–	–	30,3	33,5	37,0
			90	66	10	–	–	22,8	24,8	27,3
				66	25	–	–	30,3	33,5	37,0
	125	100		66	16	–	–	24,7	27,0	29,9
				66	50	–	–	38,5	42,6	_[b)]
			150	66	25	–	–	30,3	33,5	37,0
				66	70	–	–	43,4	48,4	_[b)]
			160	66	25	–	–	30,3	33,5	37,0
				66	70	–	–	43,4	48,4	_[b)]
	250	200		66	70	–	–	43,4	48,4	_[b)]
				66	150	–	–	_[b)]	65,5	_[b)]
	315	300		66	150	–	–	_[b)]	65,5	_[b)]
		350			185	–	–	_[b)]	_[b)]	_[b)]
	400				240	–	–	_[b)]	_[b)]	_[b)]
		500			300	–	–	_[b)]	_[b)]	_[b)]

Rated operating voltage V	Nominal current A			Type of cable	Nominal cross-section	Approximate external diameter of the cable[a]				
	Preferred rated current		Other ratings			Type of accessory				
	Series I	Series II		IEC 60245-4	mm^2	2 P	3 P	1 P + N + E 2 P + E	2 P + N + E 3 P+ E	3 P + N + E
	630	600			400	–	–	–[b]	–[b]	–[b]
	800				500	–	–	–[b]	–[b]	–[b]

[a] The value for each of the approximate external diameters shown is the average value of the upper and lower line specified in IEC 60245-4:2011 for the overall diameter of the cable.

[b] Values are under consideration.

Conductors of the cable of rewireable accessories are introduced into the terminals, the terminal screws being tightened just sufficiently to prevent the conductors from easily changing their position.

The cable anchorage is used in the normal way, the clamping being tightened with a torque equal to:

- *two-thirds of that specified in Table 19 for screws; or*
- *two-thirds of that specified in 24.5 for cable glands; or*
- *that specified by the manufacturer in the instruction sheet or on the product.*

After reassembly of the sample, with cable glands, if any, in position, the component parts shall fit snugly and it shall not be possible to push the cable into the sample to any appreciable extent.

The sample is fixed in the test apparatus so that the axis of the cable is vertical where it enters the sample.

The cable is then subjected 100 times to a pull of the value shown in Table 14. Each pull is applied without jerks and has a duration of 1 s.

Immediately afterwards, the cable is subjected for 1 min to a torque of the value shown in Table 14.

Table 14 – Torque test values

Nominal current A			Pulling force	Torque
Preferred rated current		Other ratings		
Series I	Series II		N	Nm
		6	80	0,35
		10	80	0,35
16	20		80	0,35
		25	100	0,425
32	30		100	0,425
		40	100	0,425
		50	110	0,610
63	60		120	0,8
		80	160	1,2
		90	160	1,2
125	100		200	1,5
		150	250	2,3
		160	250	2,3
250	200		300	3
315	300		400	4,0
	350		400	4,0
400			500	4,5
	500		500	4,5
630	600		600	5,0
800			600	5,0

During the tests, the cable shall not be damaged.

After the tests, the cable shall not have been displaced by more than 2 mm. For rewireable accessories, the ends of the conductors shall not have moved noticeably in the terminals; for non-rewireable accessories, there shall be no break in the electrical connections.

For the measurement of the longitudinal displacement, a mark is made on the cable at a distance of approximately 2 cm from the end of the sample or the cable anchorage before starting the tests. If, for non-rewireable accessories, there is no definite end to the sample, an additional mark is made on the body of the sample.

After the tests, the displacement of the mark on the cable in relation to the sample or the cable anchorage is measured.

24 Mechanical strength

24.1 Accessories shall have adequate mechanical strength.

Compliance is checked by the appropriate tests of 24.2 to 24.7 as follows:

– for fixed socket-outlets and appliance inlets, 24.2;
– for rewireable plugs and portable socket-outlets, 24.3;

– for non-rewireable plugs and portable socket-outlets, 24.3 and 24.4;
– for accessories with a degree of protection IP23 or higher, 24.5;
– for accessories with shutter(s), 24.6;
– for accessories with insulated end caps on the contacts, 24.7.

Before starting the test of 24.2 or 24.3, accessories with enclosures of resilient or thermoplastic material are placed, with their bases or flexible cables, in a refrigerator at a temperature of (−25 ± 2) °C for at least 16 h; they are then removed from the refrigerator and immediately subjected to the test of 24.2 or 24.3, as appropriate.

24.2 Accessories shall have adequate strength to maintain the integrity of the marked degree of protection after being subjected to impact blows occurring in normal use.

Fixed socket-outlet and appliance inlet samples shall each be fixed to a rigid mounting board as in normal use, cable entries are left open and fixing screws of covers and enclosures are tightened with a torque equal to two-thirds of that specified in Table 19. Lids on fixed socket-outlets are closed. Caps supplied with appliance inlets are fitted.

Blows shall be applied to the samples by means of the impact test apparatus. Annex A gives guidance and description of test apparatus. The test apparatus is shown in Figure A.1.

It is intended that blows applied to samples in these tests will not strike mounting flanges or male contacts of appliance inlets. The test apparatus shall be adjusted to apply blows as they might occur in actual use and according to the following test description.

Five blows shall be applied to each test sample by means of the impact apparatus shown in Figure A.1.

The first four blows are applied when the accessory is mounted as in normal use on a vertical board. The pendulum shall be mounted so that it swings parallel to that board. The impact face of the pendulum shall be arranged so that when the pendulum hangs freely, the impact face just touches the side of the accessory. The point of contact shall be substantially at the geometric centre of the side face of the accessory, or the appropriate projections of that face. The pendulum is then raised, released and the blow applied. The accessory is then revolved 90° about an axis perpendicular to the mounting face and its relationship to the impact face corrected, if necessary. A second blow is then applied.

The same procedure is repeated for two successive rotations of 90°, the total number of blows being four.

The fifth blow is applied with the plane of the pendulum perpendicular to the plane of the mounting board so that the pendulum strikes the sample at its furthermost projection from the mounting board.

The blows shall have an impact energy according to Table 15.

Table 15 – Blow test impact energy

Nominal current A			Energy
Preferred rated current		Other ratings	
Series I	Series II		J
		6	1
		10	1
16	20		1
		25	1
32	30		1
		40	1
		50	2
63	60		2
		80	2
		90	2
125	100		2
		150	3
		160	3
250	200		4
315	300		4
	350		4
400			4
	500		4
630	600		4
800			4

After the test, the samples shall show no damage within the meaning of this document; in particular, no part shall have become detached or loosened.

Accessories with a degree of protection IPX7 and above shall withstand the relevant test specified in Clause 18.

Accessories with enclosures of thermoplastic material shall withstand the test of 19.6.

Small chips, cracks and dents which do not adversely affect the protection against electrical shock or moisture are neglected. In case of doubt, the appropriate tests of Clause 18 and Clause 19 are carried out.

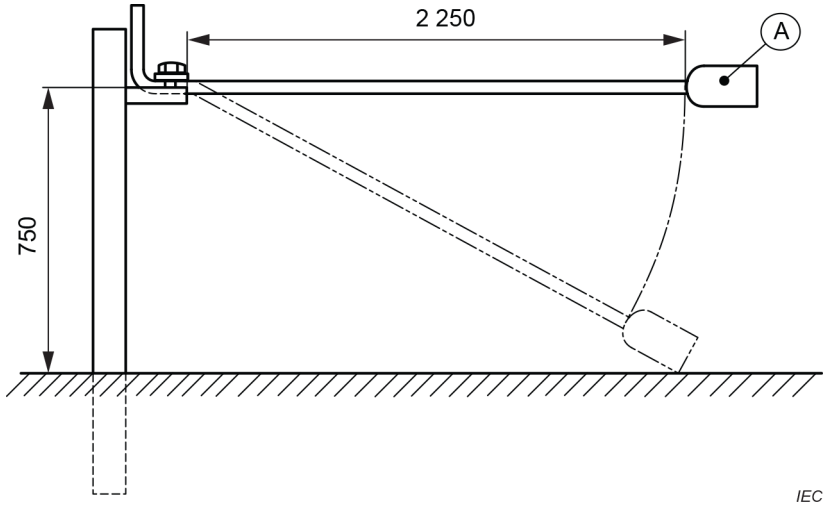
24.3 *Rewireable accessories are fitted with the lightest type of flexible cable of the smallest cross-sectional area for the relevant rating specified in Table 13*.

Non-rewireable accessories are tested as delivered.

The free end of the cable, which is about 2,25 m long, is fixed to a wall at a height of 75 cm above the floor, as shown in Figure 18.

The sample is held so that the cable is horizontal and then it is allowed to fall on to a concrete floor. This is done eight times, the cable being rotated through 45° at its fixing each time.

Dimensions in millimetres



Key

A Sample

Figure 18 – Arrangement for mechanical strength test for plugs and portable socket-outlets

After the test, the samples shall show no damage within the meaning of this document; in particular, no part shall have become detached or loosened.

Accessories with a degree of protection IPX7 and above shall withstand the relevant test specified in Clause 18.

Accessories with enclosures of thermoplastic material shall withstand the test of 19.6.

NOTE Small chips and dents which do not adversely affect the protection against electric shock or moisture are neglected.

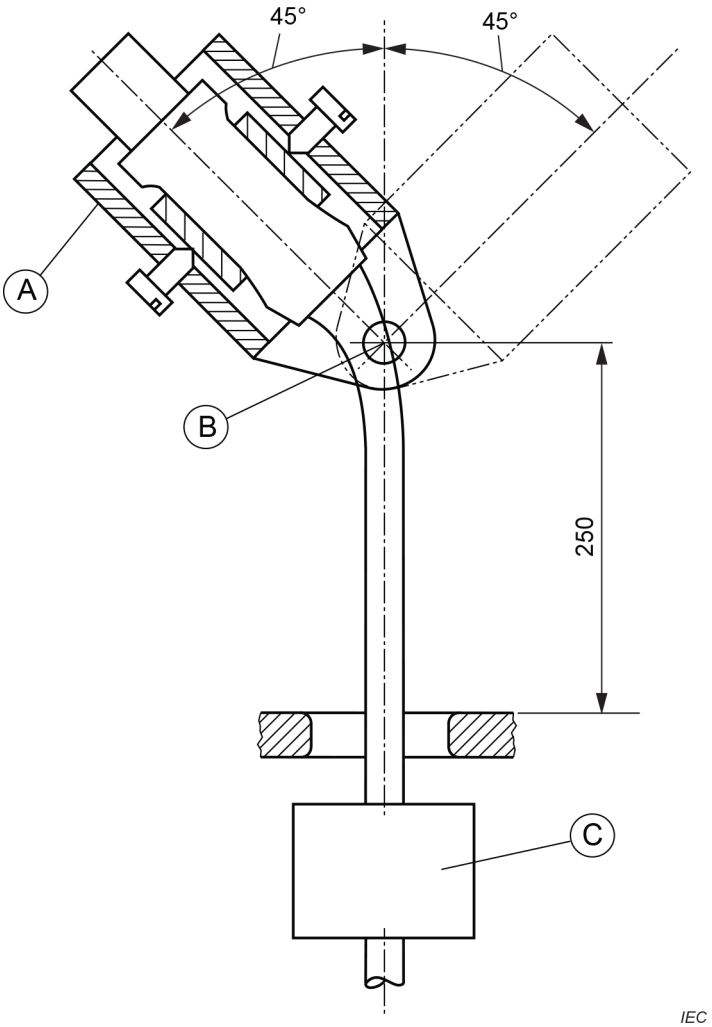
24.4 *Non-rewireable accessories are subjected to a flexing test in an apparatus similar to that shown in Figure 19*.

The sample is fixed to the oscillating member of the apparatus so that, when this is at the middle of its travel, the axis of the flexible cable, where it enters the sample, is vertical and passes through the axis of oscillation.

The oscillating member is so positioned that the flexible cable makes the minimum lateral movement when the oscillating member of the test apparatus is moved over its full travel.

The cable is loaded with a weight such that the force applied is as shown in Table 16.

Dimensions in millimetres



Key

A Device for fixing the sample

B Axis of oscillation

C Weight

Figure 19 – Apparatus for flexing test

Table 16 – Flexing test load values

Rated current A	Force N
Up to and including 20 A	20
From 21 A up to and including 32 A	25

A current equal to the rated current of the accessory is passed through the conductors, the voltage between them being the rated operating voltage.

The oscillating member is moved backwards and forwards through an angle of 90° (45° on either side of the vertical), the number of flexings being 20 000 and the rate of flexing 60 per minute.

After the test, the samples shall show no damage within the meaning of this document.

NOTE A flexing is one movement, either backwards or forwards.

For accessories having a rated current exceeding 32 A, details of the test are under consideration.

24.5 Screwed glands are fitted with a cylindrical metal rod having a diameter, in millimetres, equal to the nearest whole number below the internal diameter of the packing, in millimetres. The glands are then tightened by means of a suitable spanner, the force shown in Table 17 being applied to the spanner for 1 min, at a point 25 cm from the axis of the gland.

Table 17 – Test values for screwed glands

Diameter of test rod	**Force** N	
mm	**Metal glands**	**Glands of moulded material**
Up to and including 20	30	20
Over 20 up to and including 30	40	30
Over 30	50	40

After the test, the glands and the enclosures of the samples shall show no damage within the meaning of this document.

24.6 Shutters, if any, shall be so designed that they withstand the mechanical force which may be expected in normal use, for example when a plug contact is inadvertently forced against the shutter of a socket-outlet entry hole.

Compliance is checked by the following test, which is carried out on samples which have been submitted to the test according to Clause 21.

One plug contact of the same system is applied for 1 min with a force of 75 N against the shutter of an entry hole in a direction perpendicular to the front surface of the socket-outlet.

The plug contact shall not come in contact with live parts.

An electrical indicator with a voltage not less than 40 V and not more than 50 V is used to show contact with the relevant part.

After the test, the samples shall show no damage within the meaning of this document.

NOTE Small dents on the surface which do not adversely affect further use of the socket-outlet are ignored.

24.7

24.7.1 Insulated end caps, if any, shall be fixed sufficiently to the contact pins so that they withstand the mechanical force and abuse to which the accessories may be exposed in normal use.

They shall be subjected to the tests of 24.7.2 and 24.7.3.

After each of the following tests, the samples shall show no damage as follows:

– *no part shall become detached;*

– *no part shall have moved, loosened or deformed to the extent that the samples no longer function or operate as intended;*

– *no uninsulated live part shall become accessible with the standard test finger according to IEC 61032, Probe B;*

– *no reduction shall occur of creepage and clearance between uninsulated live parts of opposite polarity, uninsulated live parts and accessible dead or grounded metal parts, below the minimum acceptable values;*

– *no other evidence of damage shall result, that could increase the risk of fire or electric shock.*

24.7.2 Accessories with insulated end cap on the contacts shall not be adversely affected by the temperature stress conditions which may occur in normal use

Compliance is checked by conditioning the accessories, while mated with their complementary accessory, as specified below.

Test samples of the largest and smallest size caps shall be tested.

The samples are mated with their complimentary accessory and subjected to the change of temperature test of IEC 60068-2-14 with the following parameters:

– test procedure Na
– laboratory ambient +25 °C ± 5 K
– high temperature 100 °C
– low temperature −25 °C
– duration of exposure 30 min
– transfer time or rate of change max. 3 min
– number of test cycles 10 cycles

24.7.3 *A set of six contact assemblies with insulated end caps shall be subjected to a pull test. A force defined in Table 18 is applied for 1 min and it shall be applied in a direction opposite from the contact, along the contact axis. The pulling force shall be applied in such a way where it causes no effect on the fixing area of the part.*

NOTE The force can be applied by a drilling in the insulated end cap, perpendicular to the contact axis, close to the end.

Table 18 – Pulling force on insulated end caps

Contact diameter mm	Pulling force N
Up to 3	20
Above 3	40

25 Screws, current-carrying parts and connections

25.1 Connections, electrical or otherwise, shall withstand the mechanical stresses occurring in normal use.

Screws transmitting contact pressure and screws which are operated when connecting up the accessory and have a nominal diameter less than 3,5 mm shall screw into a metal nut or metal insert.

Compliance is checked by inspection and, for screws and nuts transmitting contact pressure or which are operated when connecting up the accessory, by the following test.

The screws or nuts are tightened and loosened:

– ten times for screws in engagement with a thread of insulating material;
– five times for nuts and other screws.

Screws in engagement with a thread of insulating material are completely removed and reinserted each time.

This removal and insertion of the screws or nuts shall be carried out at such a rate that the thread in the insulating material suffers no appreciable temperature rise owing to friction.

When testing terminal screws and nuts, a copper conductor having the largest cross-sectional area in Table 3, rigid (solid or stranded) for fixed socket-outlets and appliance inlets and flexible for plugs and portable socket-outlets, is placed in the terminal.

The test is made by means of a suitable screwdriver or spanner. The maximum torque applied when tightening is equal to that shown in Table 19, except that the torque is increased by 20 % for screws in engagement with a thread in a hole which is obtained by plunging, if the length of the extrusion exceeds 80 % of the original thickness of the metal.

When the manufacturer specifies, for terminal screws, a torque greater than values given in Table 19, this specified torque shall be applied for the test.

Table 19 – Tightening torques

Metric standard values	**Nominal diameter of thread** mm	**Torque** Nm		
		I	**II**	**III**
2,5	Up to and including 2,8	0,2	0,4	0,4
3,0	over 2,8 up to and including 3,0	0,25	0,5	0,5
–	over 3,0 up to and including 3,2	0,3	0,6	0,6
3,5	over 3,2 up to and including 3,6	0,4	0,8	0,8
4,0	over 3,6 up to and including 4,1	0,7	1,2	1,2
4,5	over 4,1 up to and including 4,7	0,8	1,8	1,8
5,0	over 4,7 up to and including 5,3	0,8	2,0	2,0
6,0	over 5,3 up to and including 6,0	1,2	2,5	3,0
8,0	over 6,0 up to and including 8,0	2,5	3,5	6,0
10,0	over 8,0 up to and including 10,0		4,0	10,0
12,0	over 10,0 up to and including 12,0			14,0
14,0	over 12,0 up to and including 15,0			19,0
16,0	over 15,0 up to and including 20,0			25,0
20,0	over 20,0 up to and including 24,0			36,0
24,0	over 24,0			50,0

Column I *applies to screws without heads which when tightened do not protrude from the hole, and to screws which cannot be tightened by means of a screwdriver having a blade wider than the diameter of the screw.*

Column II *applies to other screws and nuts which are tightened by means of a screwdriver.*

Column III *applies to screws and nuts which can be tightened by means other than a screwdriver.*

Each time the clamping screw(s) or nut(s) is (are) loosened, a new conductor shall be used for a further connection.

When a screw has a hexagonal head with means for tightening with a screwdriver and the values in columns II and III are different, the test is made twice, first applying the torque specified in column III to the hexagonal head and then, on another set of samples, applying the torque specified in column II by means of a screwdriver. If the values in columns II and III are the same, only the test with the screwdriver is made.

After the test for clamping screws or nuts, the clamping unit shall not have undergone changes that adversely affect its further use.

NOTE For mantle terminals, the specified nominal diameter is that of the slotted stud.

For mantle terminals in which the nut is tightened by means other than a screwdriver and for which the nominal screw diameter is over 10 mm, the value of the torque is under consideration.

Screws or nuts which are operated when connecting up the accessory include terminal screws or nuts, assembly screws, screws for fixing covers, etc. but not connections for screwed conduits and screws for fixing fixed socket-outlets or appliance inlets to the mounting surface.

The shape of the blade of the test screwdriver shall suit the head of the screw to be tested.

The screws and nuts shall not be tightened in jerks.

NOTE Damage to covers is neglected.

Screwed connections will have been partially checked by the test of Clause 21 and Clause 24.

25.2 Screws in engagement with a thread of insulating material and which are operated when connecting up the accessory shall have a length of engagement of at least 3 mm plus one-third of the nominal screw diameter, or 8 mm, whichever is the shorter.

Correct introduction of the screw into the threaded hole shall be ensured.

The requirement with regard to correct introduction is met if introduction of the screw in a slanting manner is prevented, for example by guiding the screw by the pan to be fixed, by a recess in the threaded hole, or by the use of a screw with the leading thread removed.

Compliance is checked by inspection, by measurement and by manual test.

25.3 Electrical connections shall be so designed that the contact pressure is not transmitted through insulating material other than ceramic, pure mica or other material with characteristics no less suitable, unless there is sufficient resiliency in the metallic parts to compensate for any shrinkage or yielding of the insulating material.

Compliance is checked by inspection.

NOTE The suitability of the material is considered with respect to its dimensional stability.

25.4 Screws and rivets which serve as electrical as well as mechanical connections shall be locked against loosening.

Examples of satisfactory solutions are:

– spring washers;
– rivets with a non-circular shank or an appropriate notch;
– sealing compound, which softens on heating, only for screw connections not subject to torsion in normal use.

Compliance is checked by inspection and by manual test.

25.5 Current-carrying parts, other than terminals, shall be of one of the following:

– copper;
– an alloy containing at least 50 % copper;
– other metal no less resistant to corrosion than copper and having mechanical properties no less suitable shall be the subject of investigation.

Compliance is checked by inspection and, if necessary, by chemical analysis.

NOTE The requirements for terminals are included in Clause 11.

25.6 Contacts which are subjected to a sliding action in normal use shall be of a metal resistant to corrosion.

Springs ensuring the resiliency of contact tubes shall be of metal resistant to corrosion or be adequately protected against corrosion.

Compliance is checked by inspection and, if necessary, by chemical analysis.

NOTE A test for determining the resistance to corrosion or the adequacy of the protection against corrosion is under consideration.

26 Creepage distances, clearances and distances through sealing compound

26.1 General

26.1.1 Creepage distances, clearances and distances through sealing compound shall be evaluated with one of the alternative methods according to 26.1.2 or 26.1.3.

26.1.2 Creepage distances, clearances and distances through sealing compound shall be not less than the values in millimetres shown in Table 20.

Table 20 – Creepage distances, clearances and distances through sealing compound

	Insulation voltage of the accessory V				
	Up to and including 50	**Over 50 up to and including 415**	**Over 415 up to and including 500**	**Over 500 up to and including 690**	**Over 690 up to and including 1 000**
Creepage distance:					
1. between live parts of different polarity	3	4	6	10	16
2. between live parts and:					
– accessible metal parts,					
– earthing contacts, fixing screws and similar devices,					
– external assembly screws, other than screws which are on the engagement face of plugs and are isolated from the earthing contacts	3	4	6	10	16
Clearance:					
3. between live parts of different polarity	2,5	4	6	8	8
4. between live parts and:					
– accessible metal parts not listed under item 5,					
– earthing contacts, fixing screws and similar devices,					
– external assembly screws, other than screws which are on the engagement face of plugs and are isolated from the earthing contacts	2,5	4	6	8	8
5. between live parts and:					
– metal enclosures, if not lined with insulating material,					
– surface on which the base of a fixed socket-outlet is mounted	4	6	10	10	10
6. between live parts and the bottom of any conductor recess in the base of a fixed socket-outlet	4	5	10	10	10
Distance through sealing compound:					
7. between live parts covered with at least 2,5 mm of sealing compound and the surface on which the base of a fixed socket-outlet is mounted	2,5	4	6	6	6
8. between live parts covered with at least 2 mm of sealing compound and the bottom of any conductor recess in the base of a fixed socket-outlet	2,5	4	5	5	5

Compliance is checked by measurement.

For rewireable accessories, the measurements are made on the sample fitted with conductors of the largest cross-sectional area specified in Table 3, and also without conductors. For non-rewireable accessories, the measurements are made on the sample as delivered.

Socket-outlets are checked when in engagement with a plug and also without a plug.

NOTE The contribution to the creepage distance of any groove less than 1 mm wide is limited to its width.

Any air gap less than 1 mm wide is ignored in computing the total clearance.

The surface on which the base of a fixed socket-outlet is mounted includes any surface with which the base is in contact when the fixed socket-outlet is installed. If the base is provided with a metal plate at the back, this plate is not regarded as the mounting surface.

26.1.3 Creepage distances, clearances and distances through sealing compound:

– between live parts of different polarity,
– between live parts and
  - accessible metal parts,
  - earthing contacts, fixing screws and similar devices,
  - external assembly screws, other than screws which are on the engagement face of plugs and are isolated from the earthing contacts,
  - the bottom of any conductor recess in the base of a fixed socket-outlet;
– through sealing compound (as solid insulation),
– between live parts covered with at least 2,5 mm of sealing compound and the surface on which the base of a fixed socket-outlet is mounted,
– between live parts covered with at least 2 mm of sealing compound and the bottom of any conductor recess in the base of a fixed socket-outlet,

shall be evaluated in accordance with IEC 60664-1, and with IEC 60664-3, and according to 26.1.5.

Creepage distances, clearances and distances through sealing compound:

– between live parts and
  - metal enclosures, if not lined with insulating material, including fittings for conduit or armoured cable,
  - the surface on which the base of a fixed socket-outlet is mounted,

shall be evaluated in accordance with IEC 60664-1, and with IEC 60664-3, and according to 26.1.5, and taking into account double insulation. The control pilot shall be treated as a "live part" and signal circuits shall be treated as "accessible metal parts" for the purpose of 26.1.3.

For rewireable accessories, compliance is checked using samples fitted with conductors of the largest cross-sectional area specified in Table 3, and also without conductors. For non-rewireable accessories, compliance is checked using samples as delivered.

Socket-outlets are checked when in engagement with a plug and also without a plug.

NOTE Any air gap less than 1 mm wide is ignored in computing the total clearance.

The surface on which the base of a fixed socket-outlet is mounted includes any surface with which the base is in contact when the fixed socket-outlet is installed. If the base is provided with a metal plate at the back, this plate is not regarded as the mounting surface.

26.1.4 Accessories shall be designed for pollution degree 3 according to IEC 60664-1.

26.1.5 For the interior of the accessory a lower pollution degree can be considered if protection is afforded by a suitable enclosure. If other pollution degrees are needed, creepage and clearance distances shall be in accordance with IEC 60664-1. The comparative tracking index (CTI) value shall be evaluated in accordance with IEC 60112.

26.1.6 In conducting evaluations in accordance with IEC 60664-1 and IEC 60664-3 all accessories shall be considered as being of overvoltage Category II.

Determination of the dimensions of clearance and creepage distances shall be conducted in accordance with IEC 60664-1:2020, 6.2.

26.2 Sealing compound

Sealing compound shall not protrude above the edge of the cavity in which it is contained.

Compliance is checked by inspection.

27 Resistance to heat, to fire and to tracking

27.1 Accessories shall be sufficiently resistant to heat.

Compliance is checked by the following tests.

The samples are kept for 1 h in a heating cabinet at a temperature of (100 ± 5) °C.

They shall not undergo any change impairing their further use, and sealing compound shall not flow to such an extent that live parts are exposed.

Marking shall still be easily legible.

NOTE A slight displacement of the sealing compound is neglected.

Parts of insulating material are subjected to a ball-pressure test according to IEC 60695-10-2.

The test is made in a heating cabinet at a temperature of:

– (125 ± 5) °C for parts supporting live parts of rewireable accessories;
– (80 ± 3) °C for other parts.

For materials which show deformation, the diameter of the indentation shall not exceed 2 mm.

NOTE For elastomeric materials, a test is under consideration.

The test is not made on parts of ceramic material.

27.2 External parts of insulating material and insulating parts supporting live parts of accessories shall be resistant to abnormal heat and to fire.

Conductors shall not be considered as retaining the current-carrying parts.

In case of doubt, to determine whether an insulating part is necessary to retain the current-carrying parts or the parts of the earthing circuit in position, the accessory is examined without conductors while held in positions most likely to cause displacement of the current-carrying parts or parts of the earthing circuit, with the insulating material in question removed.

Compliance is checked by the glow-wire test given in IEC 60695-2-11 with the following specifications.

The temperature of the tip of the glow-wire is:

– *(650 ± 10) °C for parts of insulating material not necessary to retain current-carrying parts and parts of the earthing circuits in position, even though they are in contact with them.*

  Tests are not made on glands and sealing compounds.

– *(850 ± 15) °C for parts of insulating material necessary to retain current-carrying parts and parts of the earthing circuits in position.*

The tip of the glow-wire is applied to the following places:

– *in the middle of one external part for each part, with the exception of glands and sealing compounds;*
– *in the middle of an insulating contact-carrying part for each material.*

The tip is applied to flat surfaces and not to grooves, knock-outs, narrow recesses or sharp edges and if possible not less than 9 mm from the edges of the accessories.

The test is made on one sample. In case of doubt regarding the results of the test, the test is repeated with two further samples.

The accessories are considered to have withstood the glow-wire test if:

– *there is no visible flame and no sustained glowing, or*
– *flame or glowing of the sample or of the surroundings extinguish within 30 s after the removal of the glow-wire, and the surrounding parts have not burned away completely. There shall be no permanent ignition of the tissue paper.*

27.3 Insulating parts supporting live parts shall be of material resistant to tracking.

For materials other than ceramic, compliance is checked by the test according to IEC 60112 with the following parameters:

– *CTI test;*
– *solution a;*
– *applied voltage 175 V.*

No flashover or breakdown between electrodes shall occur before a total of 50 drops has fallen.

28 Corrosion and resistance to rusting

Ferrous parts, including enclosures, shall be adequately protected against rusting.

Where corrosion can be a problem on electrical parts, IP67 accessories are recommended.

For specific conditions and the provisions for these conditions, special consideration should be given to the product by the manufacturer with regard to resistance to corrosion.

Compliance is checked by the following test.

All grease is removed from the parts to be tested, by immersion for 10 min in carbon-tetrachloride, trichloroethane or an equivalent degreasing agent. The parts are then immersed for 10 min in a 10 % solution of ammonium chloride in water at a temperature of (20 ± 5) °C.

Without drying, but after shaking off any drops, the parts are placed for 10 min in a box containing air saturated with moisture at a temperature of (20 ± 5) °C.

After the parts have been dried for 10 min in a heating cabinet at a temperature of (100 ± 5) °C, their surfaces shall show no signs of rust.

Traces of rust on sharp edges and any yellowish film removable by rubbing are ignored.

For small helical springs and the like, and for inaccessible parts exposed to abrasion, a layer of grease may provide sufficient protection against rusting. Such parts are subjected to the test only if there is doubt about the effectiveness of the grease film and the test is then made without previous removal of the grease.

29 Conditional short-circuit current withstand test

29.1 Minimum prospective short-circuit current

Socket-outlets and mating plugs shall have the minimum prospective short-circuit current withstand of 10 kA or of a higher value specified by the manufacturer.

Compliance is checked by the test of 29.2

29.2 Ratings and test conditions

29.2.1 General

The test is applied to a new socket-outlet and mating plug mounted as in normal use.

Different numbers of poles for the same rated current and the same construction are considered as representative of the type.

The short-circuit protective device shall be a "gG" type fuse for general application complying with the requirements of IEC 60269-1 and IEC 60269-2 and having ratings identical to those of the socket-outlet and mating plug under test.

In case a fuse with a rated current equal to that of the socket-outlet and mating plug being tested does not exist, a fuse having the next higher rated value shall be used.

Fuse technical data as well as its cut-off value shall be stated in the test report.

The fuse (F1) is to be installed between the supply source and the socket-outlet and mating plug being tested.

The test voltage shall be identical to the rated operating voltage of the socket-outlet and mating plug tested.

No power-factor value nor time constant is specified for this test.

The following tolerances shall be applied during the test:

a) current: from 95 % to 105 %;

b) voltage: from 100 % to 105 %;

c) frequency: from 95 % to 105 %.

29.2.2 Test-circuit

a) Figure 20, Figure 21 and Figure 22 give the diagrams of the circuit to be used for the test:

- two-pole accessories on single-phase AC or DC (Figure 20);
- three-pole accessories on three-phase AC (Figure 21);
- four-pole accessories on three-phase four-wire AC (Figure 22).

b) The supply S feeds a circuit including resistors R_1, reactors X and the accessories D under test.

In all cases, the supply shall have sufficient power to permit the verification of the characteristics given by the manufacturer.

c) In each test circuit (Figure 20, Figure 21 and Figure 22), the resistors and reactors are inserted between the supply source S and the equipment D under test. The position of the closing device A and the current sensing devices (I_1, I_2, I_3) may be different.

There shall be one and only one point of the test circuit which is earthed; this may be the short-circuit link of the test circuit of the neutral point of the supply or any other convenient point.

d) All parts of the accessories normally earthed in service, including the earth contact and pilot contact, the enclosure or the screens, shall be insulated from earth and connected to a point as indicated in Figure 20, Figure 21 and Figure 22.

This connection shall comprise a fuse element F2 consisting of a copper wire 0,8 mm in diameter and at least 50 mm long, or of a fuse element of 30/35 A for the detection of the fault current.

The connection of the accessories under test shall be made with copper wires having cross-sectional areas as indicated in Table 3, and lengths as short as possible, not exceeding 1 m on either side.

29.2.3 Calibration

The calibration of the test circuit is carried out by placing temporary connections B of negligible impedance as close as reasonably possible to the terminals provided for connecting the accessories under test.

29.2.4 Test procedure

Temporary connections B are replaced by the accessories under test. The circuit is closed on a value of the prospective current at least equal to the conditional short-circuit withstand current of the accessories under test.

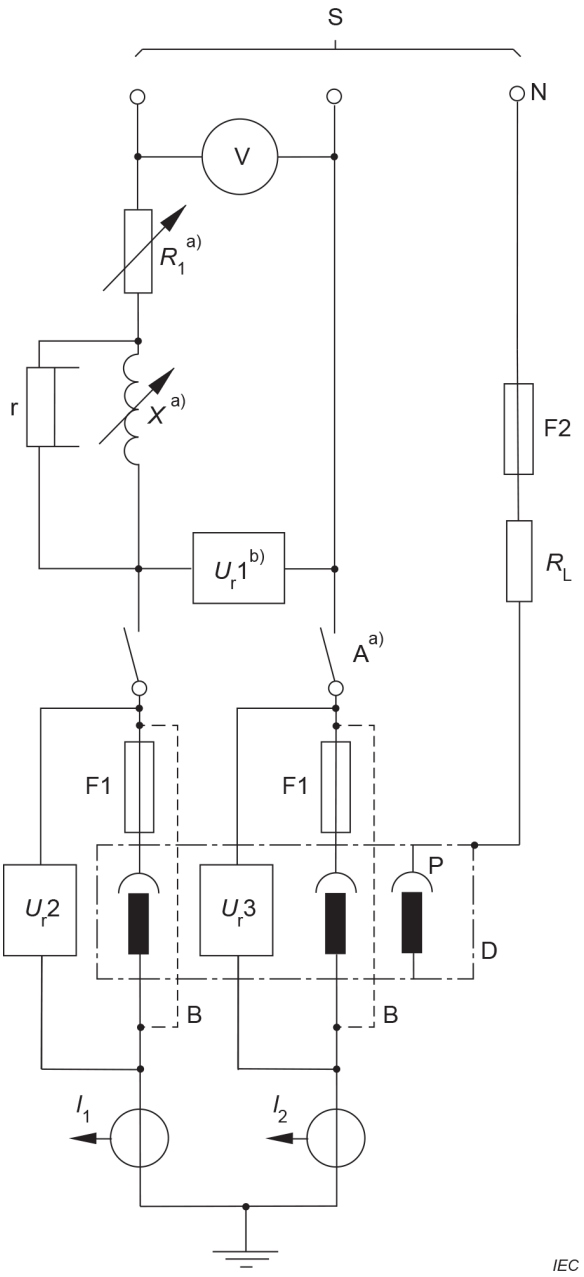
29.2.5 Acceptance conditions

There shall be neither arcing nor flashover between poles, and no melting of the fault detection circuit fuse of the exposed conductive parts (F2).

– The accessories shall remain mechanically operable.

– Contact welding, such as to prevent an opening operation using normal operating means, is not permitted.

– Immediately after the test, the accessories shall comply with a dielectric test in accordance with 19.5 with voltage applied between the parts as indicated in 19.3 b) or 19.4 b), as applicable.



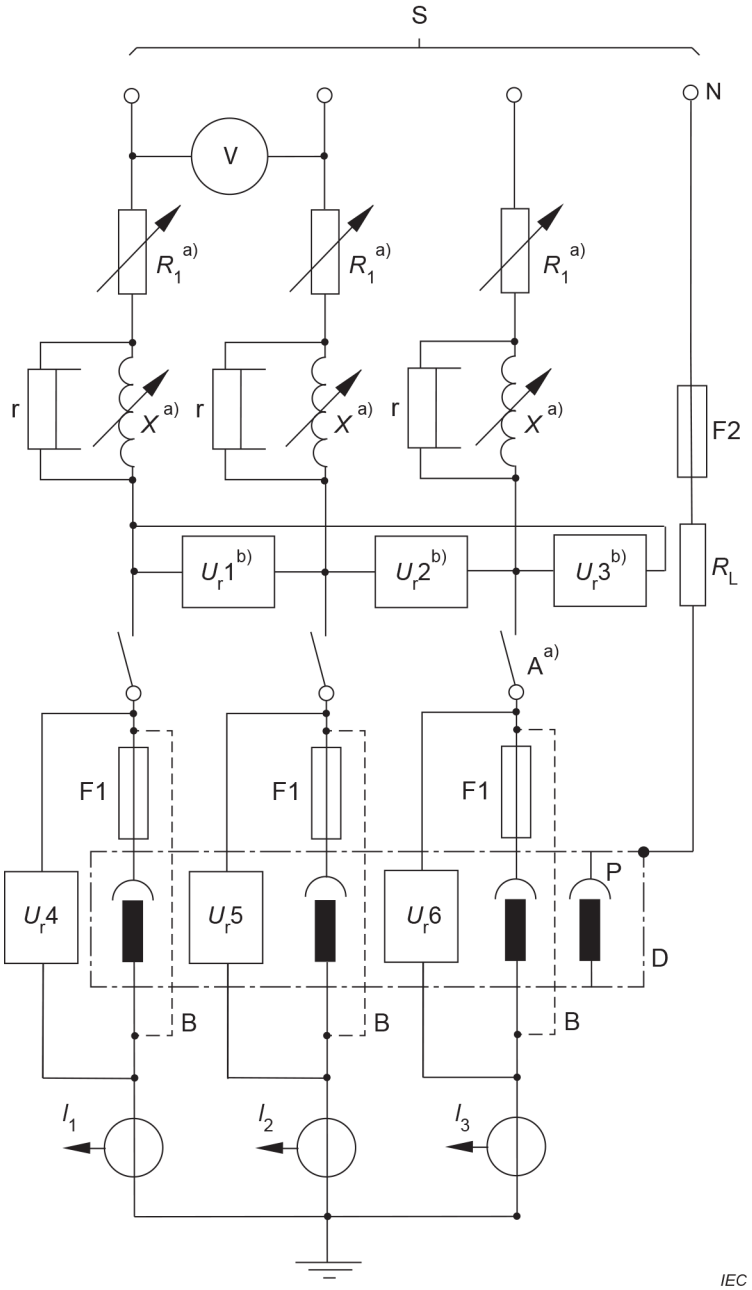
Key

S	=	Supply
U_r1, U_r2, U_r3	=	Voltage sensors
V	=	Voltage measuring device
A	=	Closing device
R_1	=	Adjustable resistor
N	=	Neutral of supply (or artificial neutral)
F2	=	Fusible element
X	=	Adjustable reactor
R_L	=	Fault current limiting resistor
D	=	Equipment under test (including connecting cables)
F1	=	Fuses
B	=	Temporary connections for calibration
I_1, I_2	=	Current sensors
T	=	Earth – One earthing point only (load side or supply side)
r	=	Shunt resistor
P	=	Pilot contact

a) Adjustable loads X and R_1 may be located either on the high-voltage side or on the low-voltage side of the supply circuit, the closing device A being located on the low-voltage side.

b) U_r1, U_r2 and U_r3, may, alternatively, be connected between phase and neutral.

Figure 20 – Diagram of the test circuit for the verification of short-circuit current withstand of a two-pole accessory on a single-phase AC or DC



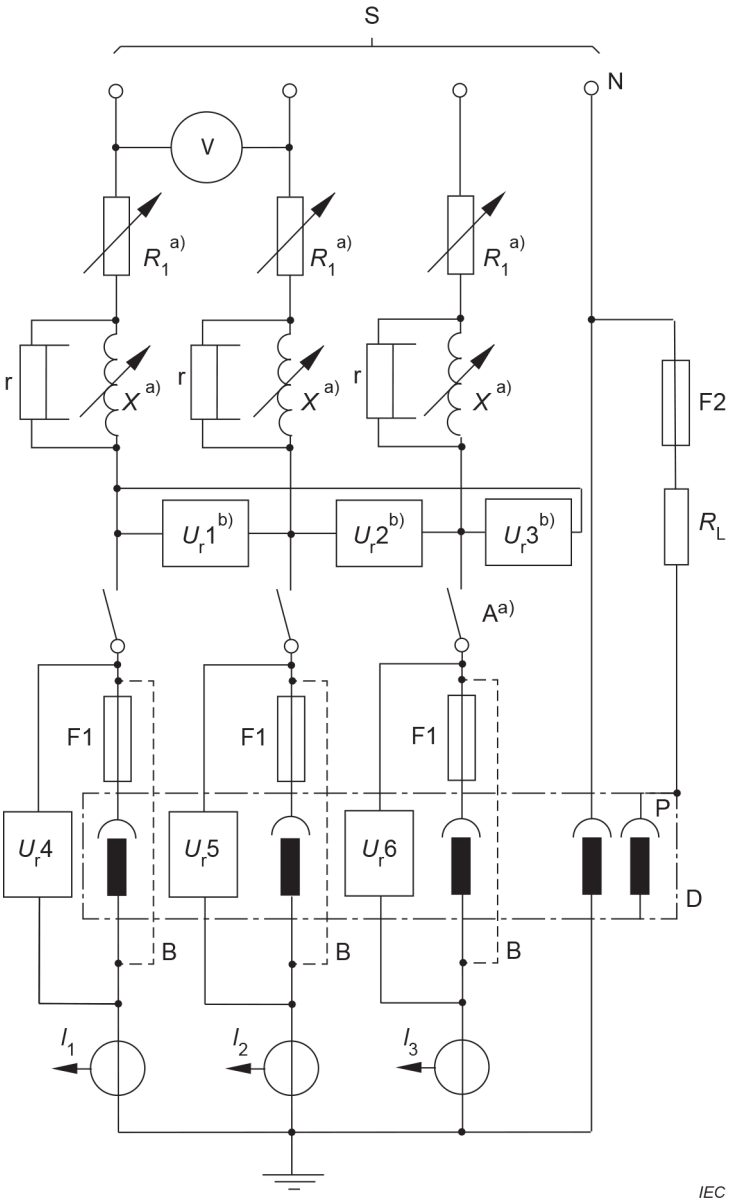
Key

S	=	Supply
U_r1, U_r2, U_r3, U_r4, U_r5, U_r6	=	Voltage sensors
V	=	Voltage measuring device
A	=	Closing device
R_1	=	Adjustable resistor
N	=	Neutral of supply (or artificial neutral)
F2	=	Fusible element
X	=	Adjustable reactors
R_L	=	Fault current limiting resistor
D	=	Equipment under test (including connecting cables)
F1	=	Fuses
B	=	Temporary connections for calibration
I_1, I_2, I_3	=	Current sensors
T	=	Earth – One earthing point only (load side or supply side)
r	=	Shunt resistor
P	=	Pilot contact

a) Adjustable loads X and R_1 may be located either on the high-voltage side or on the low-voltage side of the supply circuit, the closing device A being located on the low-voltage side.

b) U_r1, U_r2 and U_r3, may, alternatively, be connected between phase and neutral.

Figure 21 – Diagram of the test circuit for the verification of short-circuit current withstand of a three-pole accessory



Key

S	=	Supply
U_r1, U_r2, U_r3, U_r4, U_r5, U_r6	=	Voltage sensors
V	=	Voltage measuring device
R_1	=	Adjustable resistor
N	=	Neutral of supply (or artificial neutral)
F2	=	Fusible element
X	=	Adjustable reactors
R_L	=	Fault current limiting resistor
D	=	Equipment under test (including connecting cables)
F_1	=	Fuses
B	=	Temporary connections for calibration
I_1, I_2, I_3	=	Current sensors
T	=	Earth – One earthing point only (load side or supply side)
r	=	Shunt resistor
P	=	Pilot contact

a) Adjustable loads X and R_1 may be located either on the high-voltage side or on the low-voltage side of the supply circuit, the closing device A being located on the low-voltage side.

b) U_r1, U_r2 and U_r3, may, alternatively, be connected between phase and neutral.

Figure 22 – Diagram of the test circuit for the verification of short-circuit current withstand of a four-pole accessory

30 Electromagnetic compatibility

30.1 Immunity

Accessories not incorporating electronic components are not sensitive to normal electromagnetic disturbances and therefore no immunity tests are required.

Accessories incorporating electronic components shall comply with IEC 61000-6-2.

NOTE Glow lamps, for example, neon indicators and the like, are not considered to be electronic components in this context.

Compliance is checked by inspection.

30.2 Emission

Accessories not incorporating electronic components are intended for continuous use; in normal use they do not generate electromagnetic disturbances.

NOTE 1 These accessories will only generate electromagnetic disturbances during occasional operations of insertion and withdrawal. The frequency, the level and the consequences of these emissions are considered as part of the normal electromagnetic environment.

NOTE 2 Glow lamps, for example, neon indicators and the like, are not considered to be electronic components in this context.

Accessories incorporating electronic components shall comply with IEC 61000-6-3.

Compliance is checked by inspection.

Annex A
(normative)

Guidance and description of test apparatus

A.1 Pendulum and mount

The repeatability and reproducibility of the impact test is dependent on the details of the test apparatus. The factors influencing the results obtained are the location of the pendulum centre of percussion, the total mass of the pendulum, the hammer nose radius, the hammer material, and the rigidity of the mounting board. In the example of a suitable apparatus, the pendulum is designed so that the impact point coincides with the centre of percussion. Any alteration to the construction of the pendulum shall not alter the location of the centre of percussion. Furthermore, any alteration of the pendulum mass or moment of inertia shall not alter the impact characteristic and the release angle.

The centre of percussion is the point through which the total momentum of the body can be represented by a single vector equal to mv_g, where m is the mass of the body and v_g is the velocity of the centre of gravity. The centre of percussion, ℓ , can be calculated from:

$$\ell = l/md$$

where l is the moment of inertia about the pivot axis, m is the mass, and d is the distance from the pivot to the centre of gravity.

Variation of the hammer nose radius and material will also affect the impact characteristic by changing the contact area of the impact and the duration of the impulse.

The mounting board shall be sufficiently massive and rigid so that it will not influence the test results. By having a large mass, movement of the mounting board, and therefore momentum transfer, is negligible. The rigidity of the mount ensures that it will not be an energy storage or dissipating device during the impact test.

A.2 Impact energy and release angle

For the purpose of this test, the impact energy is defined as the potential energy (E) of the pendulum prior to its release, and is equal to:

$$E = mgh_{c.g.}$$

where m is the mass, g is the acceleration due to gravity, and $h_{c.g.}$ is the vertical displacement of the pendulum centre of gravity. The release angle, measured in degrees from vertical, has been computed to avoid confusion about the point where the release height is measured. The angle is found from the trigonometric relationship between $h_{c.g.}$ and d, the distance from the pivot to the centre of gravity. See Table A.1 for standardised values.

A.3 Description of test apparatus

The pendulum described in Figure A.1 to Figure A.7 has been designed to produce the desired impact energy levels required in this document, as well as energy levels under consideration. Specifically, the test apparatus is a physical pendulum made up of a pivot, a tubular steel shaft, a shaft end, a hammer or anvil, and two 0,25 kg mass, the distance between the pivot and the hammer nose is 1 m. The hammer nose corresponds to the centre of percussion of the pendulum. The placement of the mass is critical to maintain the location of the centre of percussion.

For tests with 0,500 kg of mass, the mass shall be installed in the lowest mounting hole in the pendulum shaft end.

For tests with 1 kg of mass, the mass shall be installed in the uppermost mounting hole in the pendulum shaft end.

The following are critical parameters to the performance of the pendulum:

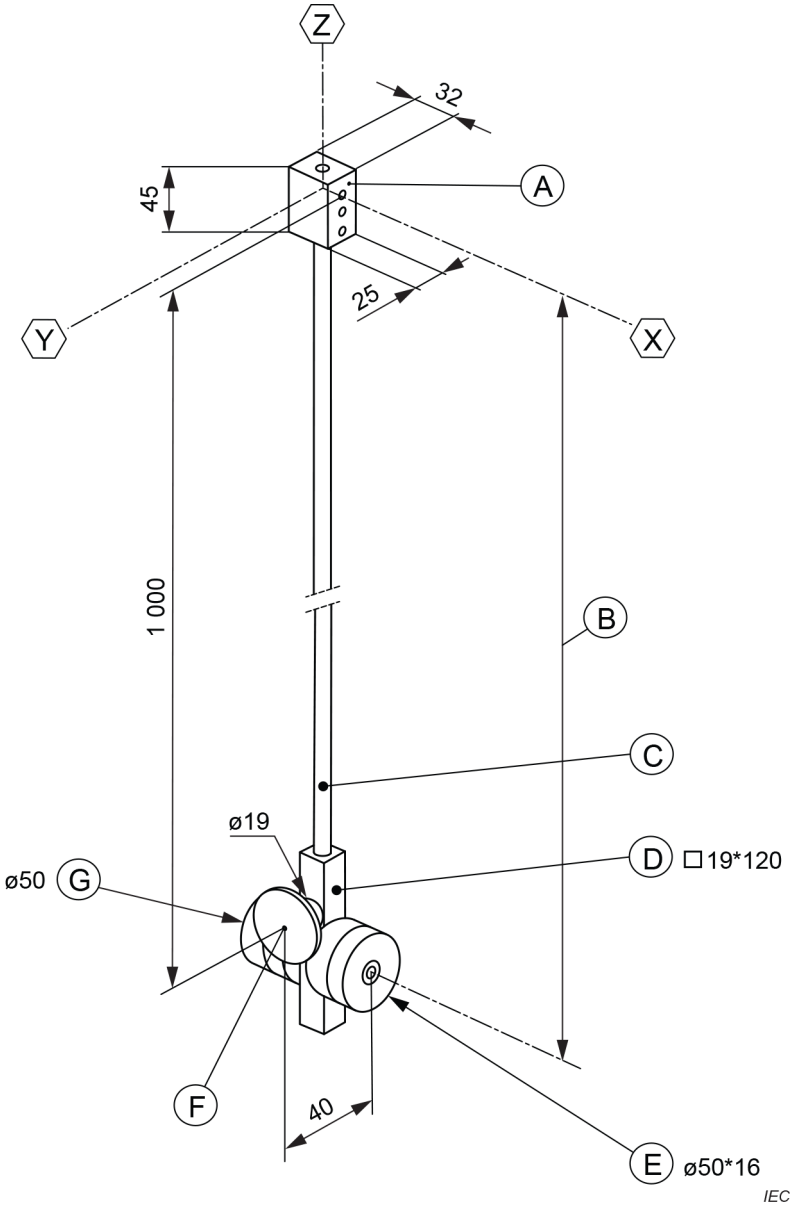
– Using 0,500 kg of mass:

Pendulum mass	=	1,44 kg
Moment of inertia	=	1,17 kg · m^2
Distance to gravity centre	=	0,776 m

– Using 1 kg of mass:

Pendulum mass	=	1,93 kg
Moment of inertia	=	1,61 kg · m^2
Distance to gravity centre	=	0,833 m

Dimensions in millimetres



Key

A Aluminium pivot

B L = 1 031/Mass: 1,0 kg or L = 1 059/Mass: 0,5 kg

C Steel shaft Ø10 with 1 wall

D Shaft end, steel

E Two 0,25 kg mass = 0,50 kg or four 0,25 kg mass = 1,0 kg – Each mass: steel

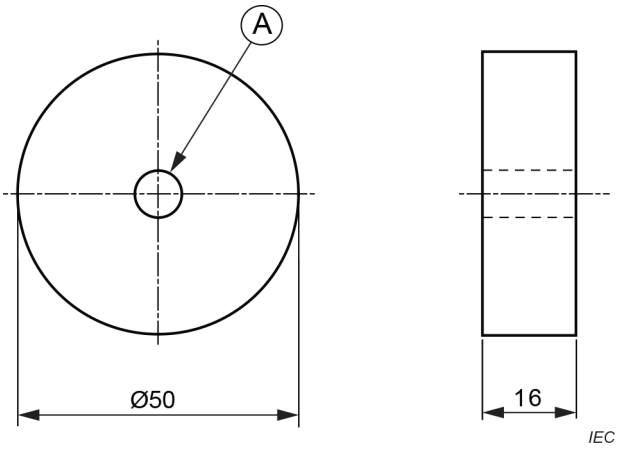
F Impact at centre of percussion

G Anvil, steel

Figure A.1 – Impact test fixture – Pendulum assembly

Table A.1 – Impact test release angles

Impact test release angles		
Impact level J	**Mass used** kg	**Release angle** (degrees from vertical)
1	0,5	25°
2	0,5	35°
3	1	36°
4	1	42°
5	1	47°
6	1	52°



Key

A See Table

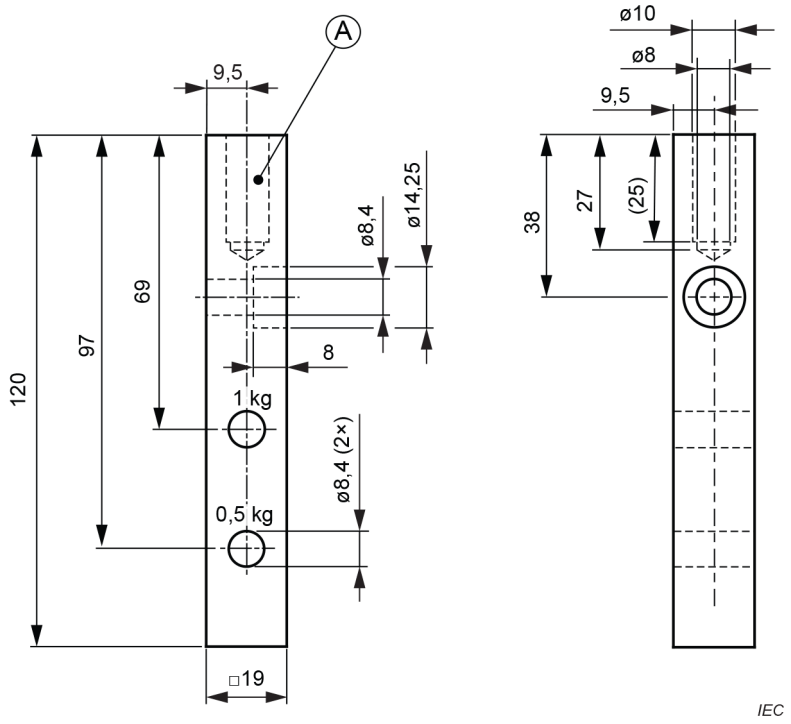
Hole configuration	**Used on**	
	0,5 kg	**1 kg**
∅ 8,4	–	2
M8 × 1,25	1	1
Bolt dimensions		
∅ 8,4 ⌴ 14,25 ↓ 8	1	1
M8 × 1,25 SHCS × 43	1	–
M8 × 1,25 SHCS × 75	–	1

NOTE 1 All dimensions are in millimetres.

NOTE 2 Material: steel.

NOTE 3 SHCS: Socket-head cap screw.

Figure A.2 – Impact test fixture – Pendulum masses – Quantity: 4



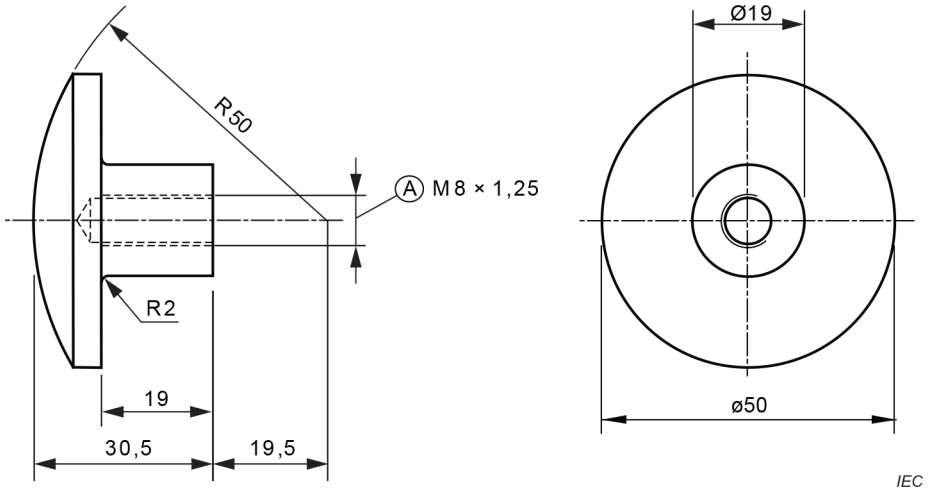
Key

A Pin or braze at assembly with shaft

NOTE 1 All dimensions are in millimetres.

NOTE 2 Material: steel.

Figure A.3 – Impact test fixture – Pendulum shaft end



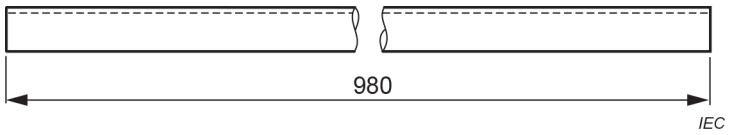
Key

A Depth 19 mm

NOTE 1 All dimensions are in millimetres.

NOTE 2 Material: steel.

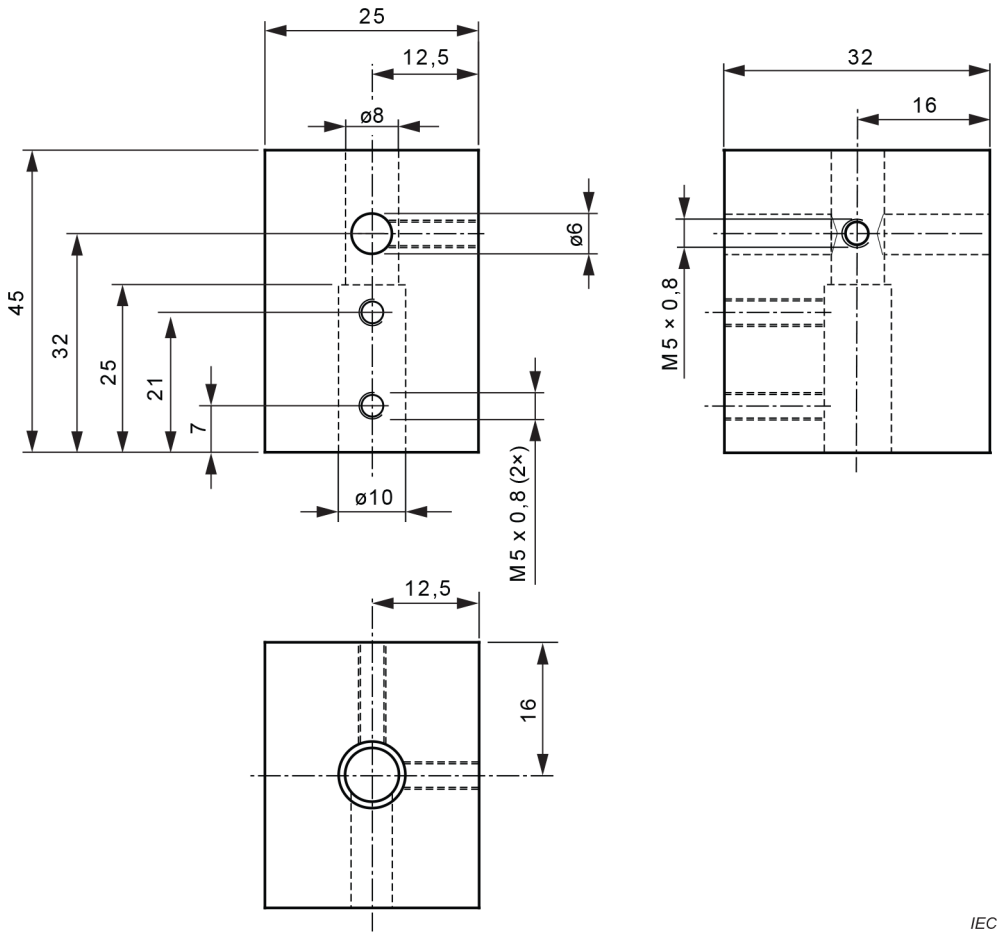
Figure A.4 – Impact test fixture – Pendulum anvil



NOTE 1 All dimensions are in millimetres.

NOTE 2 Material: steel tube, ∅ 10 × 1,0 wall.

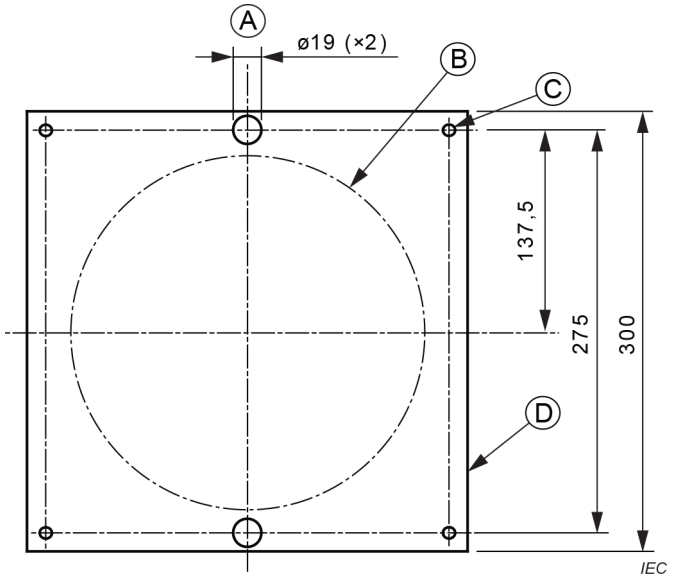
Figure A.5 – Impact test fixture – Pendulum shaft



NOTE 1 All dimensions are in millimetres.

NOTE 2 Material: aluminium.

Figure A.6 – Impact text fixture – Pendulum pivot



Key

A Dowel pins

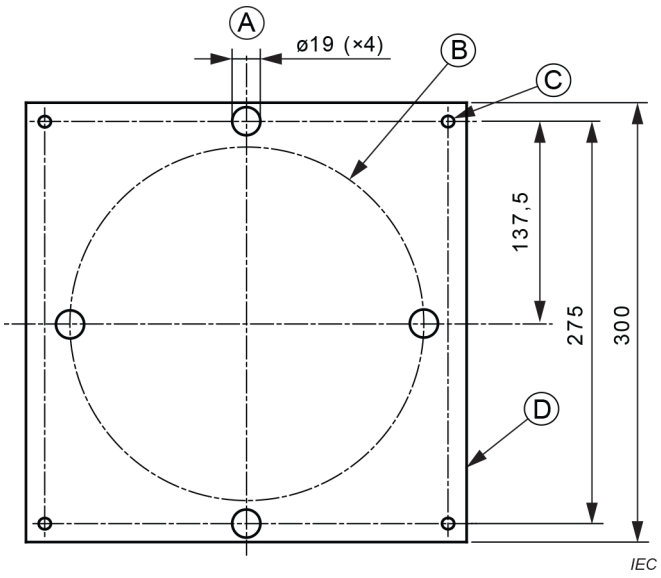
B Optional hole for flush mounting device

C Four fast-locking fasteners (i.e. wedges)

D Back plate

NOTE 1 All dimensions are in millimetres.

NOTE 2 Material: 8 mm steel.



Key

A Dowel pins

B Optional hole for flush mounting device

C Four fast-locking fasteners (i.e. wedges)

D Mounting plate

NOTE 1 All dimensions are in millimetres.

NOTE 2 Material: 8 mm steel.

NOTE 3 Additional holes can be drilled as required to mount test samples.

Figure A.7 – Impact test apparatus – Back and mounting plates

Bibliography

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