

BS EN 60320-1:2015



BSI Standards Publication

# Appliance couplers for household and similar general purposes

Part 1: General requirements

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**National foreword**

This British Standard is the UK implementation of EN 60320-1:2015. It is identical to IEC 60320-1:2015. It supersedes BS EN 60320-1:2001+A1:2007, which will be withdrawn on 29 July 2018.

The UK participation in its preparation was entrusted by Technical Committee PEL/23, Electrical accessories, to Subcommittee PEL/23/3, Connectors for portable appliances.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Published by BSI Standards Limited 2015

ISBN 978 0 580 74237 8

ICS 29.120.30

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 October 2015.

**Amendments/corrigenda issued since publication**

Date	Text affected
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EUROPEAN STANDARD

**EN 60320-1**

NORME EUROPÉENNE

EUROPÄISCHE NORM

September 2015

ICS 29.120.30

Supersedes EN 60320-1:2001

English Version

Appliance couplers for household and similar general purposes -  
Part 1: General requirements  
(IEC 60320-1:2015)

Connecteurs pour usages domestiques et usages généraux  
analogues - Partie 1: Exigences générales  
(IEC 60320-1:2015)

Gerätesteckvorrichtungen für den Hausgebrauch und  
ähnliche allgemeine Zwecke -Teil 1: Allgemeine  
Anforderungen  
(IEC 60320-1:2015)

This European Standard was approved by CENELEC on 2015-07-29. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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

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

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

## European foreword

The text of document 23G/345/FDIS, future edition 3 of IEC 60320-1, prepared by SC 23G "Appliance couplers", of IEC/TC 23 "Electrical accessories" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60320-1:2015.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2016-04-29
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2018-07-29

This document supersedes EN 60320-1:2001.

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

## Endorsement notice

The text of the International Standard IEC 60320-1:2015 was approved by CENELEC as a European Standard without any modification.

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

IEC 60364-4-44	NOTE	Harmonized as HD 60364-4-44.
IEC 61140	NOTE	Harmonized as EN 61140.
ISO 1466	NOTE	Harmonized as EN ISO 1456.
ISO 2081	NOTE	Harmonized as EN ISO 2081.

**Annex ZA**  
 (normative)

**Normative references to international publications  
 with their corresponding European publications**

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

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: [www.cenelec.eu](http://www.cenelec.eu).

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60068-2-31	-	Environmental testing -- Part 2-31: Tests Test Ec: Rough handling shocks, primarily for equipment-type specimens	-EN 60068-2-31	-
IEC 60068-2-60	-	Environmental testing -- Part 2-60: Tests Test Ke: Flowing mixed gas corrosion test	-EN 60068-2-60 <sup>1)</sup>	-
IEC 60068-2-75	-	Environmental testing - Part 2-75: Tests Test Eh: Hammer tests	-EN 60068-2-75	-
IEC 60112	-	Method for the determination of the proof and the comparative tracking indices of solid insulating materials	EN 60112	-
IEC 60227	series	Polyvinyl chloride insulated cables of rated- voltages up to and including 450/750 V --		series
IEC 60245	series	Rubber insulated cables - Rated voltages- up to and including 450/750 V		series
IEC 60320	series	Appliance couplers for household and similar general purposes	and EN 60320	series
IEC 60320-3	2014	Appliance couplers for household and similar general purposes - Part 3: Standard sheets and gauges	and EN 60320-3	2014
IEC 60417	-	Graphical symbols for use on equipment.- Index, survey and compilation of the single sheets.		-
IEC 60664-1	2007	Insulation coordination for equipment within low-voltage systems -- Part 1: Principles, requirements and tests	EN 60664-1	2007
IEC 60695-2-10	2000	Fire hazard testing -- Part 2-10: Glowing/hot-wire based test methods - Glow-wire apparatus and common test procedure	EN 60695-2-10	2001
IEC 60695-2-11	2000	Fire hazard testing -- Part 2-11: Glowing/hot-wire based test methods - Glow-wire flammability test method for end-products	EN 60695-2-11	2001

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1) To be published

**EN 60320-1:2015**

IEC 60695-2-12	2000	Fire hazard testing -- Part 2-12:EN 60695-2-12 Glowing/hot-wire based test methods - Glow-wire flammability test method for materials	2001
IEC 60695-2-13	2000	Fire hazard testing -- Part 2-13:EN 60695-2-13 Glowing/hot-wire based test methods - Glow-wire ignitability test method for materials	2001
IEC 60695-10-2	-	Fire hazard testing -- Part 10-2: Abnormal heat - Ball pressure test method	EN 60695-10-2 -
IEC 60730-2-11	-	Automatic electrical controls for household and similar use -- Part 2-11: Particular requirements for energy regulators	EN 60730-2-11 -
IEC 60999-1	-	Connecting devices - Electrical copper conductors - Safety requirements for screw-type and screwless-type clamping units -- Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm <sup>2</sup> up to 35 mm <sup>2</sup> (included)	EN 60999-1 -
IEC 61058	series	Switches for appliances	EN 61058 series

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**APPLIANCE COUPLERS FOR HOUSEHOLD  
AND SIMILAR GENERAL PURPOSES –****Part 1: General requirements**

## FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60320-1 has been prepared by subcommittee 23G: Appliance couplers, of IEC technical committee 23: Electrical accessories.

This third edition cancels and replaces the second edition published in 2001 and Amendment 1:2007. This edition constitutes a technical revision.

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

- a) Standard sheets moved from IEC 60320-1 to IEC 60320-3.
- b) Clarification of requirements for non-standardized appliance couplers.

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

FDIS	Report on voting
23G/345/FDIS	23G/346/RVD

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

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

A list of all the parts in the IEC 60320 series, under the general title *Appliance couplers for household and similar general purposes*, can be found on the IEC website.

Part 1 is to be used in conjunction with the following parts of the IEC 60320 series, if applicable.

IEC 60320-2-1, *Appliance couplers for household and similar general purposes – Part 2-1: Sewing machine couplers*

IEC 60320-2-3, *Appliance coupler for household and similar general purposes – Part 2-3: Appliance coupler with a degree of protection higher than IPX0*

IEC 60320-2-4, *Appliance couplers for household and similar general purposes – Part 2-4: Couplers dependent on appliance weight for engagement*

IEC 60320-3, *Appliance couplers for household and similar general purposes – Part 3: Standard sheets and gauges*

NOTE If these standards are referring to another edition of IEC 60320-1, that edition is applicable.

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

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

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

# APPLIANCE COUPLERS FOR HOUSEHOLD AND SIMILAR GENERAL PURPOSES –

## Part 1: General requirements

### 1 Scope

This part of IEC 60320 sets the general requirements for appliance couplers for two poles and two poles with earth contact and for the connection of electrical devices for household and similar onto the mains supply.

This part of IEC 60320 is also valid for appliance inlets/appliance outlets integrated or incorporated in appliances.

The rated voltage does not exceed 250 V (a.c.) and the rated current does not exceed 16 A.

Appliance couplers complying with this part of IEC 60320 are suitable for normal use at ambient temperatures not normally exceeding +40 °C, but their average over a period of 24 h does not exceed +35 °C, with a lower limit of the ambient air temperature of –5 °C.

Appliance couplers are not suitable for

- use in place of plug and socket-outlet systems according to IEC 60884-1.
- use in place of devices for connecting luminaires (DCLs) according to IEC 61995 or luminaire supporting couplers (LSCs).

NOTE Requirements for d.c. are under consideration.

### 2 Normative references

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

IEC 60068-2-31, *Environmental testing – Part 2-31: Tests – Test Ec: Rough handling shocks, primarily for equipment-type specimens*

IEC 60068-2-60, *Environmental testing – Part 2-60: Tests – Test Ke: Flowing mixed gas corrosion test*

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

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

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

IEC 60245 (all parts), *Rubber insulated cables – Rated voltages up to and including 450/750 V*

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

IEC 60320-3:2014, *Appliance couplers for household and similar general purposes – Part 3: Standard sheets and gauges*

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

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

IEC 60695-2-10:2000, *Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure*

IEC 60695-2-11:2000, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products (GWEPT)*

IEC 60695-2-12:2000, *Fire hazard testing – Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability index (GWFI) test method for materials*

IEC 60695-2-13:2000, *Fire hazard testing – Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignition temperature (GWIT) test method for materials*

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

IEC 60730-2-11, *Automatic electrical controls for household and similar use – Part 2-11: Particular requirements for energy regulators*

IEC 60999-1, *Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units – Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm<sup>2</sup> up to 35 mm<sup>2</sup> (included)*

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

IEC 61058 (all parts), *Switches for appliances*

### **3 Terms and definitions**

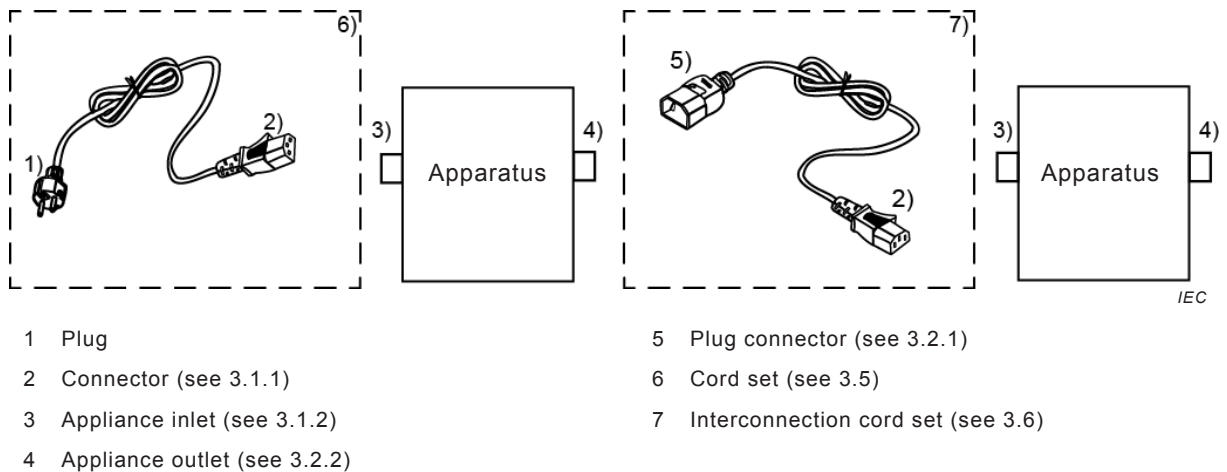
For the purposes of this document, the following terms and definitions apply.

#### **3.1**

##### **appliance coupler**

means enabling the connection and disconnection of an appliance or equipment to the supply

SEE: Figure 1.



**Figure 1 – Intended use of appliance couplers**

### 3.1.1 connector

part of the appliance coupler integral with, or intended to be attached to, one cord connected to the supply

SEE: Figure 1.

[SOURCE: IEC 60050-442:1998, 442-07-02]

### 3.1.2 appliance inlet

part of the appliance coupler integrated as a part of an appliance or incorporated as a separate part in the appliance or equipment or intended to be fixed to it

SEE: Figure 1.

### 3.2 interconnection coupler

appliance coupler enabling the connection and disconnection of an appliance or equipment to a cord leading to another appliance or equipment

SEE: Figure 1.

Note 1 to entry: An interconnection coupler is a type of appliance coupler.

### 3.2.1 plug connector

part of the interconnection coupler integral with or intended to be attached to one cord

SEE: Figure 1.

[SOURCE: IEC 60050-442:1998, 442-07-09]

### 3.2.2

#### **appliance outlet**

part of the interconnection coupler which is the part integrated or incorporated in the appliance or equipment or intended to be fixed to it and from which the supply is obtained

SEE: Figure 1.

[SOURCE: IEC 60050-442:1998, 442-07-08]

### 3.3

#### **rewirable accessory**

accessory so constructed that a cable or cord can be replaced

### 3.4

#### **non-rewirable accessory**

accessory so constructed that it forms a complete unit with flexible supply cable or cord after connection and assembly by the manufacturer of the accessory

### 3.5

#### **cord set**

assembly consisting of one cable or cord fitted with one non-rewirable plug and one non-rewirable connector, intended for the connection of an electrical appliance or equipment to the electrical supply

SEE: Figure 1.

### 3.6

#### **interconnection cord set**

assembly consisting of one cable or cord fitted with one non-rewirable plug connector and one non-rewirable connector, intended for the interconnection between two electrical appliances

SEE: Figure 1

[SOURCE: IEC 60050-442:1998, 442-07-06, modified – “a” has been changed to “one” in two places and a reference to Figure 1 has been added.]

### 3.7

#### **integrated appliance coupler**

appliance coupler which is formed by the housing or enclosure of the appliance or equipment and cannot be tested separately

### 3.8

#### **incorporated appliance coupler**

appliance coupler built in or fixed to an appliance or equipment, but that can be tested separately

### 3.9

#### **base of a pin**

part of the pin where it protrudes from the engagement face

### 3.10

#### **retaining device**

mechanical provision/arrangement which holds a connector in proper engagement with a corresponding appliance inlet and prevents its unintentional withdrawal



**3.11****rated voltage**

voltage assigned by the manufacturer for a specified operating condition of an accessory

[SOURCE: IEC 60050-442:1998, 442-01-03]

**3.12****rated current**

current assigned by the manufacturer for a specified operating condition of an accessory

[SOURCE: IEC 60050-442:1998, 442-01-02]

**3.13****terminal**

part of an accessory to which a conductor is attached, providing a re-usable connection

[SOURCE: IEC 60050-442:1998, 442-06-05]

**3.14****termination**

part of an accessory to which a conductor is permanently attached

[SOURCE: IEC 60050-442:1998, 442-06-06]

**3.15****thread-cutting screw**

screw having an interrupted thread which, by screwing in, makes a thread by removing material from the cavity

[SOURCE: IEC 60050-442:1998, 442-06-03]

**3.16****type test**

test of one or more devices made to a certain design to show that the design meets certain requirements

[SOURCE: IEC 60050-811:1991, 811-10-04]

**3.17****routine test**

test to which each individual device is subjected during and/or after manufacture to ascertain whether it complies with certain criteria

[SOURCE: IEC 60050-811:1991, 811-10-05]

## 4 General requirements

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

Non-standardized appliance couplers shall comply with all safety requirements of this standard and shall be tested together with its counterpart.

Compliance is checked by carrying out all the tests specified.

Appliance couplers according to this standard are not intended to be used in portable accessories covered by IEC TC 23.

## 5 General notes on tests

### 5.1 General

Tests shall be made to prove compliance with the requirements laid down in this standard, where applicable.

Tests are as follows:

- Type tests shall be made on representative samples of each accessory.
- Routine tests shall be conducted by the manufacturer and made on each accessory.
- Unless otherwise specified, the tests are carried out in the order of the clauses.
- Unless otherwise specified, appliance couplers are tested with their counterparts, complying with this standard.
- Appliance inlets and appliance outlets integrated or incorporated in an appliance or equipment are tested under the conditions of use of the equipment, the number of test samples then being the same as the number of test samples of equipment required according to the relevant standard for the equipment.
- Appliance couplers are considered to comply with this standard if there is not more than one failure of one test sample in one of the tests. If one test sample fails in a test, that test and those preceding which may have influenced the result of that test are repeated on another set of test samples, all of which shall then comply with the repeated tests.

Subclauses 5.2 to 5.3 are applicable to type tests. For number of samples and test sequences, see Annex C.

### 5.2 Test samples

Unless otherwise specified, the test samples are tested as delivered and under normal conditions assembled and installed as in normal use according to the manufacturer's instructions at an ambient temperature of  $20\text{ °C} \pm 5\text{ °C}$ ; they are tested with a.c. at 50 Hz or 60 Hz. Tests shall not commence earlier than 168 h after manufacture.

Non-rewirable connectors/plug connectors, other than those forming part of a cord set, shall be submitted with a cord at least 1 m long.

### 5.3 Failures

In general, only the test which caused the failure need be repeated unless

- a) a failure occurs to one of the three test samples when tested in accordance with Clauses 19, 20 or 21, in which case the tests are repeated from Clause 16 onwards; or
- b) a failure occurs to one of the three test samples when tested in accordance with Clauses 22 or 23 (except 22.3), in which case the tests are repeated from Clause 18 onwards.

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

### 5.4 Routine tests

Routine tests are specified in Annex B.

## 6 Standard ratings

**6.1** The maximum permitted rated voltage is 250 V.

**6.2** The maximum permitted rated current is 16 A.

Preferred rated currents for appliance couplers are 0,2 A, 2,5 A, 6 A, 10 A and 16 A.

NOTE For details of standard type ratings refer to IEC 60320-3.

## 7 Classification of appliance couplers

**7.1** According to maximum pin temperature at the base of the pins of the corresponding appliance inlet or the socket contacts of the corresponding appliance outlet:

- a) appliance couplers for cold conditions, pin temperature not exceeding 70 °C;
- b) appliance couplers for hot conditions, pin temperature not exceeding 120 °C;
- c) appliance couplers for very hot conditions, pin temperature not exceeding 155 °C.

NOTE Appliance couplers for hot conditions can also be used under cold conditions; appliance couplers for very hot conditions can also be used under cold or hot conditions.

**7.2** According to the type of equipment to be connected:

- a) appliance couplers for class I equipment;
- b) appliance couplers for class II equipment.

NOTE 1 For a description of the classes, see IEC 61140.

NOTE 2 Appliance couplers for 0,2 A are intended only for the connection of small hand-held class II equipment, if allowed by the relevant standard for the equipment.

**7.3** Connectors/plug connectors according to the method of connecting the cord:

- a) rewirable;
- b) non-rewirable.

## 8 Marking

### 8.1 General

Appliance couplers shall be marked with:

- name, trade mark or identification mark of the manufacturer or responsible vendor;
- type reference.

NOTE The type reference can be a catalogue number.

### 8.2 Additional markings

Connectors and plug connectors shall be additionally marked with:



- rated current in amperes, except for 0,2 A connectors;
- rated voltage in volts;
- symbol for nature of supply;
- the marking as specified in IEC 60999-1 to identify the type of conductors suitable for screwless terminals.

### 8.3 Appliance couplers for class II equipment

Appliance couplers for class II equipment shall not be marked with the symbol for class II construction.

### 8.4 Symbols or alphanumeric notations

When symbols or alphanumeric notations are used, they shall be as follows:

amperes	A
volts	V
alternating current	AC or ~
protective earth	 [IEC 60417-5019 (2006-08)] or PE
earth	 [IEC 60417-5017 (2006-08)]
neutral terminal	N

For the marking of rated current and rated voltage, figures may be used alone, the figure for rated current being placed before or above that for rated voltage and separated from the latter by a line. The symbol for nature of supply shall be placed next to the marking for rated current and rated voltage.

NOTE 1 Examples for marking of current, voltage and nature of supply:

$$10\text{ A } 250\text{ V } \sim \text{ or } 10/250 \sim \text{ or } \frac{10}{250} \sim \text{ or } \left( \frac{10}{250} \sim \right)$$

NOTE 2 Lines formed by the construction of the tool are not considered as part of the marking.


### 8.5 Legibility of markings

The marking according to 8.1 of connectors/plug connectors shall still be easily discernible when the connector/plug connector is wired and ready for use.

NOTE The term "ready for use" does not imply that the connector is in engagement with an appliance inlet.

### 8.6 Terminal markings and wiring instructions

In rewirable, non-reversible connectors/plug connectors, terminals shall be indicated as follows:

- earthing terminal: the symbol  or PE
- neutral terminal: the letter N

In non-rewirable, polarized connectors/plug connectors, no marking of contacts is necessary, but conductors shall be connected as specified in 22.1.

Appliance inlets/appliance outlets, other than those integrated or incorporated in an appliance or equipment, for use with connectors/plug connectors according to 8.6 shall have terminal markings to correspond with 8.6.

Rewirable connectors/plug connectors shall be supplied with the following instructions:

- a) a diagram illustrating the method of connection of the conductors, in particular the excess length of the earthing conductor;
- b) a diagram illustrating the method of the operation of the cord anchorage;
- c) a diagram showing the length of sleeving and insulation to be stripped back;

d) the sizes and types of the suitable cable or cord.

NOTE Connectors/plug connectors supplied directly to an equipment manufacturer do not need these instructions with each unit, but will be made available to the equipment manufacturer.

### **8.7 Durability**

The marking required by the standard shall be easily legible and durable. The marking shall not be placed on screws, removable washers or other removable parts.

### **8.8 Test and inspection**

Compliance with the requirements of 8.1 to 8.7 is checked by inspection and by the following test.

The marking is rubbed by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with petroleum spirit.

After this test and all non-destructive tests of the standard, the marking shall remain legible. It shall not be easily possible to remove labels and they shall not show curling.

Marking made by moulding, pressing or engraving is not subjected to this test.

## **9 Dimensions and compatibility**

### **9.1 General**

Appliance couplers shall be designed and constructed so that unintended or improper connection is prevented.

Compliance is checked by inspection and in case of doubt by the test according to 9.2 to 9.5.

### **9.2 Single-pole connections**

It shall not be possible to make single-pole connections between connectors/appliance outlets and appliance intlets/plug connectors.

Compliance is checked by manual test.

### **9.3 Compatibility**

It shall not be possible to engage:

- connectors for class II equipment in appliance inlets/plug connectors for class I equipment;
- plug connectors for devices of the protection class I in connectors/appliance outlets for devices of the protection class II;
- connectors for cold conditions in appliance inlets/plug connectors for hot or very hot conditions;
- plug connectors for cold conditions in appliance outlets for hot or very hot conditions;
- connectors for hot conditions in appliance inlets/plug connectors for very hot conditions;
- plug connectors for hot conditions in appliance outlets for very hot conditions;
- connectors in appliance inlets/plug connectors having a higher rated current than the connector.
- plug connectors in appliance outlets having a lower rated current than the plug connector.

Engagement of a connector or plug connector is attempted in any unintended configuration using a force of 60 N for 60 s.

During the test there shall be no contact of the pins.

Compliance is checked by inspection, by manual test according to 9.4 and by use of all components supplied by the manufacturer.

#### **9.4 Dimensions for standardized appliance couplers**

Standardized appliance couplers shall comply with the relevant standard sheets according to IEC 60320-3.

Dimensions are checked by means of gauges or by measurement. In case of doubt, gauges shall be used.

#### **9.5 Dimensions for non-standardized appliance couplers**

Non-standardized appliance couplers which do not refer to the dimensions specified in the standard sheets according to IEC 60320-3 are acceptable if they do not adversely affect the purpose and safety of appliance couplers complying with the standard sheets, especially with regard to interchangeability and non-interchangeability.

Small deviations from the dimensions as specified in the standard sheets, which give the impression of a standardized coupler and lead to confusion with standardized appliance couplers, are not allowed.

Changes which adversely affect the contact-making ability are not allowed.

It shall not be possible to engage a part of a non-standard appliance coupler with a complementary part of an appliance coupler complying with the standard sheets in any part of IEC 60320.

It shall not be possible within a given system to make improper connections other than the intended position or partial connections causing deformation which can impair the further use of the appliance for:

- a connector and associated appliance inlet;
- an appliance outlet with the associated plug connector.

Compliance is checked by manual test.

## **10 Protection against electric shock**

### **10.1 Accessibility of live parts**

Appliance couplers shall be so designed that live parts are not accessible when in partial or complete engagement.

Connectors/appliance outlets shall be so designed that live parts are not accessible when the connectors/appliance outlets are properly assembled and wired as in normal use.

Compliance is checked by inspection and by a test with the standard test probe B of IEC 61032.

The test probe is applied in every possible position, an electrical indicator being used to show contact with the relevant parts. For connectors with enclosures or bodies of elastomeric or thermoplastic material, the standard test finger is applied for 30 s with a force of 20 N at all points where yielding of the insulating material could impair the safety of the connector.

NOTE An electrical indicator with a voltage between 24 V and 50 V is used to show contact with the relevant part.

## **10.2 Protection against single pole connection**

It shall not be possible to make connection between a pin of an appliance inlet/plug connector and a contact of a connector/appliance outlet as long as any of the pins are accessible.

Compliance is checked by manual test followed by the test of 10.1.

## **10.3 Protection against access to live parts**

It shall not be possible to remove parts preventing access to live parts without the aid of a tool.

Bushes, if any, in the entry holes for the pins shall be adequately fixed and it shall not be possible to remove them without dismantling the connector/appliance outlet.

Compliance is checked by inspection and by manual test.

## **10.4 External parts**

External parts of connectors, appliance outlets and plug connectors, with the exception of assembly screws and the like, shall be of insulating material.

Compliance is checked by inspection.

## **10.5 Shrouds**

The shroud and the base of appliance inlets without earthing contact and those of 2,5 A appliance inlets/appliance outlets with earthing contact, shall be of insulating material.

Compliance is checked by inspection.

NOTE The suitability of the insulating material is checked during the insulation tests of Clause 15.

## **11 Provision for earthing**

Appliance couplers with protective earthing contact shall be so constructed that the protective earthing contact will first make and last break relative to any other contact.

Compliance is checked by inspection.

## **12 Terminals and terminations**

### **12.1 General**

For terminals and terminations the requirements in the appropriate IEC standard apply.

Clamping means of terminals shall not serve to fix any other component, although they may hold the terminals in place or prevent them from turning.

## 12.2 Rewirable appliance couplers

Rewirable appliance couplers shall be provided with screw-type clamping units or screwless clamping units according to IEC 60999-1.

Compliance is checked by inspection.

## 12.3 Non-rewirable appliance couplers

Non-rewirable appliance couplers shall be provided with soldered, welded, crimped or equally effective screwless connections, which shall not allow the possibility to disconnect the conductor.

Compliance is checked by inspection.

## 13 Construction

### 13.1 Risk of accidental contact

Appliance couplers shall be so designed that there is no risk of accidental contact between the earthing contact of the appliance inlet/plug connector and the current-carrying contacts of the connector/appliance outlet.

### 13.2 Contact positions

In non-reversible connectors/plug connectors, the contact positions shall be established by looking at the engagement face of the connectors/plug connectors as shown in the standard sheets overview in Clause 4 of IEC 60320-3:2014.

Their position shall be as in Table 1.

**Table 1 – Position of contacts**

Type of contact	Position of contacts	
	Non-reversible connectors	Non-reversible plug connectors
Earthing contact	Preferably in a symmetrical arrangement	Preferably in a symmetrical arrangement
Line contact	Lower right-hand position	Lower left-hand position
Neutral contact	Lower left-hand position	Lower right-hand position

In non-reversible appliance couplers, which do not comply with the standard sheets shown in the overview of Clause 4 of IEC 60320-3:2014, the correct polarization shall be verified.

Compliance is checked by inspection.

NOTE Conformity to the standard sheets ensures compliance with this requirement.

### 13.3 Parts covering live parts

Parts covering live parts shall be adequately locked against loosening.

Compliance is checked by inspection and by the tests of Clauses 18, 20 and 23.



## 13.4 Pin construction

### 13.4.1 Prevention of rotation

Pins of appliance inlets/plug connectors and contacts of connectors/appliance outlets shall be locked against rotation.

Compliance is checked by inspection and by manual test.

NOTE Clamping screws can serve to prevent contacts from rotating.

### 13.4.2 Pin retention

Pins of appliance inlets/plug connectors shall be securely retained and shall have adequate mechanical strength. It shall not be possible to remove them without the aid of a tool and they shall be surrounded by a shroud. The pins shall not protrude beyond the rim of the shroud.

A minimal movement of the pins is allowed.

The security of the pin retention is checked by inspection and, in case of doubt, by the following test:

The test sample is heated to the temperature according to the appropriate temperature class given in 7.1 for 1 h and maintained at this temperature for the duration of the test including the 5 min period after removal of the test load.

The appliance inlet/plug connector is held firmly in such a manner that there will be no undue squeezing or distortion of the body, and the means of holding shall not assist in maintaining the pins in their original position.

Each pin is subjected to a force of  $60 \text{ N} \pm 0,6 \text{ N}$ , applied without jerks, in a direction along the axis of the pin and maintained at this value for a period of 60 s.

For all pins the force is applied, first in the direction away from the base of the appliance inlet/plug connector, and then in the direction towards the base of the appliance inlet/plug connector.

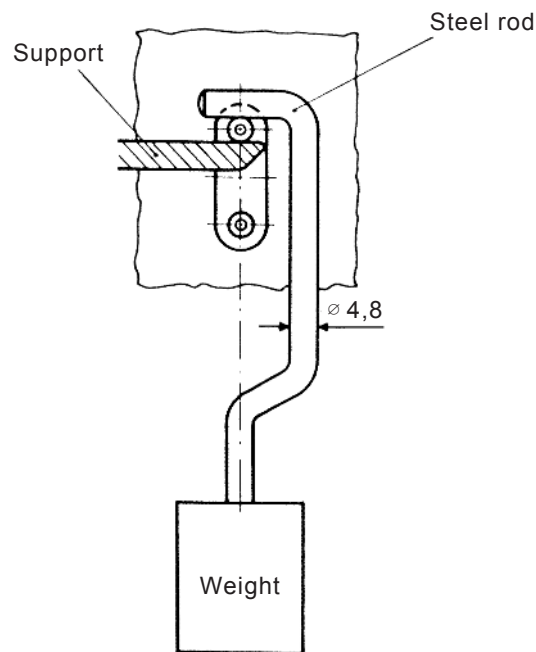
The attachment of the pins is deemed to be satisfactory if there is no movement exceeding 2,5 mm during the test on any pin, and provided that within 5 min after removal of the pushing-in test force or within 5 min after the removal of the pulling-out test force, all pins remain within the tolerances of the standard sheets or, for non-standardized appliance couplers, as specified by the manufacturer.

Compliance is checked by inspection and by manual test.

### 13.4.3 Non-solid pins

Non-solid pins are additionally tested by the following test after all other tests have been completed.

The shroud is removed from the appliance inlet/plug connector and the pin supported as shown in Figure 2.

*Dimensions in millimetres*

IEC

**Figure 2 – Device for testing non-solid pins**

A force of 100 N is exerted on the pin for 1 min in a direction perpendicular to the axis of the pin, by means of a steel rod having a diameter of 4,8 mm, the axis of which is also at right angles to the axis of the pin.

After the test, there shall be no significant alteration in the shape of the pin.

### 13.5 Contact pressure

Contacts of connectors/appliance outlets shall be self-adjusting so as to provide adequate contact pressure.

For connectors/appliance outlets other than 0,2 A connectors, self-adjustment of the contacts shall not depend upon the resiliency of insulating material.

Compliance is checked by inspection and by the tests of Clauses 16 to 21 inclusive.

### 13.6 Enclosure

#### 13.6.1 General

Parts of the body of connectors/plug connectors shall be reliably fixed to one another.

Compliance is checked by inspection, by manual test and by the test of 23.6.

#### 13.6.2 Rewirable connectors/plug connectors

It shall not be possible to dismantle the connector/plug connector without the aid of a tool.

The enclosure of rewirable connectors/plug connectors shall completely enclose the terminals and the ends of the cord, at least as far as to the point from which the sheath has to be removed.

The construction shall be such that, from the point of separation of the cores, the conductors can be properly connected and that, when the connector/plug connector is assembled and wired as in normal use, there is no risk of

- pressing the cores together in such a way that it causes damage to the core insulation, likely to result in a break-down of the insulation;
- a core, the conductor of which is connected to a live terminal, being likely to be pressed against accessible metal parts;
- a core, the conductor of which is connected to the earthing terminals, being likely to be pressed against live parts.

For rewirable connectors, it shall not be possible to assemble the connector in such a way that the terminals are enclosed and the contacts are accessible.

NOTE This requirement excludes the use of separate front pieces enclosing only the contacts.

For rewirable connectors/plug connectors there shall be separate independent means for fixing and locating the parts of the body with respect to each other, at least one of which, for example a screw, can only be operated with the aid of a tool; thread-cutting screws shall not be used for this purpose.

The resiliency of the contacts shall not depend upon the assembly of the parts of the body.

Partial loosening of assembly screws or the like shall not allow the detachment of parts providing protection against electric shock.

Compliance is checked by inspection and by manual test.

### **13.6.3 Non-rewirable connectors/plug connectors**

Non-rewirable accessories shall be such that:

- the flexible cable or cord cannot be separated from the accessory without making this permanently useless, and
- the accessory cannot be opened by hand or by using a general purpose tool

NOTE An accessory is considered to be permanently useless when for re-assembling the accessory, parts or materials other than the original are to be used.

Compliance is checked by inspection and by manual test.

### **13.7 Earth connection**

For connectors/plug connectors, the earthing contact/earthing pin shall be fixed to the body. If the earthing contact/earthing pin and the earthing terminal are not in one piece, the various parts shall be fixed together by riveting, welding or in a similar reliable manner.

Metal parts of appliance couplers shall be so designed that corrosion shall not impair safety with regard to electrical and mechanical characteristics.

The connection between the earthing contact/earthing pin and the earthing terminal shall be of metal and resistant to corrosion.

Compliance is checked by inspection.

## 13.8 Location of terminals and terminations

### 13.8.1 General

Terminals of rewirable accessories and terminations of non-rewirable accessories shall be so located or shielded that loose wires of a conductor in the accessory will not present a risk of electric shock.

For non-rewirable moulded-on accessories, means shall be provided to prevent loose wires of a conductor from reducing the minimum isolation distance requirements between such wires and all accessible external surfaces of the accessory, with the exception of the engagement face of the inlet.

Compliance is checked by the following:

- for rewirable accessories, the test of 13.8.2;
- for non-rewirable non-moulded-on accessories, the test of 13.8.3;
- for non-rewirable moulded-on accessories, by verification and inspection according to 13.8.4.

### 13.8.2 Free wire test for rewirable accessories

A length of 6 mm of insulation is removed from the end of a flexible conductor having a cross-sectional area of 0,75 mm<sup>2</sup>. One wire of the flexible conductor is left free and the remaining wires are fully inserted into and clamped in the terminal, as for normal use.

The free wire is bent, without tearing the insulation back, in every possible direction, but without making sharp bends around the barriers.

NOTE The prohibition against making sharp bends around the barriers does not imply that the free wire has to be kept straight during the test. Sharp bends, moreover, are made if it is considered likely that such bends can occur during the normal assembly of the accessory, for example when a cover is pushed on.

The free wire of a conductor connected to a live terminal shall not touch any accessible metal part or be able to emerge from the enclosure when the accessory has been assembled.

The free wire of a conductor connected to an earthing terminal shall not touch a live part.

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

### 13.8.3 Free wire test for non-rewirable non-moulded-on accessories

A length of insulation equivalent to the maximum designed stripping length declared by the manufacturer plus 2 mm is removed from the end of a flexible conductor having the cross-sectional area as fitted. One wire of the flexible conductor is left free in the worst position whilst the remaining wires are terminated in a manner as used in the construction of the accessory.

The free wire is bent, without tearing the insulation back, in every possible direction but without making sharp bends around the barriers.

NOTE The prohibition against making sharp bends around the barriers does not imply that the free wire has to be kept straight during the test. Sharp bends, moreover, are made if it is considered likely that such bends can occur during the normal assembly of the accessory, for example when a cover is pushed on.

The free wire of a conductor connected to a live termination shall not touch any accessible metal part or reduce the creepage distance and clearance through any constructional gap to the external surface below 1,5 mm.

The free wire of a conductor connected to an earth termination shall not touch any live parts.

#### **13.8.4 Free wire verification for non-rewirable moulded-on accessories**

Non-rewirable moulded-on accessories shall be inspected to verify that there are means to prevent stray wires of the conductor and/or live parts reducing the minimum distance through insulation to the external accessible surface (with the exception of the engagement face of inlets) below 1,5 mm.

NOTE The verification of means may require the checking of the product construction or assembly method.

#### **13.9 Connectors/plug connectors without earthing contact**

Connectors/plug connectors without earthing contact and 2,5 A connectors/plug connectors with earthing contact shall be part of a cord set or an interconnection cord set.

Compliance is checked by inspection.

#### **13.10 Fuses, relays, thermostats, thermal cut-outs and switches**

Fuses, relays, thermostats and thermal cut-outs shall not be incorporated in connectors and plug connectors complying with the standard sheets of IEC 60320-3.

Fuses, relays, thermostats and thermal cut-outs incorporated in appliance inlets and appliance outlets shall comply with the relevant IEC standards.

Switches incorporated in appliance couplers shall comply with IEC 61058.

Energy regulators incorporated in appliance couplers shall comply with IEC 60730-2-11.

Compliance is checked by inspection and by testing the switches, fuses, relays, thermostats, thermal cut-outs and energy regulators according to the relevant IEC standard.

### **14 Moisture resistance**

Appliance couplers shall be able to withstand humid conditions which may occur in normal use.

If such appliance couplers are used with equipment which is subject to spillage of liquid in normal use then the protection against moisture shall be provided by the equipment.

Compliance is checked by the humidity treatment described in Clause 14, followed immediately by the tests of Clause 15.

Connectors/plug connectors and appliance inlets/appliance outlets are not in engagement when subjected to the humidity treatment; rewirable connectors/plug connectors are not fitted with a cord.

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 test samples can be located, is maintained within  $\pm 1$  °C of any convenient value  $t$  °C between 20 °C and 30 °C.

Before being placed in the humidity cabinet, the test samples are brought to a temperature between  $t$  °C and  $(t + 4)$  °C.

The test samples are kept in the cabinet for

- 168 h (7 days) for appliance couplers with earthing contact, which are submitted as individual accessories, not incorporated in other equipment;
- 48 h (2 days) in all other cases.

NOTE 1 In most cases, the test samples can be brought to the specified temperature by keeping them at this temperature for at least 4 h before the humidity treatment.

NOTE 2 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.

After this treatment, the test sample shall show no damage within the meaning of this standard.

## 15 Insulation resistance and electric strength

### 15.1 General

Appliance couplers shall have adequate insulation resistance and dielectric strength.

Compliance is checked by the tests of 15.2 and 15.3 immediately after the humidity treatment according to Clause 14.

Indicators which might otherwise be damaged by the tests of 15.2 and 15.3, such as neon lamps, shall be disconnected at one pole prior to testing.

The insulation resistance is measured considering the following conditions:

- a) for appliance inlets with a connector in engagement, between the current-carrying contacts connected together and the body;
- b) for appliance inlets with a connector in engagement, between each pin in turn and the others connected together;
- c) for appliance outlets with a plug connector in engagement, between the current-carrying contacts connected together and the body;
- d) for appliance outlets without a plug connector in engagement, between the current-carrying contacts connected together and the body;
- e) for appliance outlets with a plug connector in engagement, between each pin in turn and the others connected together;
- f) for connectors, between the current-carrying contacts connected together and the body;
- g) for connectors, between each contact in turn and the others connected together;
- h) for plug connectors, between the current-carrying contacts connected together and the body;
- i) for plug connectors, between each contact in turn and the others connected together.

Additional test for rewirable connectors and plug connectors:

- j) for rewirable connectors, between any metal part of the cord anchorage, including clamping screws, and the earthing contact or earthing terminal;
- k) for rewirable connectors, between any metal part of the cord anchorage, excluding clamping screws, and a metal rod, of the maximum diameter of the cord as specified in Table 2, inserted in its place.
- l) for rewirable plug connectors, between any metal part of the cord anchorage, including clamping screws, and the earthing contact or earthing terminal;

m) for rewirable plug connectors, between any metal part of the cord anchorage, excluding clamping screws, and a metal rod, of the maximum diameter of the cord as specified in Table 2, inserted in its place.

The term "body" used in items a), c), d), f) and h) above includes all accessible metal parts, fixing screws, external assembly screws and the like and a metal foil in contact with the outer surface of external parts of insulating material, in items d), f) and h) including the engagement face of connectors or appliance outlets but excluding the engagement face of plug connectors.

The metal foil is wrapped round the outer surface of external parts of insulating material; however, it is not pressed into openings.

**Table 2 – Maximum diameters of the cords**

Type of cord	Number of conductors and nominal cross- sectional area	Maximum diameter
	mm <sup>2</sup>	mm
60227 IEC 53	3 × 0,75	7,6
	3 × 1	8,0
	3 × 1,5	9,4
60245 IEC 53	3 × 0,75	8,1
	3 × 1	8,5
	3 × 1,5	10,4

The test voltage according to 15.2 and 15.3 is applied in the case of:

- functional insulation: between the different poles of the appliance coupler;
- basic insulation: between all live parts connected together and a metal foil covering the outer surface of the basic insulation and/or exposed conductive parts;
- supplementary insulation: between two metal foils covering separately the inner, normally inaccessible surface, of the supplementary insulation and its accessible surface;
- reinforced insulation: between all live parts connected together and a metal foil covering the accessible surface of the reinforced insulation.

The clearances and creepage distances shall be maintained when preparing the sample for this test.

In cases where basic insulation and supplementary insulation cannot be tested separately, the insulation provided is subjected to the test voltages specified for reinforced insulation.

## 15.2 Insulation resistance

The insulation resistance of the sample is measured with an applied d.c. voltage of  $500^{+50}_0$  V, the measurement being made  $60\text{ s} \pm 5\text{ s}$  after application of the voltage. The insulation resistance shall not be less than that specified in Table 3.

**Table 3 – Minimum insulation resistance**

Insulation to be tested	Insulation resistance
	MΩ
Functional	2
Basic	2
Supplementary	5
Reinforced	7

NOTE Materials such as glazed ceramic or porcelain are considered to have insulation resistance and are not subjected to the insulation resistance tests.

### 15.3 Dielectric strength

The test sample is subjected to a voltage of substantially sine wave form, having a nominal frequency 50 Hz or 60 Hz. The voltage is applied for  $60 \text{ s} \pm 5 \text{ s}$  across the insulation as specified in Table 4.

Initially, not more than half the prescribed voltage is applied, and then it is raised rapidly to the full value. No flashover or breakdown shall occur. Glow discharges without drop in voltage are neglected.

**Table 4 – Dielectric strength**

Insulation or disconnection to be tested <sup>b</sup>	Test voltage (r.m.s.) <sup>a</sup>		
	Rated voltage up to and including 50 V	Rated voltage above 50 V up to and including 130 V	Rated voltage above 130V up to and including 250V
	V	V	V
Functional insulation <sup>c</sup>	500	1 300	1 500
Basic insulation <sup>d</sup>	500	1 300	1 500
Supplementary insulation <sup>d</sup>	500	1 300	1 500
Reinforced insulation <sup>d,e</sup>	500	2 600	3 000

NOTE 1 Up to 50 V: Not intended to be connected directly to the mains and not expected to be subjected to temporary overvoltages as defined in IEC 60364-4-44.

NOTE 2 Over 50 V: The values are based on IEC 60364-4-44. For functional, basic and supplementary insulation, the values are calculated with the formula:  $U_0 + 1\,200 \text{ V}$  and rounded. In this standard the maximum voltage considered between line and earth is  $U_0 = 300 \text{ V}$ .

<sup>a</sup> The high-voltage transformer used for the test shall be designed so that, when the output terminals are short-circuited after the output voltage has been adjusted to the test voltage, the output current is at least 200 mA. The overcurrent relay shall not trip when the output current is less than 100 mA. Care is taken that the r.m.s. values of the test voltage are measured within  $\pm 3 \%$ .

<sup>b</sup> Special components which might render the test impractical such as discharge lamps, coils, windings, or capacitors are disconnected at one pole, or bridged, as appropriate to the insulation being tested.

<sup>c</sup> An example is the insulation between poles.

<sup>d</sup> For the test all live parts are connected together and care is taken to ensure that all moving parts are in the most onerous position.

<sup>e</sup> For appliance couplers incorporating reinforced insulation as well as double insulation care is taken that the voltage applied to the reinforced insulation does not overstress the basic or the supplementary parts of the double insulation.



## 16 Forces necessary to insert and to withdraw the connector/appliance outlet

### 16.1 General

The construction of appliance couplers shall allow the easy insertion and withdrawal of the connector/appliance outlet, and prevent the connector/appliance outlet from working out of the appliance inlet/plug connector in normal use.

Compliance is checked for connectors/appliance outlets by the following tests:

- 16.2 to ascertain that the maximum force necessary to withdraw the connector/appliance outlet from the appliance inlet/plug connector shall not be higher than the maximum force specified in Table 5. For test purposes the relevant counterpart of the connector/appliance outlet shall be used (multi-pin gauge);
- 16.3 to ascertain that the minimum force necessary to withdraw a single pin from the individual contact assembly shall not be lower than the minimum force specified in Table 5.

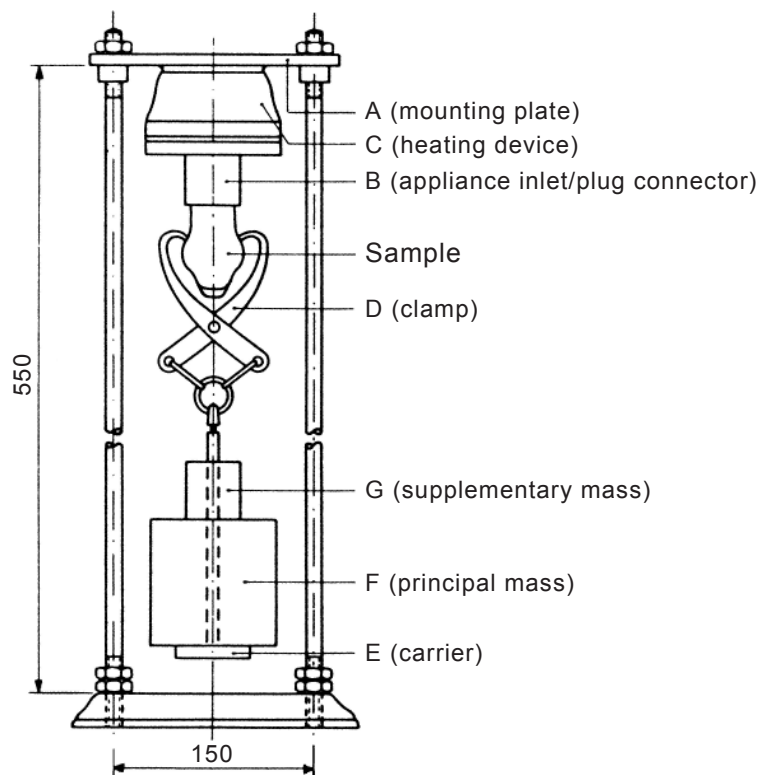
**Table 5 – Maximum and minimum withdrawal forces**

Type of connector/ appliance outlet	Withdrawal forces N	
	16.2 Multi-pin gauge maximum	16.3 Single-pin minimum
0,2 A, 2,5 A, 6 A and 10 A	50	1,5
16 A	60	2

Accessories with retaining devices are tested with the retaining device inoperative.

### 16.2 Verification of the maximum withdrawal force

The appliance inlet/plug connector is fixed to the mounting plate A of an apparatus as shown in Figure 3, so that the axes of the appliance inlet/plug connector pins are vertical and the free ends of the pins are downwards. The total mass consists of the principal mass, the supplementary mass, the clamp and the carrier.



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**Figure 3 – Apparatus for checking the withdrawal force**

The pins are wiped free from grease before each test using a cold chemical degreaser.

NOTE 1 When using the liquid specified for the test, adequate precautions can be taken to prevent inhalation of vapour.

The connector/appliance outlet is inserted to the full depth into, and withdrawn from, the appropriate appliance inlet/plug connector 10 times. It is then again inserted, a carrier E for a principal mass F and a supplementary mass G being attached to it by means of a suitable clamp D. The supplementary mass is such that it exerts a force equal to one tenth of the maximum withdrawal force specified in Table 5 and it shall be made in one piece.

The principal mass is hung on the connector/appliance outlet without jolting and the supplementary mass is allowed to fall from a height of 5 cm on to the principal mass. The connector/appliance outlet shall not remain in the appliance inlet/plug connector.

For standardized types:

The appliance inlet/plug connector has finely ground pins of hardened steel, having a surface roughness not exceeding  $0,8 \mu\text{m}$  over their active length and spaced at the nominal distance with a tolerance of  $^{+0,02}_0$  mm.

The pin dimensions have the maximum values, with a tolerance of  ${}_{-0,01}^0$  mm, except that the pin length need only comply with the tolerance of the standard sheet, and the inner dimensions of the shroud have the minimum values, with a tolerance of  ${}_{0}^{+0,1}$  mm, specified in the relevant standard sheet.

NOTE 2 The maximum value is the nominal plus the maximum tolerance. The minimum value is the nominal minus the maximum tolerance.

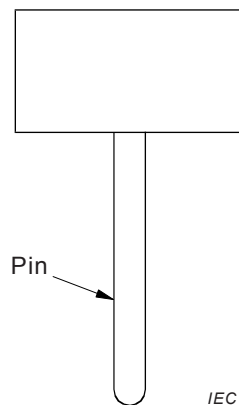
For non-standardized types:

The counterpart as specified by the manufacturer shall be used

### 16.3 Verification of the minimum withdrawal force

The test pin gauge, as illustrated in Figure 4, is applied to each individual connector/appliance outlet contact with the contact axes vertical and the gauge hanging vertically downwards.

*Dimensions according to the relevant standard sheet*



The mass is to be equally positioned around the centre line(s) of the pin.

**Figure 4 – Gauge for verification of the minimum withdrawal force**

The total mass of the test equipment shall be such as to exert the applicable force as shown in Table 5.

The pin is wiped free from grease before each test using a cold chemical degreaser.

The test pin gauge is then inserted into the contact assembly. The test equipment is applied gently, and care is taken not to knock the assembly when checking the minimum withdrawal force.

The test equipment shall not fall from the contact assembly within 3 s.

For standardized types:

The test pin gauge is made of hardened steel, having a surface roughness not exceeding  $0,8 \mu\text{m}$  over its active length.

The pin portion of the gauge shall have dimensions equal to the minimum shown in the appropriate appliance inlet/plug connector standard sheet, with a tolerance of  ${}^{+0,01}_0$  mm, except that the pin length need only comply with the tolerance of the standard sheet.

For non-standardized types:

The test pin is a single pin with minimum dimensions as specified by the manufacturer.

## 17 Operation of contacts

Contacts and pins of appliance couplers shall make connection with a sliding action. The contacts of connectors/appliance outlets shall provide adequate contact pressure and shall not deteriorate in normal use.

The effectiveness of the pressure between contacts and pins and earthing contacts and earthing pins shall not depend upon the resiliency of the insulating material on which they are mounted.

Compliance with the requirements is checked by inspection and by taking into consideration the requirements of Clauses 16, 18, 19, 20 and 21.

## 18 Resistance to heating of appliance couplers for hot conditions or very hot conditions

### 18.1 General

Appliance couplers as classified according to 7.1 shall withstand the heating to which they may be subjected by an appliance or other equipment.

Connectors/plug connectors shall be so constructed that the insulation of the conductors is not subjected to excessive heating.

Compliance is checked, for connectors/plug connectors, by the test of 18.2, and, for appliance inlets/appliance outlets, by the test of 18.3.

### 18.2 Heating test for connectors/plug connectors

Rewirable connectors/plug connectors are fitted with a three-core cord, having the minimum allowed cross-sectional area. Non-rewirable connectors/plug connectors are tested with the cord as delivered.

The connector/plug connector is inserted in a suitable appliance inlet/appliance outlet, following the manufacturer's instructions and then placed in a heating cabinet for 96 h at a temperature of:

- 120 °C ± 2 °C for connectors/plug connectors for hot conditions classified in 7.1b);
- 155 °C ± 2 °C for connectors/plug connectors for very hot conditions classified in 7.1c).

After removal from the heating cabinet, the connectors/plug connectors are then allowed to cool down to approximately ambient air temperature and are inserted into and withdrawn from the appliance inlet/appliance outlet 10 times.

The test samples shall show:

- no damage affecting the protection against electric shock;

- no loosening of electrical or mechanical connections;
- no cracks, swelling, shrinkage or the like.

### 18.3 Heating test for appliance inlets/appliance outlets

Appliance inlets/appliance outlets for hot conditions and those for very hot conditions, other than those integrated or incorporated in an appliance or equipment, are kept in a heating cabinet for 96 h at a temperature of

- 120 °C ± 2 °C for appliance inlets/appliance outlets for hot conditions classified in 7.1b);
- 155 °C ± 2 °C for appliance inlets/appliance outlets for very hot conditions classified in 7.1c).

After the test, the test sample shall show no damage impairing its further use.

## 19 Breaking capacity

Appliance couplers shall have adequate breaking capacity.

Compliance is checked, for connectors/appliance outlets, by the following test.

The connector or appliance outlet is mounted in an appropriate test apparatus, which incorporates the corresponding appliance inlet or plug connector.

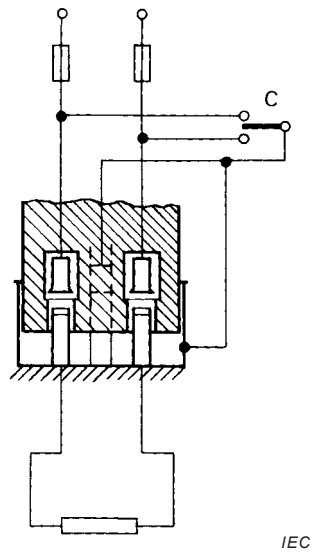
For standardized types, the appliance inlet or plug connector shall have polished, hardened steel pins, and dimensions as specified in the relevant standard sheet. The ends of the pins shall be rounded for rectangular pins and hemispherical for round pins as shown in the standard sheets.

For non-standardized types, the counterpart as specified by the manufacturer shall be used.

Connectors and appliance outlets for up to 0,2 A are not tested.

The appliance inlet/plug connector is positioned so that the plane through the axes of the pins is horizontal and the earthing pin, if any, is uppermost.

The test apparatus shall be designed and adjusted so as to simulate as far as possible disconnection in normal use (see Figure 5 for circuit diagram).



IEC

**Key**

C selector switch

**Figure 5 – Circuit diagram for breaking capacity and normal operation tests**

For testing 10 A and 16 A connectors with earthing contact, the shroud of the appliance inlet shall be of metal. For testing other connectors and appliance outlets the shroud shall be of insulating material.

Ratings for the tests are taken from Table 6.

**Table 6 – Ratings for the tests of Clause 19**

Rated current [A]	Test voltage [V]	Test current [A]	Power factor ( $\cos \phi$ )	Number of strokes
> 0,2 to < 10	$1,1 \times$ rated voltage	$1,25 \times$ rated current	$0,6 \pm 0,05$	100
$\geq 10$	$1,1 \times$ rated voltage	$1,25 \times$ rated current	$0,95 \pm 0,05$	100

NOTE 1 28 to 30 strokes per minute with continuous movement.

NOTE 2 Current flow period:  $1,5^{+0,5}_0$  s .

NOTE 3 A stroke is an engagement or a disengagement of the sample under test into the counterpart.

NOTE 4 The test sample is fully inserted into and withdrawn from its counterpart during each cycle.

No current is passed through the earthing circuit, if any.

The selector switch C, connecting the earthing circuit and accessible metal parts to one of the poles of the supply, is operated after half the number of strokes.

During the test, there shall be no flashover between live parts of different polarity or between live parts and parts of the earthing circuit, if any, nor shall there be any sustained arcing.

After the test, the test sample shall show no damage impairing its further use.

## 20 Normal operation

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

Compliance is checked by testing the connectors/appliance outlets in the apparatus described in Clause 19.

Appliance inlets and plug connectors are not tested.

Ratings for the tests are taken from Table 7.

The selector switch C, connecting the earthing circuit and accessible metal parts to one of the poles of the supply, is operated after half the number of strokes at rated current.

**Table 7 – Ratings for the tests of Clause 20**

Rated current [A]	Test voltage [V]	Test current [A]	Power factor (cos $\phi$ )	Minimum number of strokes
$\leq 0,2$	–	no current	–	4 000
$> 0,2$ to $< 10$	rated voltage	rated current	$0,6 \pm 0,05$	2 000
	–	no current	–	6 000
$\geq 10$	rated voltage	rated current	$0,95 \pm 0,05$	2 000
	–	no current	–	6 000

NOTE 1 28 to 30 strokes per minute with continuous movement.

NOTE 2 Current flow period:  $1,5^{+0,5}_0$  s .

NOTE 3 A stroke is an engagement or a disengagement of the sample under test into the counterpart.

NOTE 4 The test sample is fully inserted into and withdrawn from its counterpart during each cycle.

After the test, the test samples shall withstand an electric strength test as specified in 15.3. The test voltage is reduced to 50 % of the value of Table 4 without humidity treatment.

The test sample shall not show any

- wear impairing its further use;
- deterioration of enclosures or barriers;
- damage to the entry holes for the pins that might impair proper working;
- loosening of electrical or mechanical connections;
- seepage of sealing compound.

The electrical safety shall not be impaired.

## 21 Temperature rise

Contacts and other current-carrying parts shall be so designed as to prevent excessive temperature rise due to the passage of current.

Compliance is checked, for connectors/appliance outlets, by the following test.

Rewirable connectors are fitted with polyvinyl chloride insulated cords having a length of 1 m and a cross-sectional area according to Table 8.

Appliance outlets are fitted with insulated conductors according to Table 8.

The terminal screws, if any, are tightened with two-thirds of the torque specified in the appropriate column of Table 12.

**Table 8 – Cords and conductors for the tests of Clause 21**

Type of coupler	Rated current [A]	Conductor [mm <sup>2</sup> ]	Test current [A]
Connectors	≤ 0,2	–	not tested
Non-rewirable connectors	> 0,2 to ≤ 16	with cord as delivered	1,25 × rated current
Rewirable connectors	≤ 10	1,0	1,25 × rated current
	> 10	1,5	
Appliance outlets	> 0,2 to ≤ 6	0,75	1,25 × rated current
	> 6 to ≤ 10	1,0	
	> 10	1,5	

The connector is inserted into an appliance inlet having brass pins with the minimum dimensions specified in the relevant standard sheet, a tolerance of +0,02 mm being allowed, the distance between pin centres having the value specified in the standard sheet.

Appliance outlets are connected to a plug connector.

For non-standardized appliance couplers, the counterpart specified by the manufacturer is used.

An alternating current of 1,25 times the rated current is passed through the current-carrying contacts for 1 h.

For connectors/appliance outlets with earthing contact, the current is then passed through one current-carrying contact and the earthing contact for 1 h.

The temperature rise of terminals and contacts shall not exceed 45 K.

After this test, the test samples shall withstand the test of Clause 16.

## 22 Cords and their connection

### 22.1 Cords for non-rewirable connectors/plug connectors

Non-rewirable connectors/plug connectors shall be provided with a cord complying with Table 9 or equivalent.

Non-rewirable connectors/plug connectors shall be provided with a type of cord complying with the standard indicated in Table 9 for the type of connector/plug connector and, in addition, the cord shall have a cross-sectional area not less than that specified in Table 9.



**Table 9 – Type and nominal cross-sectional area of cords**

Type of connector/plug connector	Type of cord <sup>a</sup>	Nominal cross-sectional area mm <sup>2</sup>
0,2 A	60227 IEC 41 <sup>b</sup>	–
2,5 A for class I equipment	60227 IEC 52	0,75
2,5 A for class II equipment	60227 IEC 52	0,75 <sup>c</sup>
6 A	60227 IEC 52	0,75
10 A for cold conditions	60227 IEC 53 or 60245 IEC 53	0,75 <sup>d</sup>
10 A for hot conditions	60245 IEC 53 60245 IEC 89	0,75 <sup>d</sup>
10 A for very hot conditions	60245 IEC 53 60245 IEC 89	0,75 <sup>d</sup>
16 A for cold conditions	60227 IEC 53 or 60245 IEC 53	1,0 <sup>d</sup>
16 A for very hot conditions	60245 IEC 53 60245 IEC 89	1,0 <sup>d</sup>

NOTE For a cross-sectional area using American Wire Gauge (AWG), see Annex D.

<sup>a</sup> Other cable or cord with equivalent properties may also be used.

<sup>b</sup> In length not exceeding 2 m.

<sup>c</sup> If the cord has a length not exceeding 2 m, a nominal cross-sectional area of 0,5 mm<sup>2</sup> is allowed.

<sup>d</sup> If the cord has a length exceeding 2 m, nominal cross-sectional areas shall be minimum

- 1,0 mm<sup>2</sup> for 10 A connectors;
- 1,5 mm<sup>2</sup> for 16 A connectors.

Non-rewirable connectors/plug connectors with earthing contact shall be provided with a three-core cord.

In non-rewirable, non-reversible connectors/plug connectors the cores of the cord shall be connected to the contacts in the following manner:

- green/yellow core to the earthing contact;
- brown core to the line contact;
- light blue core to the neutral contact.

Compliance is checked by inspection and by measurement.

## 22.2 Cord anchorage

### 22.2.1 General

Connectors/plug connectors shall be provided with a cord anchorage such that the conductors are relieved from strain, including twisting, where they are connected to the terminals or terminations, and that their outer covering is protected from abrasion.

NOTE Cord anchorages of the "labyrinth" type are allowed, provided they withstand the relevant tests.

### 22.2.2 Additional requirements for rewirable connectors/plug connectors

Additional requirements for rewirable connectors/plug connectors are:

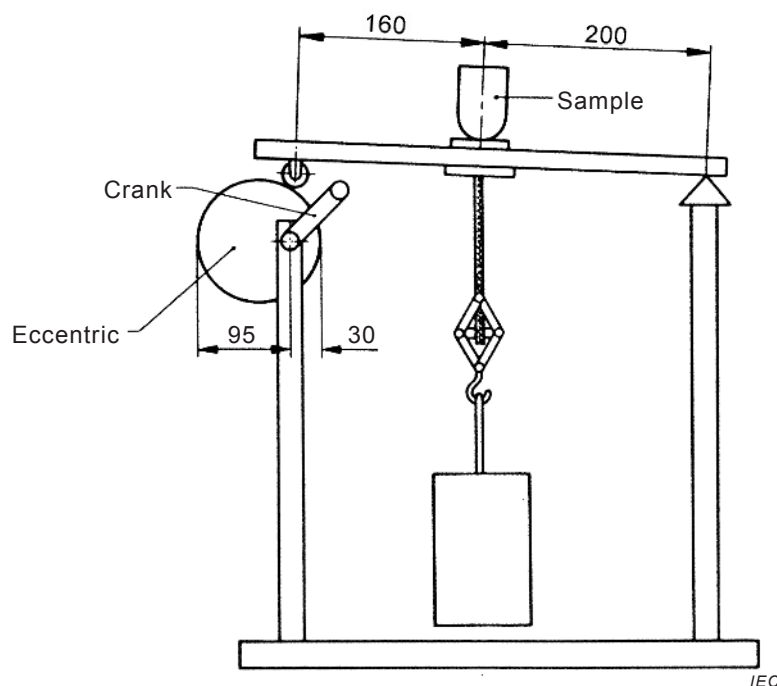
- it shall be clear how the relief from strain and the prevention of twisting is intended to be effected;

- the cord anchorage, or at least a part of it, shall be integral with or fixed to one of the other component parts of the connector/plug connector;
- makeshift methods, such as tying the cord into a knot or tying the ends with string, shall not be used;
- cord anchorages shall be suitable for the different types of cord which may be connected, and their effectiveness shall not depend upon the assembly of the parts of the body;
- cord anchorages shall be of insulating material or be provided with an insulating lining fixed to the metal parts;
- it shall not be possible for the cord to touch the clamping screws of the cord anchorage if these screws are accessible with the test probe B of IEC 61032 (standard test finger) or are electrically connected to accessible metal parts;
- metal parts of the cord anchorage, including its screws, shall be insulated from the earthing circuit.

### 22.2.3 Pull test for cable anchorage

Compliance with the requirements of 22.2.1 and 22.2.2 is checked by inspection and by a pull test in an apparatus similar to that shown in Figure 6, followed by a torque test.

*Dimensions in millimetres*



**Figure 6 – Apparatus for testing the cord anchorage**

Non-rewirable connectors/plug connectors are tested with the cord as delivered; rewirable connectors/plug connectors are tested first with one and then with the other type of cord, as specified in Table 10.

**Table 10 – Types of cord for the rewirable connector/plug connector test**

Type of connector/plug connector	Type of cord <sup>a</sup>	Cross-sectional area mm <sup>2</sup>	
		Pull test acc. to 22.2.3	Flexing test acc. to 22.3
10 A for cold conditions	60227 IEC 53 60227 IEC 53	0,75 1,0	1,0
10 A for hot conditions	60245 IEC 53 60245 IEC 53	0,75 1,0	1,0
10 A for very hot conditions	60245 IEC 53 60245 IEC 53	0,75 1,0	1,0
16 A for cold conditions	60227 IEC 53 60227 IEC 53	1,0 1,5	1,5
16 A for very hot conditions	60245 IEC 53 60245 IEC 53	1,0 1,5	1,5

<sup>a</sup> Other cable or cord with equivalent properties may also be used.

Conductors of the cord of rewirable connectors/plug connectors are introduced into the clamping units, and the screws of clamping units, if any, are tightened just sufficiently to prevent the conductors from easily changing their position.

The cord anchorage is used in the normal way, clamping screws being tightened with a torque equal to two-thirds of the torque specified in the appropriate column of Table 12. After assembly of the test sample, the component parts shall fit snugly and it shall not be possible to push the cord into the connector/plug connector to any appreciable extent.

The test sample is fixed in the test apparatus so that the axis of the cord is vertical where it enters the connector/plug connector.

The cord is then subjected 100 times to a pull of 50 N for connectors/plug connectors having a rated current not exceeding 2,5 A and 60 N for other connectors/plug connectors. The pulls are applied without jerks, each time for 1 s.

Connectors/plug connectors provided with flat twin tinsel cords are not subjected to the torque test.

Immediately afterwards, the cord is subjected for 1 min to a torque of

- 0,1 N·m for cords, other than flat twin tinsel cords, having a nominal cross-sectional area not exceeding 0,5 mm<sup>2</sup>;
- 0,15 N·m for two-core cords having a nominal cross-sectional area of 0,75 mm<sup>2</sup>;
- 0,25 N·m in all other cases.

During the tests, the cord shall not be damaged.

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

For the measurement of the longitudinal displacement, a mark is made on the cord before starting the test while subjecting it to a preliminary pull of the value specified; the mark is made at a distance of approximately 2 cm from the end of the connector/plug connector or the cord guard. If, for non-rewirable connectors/plug connectors, there is no definite end to the

connector/plug connector or the cord guard, an additional mark is made on the body, from which the distance to the other mark is measured.

After the tests, the displacement of the mark on the cord in relation to the connector/plug connector or the cord guard is measured while the cord is subjected to a pull of the value specified.

### **22.3 Flexing test**

Connectors/plug connectors shall be so designed that the cord cannot be subjected to excessive bending where it enters the connector/plug connector.

Guards provided for this purpose shall be of insulating material and shall be fixed in a reliable manner.

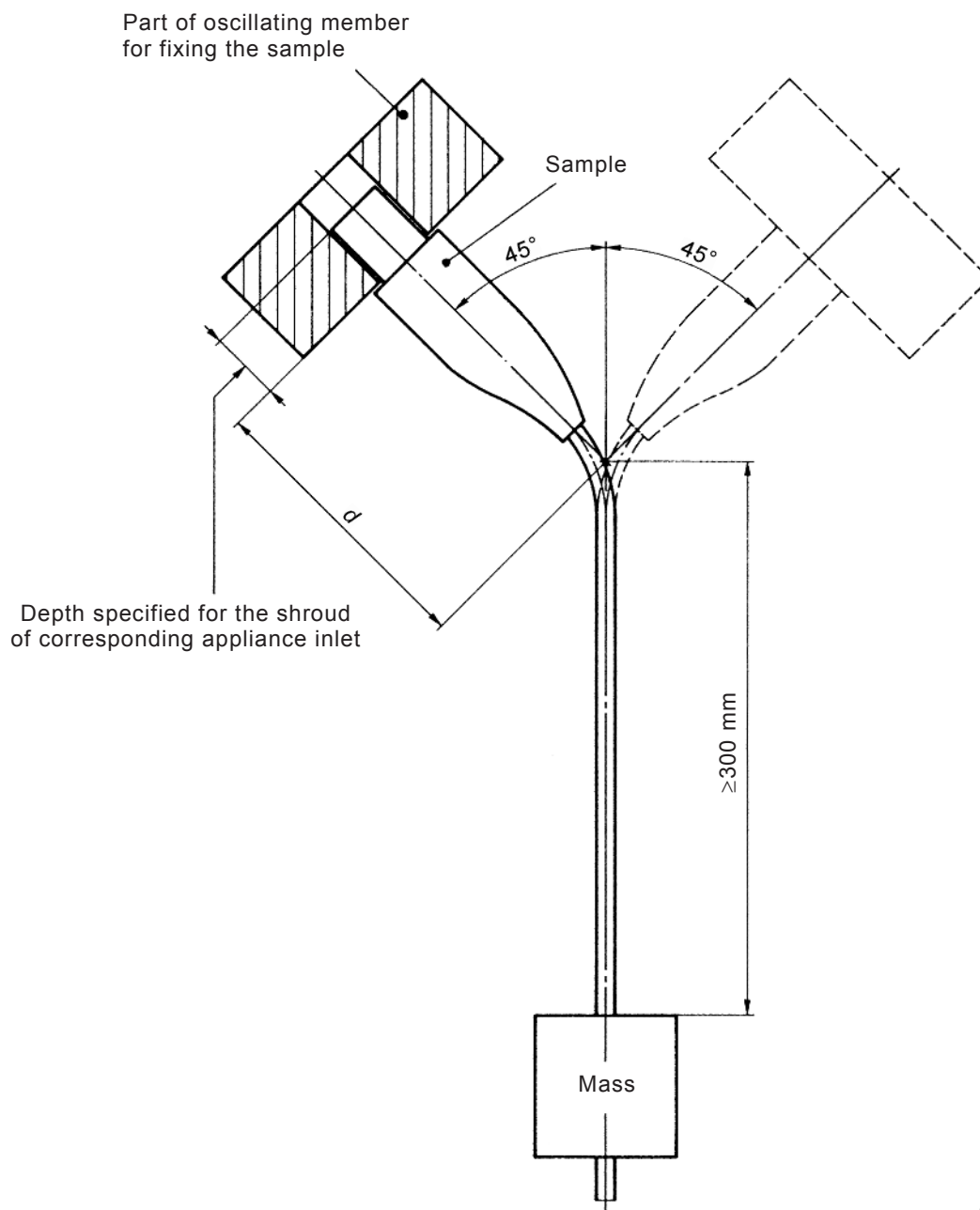
Helical metal springs, whether bare or covered with insulating material, are not allowed as cord guards.

Compliance is checked by inspection and the following test.

For rewirable connectors/plug connectors, before this test is started, the guards are subjected to an accelerated ageing test as specified in

- 24.2.2, if of elastomeric material;
- 24.2.3, if of thermoplastic material.

Connectors/plug connectors are subjected to a test in an apparatus having an oscillating member similar to that shown in Figure 7



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**Figure 7 – Apparatus for the flexing test**

Rewirable connectors/plug connectors are fitted with a cord as specified in Table 10, having an appropriate length and strands of the largest diameter allowed for that type of flexible cord. The cord guard, if any, is put in place.

Non-rewirable connectors/plug connectors are tested with the cord as delivered.

The test 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 cord, where it enters the connector/plug connector, is vertical and passes through the axis of oscillation.

The part of the connector/plug connector which, in normal use, is inside the appliance inlet/appliance outlet, is fixed in the test apparatus.

The oscillating member is, by variation of distance  $d$  shown in Figure 7, so positioned that the cord makes the minimum lateral movement when the oscillating member of the test apparatus is moved over its full travel.

Test samples with flat cords are mounted so that the major axis of the section is parallel to the axis of oscillation.

The cord is loaded so that the force applied is

- 20 N for rewirable connectors/plug connectors, and for non-rewirable connectors/plug connectors with cords having a nominal cross-sectional area exceeding 0,75 mm<sup>2</sup>;
- 10 N for other non-rewirable connectors/plug connectors.

A current equal to the rated current of the connectors/plug connectors is passed through the conductors, the voltage between them being equal to the rated voltage. No current is passed through the earthing conductor, if any.

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 10 000 and the rate of flexing being 60 per minute.

Test samples with circular-section cords are turned through 90° in the oscillating member after half the required number of flexings; test samples with flat cords are only bent in a direction perpendicular to the plane containing the axes of the cores.

During the test there shall be no interruption of the test current, and no short-circuit between conductors.

After the test, the test sample shall show no damage within the meaning of this standard, the guard, if any, shall not have separated from the body and the insulation of the cord shall show no sign of abrasion or wear; moreover, for non-rewirable connectors/plug connectors, broken strands of the conductors shall not have pierced the insulation so as to become accessible.

NOTE 1 A flexing is one movement, either backwards or forwards.

NOTE 2 The test is carried out on test samples not subjected to any other test.

NOTE 3 A short-circuit between the conductors of the cord is considered to occur if the current attains a value equal to twice the rated current of the connector.

## 23 Mechanical strength

### 23.1 General

Appliance couplers shall have adequate mechanical strength.

Compliance is checked

- for connectors/plug connectors, by the test of 23.2;
- for connectors/plug connectors with a rating exceeding 0,2 A, by the tests of 23.3 and 23.6;
- for appliance couplers intended for surface mounting and the shrouds of plug connectors, by the tests of 23.4;
- for connectors according to standard sheet C7 of IEC 60320-3, by the additional test of 23.5.

### 23.2 Free fall test

Rewirable connectors/plug connectors are fitted with the cord, specified in 22.3, having the smallest cross-sectional area and a free length of approximately 100 mm, measured from the outer end of the guard.

Terminal screws and assembly screws are tightened with a torque equal to two-thirds of the torque specified in the appropriate column of Table 12.

Non-rewirable connectors/plug connectors are tested with the cord as delivered, the cord being cut so that a free length of approximately 100 mm projects from the outer end of the guard.

The test samples shall be subjected one at a time to the free fall test procedure 2 according to IEC 60068-2-31, the number of falls being

- 500 if the mass of the test sample without cord or cord guard does not exceed 200 g and
- 100 in all other cases.

After the test, the test samples shall show no damage and no part shall have become detached or loosened which may influence the electrical safety.

NOTE 1 Small pieces can be broken off without causing rejection, provided that protection against electric shock is not affected.

NOTE 2 Damage to finish and small dents which do not reduce the creepage distances or clearances below the values specified in Clause 26 are neglected.

NOTE 3 The approximate 100 mm length can be reduced in order to ensure free fall.

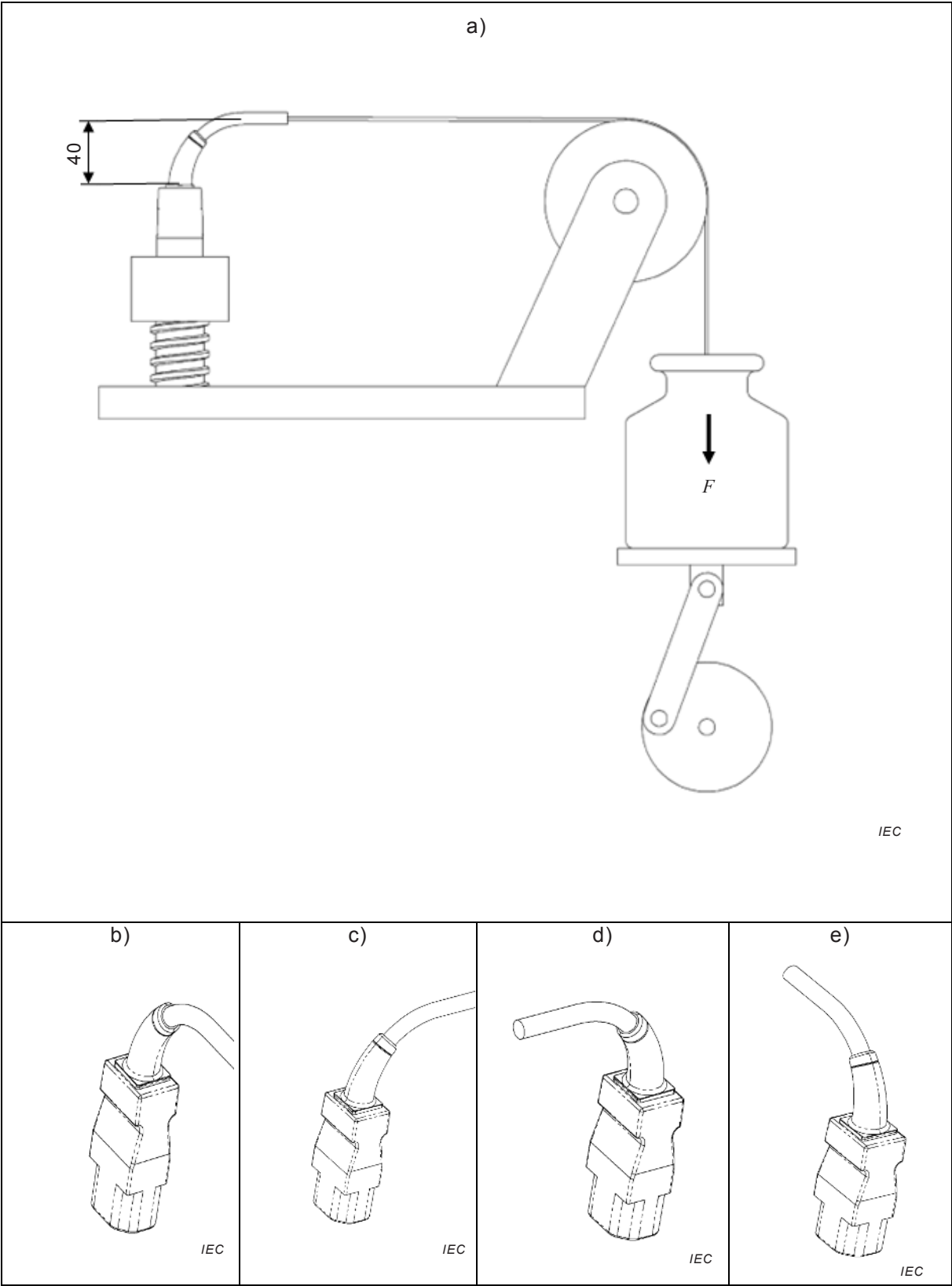
### 23.3 Lateral pull test

After the test of 23.2, the connector/plug connector is inserted into the corresponding appliance inlet/appliance outlet.

The appliance inlet/appliance outlet is mounted in an appropriate test apparatus with the pins/contacts pointing upwards.

An example of the test apparatus is shown in Figure 8a).

*Dimensions in millimetres*



**Figure 8 – Example of apparatus for pulling test**



A lateral pull force is applied in steps of  $90^\circ \pm 5^\circ$  as shown in Figure 8a), b), c), d) and e) parallel with the plane containing the axes of the current-carrying pins/contacts and parallel with the engagement face of the connector/plug connector.

A pull force according to Table 11 is applied 50 times in each direction to the cord for  $1 \text{ s} \pm 0,5 \text{ s}$ .

**Table 11 – Values for the lateral pulls applied**

Rated current A	Pull N
2,5	6
6	35
10	35
16	50

If necessary, the connector/plug connector is prevented from coming out of the appliance inlet/appliance outlet but shall be free to move inside the appliance inlet/appliance outlet.

After the test, the connector/plug connectors shall show no damage and the test samples shall comply with 16.3.

#### 23.4 Impact test

Appliance inlets designed for surface-mounting, and the shrouds of plug connectors and appliance outlets of insulating material, other than elastomeric material, are tested by means of vertical hammer or spring hammer according to IEC 60068-2-75.

The hammer head has a hemispherical face with a radius of 10 mm.

The impact energy is  $0,5 \text{ J} \pm 0,05 \text{ J}$ .

The hammer head has a hemispherical face of polyamide having a Rockwell hardness of HR 85 to 100.

The test sample is rigidly supported and 12 impacts are applied, three to each of four places chosen so as to include the weakest areas.

After the test, the test sample shall show no damage within the meaning of this standard.

#### 23.5 Deformation test

For 2,5 A connectors for class II equipment according to standard sheet C7 of IEC 60320-3, the area where the switch cam(s) can touch the connector shall be sufficiently resistant to deformation.

NOTE This area is indicated by "3)" on standard sheet C7.

Compliance is checked by the following test, which is made by means of an apparatus having a rectangular blade as shown in Figure 8 in IEC 60320-3:2014. The test is made with blade A and with blade B successively, which are pressed against the connector body in the area to be checked, with the force as specified in Figure 8 in IEC 60320-3:2014.

The apparatus with the test sample in position is kept in a heating cabinet at a temperature of  $70^\circ \text{C} \pm 2^\circ \text{C}$  for 2 h.

The test sample is then removed from the apparatus and cooled down within 10 s to approximately room temperature by immersion in cold water.

The thickness of the connector body is measured immediately at the point of impression. The difference between the thickness values before and after the test shall be not more than 0,2 mm.

### 23.6 Torque and pull test

The external parts of connectors/plug connectors with a separate front part enclosing the contacts shall be reliably fixed to one another.

Compliance is checked for all connectors and plug connectors by the following test, but for connectors and plug connectors for hot and very hot conditions immediately after the test in 18.2.

The front part and the rear part of the connectors/plug connectors are securely fixed to two claws which are so arranged that they can separate from each other in a straight line. A pull force following Table 12 is applied in the axial direction without jerks to the claws. The force is maintained for 1 min. After having removed the force, a torque following Table 12 is applied twice to the connector, first for 1 min twisting the connector in a direction perpendicular to the axis of the previous applied force and then for 1 min bending the connector in a direction perpendicular to the axis of the previous applied force and torque.

**Table 12 – Values for torque and pull forces**

Rated current A	Torque N·m	Pull N
0,2	$0,2 \pm 0,02$	$75 \pm 2$
2,5	$0,2 \pm 0,02$	$75 \pm 2$
6	$0,5 \pm 0,02$	$75 \pm 2$
10	$0,5 \pm 0,02$	$100 \pm 2$
16	$0,5 \pm 0,02$	$100 \pm 2$

After the test, the two parts of the connectors/plug connectors shall not have been detached, nor shall parts providing protection against electric shock have loosened or live parts become accessible.

## 24 Resistance to heat and ageing

### 24.1 Resistance to heat

Appliance couplers shall be sufficiently resistant to heat.

Parts of the cord anchorage and the cord guard, parts not immediately surrounding the socket contacts of connectors moulded together with the cord, and parts of ceramic are not subjected to this test.

Compliance is checked with new samples using the ball pressure test according to IEC 60695-10-2 at the following temperatures:

- $155 \text{ °C} \pm 2 \text{ °C}$  for parts classified according to 7.1c) (very hot conditions);
- $125 \text{ °C} \pm 2 \text{ °C}$  for parts classified according to 7.1b) (hot conditions);

- $125\text{ °C} \pm 2\text{ °C}$  for parts classified according to 7.1a) (cold conditions) which retain current-carrying parts and parts of the earthing circuit in position;
- $75\text{ °C} \pm 2\text{ °C}$  for other parts classified according to 7.1a) (cold conditions).

The diameter of the impression caused by the ball is measured and shall not exceed 2 mm.

## **24.2 Resistance to ageing**

### **24.2.1 General**

Connectors/plug connectors of elastomeric or thermoplastic material shall be sufficiently resistant to ageing.

Compliance is checked:

- for connectors/plug connectors of elastomeric material, by the tests of 24.2.2 and 24.2.3;
- for connectors/plug connectors of thermoplastic material, by the tests of 24.2.2 and 24.2.3.

For the tests of 24.2.2 to 24.2.4, two new test samples are used, which are first subjected to the test of Clause 16.

For the tests of 24.2.2 and 24.2.3, the use of an electrically heated cabinet is recommended.

NOTE 1 Natural air circulation can be provided by holes in the walls of the cabinet.

NOTE 2 Temperature can be measured by means of thermometers.

### **24.2.2 Ageing test for elastomeric materials**

Connectors/plug connectors of elastomeric material are subjected to an accelerated ageing test made in an atmosphere having the composition and pressure of the ambient air. The test samples are suspended freely in a heating cabinet, ventilated by natural air circulation. They are kept in the cabinet, which is maintained at a temperature of  $70\text{ °C} \pm 2\text{ °C}$ , for 240 h (10 days).

### **24.2.3 Ageing test for thermoplastic materials**

Connectors/plug connectors of thermoplastic material are subjected to an accelerated ageing test made in an atmosphere having the composition and pressure of the ambient air. The test samples are suspended freely in a heating cabinet, ventilated by natural circulation. They are kept in the cabinet, which is maintained at a temperature of  $80\text{ °C} \pm 2\text{ °C}$ , for 168 h (7 days).

During the test, the connectors/plug connectors are in engagement with a corresponding appliance inlet/appliance outlet according to the relevant standard sheet.

### **24.2.4 Ageing test assessment**

After the tests of 24.2.2 or 24.2.3, the test samples are allowed to attain approximately ambient temperature and are then examined. They shall show no crack visible to the naked eye, nor shall the material have become sticky or greasy, this being judged as follows.

A forefinger wrapped in a dry piece of rough cloth is pressed on the test sample with a force of 5 N.

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

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

NOTE The force of 5 N can be obtained in the following way.

The test 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 test sample plus 500 g. Equilibrium is then restored by pressing the test sample with the forefinger, wrapped in the piece of cloth.

## 25 Screws, current-carrying parts and connections

### 25.1 General

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

Screws and nuts for the connection of conductors shall be in engagement with a metal thread.

Screws for mounting parts of appliance couplers shall not be a thread-cutting type.

Screws or nuts for fixing the base of the appliance inlet/appliance outlet on an appliance can be any type. Screws of insulating material shall not be used in cases when the replacement with metal screws could impair the insulation of the appliance coupler.

Compliance is checked by inspection and by the following test.

The screws and nuts are tightened and loosened:

- 10 times for metal screws in engagement with a thread of insulating material and for screws of insulating material;
- 5 times in all other cases.

Screws or nuts in engagement with a thread of insulating material and screws of insulating material are completely removed and reinserted each time. The test is made by means of a suitable test screwdriver or spanner applying a torque as declared by the manufacturer. If not declared then the values shown in Table 13 are used.

When testing the terminal screws of connectors/plug connectors, a flexible conductor is placed in the terminal. The conductor is moved each time the screw or nut is loosened.

The nominal cross-sectional area of this conductor is 1 mm<sup>2</sup> for 10 A connectors/plug connectors and 1,5 mm<sup>2</sup> for 16 A connectors/plug connectors.

The screws and nuts shall be tightened smoothly.

**Table 13 – Torque applied for the tightening and loosening test**

Nominal diameter of thread mm	Torque N·m	
	I	II
Up to and including 2,8	0,2	0,4
Over 2,8 up to and including 3,0	0,25	0,5
Over 3,0 up to and including 3,2	0,3	0,6
Over 3,2 up to and including 3,6	0,4	0,8
Over 3,6 up to and including 4,1	0,7	1,2
Over 4,1 up to and including 4,7	0,8	1,8
Over 4,7 up to and including 5,3	0,8	2,0

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

Column II applies to other screws and to nuts.

For screws having a hexagonal head with a slot, only the test with the screwdriver is made.

During the test, the screwed connection shall not work loose and there shall be no damage, such as breakage of screws or damage to the head slots, threads, washers or stirrups, which will impair the further use of the accessory.

## 25.2 Electrical connections

Electrical connections shall be so designed and constructed that contact pressure shall not be transmitted via the insulating material, other than ceramic or pure mica, unless there is sufficient resiliency in the metallic parts to compensate for any possible shrinkage or yielding of the insulated material.

Compliance is checked by inspection.

NOTE For electrical connections up to 0,2 A the contact pressure can be obtained by insulating material that ensures reliable and permanent contact under all conditions of normal use.

## 25.3 Securement of connections

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

Connections between terminals and other parts shall be so designed that they will not work loose in normal use.

Compliance is checked by inspection and 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.

## 25.4 Metallic parts

Current-carrying parts and earthing contacts shall be of a metal having, under conditions occurring in the appliance coupler, adequate mechanical strength and resistance to corrosion.

Parts which may be subjected to mechanical wear shall not be made of steel provided with electroplated coating.

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

Under moist conditions, metals having a great difference of electro-chemical potential with respect to each other shall not be used in contact with each other.

NOTE 1 Examples of suitable metals, when used within the permissible temperature range and under normal conditions of chemical pollution are (this list is not exhaustive):

- 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 a coating of zinc according to ISO 2081, the coating having a thickness of at least 5 µm (ISO Service Condition No. 1);
- steel provided with a coating of nickel and chromium according to ISO 1456, the coating having a thickness of at least 20 µm (ISO Service Condition No. 2);
- steel provided with a coating of tin according to ISO 2093, the coating having a thickness equal to at least 12 µm (ISO Service Condition No. 2).

NOTE 2 Screws, nuts, washers, clamping plates and similar parts of terminals are not regarded as current-carrying parts.

## **26 Clearances, creepage distances and solid insulation**

### **26.1 General**

Appliance couplers shall be constructed so that the clearances, creepage distances and solid insulation are adequate to withstand the electrical, mechanical and thermal stresses under the environmental influences that may occur during the anticipated life of the appliance couplers and interconnection couplers.

Compliance is checked by inspection and by the tests 26.2, 26.3 and 26.4.

NOTE The requirements and tests are based on IEC 60664-1.

### **26.2 Clearances**

#### **26.2.1 Dimensioning**

The clearances shall be dimensioned to withstand the rated impulse voltage declared by the manufacturer.

For a standard appliance coupler, the minimum rated impulse voltage is 2 500 V. For other rated impulse voltages, see Table 14.

**Table 14 – Rated impulse withstand voltage for appliance couplers energized directly from the low voltage mains**

Voltage line to neutral derived from nominal voltages a.c. up to and including  V	Rated impulse withstand voltage  kV		
	Overtoltage category		
	I	II	III
50	0,33	0,5	0,8
100	0,5	0,8	1,5
150	0,8	1,5	2,5
300	1,5	2,5	4,0

NOTE 1 For more detailed information, see IEC 60664-1. For example, for the overvoltage category, see 4.3.3.2 of 60664-1:2007.

NOTE 2 Appliance couplers are considered to fall within overvoltage category II. Overtoltage category I is applicable if special precautions against transient overvoltages are taken.

For the measurements:

Parts which can be removed without the use of a tool shall be removed and parts which can be assembled in different orientations are placed in the most unfavourable position.

NOTE Movable parts are for example hexagonal nuts, the position of which cannot be controlled throughout an assembly.

Distances through slots or openings in the surfaces of the insulating material are measured to a metal foil in contact with the surface. The foil is pushed into corners and the like by means of test probe 11 according to IEC 61032, but is not pressed into openings.

A force of 2 N is applied to bare conductors and 30 N for accessible surfaces in order to attempt to reduce clearances when making the measurement.

The force is applied by means of test probe 11 according to IEC 61032.

### 26.2.2 Minimum values for clearances

The clearance for basic insulation, supplementary insulation and functional insulation shall not be less than the values specified in Table 15.

The clearances for reinforced insulation shall be not less than the values specified for basic insulation in Table 15 but using the next higher step for the rated impulse withstand voltage in Table 14.

Compliance is checked by measurement.

**Table 15 – Minimum clearances for basic insulation**

Rated impulse withstand voltage <sup>a</sup> V	Minimum clearances in air up to 2 000 m above sea-level <sup>b</sup> mm	
	Pollution degree 1	Pollution degree 2
500	0,04	0,2
800	0,10	0,2
1 500	0,5	0,5
2 500	1,5	1,5
4 000 <sup>c</sup>	3	3

<sup>a</sup> This voltage is:

- for functional insulation: the maximum impulse voltage expected to occur across the clearance;
- for basic insulation directly exposed to or significantly influenced by transient overvoltage from the low-voltage mains: the rated impulse withstand voltage of the appliance couplers and interconnection couplers;
- for other basic insulation: the highest impulse voltage that can occur in the circuit.

<sup>b</sup> Clearances for altitudes higher than 2 000 m above sea-level shall be multiplied by the altitude correction factor following IEC 60664-1.

<sup>c</sup> This voltage is only applicable when determining reinforced insulation for a rated impulse withstand voltage of 2,5 kV.

## 26.3 Creepage distances

### 26.3.1 Dimensioning

The creepage distances shall be dimensioned for the voltage which is expected to occur in normal use taking into account pollution degree 2 and the material group. Locally pollution degree 1 may be achieved by encapsulation of the creepage distances.

For the measurements:

Parts which can be removed without the use of a tool shall be removed and parts which can be assembled in different orientations are placed in the most unfavourable position.

NOTE 1 Movable parts are for example hexagonal nuts, the position of which cannot be controlled throughout an assembly.

Distances through slots or openings in the surfaces of the insulating material are measured to a metal foil in contact with the surface. The foil is pushed into corners and the like by means of test probe 11 according to IEC 61032, but is not pressed into openings.

A force of 2 N is applied to bare conductors and 30 N for accessible surfaces in order to attempt to reduce creepage distances when making the measurement.

The force is applied by means of test probe 11 according to IEC 61032.

NOTE 2 A creepage distance cannot be less than the associated clearance.

The material group is determined according to Annex A.

### 26.3.2 Minimum creepage distances

The creepage distances for basic insulation, supplementary insulation and functional insulation shall not be less than the values specified in Table 16.



The creepage distances for reinforced insulation shall not be less than double the values specified for basic insulation in Table 16.

Compliance is checked by measurement.

**Table 16 – Minimum creepage distances for basic and functional insulation**

Voltage r.m.s <sup>a</sup>  V	Creepage distances mm			
	Pollution degree 1 <sup>b</sup>	Pollution degree 2 <sup>b</sup>		
		Material group		
		I	II	III <sup>c</sup>
50	0,18	0,6	0,85	1,2
63	0,2	0,63	0,9	1,25
80	0,22	0,67	0,95	1,3
100	0,25	0,74	1	1,4
125	0,28	0,75	1,05	1,5
160	0,32	0,8	1,1	1,6
200	0,42	1	1,4	2
250	0,56	1,25	1,8	2,5

<sup>a</sup> This voltage is the voltage rationalized by Table F.4 of IEC 60664-1:2007.  
Interpolation for intermediate values is allowed.

<sup>b</sup> Pollution degree 1 – No pollution or only dry, non-conductive pollution occurs. The pollution has no influence.  
Pollution degree 2 – Only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation is to be expected.

<sup>c</sup> Material group III includes IIIa and IIIb.

## 26.4 Solid insulation

Solid insulation shall be capable of durably withstanding electrical and mechanical stresses as well as thermal and environmental influences which may occur during the anticipated life of the appliance couplers.

Compliance is checked by measurement and during the tests of Clause 15.

The distance through accessible supplementary solid insulation shall have a minimum value of 0,8 mm.

The distance through accessible reinforced solid insulation shall have the following minimum values:

- for rated impulse withstand voltage 1 500 V: 0,8 mm;
- for rated impulse withstand voltage 2 500 V: 1,5 mm.

NOTE No minimum thickness is specified for functional, basic, inaccessible supplementary and inaccessible reinforced solid insulation.

Compliance is checked by inspection and by measurement.

## **27 Resistance of insulating material to heat, fire and tracking**

### **27.1 Resistance to heat and fire**

#### **27.1.1 General**

Parts made of insulating material which might be exposed to thermal stresses due to electric effects and whose deterioration might impair safety shall not be unduly affected by heat and fire generated within the accessory.

For accessories with a rated current exceeding 0,2 A, compliance is checked by the glow-wire test according to 27.1.2 to 27.1.11.

Appliance inlets/appliance outlets integrated or incorporated in an appliance or equipment are tested in accordance with the relevant appliance standard.

#### **27.1.2 Object of the test**

The glow-wire test is applied to ensure that an electrically heated test wire under defined test conditions does not cause ignition of insulating parts or to ensure that a part made of insulating material, which might be ignited by the heated test wire under defined conditions, burns for a limited time only and without spreading fire by flame, or burning parts, or drops falling down from the part under test.

#### **27.1.3 General description of the test**

The test is made on one test sample only.

In case of doubt, the test shall be repeated on two further test samples.

The test is made by applying the glow-wire once only. The test sample shall be positioned during the test in the most unfavourable position of its intended use (with the surface tested in a vertical position).

The tip of the glow-wire shall be applied to the specified surface of the test sample, taking into account the conditions of the intended use under which a hot part may come into contact with the test sample.

If the test cannot be made on the complete test sample, a suitable part may be cut from it.

If the specified tests are carried out at several places on the same test sample, any deterioration caused by previous tests shall not affect the results of the test to be made.

Small parts as defined in IEC 60995-2-11 are not subjected to this test.

#### **27.1.4 Description of test apparatus**

Clause 5 of IEC 60695-2-10:2000 is applicable. The pinewood board covered with a layer of wrapping tissue shall be used.

#### **27.1.5 Degree of severity**

The following test temperatures, selected from the preferred test temperatures specified in Clause 6 of IEC 60695-2-11:2000, Clause 6 of IEC 60695-2-12:2000 and Clause 6 of IEC 60695-2-13:2000, are applicable:

- 750 °C for parts made of insulating material intended to retain current-carrying parts and parts of the earthing circuit in position;
- 650 °C for all other parts made of insulating material.

#### **27.1.6 Verification of the thermocouple**

Subclause 6.2 of IEC 60695-2-10:2000 is applicable.

#### **27.1.7 Preconditioning**

Clause 7 of IEC 60695-2-10:2000 is applicable.

#### **27.1.8 Initial measurements**

Clause 8 of IEC 60695-2-11:2000, Clause 8 of IEC 60695-2-12:2000 and Clause 8 of IEC 60695-2-13:2000 are applicable.

#### **27.1.9 Test procedure**

Clause 8 of IEC 60695-2-10:2000 is applicable.

#### **27.1.10 Observations and measurements**

Clause 11 of IEC 60695-2-11:2000, Clause 11 of IEC 60695-2-12:2000 and Clause 11 of IEC 60695-2-13:2000 are applicable.

#### **27.1.11 Evaluation of test results**

Clause 12 of IEC 60695-2-11:2000, Clause 12 of IEC 60695-2-12:2000 and Clause 12 of IEC 60695-2-13:2000 are applicable.

### **27.2 Resistance to tracking**

Insulating parts supporting, or in contact with, live parts of appliance couplers for hot conditions and of appliance couplers for very hot conditions shall be of material resistant to tracking.

For materials other than ceramic, compliance is checked by the test of Annex A.

### **28 Resistance to rusting**

Ferrous parts shall be adequately protected against rusting.

Compliance is checked by the following test.

The sample is degreased by immersion in white spirit or an equivalent degreasing agent for 10 min. The parts are then immersed for 10 min in a 10 % solution of ammonium chloride at a temperature of  $20\text{ °C} \pm 5\text{ °C}$ .

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  $20\text{ °C} \pm 5\text{ °C}$ .

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

*Alternative:*

After degreasing, the sample is submitted to a test according to IEC 60068-2-60 using test method 1 with a test duration of 4 days.

After exposure, the surface shall show no areas of red rust. White rust (zinc oxide) and traces of red rust which are removable by rubbing as well as traces of rust at the surface of cuts, bent edges and welded joints are ignored.

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

## **29 Electromagnetic compatibility (EMC) requirements**

NOTE Requirements for accessories incorporating electronic components are not included as the need has not yet been established.

### **29.1 Immunity – Accessories not incorporating electronic components**

These accessories are not sensitive to normal electromagnetic disturbances and therefore no immunity tests are required.

### **29.2 Emission – Accessories not incorporating electronic components**

These accessories do not generate electromagnetic disturbances; consequently no emission tests are necessary.

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

## **Annex A** (normative)

### **Proof tracking test**

The proof tracking test is carried out in accordance with IEC 60112.

NOTE If the surface 15 mm × 15 mm cannot be obtained because of the small dimensions of the appliance couplers, special test samples made with the same manufacturing procedure can be used.

## Annex B (normative)

### Routine tests for factory wired appliance couplers related to safety

#### B.1 General

All factory wired accessories shall be subjected to the following tests as shown in Table B.1.

**Table B.1 – Test overview**

Type of accessory	Test to be performed according to ...
Two-pole accessories	B.2, B.4.1
More than two-pole accessories	B.2, B.3, B.4

Failed samples have to be treated in such a way that they cannot fulfil the intended function or be separated from satisfactory products in such a way that they cannot be released for sale.

It shall be possible to identify that appliance couplers released for sale have been subjected to the routine test.

The manufacturer shall maintain a record of the tests carried out which shows:

- type of product;
- date of test;
- place of manufacture (if manufactured in more than one place);
- tested quantity;
- number of failures and actions taken, i.e. destroyed/repaired.

The test equipment shall be checked before and after each period of use and for periods of continuous use, at least every 24 h. During these checks the equipment shall show that it indicates faults when known faulty products are inserted or simulated faults are applied.

Products manufactured prior to a check shall only be released for sale if the check is found satisfactory.

Test apparatus/equipment shall be verified/calibrated at least once a year.

Records shall be kept of all checks and any adjustments found necessary.

#### B.2 Polarized systems: Phase (L) and neutral (N) – Correct connection

For polarized systems the test shall be made by applying a current for a period of not less than 2 s between the remote end of the L and N conductors of the flexible cord independently and the corresponding L and N pin or contact of the appliance coupler.

The period of 2 s may be reduced to not less than 1 s on test equipment with automatic timing.

Polarity shall be correct.

### **B.3 Earth (PE) continuity**

The test shall be made applying a current for a period of not less than 2 s between the remote end of the PE conductor of the flexible cord and the PE pin or contact of the appliance coupler, as appropriate.

The period of 2 s may be reduced to not less than 1 s on test equipment with automatic timing.

Other suitable tests may be used.

Continuity shall be present.

### **B.4 Short-circuit/wrong connection and reduction in creepage distance and clearance**

#### **B.4.1 Accessible surface safety check**

For non-rewirable appliance coupler it shall be checked that live parts, e.g. loose strands, are not coming through the accessible surface.

If this danger cannot be prevented by the construction and/or suitable manufacturing processes, the following test or a similar one (e.g. impulse voltage test) shall be performed.

The accessible surface of appliance couplers except the engagement face of connectors and plug connectors are scanned by adjusted electrodes and a pressure force of 20 N.

Through the live parts and the surface of the appliance coupler an a.c. voltage of  $2\,000\text{ V} \pm 10\%$  shall be applied for at least 1 s.

Neither a flash-over nor a breakdown shall occur.

#### **B.4.2 Short-circuit/wrong connection**

The test shall be made between the L and N conductors and the E conductor by applying at the supply end an a.c. voltage of  $2\,000\text{ V} \pm 10\%$ , 50 Hz or 60 Hz for a period of not less than 2 s or by an impulse voltage test using 1,2/50  $\mu\text{s}$  wave form, 4 kV peak value, three impulses for each pole, with intervals of not less than 1 s, the test voltage being applied at the supply end.

The period of 2 s may be reduced to not less than 1 s on test equipment with automatic timing.

The L and N conductors may be connected together for this test.

No flashover shall occur.

## Annex C (normative)

### Test schedule

See Table C.1.

**Table C.1 – Test schedule**

Group	Clause/subclause	Description of the tests	Appliance inlet	Connector	Appliance outlet	Plug connector
1 <i>3 samples</i>	8	Marking	X	X	X	X
	9	Dimensions and compatibility	X	X	X	X
	10	Protection against electrical shock	X	X	X	X
	11	Provision for earthing	X	X	X	X
	12	Terminals and terminations	X	X	X	X
	13	Construction	X	X	X	X
	16	Forces necessary to insert and to withdraw the connector/appliance outlet		X	X	
	17	Operation of contacts	X	X	X	X
	18	Resistance to heating of appliance couplers for hot and very hot conditions	X	X		
	23	Mechanical strength	X	X	X	X
	23.2	Free fall test		X		X
	23.3	Lateral pull test		X	X	
	25	Screws, current-carrying parts and connections	X	X	X	X
	26	Clearances, creepage distances and solid insulation	X	X	X	X
	28	Resistance to rusting	X	X	X	X
29	Electromagnetic compatibility (EMC) requirements	X	X	X	X	
2 <i>3 samples<sup>a</sup></i>	14	Moisture resistance	X	X	X	X
	15	Insulation resistance and electrical strength	X	X	X	X
	16	Forces necessary to insert and to withdraw the connector/appliance outlet		X	X	
	19	Breaking capacity		X	X	
	20	Normal operation		X	X	
	21	Temperature rise		X	X	
3 <i>3 samples<sup>b</sup></i>	22	Cords and their connections		X		X



Group	Clause/subclause	Description of the tests	Appliance inlet	Connector	Appliance outlet	Plug connector
4 3 samples <sup>b</sup>	22.3	Flexing test		X		X
5 2 samples <sup>a</sup>	24	Resistance to heat and ageing	X	X	X	X
6 2 samples <sup>a</sup>	24.2.2 or 24.2.3	Ageing test for appliance couplers made of rubber or thermoplastic materials	X	X	X	X
7 2 samples <sup>a</sup>	27	Resistance of insulating material to heat, fire and tracking				
	27.1.5	Degree of severity (glow-wire test 750 °C (sample 1))	X	X	X	X
	27.1.5	Degree of severity (glow-wire test 650 °C (sample 2))	X	X	X	X
8 3 samples <sup>a</sup>	27	Resistance of insulating material to heat, fire and tracking				
	27.2	Resistance to tracking	X	X	X	X
<sup>a</sup> Sample of each different material.						
<sup>b</sup> Sample of each type of cable, cross-sectional area and manufacturer of the cable.						

## Annex D (informative)

### Comparison of typical conductor cross-sectional areas

Table D.1 provides a comparison of the conductor cross-sectional areas of the American Wire Gauge (AWG) with square millimetres, square inches, and circular mils.

**Table D.1 – Comparison of conductor sizes**

Wire size	Gauge no. (AWG)	Cross-sectional area		d.c. resistance of copper at 20 °C Ω/km	Circular mils
		mm <sup>2</sup>	in <sup>2</sup>		
0,2		0,196	0,000 304	91,62	387
	24	0,205	0,000 317	87,60	404
0,3		0,283	0,000 438	63,46	558
	22	0,324	0,000 504	55,44	640
0,5		0,500	0,000 775	36,70	987
	20	0,519	0,000 802	34,45	1 020
0,75		0,750	0,001 162	24,80	1 480
	18	0,823	0,001 272	20,95	1 620
1,0		1,000	0,001 550	18,20	1 973
	16	1,31	0,002 026	13,19	2 580
1,5		1,500	0,002 325	12,20	2 960
	14	2,08	0,003 228	8,442	4 110
2,5		2,500	0,003 875	7,56	4 934
	12	3,31	0,005 129	5,315	6 530
4		4,000	0,006 200	4,700	7 894
	10	5,26	0,008 152	3,335	10 380
6		6,000	0,009 300	3,110	11 841
	8	8,37	0,012 967	2,093	16 510
10		10,000	0,001 550	1,840	19 735
	6	13,3	0,020 610	1,320	26 240
16		16,000	0,024 800	1,160	31 576
	4	21,1	0,032 780	0,8295	41 740
25		25,000	0,038 800	0,7340	49 338
	2	33,6	0,052 100	0,5211	66 360
35		35,000	0,054 200	0,5290	69 073
	1	42,4	0,065 700	0,4139	83 690
50		47,000	0,072 800	0,3910	92 756

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