

# INTERNATIONAL STANDARD

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**Plugs, socket-outlets and couplers with arcuate contacts**

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**Plugs, socket-outlets and couplers with arcuate contacts**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

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ICS 29.120.20

ISBN 978-2-8322-4870-6

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**PLUGS, SOCKET-OUTLETS AND COUPLERS WITH  
ARCUATE CONTACTS**

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International Standard IEC 62986 has been prepared by subcommittee 23H: Plugs, socket-outlets and couplers for industrial and similar applications, and for electric vehicles, of IEC technical committee 23: Electrical accessories.

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

FDIS	Report on voting
23H/386/FDIS	23H/387/RVD

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

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

In this standard, the following print types are used:

- requirements: in roman type;
- *conformity statements: in italic type;*
- notes: in small roman type.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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## INTRODUCTION

The object of this document is to provide for a safe, compact and practical IEC system of standardized plugs and socket-outlets with arcuate contacts. It contains performance and dimensional requirements taking into account essential differences in the infrastructures and installation rules throughout the world.

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## PLUGS, SOCKET-OUTLETS AND COUPLERS WITH ARCUATE CONTACTS

### 1 Scope

This document sets the general and dimensional interchangeability requirements for plugs, socket-outlets, connectors and appliance inlets with arcuate contacts of standardized configurations (hereinafter referred to as accessories), with a rated operating voltage not exceeding 600 V AC at a frequency of 50 Hz and 60 Hz and with rated currents of 20 A and 30 A, primarily intended for commercial use indoors, in conditions where the presence of water is negligible.

This document applies to accessories for use when the ambient temperature is normally within the range of  $-25\text{ °C}$  to  $+40\text{ °C}$ . These accessories are intended to be connected to cables of copper or copper alloy only.

Interchangeability requirements are defined for IP20 accessories.

NOTE The conditions of use indoors are based on the limitations given by IEC 60364-5-51:2005, Table 51A, AD1.

Socket-outlets or appliance inlets incorporated in or fixed to electrical equipment are within the scope of this document.

### 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 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, *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 60309-1:1999, *Plugs, socket-outlets and couplers for industrial purposes – Part 1: General requirements*

IEC 60309-1:1999/AMD1:2005

IEC 60309-1:1999/AMD2:2012

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

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

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

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*

NMX-J-436-ANCE-2014/CSA C22.2 No.49-14/ANSI/UL 62, *Flexible Cords and Cables*

UL 1581, *Reference Standard for Electrical Wires, Cables and Flexible Cords*

### **3 Terms and definitions**

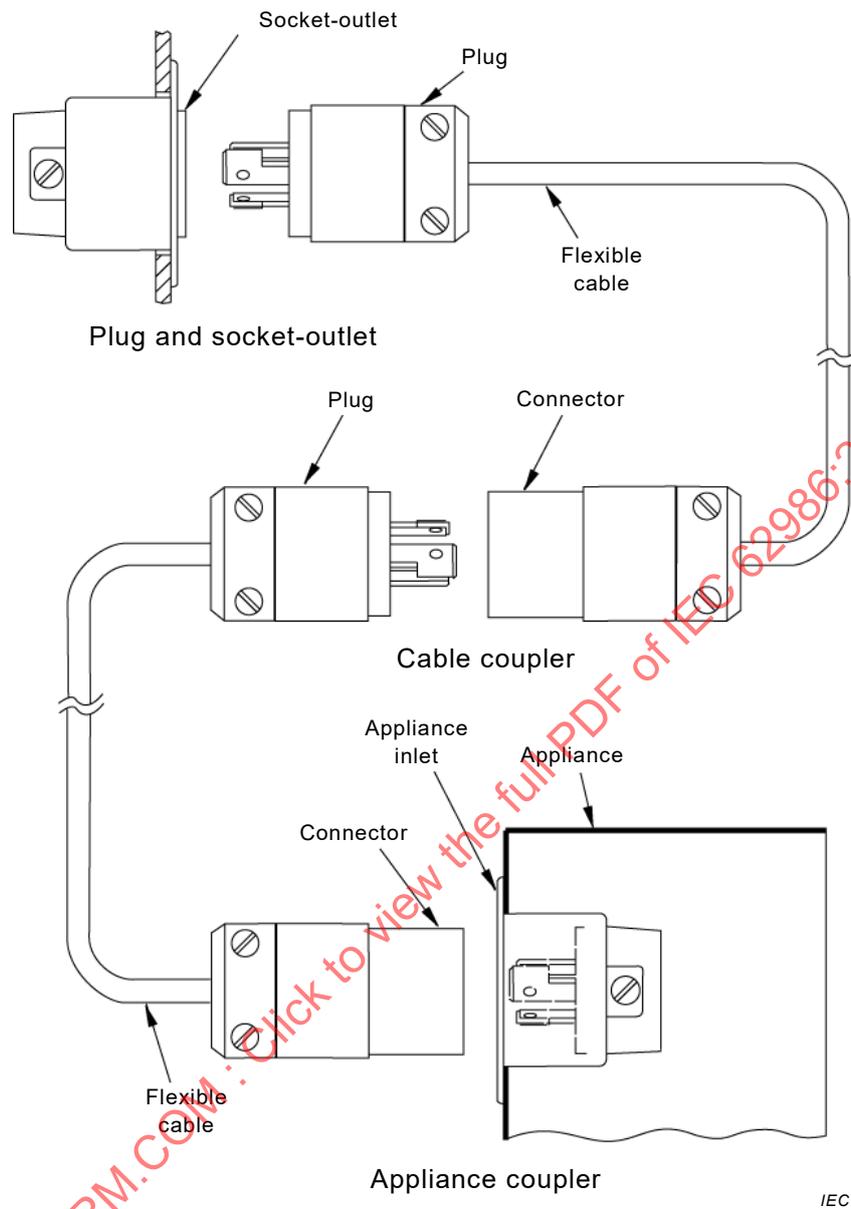
For the purposes of this document, the following terms and definitions apply.

NOTE The application of accessories is shown in Figure 1.

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>

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**Figure 1 – Diagram showing the uses of the accessories**

### 3.1

#### **plug and socket-outlet**

means enabling the connection at will of a flexible cable to fixed wiring. It consists of two parts:

[SOURCE: IEC 60309-1:1999, 2.1]

#### 3.1.1

##### **socket-outlet**

part intended to be installed with the fixed wiring or incorporated in equipment. A socket-outlet may also be incorporated in the output circuit of an isolating transformer

[SOURCE: IEC 60309-1:1999, 2.1.1]

### 3.1.2

#### **plug**

part integral with or intended to be attached directly to one flexible cable connected to the equipment or to a connector

[SOURCE: IEC 60309-1:1999, 2.1.2]

### 3.2

#### **cable coupler**

means enabling the connection at will of two flexible cables. It consists of two parts:

[SOURCE: IEC 60309-1:1999, 2.2]

#### 3.2.1

##### **connector**

part integral with or intended to be attached to one flexible cable connected to the supply

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

[SOURCE: IEC 60309-1:1999, 2.2.1]

#### 3.2.2

##### **plug**

part integral with or intended to be attached to one flexible cable connected to the equipment or to a connector

Note 1 to entry: The plug of a cable coupler is identical to the plug of a "plug and socket-outlet".

[SOURCE: IEC 60309-1:1999, 2.2.2]

### 3.3

#### **appliance coupler**

means enabling the connection at will of a flexible cable to the equipment. It consists of two parts:

[SOURCE: IEC 60309-1:1999, 2.3]

#### 3.3.1

##### **connector**

part integral with, or intended to be attached to, one flexible cable connected to the supply

Note 1 to entry: In general, the connector of an appliance coupler is identical to the connector of a cable coupler.

[SOURCE: IEC 60309-1:1999, 2.3.1]

#### 3.3.2

##### **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.

[SOURCE: IEC 60309-1:1999, 2.3.2]

### 3.4

#### **rewirable plug or connector**

accessory so constructed that the flexible cable can be replaced

[SOURCE: IEC 60309-1:1999, 2.4]

**3.5****non-rewirable plug or connector**

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

[SOURCE: IEC 60309-1:1999, 2.5]

**3.6****rated current**

current assigned to the accessory by the manufacturer

[SOURCE: IEC 60309-1:1999, 2.11]

**3.7****rated operating voltage**

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

[SOURCE: IEC 60309-1:1999, 2.13]

**3.8****basic insulation**

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

[SOURCE: IEC 60309-1:1999, 2.14]

**3.9****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

[SOURCE: IEC 60309-1:1999, 2.15]

**3.10****double insulation**

insulation comprising both basic insulation and supplementary insulation

[SOURCE: IEC 60309-1:1999, 2.16]

**3.11****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

[SOURCE: IEC 60309-1:1999, 2.17]

**3.12****terminal**

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

[SOURCE: IEC 60309-1:1999, 2.18]

**3.12.1****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. 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.

[SOURCE: IEC 60309-1:1999, 2.18.1]

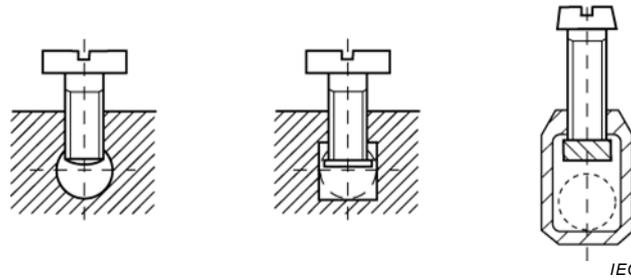


Figure 2 – Pillar terminals

**3.12.2 screw terminal**

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

[SOURCE: IEC 60309-1:1999, 2.18.2]

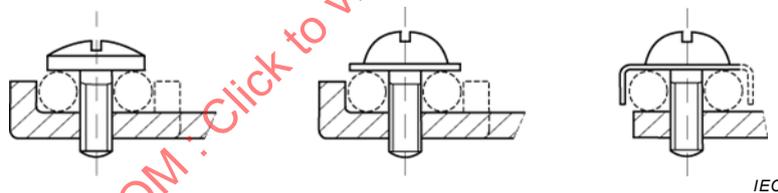


Figure 3 – Screw terminals

**3.12.3 stud terminal**

terminal in which the conductor is clamped under a nut. 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.

[SOURCE: IEC 60309-1:1999, 2.18.3]

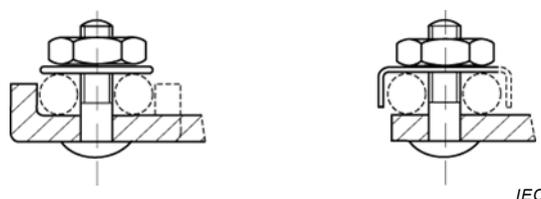


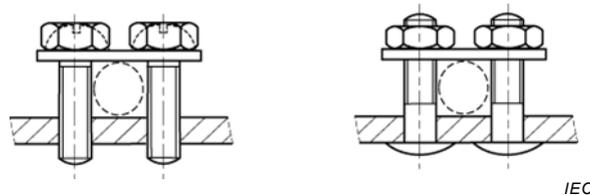
Figure 4 – Stud terminals

**3.12.4****saddle terminal**

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

SEE: Figure 5.

[SOURCE: IEC 60309-1:1999, 2.18.4]



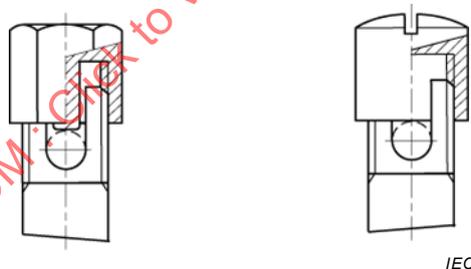
**Figure 5 – Saddle terminals**

**3.12.5****mantle terminal**

terminal in which the conductor is clamped against the base of a slot in a threaded stud by means of a nut. 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 6.

[SOURCE: IEC 60309-1:1999, 2.18.6]



**Figure 6 – Mantle terminals**

**3.13****clamping unit**

part of a terminal necessary for the clamping and the electrical connection of the conductor

[SOURCE: IEC 60309-1:1999, 2.19]

**3.14****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 IEC 60050-441:2000, 441-17-20 by broadening the concept of current-limiting device into a short-circuit protective device, the function of which is not only to limit the current.

[SOURCE: IEC 60309-1:1999, 2.20]

### 3.15

#### lid

means to ensure the degree of protection on a socket-outlet or a connector

[SOURCE: IEC 60309-1:1999, 2.22]

## 4 General

### 4.1 General requirements

Accessories shall be so designed and constructed that in normal use their performance is reliable and without danger to the user or surroundings.

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

*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 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  $(20 \pm 5)$  °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 subclause, one new set of samples is tested.

**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 Clauses 20 and 21, in which case the tests are repeated from that of Clause 19 onwards.

The applicant may submit, together with the first set of samples, the additional set which may be necessary 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 or copper alloy of the type as declared in the manufacturer's instructions and comply with the appropriate documents listed below:

Metric conductors (mm<sup>2</sup>):

IEC 60227 (all parts)

IEC 60228:2004 [Clause 3, solid (class 1), stranded (class 2), flexible (class 5)]

IEC 60245-4

AWG conductors:

NMX-J-436-ANCE-2014/CSA C22.2 No.49-14/ANSI/UL 62

UL 1581

## 5 Standard ratings

Ratings are specified in Table 1:

**Table 1 – Standard ratings**

Rated operating voltage V	Rated current A	Number of contacts	Type	Standard sheet
125	20	3	1P+N+⊥	L5-20
250			2P+⊥	L6-20
277			1P+N+⊥	L7-20
347			1P+N+⊥	L24-20
480			2P+⊥	L8-20
600			2P+⊥	L9-20
125/250		4	2P+N+⊥	L14-20
250			3P+⊥	L15-20
480			3P+⊥	L16-20
120/208		5	3P+N+⊥	L21-20
277/480			3P+N+⊥	L22-20
347/600			3P+N+⊥	L23-20
125	30	3	1P+N+⊥	L5-30
240			2P+⊥	L25-30
250			2P+⊥	L6-30
277			1P+N+⊥	L7-30
480			1P+N+⊥	L8-30
600			2P+⊥	L9-30
125/250		4	2P+N+⊥	L14-30
250			3P+⊥	L15-30
480			3P+⊥	L16-30
120/208		5	3P+N+⊥	L21-30
277/480			3P+N+⊥	L22-30
347/600			3P+N+⊥	L23-20

## 6 Classification

### 6.1 According to purpose

Accessories are classified according to purpose:

- plugs;
- socket-outlets;
- connectors;
- appliance inlets.

### 6.2 According to the method of connecting the cable

Accessories are classified according to the method of connecting the cable:

- rewirable plugs and connectors;
- non-rewirable plugs and connectors.

## 7 Marking

7.1 Accessories shall be marked with:

- rated current in amperes according to Table 1;
- rated operating voltage(s) in volts according to Table 1;
- symbol for nature of supply;
- either the name or trade mark of the manufacturer or of the responsible vendor;
- type reference, which may be a catalogue number;
- an indication that the plug/connector has to be rotated to be locked.

*Compliance is checked by inspection.*

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

- A ..... amperes
- V ..... volts
- ~ IEC 60417-5032 (2002-10) or AC ..... alternating current
-  IEC 60417-5019 (2006-08) (preferred) or  $\perp$  ..... earth

*Compliance is checked by inspection.*

7.3 For socket-outlets and appliance inlets, the marking for rated current, nature of supply and either the name or trade mark of the manufacturer or the responsible vendor 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 socket-outlets and appliance inlets, these markings 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 for rated operating voltage and type reference 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 the type reference, these markings shall be easily discernible when the accessory is mounted and wired as in normal use.

NOTE The term "main part" of a socket-outlet or an appliance inlet means the part carrying the contacts.

The type reference may be marked on the main part.

*Compliance is checked by inspection.*

The marking for rated current, nature of supply, rated operating voltage and the name or trade mark of the manufacturer or the responsible vendor, may be repeated on the lid, if any.

**7.4** For plugs and connectors, the marking specified in 7.1 shall be easily discernible when the accessory is wired ready for use.

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

*Compliance is checked by inspection.*

**7.5** For rewirable accessories, the contacts shall be indicated by:

- for the phases, the symbols L1, L2, L3, or 1, 2, 3 or X, Y, Z,
- for neutral, if any, the letter N. The letter W, the colour white or silver may be used;
- for earth, if any, the symbol  $\oplus$  IEC 60417-5019 (2006-08) (preferred) or  $\perp$ . The letters G, GR, or the colour green may be used.

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

*Compliance is checked by inspection.*

**7.6** Marking shall be indelible and easily legible.

*Compliance is checked by inspection and by the following test:*

*After the humidity treatment of Clause 17, the marking is rubbed vigorously by hand for 15 s with a piece of cloth soaked in water and again for 15 s with a piece of cloth soaked with petroleum spirit.*

*Special attention is paid to the marking of the name or trade mark of the manufacturer or the responsible vendor and to that of the nature of supply, if any.*

NOTE A special test for checking the indelibility of these markings is under consideration.

**7.7** If, in addition to the marking specified, the rated operating voltage is 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 – Voltage colour code**

Rated operating voltage V	Colour
125	Yellow
250	Blue
125/250	Orange
277	Grey
480	Red
600	Black

**7.8** For terminals, the connection and disconnection procedures shall, if necessary, be indicated on the accessory, on the smallest package unit or on the manufacturer's documentation.

**7.9** Manufacturers shall specify in an instruction sheet supplied with the accessory, the range and type of flexible cables to be connected, which shall include the nominal size for each current rating according to Table 10.

**7.10** For plugs and connectors, the accessory shall be marked with instructions to indicate how the accessory is to be connected or removed. The term "Turn and pull" or an equivalent wording or symbol shall appear on a surface that will be visible after the accessory is completely assembled and installed in the intended manner, but not on a face or other surface that will be obscured when the accessory is mated with another.

## 8 Dimensions

**8.1** Accessories shall comply with the appropriate standard sheets as specified in Table 1.

*Compliance is checked by measurement.*

**8.2** It shall not be possible to engage plugs or connectors 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 plug contact and a live socket-outlet contact, or a live plug contact and the earth socket-outlet contact;
- the phase plug contacts and the neutral socket-outlet contact, if any;
- the neutral plug contact and a phase socket-outlet contact.

*Compliance is checked by inspection.*

**8.3** It shall not be possible to make single-pole connections between mating pairs of plugs and socket-outlets or connectors, or between appliance inlet and connectors or socket-outlets.

*Compliance is checked by inspection and, in case of doubt, by the following test.*

*The plug or appliance inlet shall be aligned with the socket outlet or connector in an attempt to make a single pole connection. A slowly increasing force up to 75 N is applied in a direction to mate the attachment plug or appliance inlet blade with the socket outlet or connector contact. The force is applied for 1 min.*

*For accessories with enclosures or bodies of thermoplastic material, the test is made at an ambient temperature of  $(35 \pm 2)$  °C.*

## **9 Protection against electric shock**

**9.1** Accessories shall be so designed that live parts of socket-outlets and connectors, 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 or connector 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, test probe B of IEC 61032, 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.*

**9.2** Accessories shall be so designed that:

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

*Compliance is checked by manual test.*

## **10 Provisions for earthing**

**10.1** Accessories 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 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, which may become live in the event of an insulation fault, shall be reliably connected to the internal earthing terminal(s) by construction.

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.

NOTE 1 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.

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.

NOTE 2 Care is 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 21.

Manufacturers shall specify in an instruction sheet supplied with the accessory, the type of flexible cables to be connected, which shall include the range of sizes for each current rating according to Table 3.

**Table 3 – Size for connectable conductors**

Rating of the accessory	Internal connection				External earthing connection if any	
	Flexible cables for plugs and connectors		Solid or stranded cables for socket-outlets <sup>a</sup>			
Current	Solid or stranded cables for appliance inlets					
A	mm <sup>2</sup>	AWG	mm <sup>2</sup>	AWG	mm <sup>2</sup>	AWG
20	4 to 6	12 to 10	4 to 6	12 to 10	6	10
30	6 to 10	10 to 8	6 to 10	10 to 8	10	8

NOTE American Wire Gauge specifications can be found in ASTM B172-01a.

<sup>a</sup> Classification of conductors: according to IEC 60228.

## 11 Terminals and terminations

### 11.1 Common requirements for terminals and terminations

**11.1.1** Rewirable accessories shall be provided with terminals.

Rewirable plugs and connectors shall be provided with terminals that accept flexible conductors of the size and type as specified by the manufacturer.

**11.1.2** Non-rewirable accessories shall be provided with 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.

NOTE The term “special preparation” covers soldering of the strands 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 shall be of a metal having, under conditions occurring in the equipment, mechanical strength, electrical conductivity and resistance to corrosion adequate to intended use.

Examples of 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);
- 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);
- 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).

Current-carrying parts, 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 of such material.

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

Clamping means shall not serve to fix any other component.

NOTE 1 The clamping means for the conductor can be used to stop rotation or displacement of the plug or socket contacts.

*Compliance is checked by inspection and, if necessary, by the test of 24.1.*

NOTE 2 These requirements do not preclude the use of 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 can 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 can, however, be used to lock terminals 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 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 cannot touch metal parts connected to the earthing terminal;
- conductors becoming detached from the earthing terminal cannot touch live parts.

*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, there shall be no risk that such a wire emerges from the enclosure.

*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 as 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. 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 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 shall not touch any live part.*

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

## **11.2 Screw type terminals**

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

*Compliance is checked by the following test and by the tests of 11.3.*

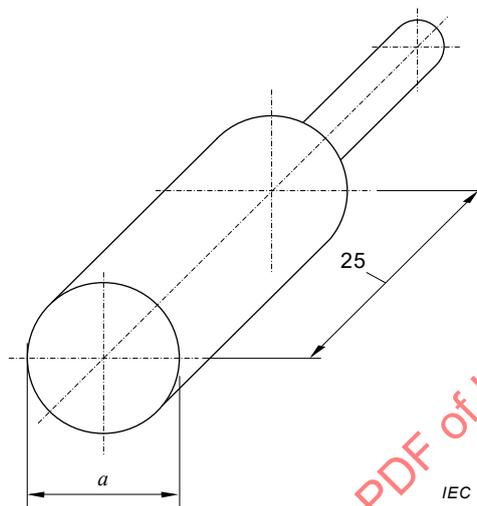
*Gauges as specified in Figure 7 having a measuring section for testing the insertability of the maximum specified cross-sectional area of Table 3, shall be able to penetrate into the terminal aperture, down to the designated depth of the terminal, under their own weight.*

*Screw type terminals that cannot be checked with the gauges specified in Figure 7, shall be tested by suitably shaped gauges having the same cross-section as those of the appropriate gauges given in Figure 8.*

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.

Dimensions in millimetres



Conductor cross-sectional area		Gauge	
Flexible	Rigid (solid or stranded)	Diameter $a$	Tolerances for $a$
AWG	AWG	mm	mm
12	-	2,80	0 -0,05
-	12	2,55	0 -0,05
10	-	3,46	0 -0,05
-	10	3,19	0 -0,06
8	-	5,4	0 -0,06
-	8	4,3	0 -0,06

Material: steel

NOTE See IEC 60999-1:1999, Table 1, for maximum conductor dimensions.

**Figure 7 – Gauges for testing insertability of round unprepared conductors having the maximum specified cross-section**

**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.

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 24.1. In addition to the requirements of 24.1, the terminals shall not have undergone changes after the test, which 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 11.3.*

**11.2.4** 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 11.3.*

### **11.3 Mechanical tests on terminals**

**11.3.1** New terminals are fitted with new conductors of the minimum and maximum cross-sectional areas and are tested with the flexing test apparatus shown in Figure 8.

*The test shall be carried out on six samples: three with the smallest conductor and three with the largest conductor.*

*The length of the test conductor shall be 75 mm longer than the height  $H$  specified in Table 4.*

*Clamping screws, if any, are tightened with the torque according to Table 16. Otherwise the terminals are connected according to the manufacturer's instructions.*

*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 4. 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  $(10 \pm 2)$  rotations per minute.*

*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 4. The bushing may be lubricated to prevent binding, twisting or rotation of the insulated conductor. A mass, as specified in Table 4, 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.*

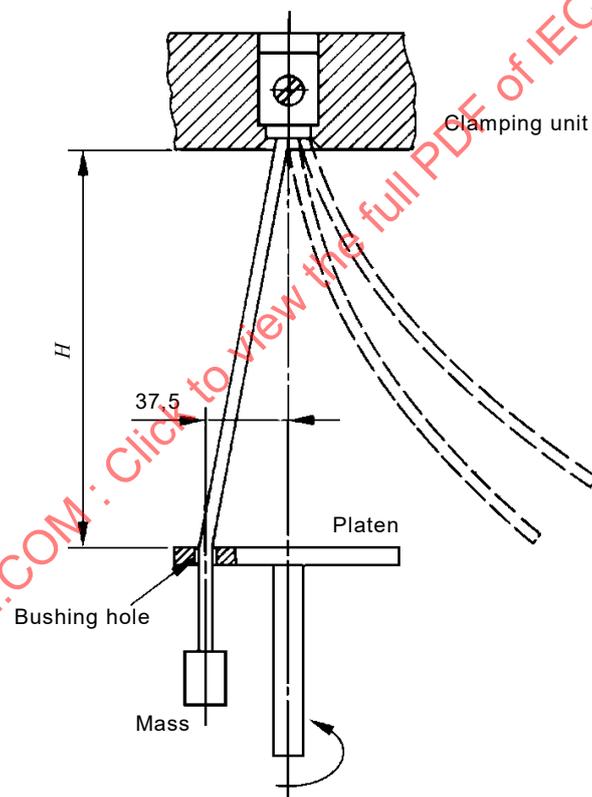
**Table 4 – Flexing under mechanical load testing for copper conductors**

Nominal cross-sectional area		Diameter of bushing	Height $H^a$	Mass
mm <sup>2</sup>	AWG			
2,5	14	9,5	280	0,7
4,0	12	9,5	280	0,9
6,0	10	9,5	280	1,4
10,0	8	9,5	280	2,0

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

<sup>a</sup> Tolerance for height  $H$ :  $\pm 15$  mm.

Dimensions in millimetres



IEC

**Figure 8 – Flexing test arrangement**

**11.3.2** Verification is made successively with conductors of the cross-sectional area specified in Table 3, using class 1 or class 2 conductors for terminals of socket-outlets or appliance inlets, and class 5 conductors for terminals of plugs or connectors.

*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 16, unless the torque is specified by the manufacturer on the accessory or in an instruction sheet.*

Each conductor is subjected to a pull according to the value in Table 5, 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 5 – Pulling force**

Nominal cross-sectional area		Pulling force
mm <sup>2</sup>	AWG	N
0,75	18	40
1,5	16	40
2,5	14	50
4,0	12	60
6,0	10	80
10,0	8	90

## 12 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:

- $(70 \pm 2) ^\circ\text{C}$  and 10 days (240 h), for rubber;
- $(80 \pm 2) ^\circ\text{C}$  and 7 days (168 h), for thermoplastic material.

After the samples have been allowed to attain approximately room temperature, they are examined and shall show no crack visible with normal or corrected to normal vision, nor shall the material have become sticky or greasy.

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

If there is a doubt as to whether the material has become sticky, the sample is placed on one of the pans of a balance and the other pan is loaded with a mass equal to the mass of the sample plus 500 g. Equilibrium is then restored by pressing the sample with the forefinger, wrapped in a dry piece of coarse woven cloth.

No trace of the cloth shall remain on the sample and the material of the sample shall not stick to the cloth.

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

### 13 General construction

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

*Compliance is checked by inspection.*

**13.2** Screws or other means for fixing the part carrying the socket-outlet contacts or the part carrying the plug contacts 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.*

**13.3** 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 of non-interchangeability of the socket-outlet or connector, or in relation to the means of non-interchangeability of the plug or appliance inlet.

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

**13.4** Socket-outlets and connectors when mounted as in normal use and without a plug in position shall ensure the degree of protection IP20.

*Compliance is checked by inspection.*

### 14 Construction of socket-outlets

**14.1** Contacts shall be so designed as to ensure adequate contact pressure when completely engaged with the corresponding plug.

*Compliance is checked by the temperature-rise test of Clause 21.*

**14.2** The pressure exerted between the socket and plug contacts shall not be so great as to make insertion and withdrawal of the plug difficult. It shall not be possible for the plug to work out of the socket-outlet in normal use.

*Compliance is checked by inspection.*

**14.3** 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.*

**14.4** Enclosures and parts of a 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.*

**14.5** 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.*

**14.6** 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 17.2 and Clause 23.*

## **15 Construction of plugs and connectors**

**15.1** The enclosure of plugs and connectors shall completely enclose the terminals and the ends of the flexible cable.

The construction of rewirable plugs and connectors 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.*

**15.2** The various parts of a plug or connector 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 connectors without the aid of a tool.

*Compliance is checked by manual test and by the test of 23.3.*

**15.3** 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 17.2 and 23.3.*

**15.4** Plug contacts shall be locked against rotation and shall not be removable without dismantling the plug.

Contacts of plugs may be either floating or fixed.

*Compliance is checked by inspection and by manual test.*

**15.5** Contacts of connectors shall be self-adjusting so as to ensure adequate contact pressure.

Contacts other than the earth contact shall be floating.

Earth contacts need not be floating provided that they have the necessary resilience in all directions.

*Compliance is checked by inspection and by test.*

**15.6** The pressure exerted by the contacts of connectors on the plug contacts shall not be so great as to make insertion and withdrawal of the plug difficult. It shall not be possible for the plug to work out of the connector in normal use.

*Compliance is checked by inspection.*

**15.7** Plugs and connectors 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 connector or socket-outlet. Connectors 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.

## **16 Construction of appliance inlets**

Appliance inlet contacts shall be locked against rotation and shall not be removable without the aid of a tool.

Contacts may be either floating or fixed.

*Compliance is checked by inspection and by manual test.*

## **17 Degrees of protection**

**17.1** Accessories shall have a degree of protection IP20.

*Compliance is checked by the appropriate tests mentioned in 17.2 and 17.3.*

*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 23.5 or 24.1, as appropriate.*

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

*Socket-outlets are mounted on a vertical surface and connectors are placed in the most unfavourable position.*

*Socket-outlets and connectors are tested with and also without the complementary accessory in engagement.*

**17.2** Accessories shall be tested in accordance with 17.1 and IEC 60529.

**17.3** All accessories shall be protected against humid conditions which may occur in normal use.

*Compliance is checked by the humidity treatment described in 17.3, followed immediately by the measurement of the insulation resistance and by the dielectric strength test specified in 18.5. 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.*

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

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.

A relative humidity between 91 % and 95 % can be obtained by placing in the humidity cabinet a saturated solution of sodium sulphate ( $\text{Na}_2\text{SO}_4$ ) or potassium nitrate ( $\text{KNO}_3$ ) in water, having a sufficiently large contact surface with the air.

In order to achieve the specified conditions within the cabinet, it is necessary to ensure constant circulation of the air within it and, in general, to use a cabinet which is thermally insulated.

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

## **18 Insulation resistance and dielectric strength**

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

*Compliance is checked by the tests of 18.2 and 18.5, which are made immediately after the test of 17.3 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 18.4.*

NOTE For the purpose of these tests, the neutral contact is considered as a pole.

**18.2** 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 M $\Omega$ .*

**18.3** For socket-outlets and connectors, 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 connectors and plugs, fixing screws of bases, enclosures and covers, external assembly screws and earthing terminals, if any.

**18.4** 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.

**18.5** A voltage of substantially sine-wave form, having a frequency of 60 Hz and the value shown in Table 6, is applied for 1 min between the parts indicated in 18.3 and 18.4.

**Table 6 – Voltage for dielectric strength test**

Rated voltage of the accessory V	Test voltage V
up to and including 300	2 000 <sup>a</sup>
over 300	3 000
<sup>a</sup> This value is increased to 2 500 V for accessible metal parts lined with insulating material. See also 10.2.	

Initially, no more than half the specified voltage is applied, and 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.

Immediately after the test of 18.5, it shall be verified that, for accessories with enclosures of thermoplastic material, the means of providing non-interchangeability have not been impaired.

## 19 Breaking capacity

Accessories 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.

*The plug or connector is fully inserted as in normal use into the socket-outlet or appliance inlet and then withdrawn from the socket-outlet or appliance inlet, at a rate of 7,5 strokes per minute.*

*The speed of insertion and separation of the plug or connector shall be  $(0,8 \pm 0,1)$  m/s.*

*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 contacts shall be maintained for no more than 4 s and no less than 2 s.*

*The two accessories shall be separated at least by 50 mm.*

*The number of cycles is specified in Table 7.*

*A stroke is a complete insertion or withdrawal of a plug or appliance inlet.*

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

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

*Accessories are tested in a circuit with  $\cos \varphi$  as defined in Table 7.*

*The test is made using the connections shown in Figure 9. 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 plug contacts shall not show any serious damage.*

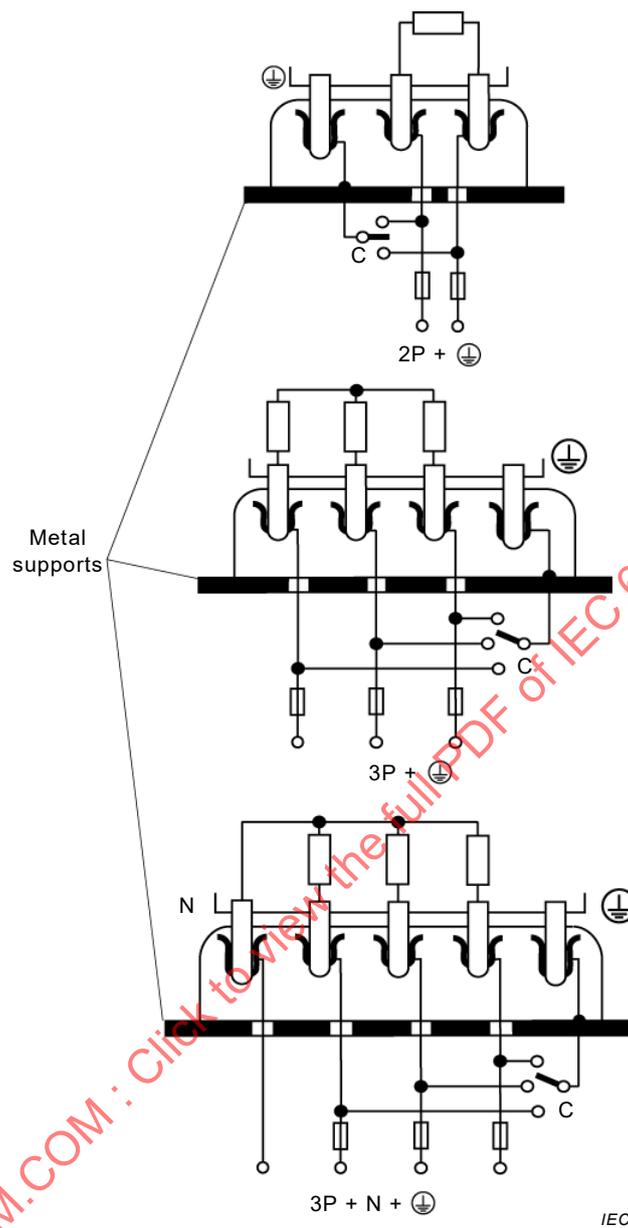


Figure 9 – Circuit diagrams for breaking capacity and normal operation tests

Table 7 – Breaking capacity

Rated current A	Number of cycles	
	$\cos \varphi \pm 0,05$	on load
20	0,6	50
30	0,6	50

## 20 Normal operation

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

Accessories which have been subjected to the tests of Clause 19 are tested with a number of cycles specified in Table 8.

*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 19 and used in the manner indicated in Clause 19.*

*The test position is as specified in Clause 19.*

*The test is made using the connections indicated in Clause 19, the selector switch C being operated as specified in Clause 19.*

*The plug or connector is inserted into or withdrawn from the 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.*

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

*After each 500 strokes, 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 are tested in a circuit with  $\cos \varphi$  as specified in Table 8.*

*During the test, no sustained arcing shall occur.*

*After the test, the samples shall show:*

- no wear impairing the further use of the accessory;*
- no deterioration of enclosures or barriers;*
- no damage to the entry holes for the plug contacts 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 18.5, the test voltage, however, being decreased by 500 V.*

NOTE 1 The humidity treatment is not repeated before the dielectric strength test of Clause 20.

*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 8.*

NOTE 2 This test can be combined with the test for the accessories.

**Table 8 – Normal operation**

Rated current A	Number of cycles		
	$\cos \varphi \pm 0,05$	on load	off load
20	0,6	5 000	
30	0,6	1 000	1 000

## 21 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 9.*

*Rewirable accessories are fitted with conductors of a cross-sectional area as specified in Table 9, the terminal screws or nuts being tightened with a torque specified on the accessory or in the instruction sheets by the manufacturer or equal to two-thirds of that specified in Table 16.*

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

*Non-rewirable 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 by passing the test current through the neutral contact and the nearest phase contact.*

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

**Table 9 – Test current and nominal cross-sectional area**

Nominal current A	Test current A	Cross-sectional area of the conductors			
		Plugs, appliance inlets connectors		Socket-outlets	
		mm <sup>2</sup>	AWG	mm <sup>2</sup>	AWG
20	27	2,5	12	4,0	12
30	40	6,0	10	10,0	8

*The duration of the test is 1 h.*

*The temperature is determined by means of thermocouples which are so chosen and positioned that they have negligible effect on the temperature being determined.*

*The temperature rise of terminals shall not exceed 50 K.*

## 22 Flexible cables and their connection

### 22.1 Cable anchorages

Plugs and connectors 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.*

### 22.2 Requirements for plugs and connectors

#### 22.2.1 Non-rewirable plugs and connectors

Accessories shall be provided with a flexible cable complying with one of the types specified in Table 10, the nominal cross-sectional area being not less than the value shown. Flexible cables having nominal cross-sections other than those specified in Table 10 may be used if the load is known.

**Table 10 – Cable type**

Nominal current A	Type of cable IEC 60245-4		Type of cable CSA C22.2 No. 49 and ANSI/UL 62	
	Type	mm <sup>2</sup>	Type	AWG
20	53 <sup>a</sup> , 57 <sup>a</sup> , 66	4,0	SJ, S, SO, STO	12
30	53 <sup>a</sup> , 66	6,0	SJ, S, SO, STO	10

<sup>a</sup> Not applicable to accessories having a rated operating voltage exceeding 347 V.

The core connected to the earthing terminal shall be identified by the colour green or green/yellow for AWG cables or the combination green/yellow for IEC cables. 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.

*Compliance is checked by inspection and by the test of 22.3.*

#### 22.2.2 Rewirable plugs and connectors

For rewirable plugs and connectors:

- 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 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 22.3.*

### **22.3 Pull test**

*Plugs and connectors provided with a flexible cable are subjected to a pull test in apparatus similar to that shown in Figure 10, followed by a torque test.*

*Non-rewirable accessories are tested as delivered.*

*Rewirable accessories are tested with the minimum and maximum diameters as specified by the manufacturer.*

*Rewirable accessories are tested first with one and then with the other type of cable, according to 4.2.6, as specified in Table 11 or Table 12.*

*Conductors of the cable of rewirable 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, clamping screws being tightened with a torque equal to two-thirds of that specified in 24.1. 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 13. 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 13.*

Dimensions in millimetres

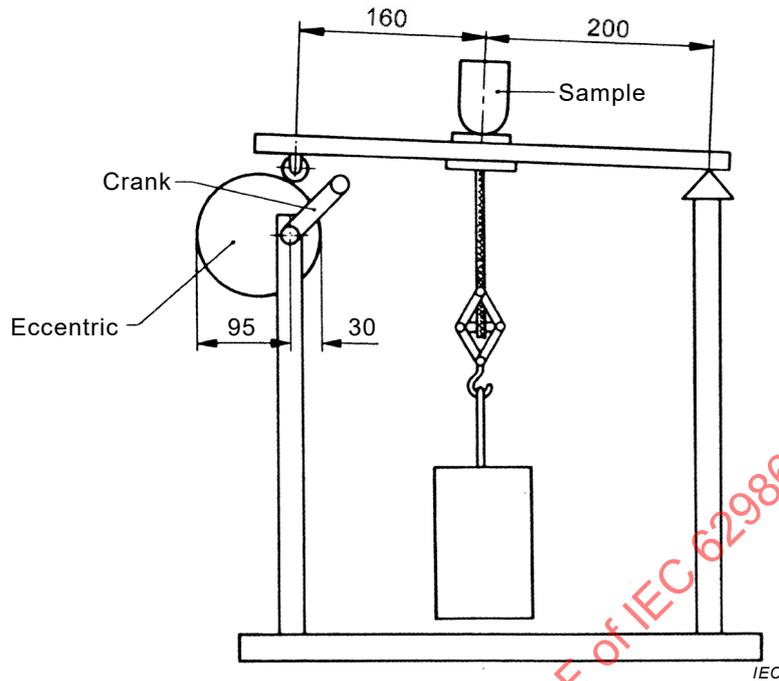


Figure 10 – Apparatus for testing the cable anchorage

Table 11 – Metric cables

Rated current A	Type of cable	Nominal cross section mm <sup>2</sup>	Approximate external diameter of the cable <sup>a</sup> mm		
			Type of accessory		
	IEC 60245-4		1 P + N + ⊕ 2 P + ⊕	2 P + N + ⊕ 3 P + ⊕	3 P + N + ⊕
20	53	1	8,1	8,8	10,0
	66	2,5	13,0	14,0	15,3
30	53	2,5	11,5	12,5	14,0
	66	6,0	17,3	19,3	21,3

<sup>a</sup> 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 for the overall diameter of the cable.

**Table 12 – AWG cables**

Rated current A	Type of cable	Nominal cross-section AWG	Approximate external diameter of the cable <sup>a</sup> mm		
			Type of accessory		
			1 P + N + ⊕ 2 P + ⊕	2 P + N + ⊕ 3 P + ⊕	3 P + N + ⊕
20	SJ	12	10,8 – 12,1	11,8 – 13,2	-
		10	14,4 – 16,1	15,9 – 17,8	-
20	S, SO, STO	12	15,0 – 16,6	16,3 – 18,0	17,8 – 19,6
		10	16,5 – 18,3	17,8 – 19,7	19,3 – 21,3
30	SJ	10	14,4 – 16,1	15,9 – 17,8	-
		8	-	-	-
30	S,SO,STO	10	16,5 – 18,3	17,8 – 19,7	19,3 – 21,3
		8	21,1 – 23,6	23,5 – 26,7	25,4 – 29,2

<sup>a</sup> The value for each of the approximate external diameters shown is the average value of the upper and lower line specified in NMX-J-436-ANCE-2014/CSA C22.2 No.49-14/ANSI/UL 62 for the overall diameter of the cable.

**Table 13 – Pulling force and torque test values**

Nominal current A	Pulling force N	Torque Nm
20	80	0,35
30	100	0,425

*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 rewirable accessories, the ends of the conductors shall not have moved noticeably in the terminals; for non-rewirable 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-rewirable 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.*

## 23 Mechanical strength

### 23.1 General

Accessories shall have adequate mechanical strength.

*Compliance is checked by the appropriate tests of 23.5 to 23.9 as follows:*

- *for socket-outlets and appliance inlets, 23.5;*

- for rewirable plugs and connectors, 23.6;
- for non-rewirable plugs and connectors, 23.7;
- for accessories with screwed glands, 23.8;
- for plugs 23.9.

*Before starting the test of 23.5 or 23.6, accessories with enclosures of resilient or thermoplastic material are placed, with their bases or flexible cables, in a refrigerator at a temperature of  $(-25 \pm 2)$  °C for at least 16 h; they are then removed from the refrigerator and immediately subjected to the test of 23.5 or 23.6, as appropriate.*

### **23.2 Impact test apparatus**

Blows shall be applied to the samples by means of the impact test apparatus. The test apparatus is shown in Figure 11. Guidance and description of the test apparatus are given in IEC 60309-1:1999, Annex A.

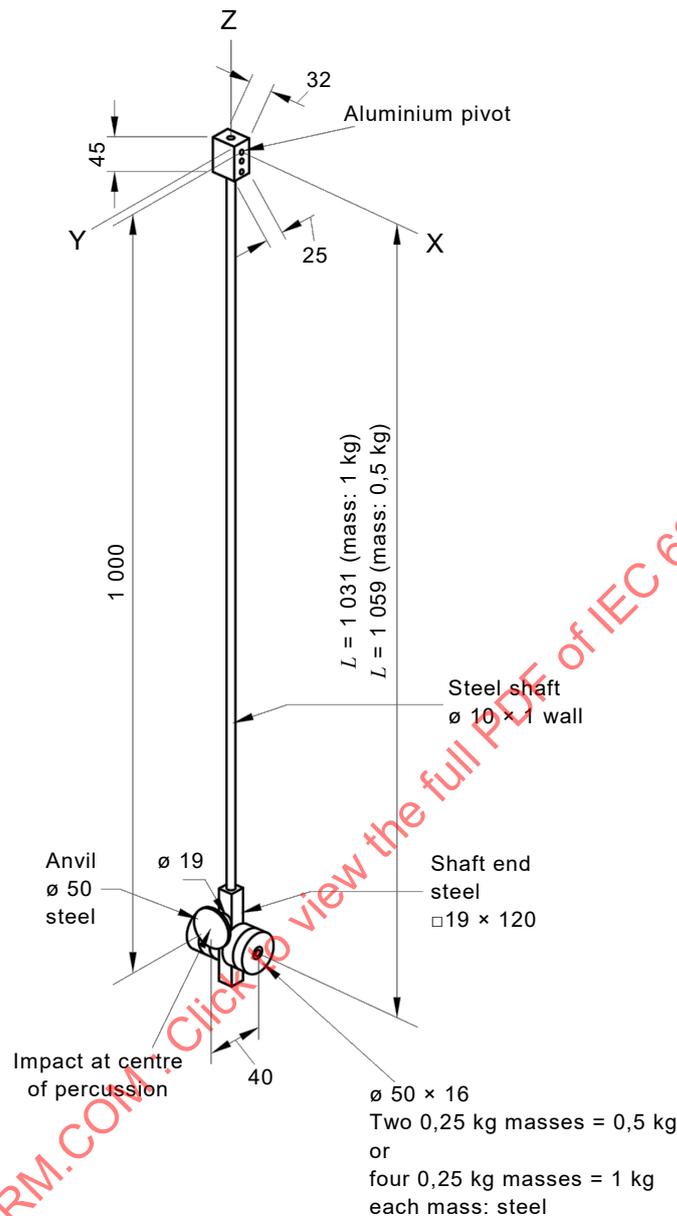
### **23.3 Normal use**

Accessories shall have adequate strength to maintain integrity after being subjected to impact blows occurring in normal use.

*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 23.4.*

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Dimensions in millimetres



IEC

**Figure 11 – Impact test apparatus – Pendulum assembly**

### 23.4 Test description

Five blows are applied to each test sample by means of the impact test apparatus shown in Figure 11.

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  $90^\circ$  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 furthest projection from the mounting board.*

*The blows shall have an impact energy of 1 J.*

### **23.5 Socket-outlets and appliance inlets**

*Socket-outlet and appliance inlet samples are each 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 16. Lids on socket-outlets are left normally closed. Caps supplied with appliance inlets shall be fitted.*

*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.*

*It shall be verified that, for accessories with enclosures of thermoplastic material, the means of providing non-interchangeability have not been impaired.*

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

### **23.6 Rewirable plugs and connectors**

*Rewirable plugs and connectors are fitted with the lightest type of flexible cable of the smallest cross-sectional area for the relevant rating specified in 22.3.*

*Non-rewirable 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 12.*

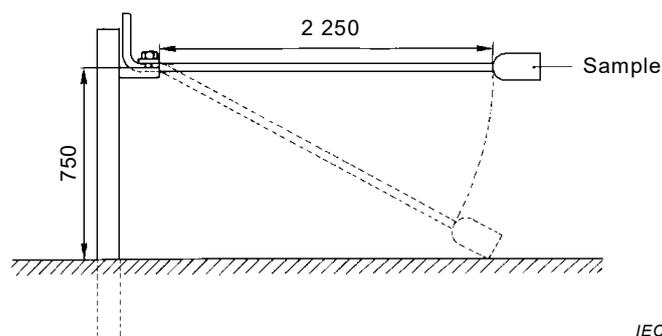
*The sample is held so that the cable is horizontal and then it is allowed to fall on to a concrete floor. This is done eight times, the cable being rotated through 45° at its fixing each time.*

*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. The contact blades shall not have become so deformed that the plug cannot be introduced into the mating accessory. For the purpose of this test the contact blades shall not be straightened.*

*It shall be verified that, for accessories with enclosures of thermoplastic material, the means of providing non-interchangeability have not been impaired.*

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

Dimensions in millimetres



**Figure 12 – Arrangement for mechanical strength test for plugs and connectors**

### 23.7 Non-rewirable plugs and connectors

Non-rewirable plugs and connectors are subjected to a flexing test in an apparatus similar to that shown in Figure 13.

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 14.

**Table 14 – Impact force**

Rated current A	Force N
20	20
30	25

A current equal to the rated current of the accessory is passed through the conductors, the voltage between them being the rated 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 of 60/min.

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.

Dimensions in millimetres

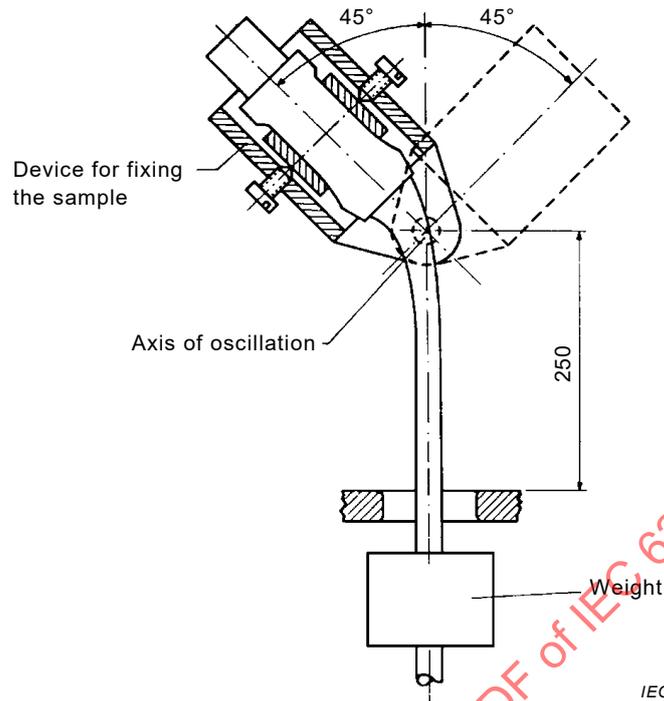


Figure 13 – Apparatus for flexing test

### 23.8 Accessories with screwed glands

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 15 being applied to the spanner for 1 min, at a point 25 cm from the axis of the gland.

Table 15 – Test force for glands

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

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

### 23.9 Plugs

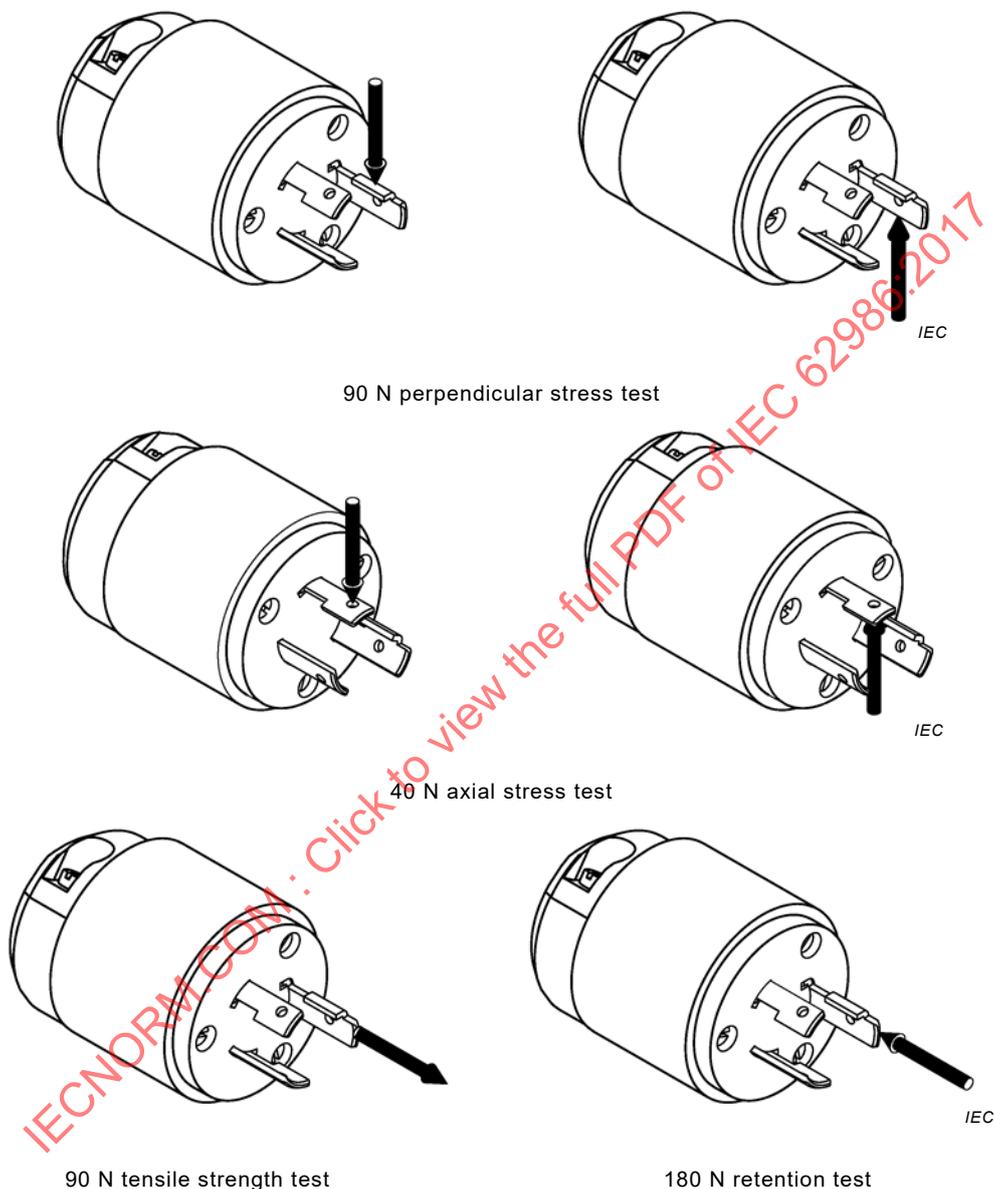
#### 23.9.1 General

Plugs shall be tested for contact blade strength in accordance with 23.9.2 through 23.9.5.

Plugs are rigidly held in place in such a manner as to withstand, without damage, the specified force, which is applied to each blade 1 min ± 5 s without jerks. The axial application of the force passes through the center of the hole in the contact plug blade. The application of

forces to the contact blades is as described in 23.9.2 through 23.9.5 and positioned as shown in Figure 14.

Compliance to each of the following tests is checked by inspection. When plugs are tested as specified, after each of the tests of 23.9.2 through 23.9.5, the blades shall not have moved more than 0,8 mm, changed in shape or position, or be otherwise damaged.



**Figure 14 – Arrangement for contact blade strength tests for plugs**

### 23.9.2 Perpendicular stress test

A force of  $90\text{ N} \pm 2\text{ N}$  is applied in each of two directions parallel with the plug face and perpendicular to the axis of the contact hole.

### 23.9.3 Axial stress test

A force of  $40\text{ N} \pm 2\text{ N}$  is applied in each of two directions parallel with the plug face and along the axis of the contact hole.

#### 23.9.4 Tensile strength test

*A force of 90 N ± 2 N is applied to each blade in a longitudinal direction away from the blade.*

#### 23.9.5 Blade retention (compression) test

*A force of 180 N ± 2 N is applied to each blade in a longitudinal direction toward the blade.*

### 24 Screws, current-carrying parts and connections

**24.1** 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 cross-sectional area in Table 3, rigid (solid or stranded) for socket-outlets and appliance inlets and flexible for plugs and connectors, 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 16, 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 the values given in Table 16, this specified torque shall be applied for the test.*

**Table 16 – Torque values for terminal screws**

Metric standard values	UNC standard values	Nominal diameter of thread mm	Torque Nm		
			I	II	III
2,5	#3	Up to and including 2,8	0,2	0,4	0,4
3,0	#4	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	#6	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	#8	Over 4,1 up to and including 4,7	0,8	1,8	1,8
5,0	#10	Over 4,7 up to and including 5,3	0,8	2,0	2,0
6,0	#12	Over 5,3 up to and including 6,0	1,2	2,5	3,0

*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 by applying the torque specified in column III to the hexagonal head and then, on another set of samples, by 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 1 For mantle terminals, the specified nominal diameter is that of the slotted stud.

NOTE 2 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 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 3 Damage to covers is neglected.

NOTE 4 Screwed connections will have been partially checked by the tests of Clauses 20 and 23.

**24.2** 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.

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

NOTE 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.

**24.3** 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.

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

*Compliance is checked by inspection and by manual test.*

NOTE 1 Spring washers can provide satisfactory locking.

NOTE 2 For rivets, a non-circular shank or an appropriate notch can be sufficient.

NOTE 3 A sealing compound which softens on heating provides satisfactory locking only for screw connections not subject to torsion in normal use.

**24.5** Current-carrying parts, other than terminals, shall be either of:

- copper;
- an alloy containing at least 50 % copper; or
- other metal no less resistant to corrosion than copper and having mechanical properties no less suitable.

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

NOTE The requirements for terminals are included in Clause 11.

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

Springs ensuring the resiliency of contacts 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 to the protection against corrosion is under consideration.

## **25 Creepage distances, clearances and distances through sealing compound**

**25.1** Creepage and clearance distances shall be not less than the values in millimetres shown in IEC 60664-1:2007, Table F.4 for pollution degree 2.

Distances through sealing compound shall comply with Table 17.

**Table 17 – Distances through sealing compound**

	Rated voltage of the accessory		
	V		
	Up to and including 347	Over 347 up to and including 480	Over 480 up to and including 600
Distances through sealing compound:			
1) between live parts covered with at least 2,5 mm of sealing compound and the surface on which the base of a socket-outlet is mounted	4	6	6
2) between live parts covered with at least 2 mm of sealing compound and the bottom of any conductor recess in the base of a socket-outlet	4	5	5

*Compliance is checked by measurement.*

*For rewirable accessories, the measurements are made on the sample fitted with conductors specified in Table 3, and also without conductors. For non-rewirable accessories, the measurements are made on the sample as delivered.*

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

NOTE 1 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.

NOTE 2 The surface on which the base of a socket-outlet is mounted includes any surface with which the base is in contact when the 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.

**25.2** The sealing compound shall not protrude above the edge of the cavity in which it is contained.

*Compliance is checked by inspection.*

## **26 Resistance to heat**

**26.1** Accessories shall be sufficiently resistant to heat.

*Compliance is checked by the tests of 26.2 and 26.3.*

**26.2** The samples are kept for 1 h in a heating cabinet at a temperature of  $(100 \pm 5) ^\circ\text{C}$ .

*They shall not undergo any change impairing their further use, and the 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.

**26.3** Parts of the insulating material are subjected to a ball-pressure test by means of the apparatus shown in Figure 15.

*The surface of the part to be tested is placed in the horizontal position and a steel ball of 5 mm diameter is pressed against this surface by a force of 20 N.*

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

- $(125 \pm 5) \text{ }^\circ\text{C}$  for parts supporting live parts of rewirable accessories;
- $(80 \pm 3) \text{ }^\circ\text{C}$  for other parts.

After 1 h, the ball is removed and the diameter of the impression measured. For materials which show deformation, this diameter shall not exceed 2 mm.

NOTE 1 For elastomeric materials a test is under consideration.

NOTE 2 The test is not made on parts of ceramic material.

Dimensions in millimetres

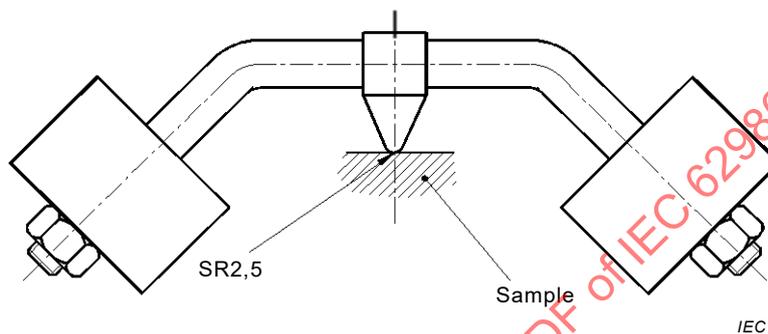


Figure 15 – Ball-pressure apparatus

## 27 Resistance to fire and to tracking

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

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:

- $(650 \pm 10) \text{ }^\circ\text{C}$  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.

NOTE Tests are not made on glands and sealing compounds.

- $(850 \pm 15) \text{ }^\circ\text{C}$  for parts of insulating material necessary to retain current-carrying parts and parts of the earthing circuits in position.

The accessories are stored for 24 h in an atmosphere having a temperature between  $15 \text{ }^\circ\text{C}$  and  $35 \text{ }^\circ\text{C}$  and a relative humidity between 45 % and 75 % before starting the test.

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

- in the middle of one external part for each material, 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 movement of the tip of the glow-wire into the accessory shall be mechanically limited to 7 mm.

*The test is made on one specimen. In case of doubt regarding the results of the test, the test is repeated with two further specimens.*

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

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

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

*For materials other than ceramic, compliance is checked by the following test:*

*A flat surface of the part to be tested, if possible at least 15 mm × 15 mm, is placed in the horizontal position.*

*Two electrodes of platinum or other sufficiently non-corrosive material, with the dimensions shown in Figure 16, are placed on the surface of the sample in the manner shown in that figure, so that the rounded edges are in contact with the sample over their whole length.*

*The force exerted on the surface by each electrode is about 1 N.*

*The electrodes are connected to a 50 Hz supply source having a voltage of 175 V, of substantially sine-wave form. The total impedance of the circuit when the electrodes are short-circuited is adjusted by means of a variable resistor, so that the current is  $(1,0 \pm 0,1)$  A and  $\cos \varphi$  is 0,9 to 1. An overcurrent relay, with a tripping time of at least 0,5 s, is included in the circuit.*

*The surface of the sample is wetted by allowing drops of a solution of ammonium chloride in distilled water to fall midway between the electrodes. The solution has a volume resistivity of 400  $\Omega$  cm at 25 °C, corresponding to a concentration of about 0,1 %. The drops have a volume of  $(20 + \overset{5}{0})$  mm<sup>3</sup> and fall from a height of 30 mm to 40 mm.*

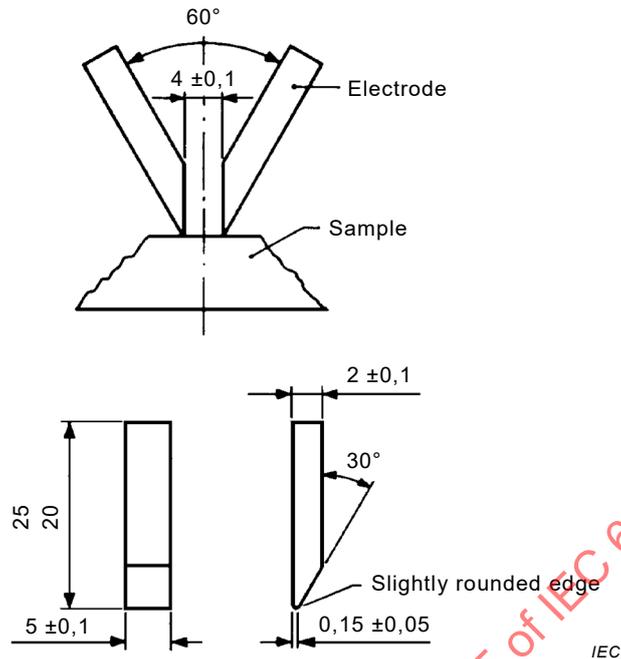
*The time interval between one drop and the next is  $(30 \pm 5)$  s.*

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

*Care shall be taken that the electrodes are clean, correctly shaped and correctly positioned before each test is started. In case of doubt, the test is repeated on a new set of samples.*

NOTE A revision of this test is under consideration.

Dimensions in millimetres



**Figure 16 – Arrangement and dimensions of the electrodes for the tracking test**

## 28 Corrosion and resistance to rusting

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

For specific conditions and the provisions for these conditions, special consideration should be given to the accessory 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 in carbon-tetrachloride, trichloroethane or an equivalent degreasing agent for 10 min. The parts are then immersed for 10 min in a 10 % solution of ammonium chloride in water at a temperature of  $(20 \pm 5)$  °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  $(20 \pm 5)$  °C.*

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

*Traces of rust on sharp edges and any yellowish film removable by rubbing shall be 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 Short-circuit current

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

*Compliance is checked by testing each socket-outlet and mating plug with a new complementary socket-outlet and mating plug complying with this document.*

### 29.2 Ratings and test conditions

*The test is applied to a new socket-outlet and mating plug mounted as in normal use and connected according to the indications of 29.3.*

*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-outlets and mating plugs.*

*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-outlets and mating plugs being tested.*

*The test voltage shall be identical to the rated operating voltage of the socket-outlets and mating plugs tested.*

*No power-factor value or time constant is specified for this test.*

*The following tolerances shall be applied during the test:*

- *current: from 95 % to 105 %;*
- *voltage: from 100 % to 105 %;*
- *frequency: from 95 % to 105 %.*

### 29.3 Test circuit

- a) *Figure 17, Figure 18 and Figure 19 give the diagrams of the circuit to be used for the test:*
- *two-pole accessories on single-phase AC (Figure 17);*
  - *three-pole accessories on three-phase AC (Figure 18);*
  - *four-pole accessories on three-phase four-wire AC (Figure 19).*

- 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.*

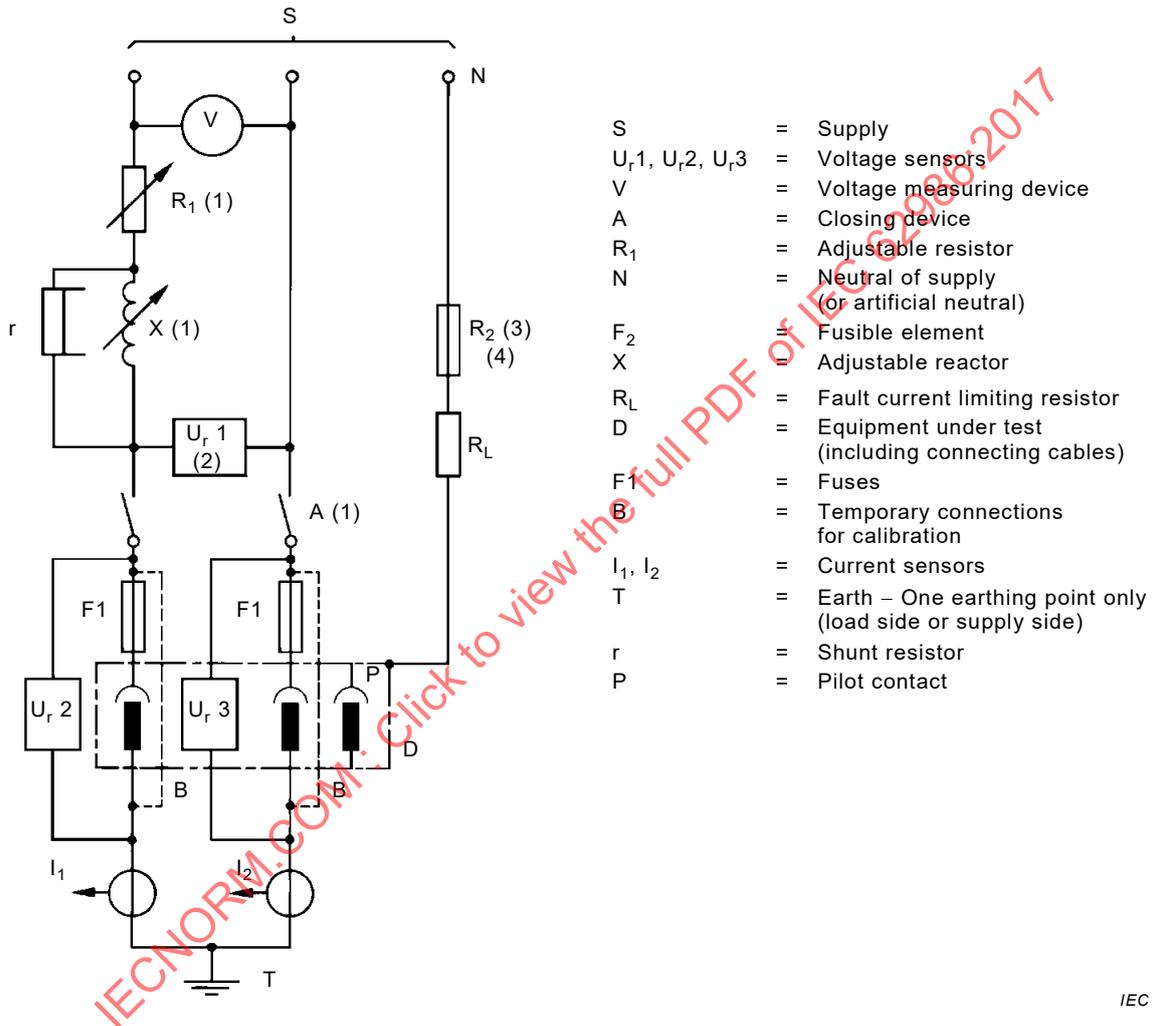
- c) *In each test circuit (Figure 17, Figure 18 and Figure 19), the resistors and reactors are inserted between the supply source S and the equipment D under test. The position of the closing device A and the current sensing devices ( $I_1$ ,  $I_2$ ,  $I_3$ ) may be different.*

*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 or 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, the enclosure or the screens, shall be insulated from earth and connected to a point as indicated in Figure 17, Figure 18 and Figure 19.

This connection shall comprise a fuse element  $F_2$  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.

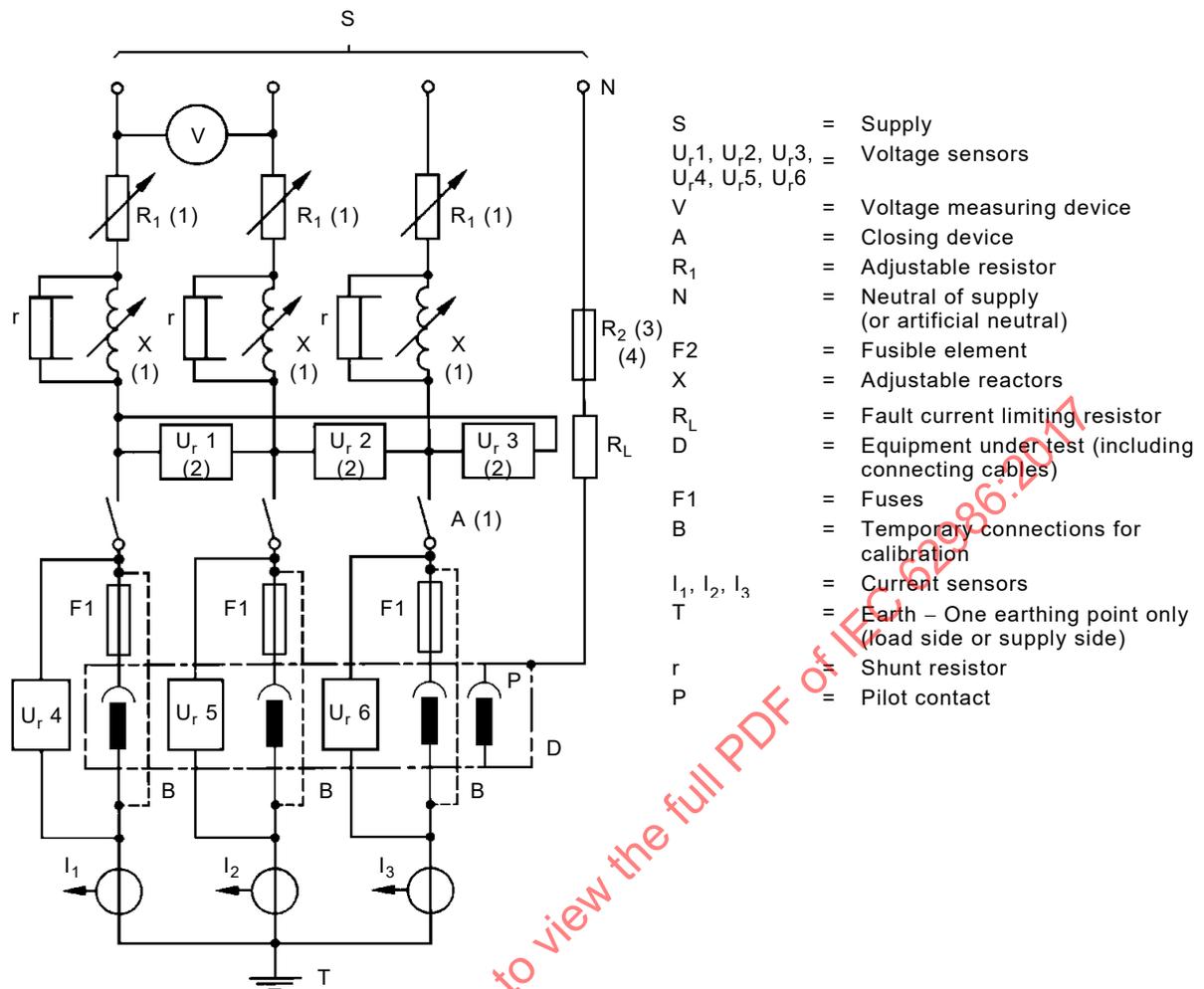
The connection of the accessories under test shall be made with copper wires having cross-sectional areas as indicated in Table 3, and lengths as short as possible, not exceeding 1 m on either side.



NOTE 1 Adjustable loads X and  $R_1$  can 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.

NOTE 2  $U_r 1, U_r 2$  and  $U_r 3$ , can, alternatively, be connected between phase and neutral.

**Figure 17 – Diagram of the test circuit for the verification of short-circuit current withstand of a two-pole equipment on a single-phase AC**

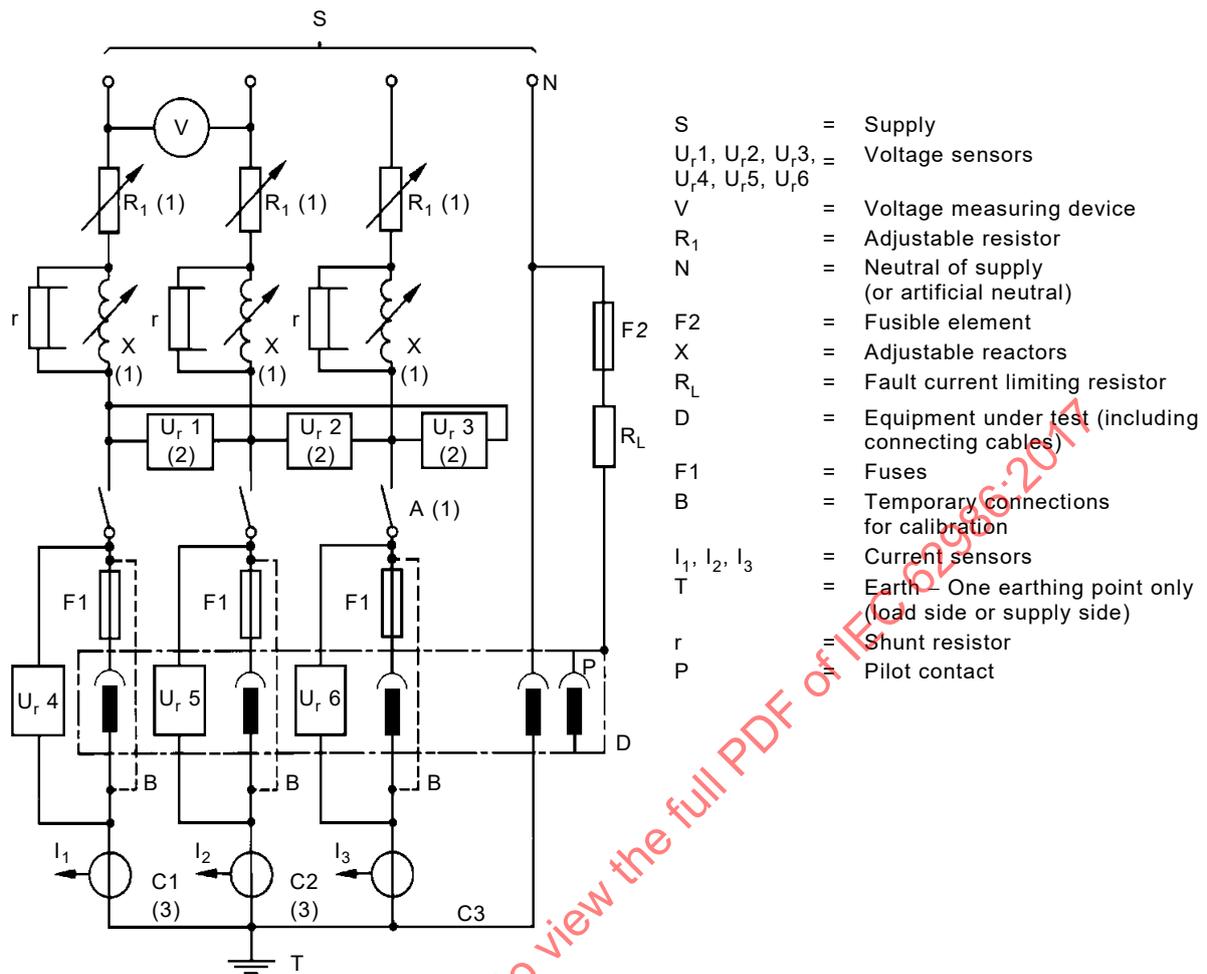


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NOTE 1 Adjustable loads X and  $R_1$  can be located either on the high-voltage side or on the low-voltage side of the supply circuit, the closing device A being located on the low-voltage side.

NOTE 2  $U_{r1}, U_{r2}$  and  $U_{r3}$ , can, alternatively, be connected between phase and neutral.

**Figure 18 – Diagram of the test circuit for the verification of short-circuit current withstand of a three-pole equipment**



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NOTE 1 Adjustable loads X and R<sub>1</sub> can 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.

NOTE 2 U<sub>r</sub>1, U<sub>r</sub>2 and U<sub>r</sub>3, can, alternatively, be connected between phase and neutral.

**Figure 19 – Diagram of the test circuit for the verification of short-circuit current withstand of a four-pole equipment**

### 29.4 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.

### 29.5 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.

### 29.6 Behaviour of the equipment under test

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

### **29.7 Acceptance conditions**

- 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 18.5 with voltage applied between the parts as indicated in 18.3 b) or 18.4 b), as applicable.

## **30 Electromagnetic compatibility**

### **30.1 Immunity**

The operation of accessories within the scope of this document in normal use is not affected by electromagnetic disturbances.

### **30.2 Emission**

Accessories within the scope of this document are intended for continuous use; in normal use they do not generate electromagnetic disturbances.

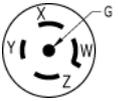
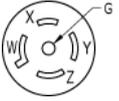
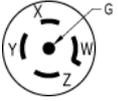
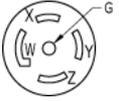
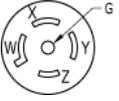
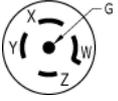
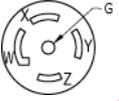
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### STANDARD SHEETS

Accessory descriptions, standard sheet numbers and configuration illustrations are provided in Table 18 followed by standard sheets with dimensional details for each configuration.

**Table 18 – Standard sheets**

Description		20 A		30 A	
		Socket-outlet	Plug	Socket-outlet	Plug
TWO-POLE THREE-WIRE EARTHING	V				
	125	L5-20R 	L5-20P 	L5-30R 	L5-30P 
	240			L25-30R 	L25-30P 
	250	L6-20R 	L6-20P 	L6-30R 	L6-30P 
	277	L7-20R 	L7-20P 	L7-30R 	L7-30P 
	347	L24-20R 	L24-20P 		
	480	L8-20R 	L8-20P 	L8-30R 	L8-30P 
600	L9-20R 	L9-20P 	L9-30R 	L9-30P 	
THREE-POLE FOUR-WIRE EARTHING	125/250	L14-20R 	L14-20P 	L14-30R 	L14-30P 
	250	L15-20R 	L15-20P 	L15-30R 	L15-30P 
	480	L16-20R 	L16-20P 	L16-30R 	L16-30P 
	600			L17-30R 	L17-30P 

Description V		20 A		30 A	
		Socket-outlet	Plug	Socket-outlet	Plug
FOUR-POLE FIVE-WIRE EARTHING	120/208	L21-20R 	L21-20P 	L21-30R 	L21-30P 
	240/415			L26-30R 	L26-30P 
	277/480	L22-20R 	L22-20P 	L22-30R 	L22-30P 
	347/600	L23-20R 	L23-20P 	L23-30R 	L23-30P 

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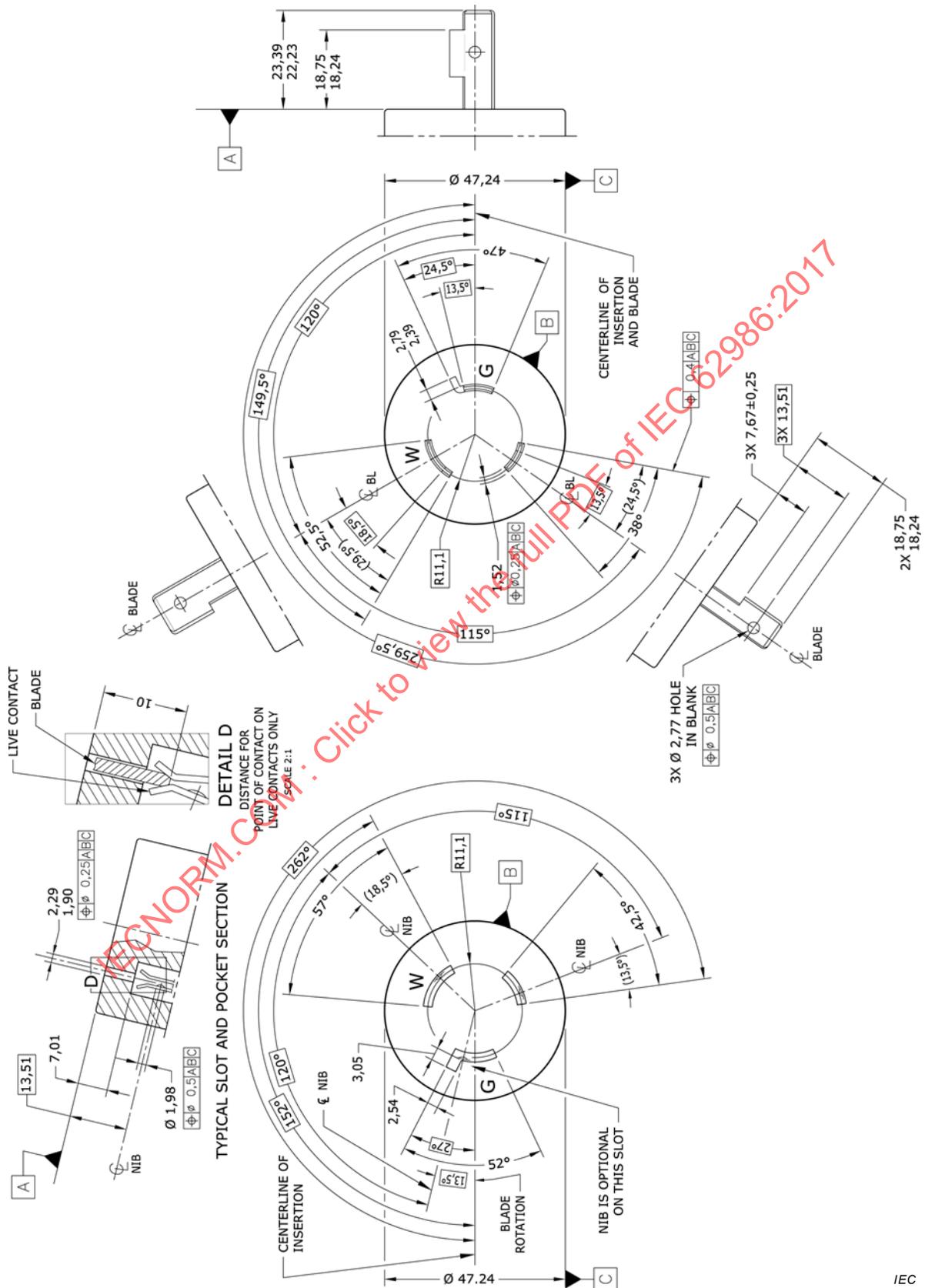








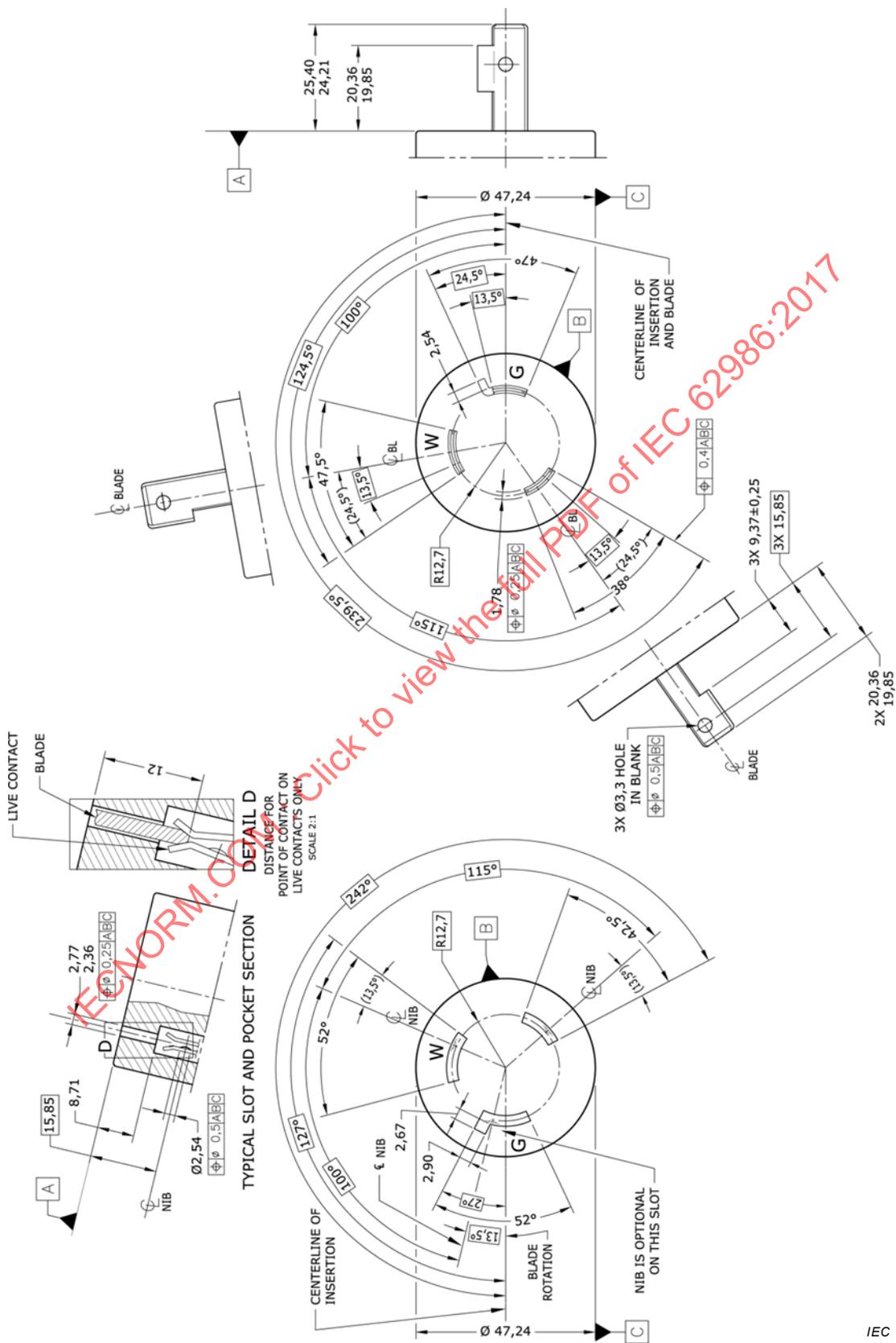
STANDARD SHEET L7-20  
277 V, 20 A, two-pole three-wire



Dimensions in millimetre

Positional tolerance applies to all basic (true) angular dimensions for plug and socket-outlet

STANDARD SHEET L7-30  
277 V, 30 A, two-pole three-wire



Dimensions in millimetre

Positional tolerance applies to all basic (true) angular dimensions for plug and socket-outlet

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