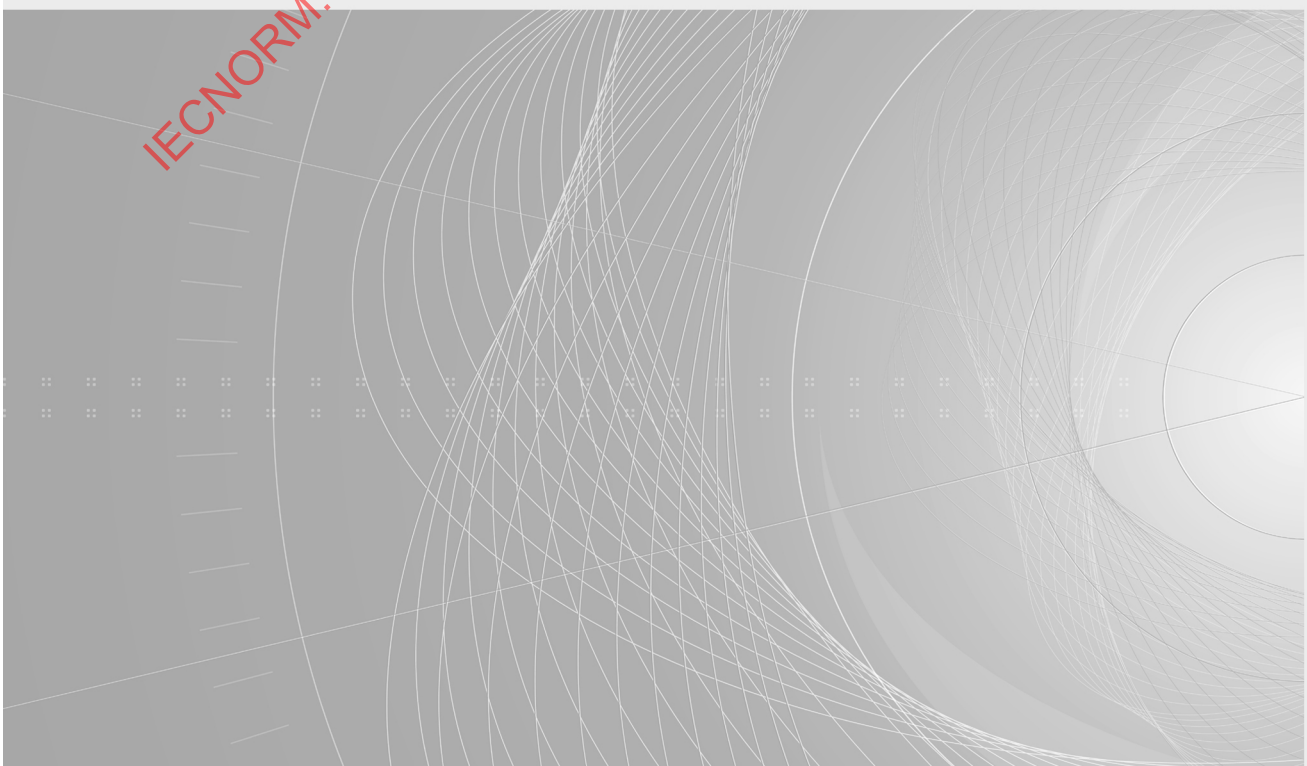
IEC TS 63236-1

Edition 1.0 2021-06

TECHNICAL SPECIFICATION

Direct current (DC) appliance couplers for information and communication technology (ICT) equipment installed in data centres and telecom central offices –
Part 1: 2,6 kW system



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DIRECT CURRENT (DC) APPLIANCE COUPLERS FOR INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) EQUIPMENT INSTALLED IN DATA CENTRES AND TELECOM CENTRAL OFFICES –

Part 1: 2,6 kW system

FOREWORD

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IEC TS 63236-1 has been prepared by IEC technical committee 23: Electrical accessories. It is a Technical Specification.

IEC TS 63236-1 is to be used in conjunction with the other parts of the IEC 63236 series, if applicable.

The text of this Technical Specification is based on the following documents:

DTS	Report on voting
23/915/DTS	23/957A/RVDTS

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

The language used for the development of this Technical Specification is English

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

In this document, the following print types are used:

- requirements proper: in roman type;
- *test specifications: in italic type;*
- notes: in small roman type.

A list of all parts in the IEC 63236 series, published under the general title *Direct current (DC) appliance couplers for information and communication technology (ICT) equipment installed in data centres and telecom central offices*, can be found on the IEC website.

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

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- withdrawn,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

DIRECT CURRENT (DC) APPLIANCE COUPLERS FOR INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) EQUIPMENT INSTALLED IN DATA CENTRES AND TELECOM CENTRAL OFFICES –

Part 1: 2,6 kW system

1 Scope

This part of IEC 63236, which is a Technical Specification, applies to DC appliance couplers for class I equipment with two active contacts plus an earthing contact, a rated power of 2,6 kW and a rated voltage range from 294 V to 400 V DC. They are intended to power DC information and communication technology equipment only, as specified in IEC 62368-1.

The accessories according to this document are intended to be used by ordinary persons in data centres only where the value of the DC voltage distribution system is defined as follows:

– 380 V with a tolerance of ±20 V for installations with no backup battery or with a voltage regulation system;
– 380 V with a voltage range of 294 V to 400 V for installations with a backup battery where voltage regulation is not guaranteed;
– the voltage value between each live conductor and earth does not exceed 200 V DC during normal operation;
– there are two abnormal voltage ranges (duration below 10 min):
  - 260 V up to 294 V, and
  - above 400 V to 410 V.

The maximum current of the appliance couplers is

– 6,5 A when the voltage between live contacts is 400 V DC,
– 8,8 A when the voltage between live contacts is 294 V DC,

and can rise up to 10 A when the voltage between live contacts decreases to 260 V DC for 10 min maximum.

The voltage between live conductors can fall down to 260 V DC when the voltage discharge value of the battery reaches the disconnecting level. The consequence is that the current increases accordingly.

The accessories according to this document do not require maintenance.

The accessories according to this document are intended for use in circuits where

– basic protection,
– an overcurrent protection (of 8,8 A or less for each socket-outlet or multiple socket-outlet),
– the fault protection (indirect contact protection), and
– additional protection

are already assured.

Appliance couplers complying with this document are suitable for normal use at ambient temperatures not normally exceeding +60 °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 the IEC TS 62735 series.

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

2 Normative references

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

IEC 60068-2-31, *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 60417, *Graphical symbols for use on equipment* (available at: http://www.graphicalsymbols.info/equipment)

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

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

IEC 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 mm2 up to 35 mm2 (included)*

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

IEC 62368-1, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

IEC TS 63236-3, *Direct current (DC) appliance couplers for information and communication technology (ICT) equipment installed in data centres and telecom central offices – Part 3: AC/DC appliance inlet*

ISO/IEC GUIDE 51, *Safety aspects – Guidelines for their inclusion in standards*

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

3 Terms and definitions

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

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

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

3.1
appliance coupler
means enabling the connection and disconnection of an appliance or equipment to the supply

SEE: Figure 1.

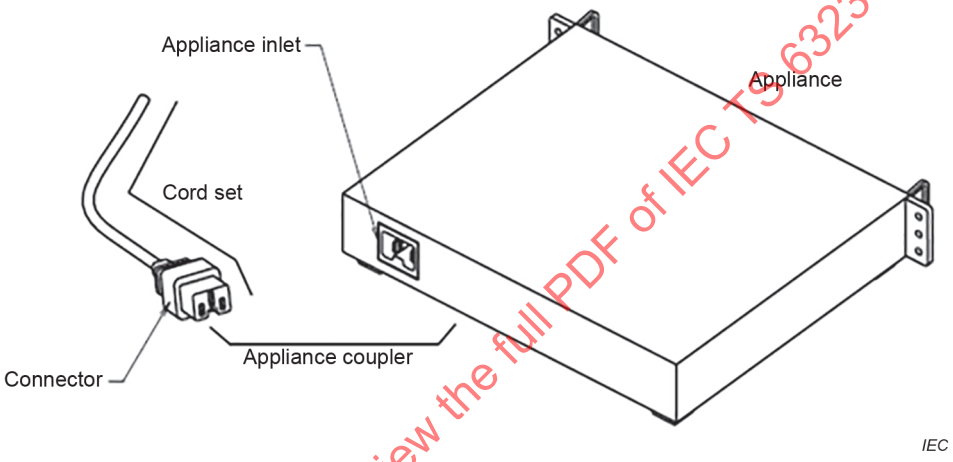


Figure 1 – Intended use of appliance couplers

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
rewirable accessory
accessory so constructed that a cable or cord can be replaced

3.3
non-rewirable accessory
accessory so constructed that it forms a complete unit with the flexible supply cable or cord after connection and assembly by the manufacturer of the accessory

3.4
cord set
assembly consisting of a flexible cable or cord fitted with a non-rewirable plug and a non-rewirable connector, intended for the connection of an electrical appliance to the electrical supply

SEE: Figure 1.

3.5
integrated appliance coupler
appliance coupler which is formed by the housing or enclosure of the appliance or equipment and cannot be tested separately

3.6
incorporated appliance coupler
appliance coupler built in or fixed to an appliance or equipment, but that can be tested separately

3.7
retaining device
mechanical provision or arrangement which holds a connector in proper engagement with a corresponding appliance inlet and prevents its unintentional withdrawal

3.8
rated voltage
voltage assigned by the manufacturer for a specified operating condition of an accessory

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

3.9
rated current
current assigned by the manufacturer for a specified operating condition of an accessory

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

3.10
terminal
part of an accessory to which a conductor is attached, providing a re-usable connection

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

3.11
termination
part of an accessory to which a conductor is permanently attached

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

3.12
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]

3.13
type test
conformity test made on one or more items representative of the production

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

3.14
routine test
conformity test made on each individual item during or after manufacture

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

3.15
clamping unit
part(s) of the terminal necessary for the mechanical clamping and the electrical connection of the conductor(s), including the parts which are necessary to ensure the correct contact pressure

3.16
screw-type terminal
terminal for the connection and subsequent disconnection of a conductor or the interconnection of two or more conductors, capable of being dismantled, the connection being made, directly or indirectly, by means of screws or nuts of any kind

3.16.1
pillar terminal
screw-type terminal in which the conductor is inserted into a hole or cavity, where it is clamped under the end of the screw or screws

3.16.2
stud terminal
screw-type terminal in which the conductor is clamped under a nut

3.16.3
saddle terminal
screw-type terminal in which the conductor is clamped under a saddle by means of two or more screws or nuts

3.16.4
mantle terminal
screw-type terminal in which the conductor is clamped against the base of a slot in a threaded stud by means of a nut

3.17
screwless terminal
connecting device for the connection and subsequent disconnection of a rigid (solid or stranded) or flexible conductor or the interconnection of two or more conductors, capable of being dismantled, the connection being made, directly or indirectly, by means of springs, parts of angled, eccentric or conical form, etc., without special preparation of the conductor concerned, other than removal of insulation

3.18
thread-forming screw
screw having an uninterrupted thread which, by screwing in, forms a thread by displacing material

3.19
rated power
power assigned to the appliance coupler

3.20
rated voltage range
voltage range assigned to the appliance coupler

3.21
base
part of the connector or inlet supporting the socket-contacts

3.22
live part
conductor or conductive part intended to be energized in normal use, including a neutral conductor, but, by convention, not a PEN conductor

[SOURCE: IEC 60050-826: 826-12-08, modified – "normal operation" has been replaced by "normal use", "PEM or PEL conductor" has been deleted, and the note has been deleted.]

3.23
cable anchorage
part of an accessory which has the ability to limit the displacement of a fitted flexible cable against pull, push and turning forces

3.24
main part
assembly consisting of the base and other parts

3.25
prospective short-circuit current
current that would flow in the circuit if the connector, the limitation device and the short circuit in the appliance inlet were replaced by links of negligible impedance without any other change in the circuit

3.26
prospective let-through i^2t value
value that would be let through by the current limiting device if the connector and the short circuit in the appliance inlet were replaced by links of negligible impedance

3.27
stroke
insertion or a withdrawal of the appliance coupler

3.28
exposed-conductive-part
conductive part of equipment which can be touched and which is not normally live, but which can become live when basic insulation fails

4 General requirements

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

Compliance is checked by meeting all the relevant requirements and tests specified.

5 General notes on tests

5.1 General

Tests shall be made to demonstrate compliance with the requirements specified in this document, 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 document.
- Appliance inlets 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 document if there is not more than one failure of one test sample in one of the tests.
- The test samples are tested with direct current.

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

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 °C ± 5 °C.

Tests shall not commence earlier than 168 h after manufacture.

Non-rewirable 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 has to be repeated unless

a) a failure occurs to one of the three test samples when tested in accordance with Clause 18, Clause 19 or Clause 20, in which case the tests are repeated from Clause 15 onwards; or

b) a failure occurs to one of the three test samples when tested in accordance with Clause 21 (except 21.3), in which case the tests are repeated from Clause 17 onwards.

The applicant may submit, together with the first set of test samples, the additional set – from the same lot or run as the original set – which can be necessary 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 A.

5.5 Test voltages

Tests shall be carried out according to the voltage described in the test with a maximum tolerance of ±5 %. In case of DC test voltage produced from rectifying the AC voltage and not coming from a battery, the ripple voltage shall not exceed 5 %.

5.6 Grouping of samples

The test schedule as given in Annex B shall be used.

6 Standard ratings

Accessories shall have a rated power of 2,6 kW at any voltage within the rated voltage range of 294 V to 400 V.

7 Classification of appliance couplers

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:

– rated power in kilowatts;
– rated voltage range in volts;
– symbol for nature of supply;
– name, trademark or identification mark of the manufacturer or responsible vendor;
– type reference;
– capacitive electronic load.

NOTE The type reference can be a catalogue number.

8.2 Additional markings

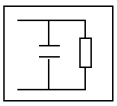
Rewirable connectors/inlets shall be additionally marked with:

– an appropriate marking indicating the length of insulation to be removed before the insertion of the conductor into the screwless terminal, if applicable;
– an indication of the suitability to accept rigid conductors only, for those connectors/inlets having this restriction.

The additional markings may be put on the connector/inlet, on the packaging unit and/or given in an instruction sheet which accompanies the connector/inlet.

8.3 Symbols or alphanumeric notations

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

watts	W
amperes	A
volts	V
direct current	DC or 
protective earth	 [IEC 60417-5019 (2006-08)] or PE
earth	 [IEC 60417-5017 (2006-08)]
capacitive load	

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 The marking for voltage, power and nature of supply can be, for example, as follows:

2600 W / 294–400 V 

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

8.4 Legibility of markings

The marking of connectors according to 8.1 shall still be easily discernible when the 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.

8.5 Terminal markings and wiring instructions

In rewirable connectors, terminals shall be indicated as follows:

– earthing terminal: the symbol  [IEC 60417-5019 (2006-08)] or PE, G, GR or the colour green adjacent to the terminal
– positive .....+
– negative .....–

In non-rewirable connectors, no marking of contacts is necessary, but conductors shall be connected as specified in 21.1.

Appliance inlets other than those integrated or incorporated in an appliance or equipment shall have terminal markings to correspond with 8.5.

Rewirable 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 cable 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.

Connectors supplied directly to an equipment manufacturer do not need these instructions with each unit, but shall be made available to the equipment manufacturer.

8.6 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.

8.7 Test and inspection

Compliance with the requirements of 8.1 to 8.6 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 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 9.4.

9.2 Single-pole connections

It shall not be possible to make single-pole connections between connectors and appliance inlets.

Compliance is checked by manual test.

9.3 Compatibility

It shall not be possible to engage connectors in inlets having a higher rated power than the connector.

Connectors and inlets for alternating current shall not be compatible with connectors and inlets for direct current unless the inlet is designed to accept alternating current and direct current as detailed in IEC TS 63236-3.

Engagement of a 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 appliance couplers

Appliance couplers shall comply with the relevant standard sheets according to Annex D.

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

Deviations from the dimensions as specified in the standard sheets, which do not adversely affect the purpose and safety of appliance couplers complying with the standard sheets, especially with regard to interchangeability and non-interchangeability, shall be acceptable in case of presence of an obvious technical benefit.

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 shall be so designed that live parts are not accessible when the connectors 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 and a contact of a connector 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.

Bushings, 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.

Compliance is checked by inspection and by manual test.

10.4 External parts

External parts of 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 couplers 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 14.

11 Provision for earthing

Appliance couplers with protective earthing contact shall be so constructed that the protective earthing contact will first make and then 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.

Accessories shall accept copper conductors having nominal cross-sectional areas as shown in Table 1.

Table 1 – Relationship between rated power and nominal cross-sectional areas or American Wire Gauge (AWG) size of copper conductors

Power and type of accessory	Flexible copper conductors	
	Nominal cross-sectional area or AWG size[a]	Corresponding diameter of the largest conductor mm
2,6 kW 2P+ ⏚	From 0,75 mm^2 up to 1,5 mm^2 inclusive or from AWG 18 up to AWG 16 inclusive	1,8 or 1,34
[a] Nominal cross-sectional area of the conductors of appliance couplers		

Compliance is checked by inspection and by measurement.

12.2 Rewirable appliance couplers

Rewirable appliance couplers shall be provided with screw-type clamping units or screwless clamping units in accordance with 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 inlet and the current-carrying contacts of the connector.

Compliance is checked by inspection.

13.2 Parts covering live parts

Parts covering live parts shall be adequately locked against loosening.

Compliance is checked by inspection and by the tests of Clause 19 and Clause 22.

13.3 Pin construction

13.3.1 Prevention of rotation

Pins and contacts of appliance couplers shall be locked against rotation.

Compliance is checked by inspection and by manual test.

NOTE Clamping screws can serve to prevent contacts from rotating.

13.3.2 Pin retention

Pins of appliance inlets 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 105° (being the maximum ambient temperature + 45 K) 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 inlet 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 N ± 0,6 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 inlet, and then in the direction towards the base of the inlet.

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.

13.3.3 Hollow pins

Pins shall be of metal. Hollow and composite pins are not allowed.

13.4 Contact pressure

Contacts of connectors shall provide adequate contact pressure which shall not be dependent upon the resiliency of insulating material.

Compliance is checked by inspection and by the tests of Clause 15 to Clause 20 inclusive.

13.5 Enclosure

13.5.1 General

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

Compliance is checked by inspection, by manual test and by the test of 22.5.

NOTE In case of doubt that the appliance coupler can be separated, a gripping test as given in Annex C can be used to verify the suitable separation.

13.5.2 Rewirable connectors

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

The enclosure of rewirable 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 is assembled and wired as in normal use, there is no possibility 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, whose conductor is connected to a live terminal, being likely to be pressed against accessible metal parts;
- a core, whose conductor 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 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.

13.5.3 Non-rewirable 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, during re-assembly of the accessory, parts or materials other than the original are used.

Compliance is checked by inspection and by manual test.

13.6 Earth connection

For connectors/appliance inlets, 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.

13.7 Location of terminals and terminations

13.7.1 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 13.7.2;*
- *for non-rewirable non-moulded-on accessories, the test of 13.7.3;*
- *for non-rewirable moulded-on accessories, by verification and inspection according to 13.7.4.*

13.7.2 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^2. 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 is 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.

13.7.3 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 is 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.

13.7.4 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 can require the checking of the product construction or assembly method.

14 Insulation resistance and electric strength

14.1 General

Appliance couplers shall have adequate insulation resistance and dielectric strength.

Compliance is checked by the tests of 14.2 and 14.3.

Indicators which might otherwise be damaged by the tests of 14.2 and 14.3, 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 connectors, between the current-carrying contacts connected together and the body;

d) for connectors, between each contact in turn and the others connected together.

Additional tests for rewirable connectors:

e) for rewirable connectors, between any metal part of the cable anchorage, including clamping screws, and the earthing contact or earthing terminal;

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

The term "body" used in items a) and c) 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 a) and c), including the engagement face of connectors .

The metal foil is wrapped around the outer surface of external parts of the 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 mm^2	Maximum diameter mm
60227 IEC 57	3 × 1,5	9,4
If a rubber cable is to be used, the maximum conductor temperature shall be 90 °C or higher.		

The test voltage according to 14.2 and 14.3 is applied between all live parts and a metal foil covering the outer surface of the couplers as follows:

- *between the different poles of the appliance coupler,*
- *between all live parts connected together and a metal foil covering the outer surface and/or exposed conductive parts.*

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

14.2 Insulation resistance

The insulation resistance of the sample is measured with an applied DC voltage of 500 V ±15 V, the measurement being made 60 s ± 5 s after application of the voltage. The insulation resistance shall not be less than 7 MΩ.

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

14.3 Dielectric strength

The test sample is subjected to a DC voltage of 4 250 V or an AC voltage of 3 000 V RMS. The voltage is applied for 60 s ± 5 s across the insulation.

Initially, not more than half the specified 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.

15 Forces necessary to insert and to withdraw the connector

15.1 General

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

Compliance is checked for connectors by the following tests:

- *Subclause 15.2 to ascertain that the maximum force necessary to withdraw the connector from the appliance inlet shall not be higher than the maximum force specified in Table 3. For the purpose of this test the gauges in Figure D.7 shall be used.*

- *Subclause 15.3 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 3. For the purpose of this test the gauges in Figure D.8 and Figure D.9 shall be used.*

Table 3 – Maximum and minimum withdrawal forces

Type of connector	Withdrawal forces N	
	15.2 Multi-pin gauge maximum	**15.3 Single-pin minimum**
2,6 kW	50	1,5

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

15.2 Verification of the maximum withdrawal force

The appliance inlet is fixed to the mounting plate A of an apparatus as shown in Figure 2, so that the axes of the appliance inlet 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.

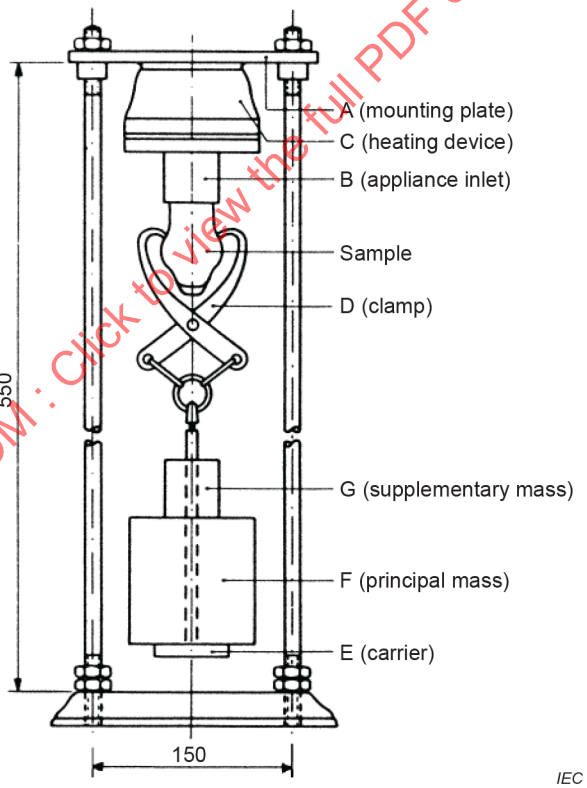


Figure 2 – Apparatus for checking the withdrawal force

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

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

The connector is inserted to the full depth into, and withdrawn from, the appropriate appliance inlet 10 times. It is then inserted again, 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 3 and it shall be made in one piece.

The principal mass is hung on the connector without jolting and the supplementary mass is allowed to fall once from a height of 5 cm on to the principal mass. The connector shall not remain for more than 3 s in the gauge.

15.3 Verification of the minimum withdrawal force

The test pin gauges are applied to each individual connector contact with the contact axes vertical and the gauge hanging vertically downwards.

The total mass of the test equipment shall be such as to exert the applicable force as shown in Table 3.

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.

16 Operation of contacts

Contacts and pins of appliance couplers shall make connection with a sliding action. The contacts of connectors 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 Clause 15, Clause 17, Clause 18, Clause 19 and Clause 20.

17 Resistance to heating of appliance couplers

17.1 General

Appliance couplers shall withstand the heating to which they can be subjected at 60 °C ambient temperature.

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

Compliance is checked, for connectors, by the test of 17.2, and, for inlets, by the test of 17.3.

17.2 Heating test for connectors

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

The connector is inserted in a suitable inlet, following the manufacturer's instructions and then placed in a heating cabinet for 96 h at a temperature of 105 °C ± 2 °C.

After removal from the heating cabinet, the connectors are then allowed to cool down to approximately ambient air temperature and are inserted into and withdrawn from the inlet 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.*

17.3 Heating test for appliance inlets

Inlets other than those integrated or incorporated in an appliance or equipment, are kept in a heating cabinet for 96 h at a temperature of 105 °C ± 2 °C

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

18 Breaking capacity

Appliance couplers shall have adequate breaking capacity.

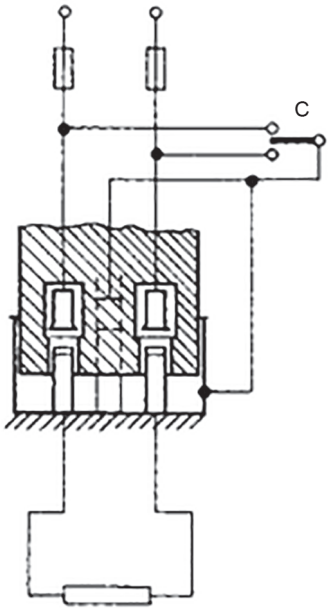
Compliance is checked, for connectors, by the following test.

The connector is mounted in an appropriate test apparatus, which incorporates the corresponding DC appliance inlet (standard sheet 1 (Figure D.1)).

The appliance inlet 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 in Annex D.

The inlet 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 3 for a circuit diagram).



Key

C selector switch

Figure 3 – Circuit diagram for breaking capacity and normal operation tests

First the test is done with a test voltage of 260 V and a test current of 1,5 times 10 A with an inrush of 300 A with a profile equivalent to that shown in IEC TS 62735-1:2015, Figure 32, for 100 strokes.

The periods during which the test current is passed from the insertion of the connector until subsequent withdrawal is 1,5 $^{+0,5}_{0}$ s.

The average speed of insertion and withdrawal of the connector during the test is 0,15 m/s.

No current is passed through the earthing circuit.

After this test the test is repeated with a test voltage of 410 V and a test current of 1,5 times 6,34 A with an inrush of 475 A with a profile equivalent to that shown in IEC TS 62735-1:2015, Figure 32, for 100 strokes.

No current is passed through the earthing circuit.

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 and the line fuse shall not open during the test. The line fuse shall be sized in accordance with the rating of the coupler.

19 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 in the apparatus described in Clause 18.

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.

First the test is done with a test voltage of 400 V and a test current of 6,5 A with an inrush of 463 A with a profile equivalent to that shown in IEC TS 62735-1:2015, Figure 32, for 1 000 strokes.

Then the test is repeated with a test voltage of 294 V and a test current of 8,8 A with an inrush of 340 A with a profile equivalent to that shown in IEC TS 62735-1:2015, Figure 32, for 1 000 strokes.

The test current is passed during each insertion and withdrawal of the connector.

The periods during which the test current is passed from the insertion of the connector until subsequent withdrawal is 1,5 $^{+0,5}_{0}$ *s.*

No current is passed through the earthing circuit.

After this test the test is repeated without a current for 6 000 strokes.

The average speed of insertion and withdrawal of the connector during the test is 0,15 m/s.

During the test, no sustained arcing shall occur.

Neither the line fuse nor the grounding fuse shall open during the test.

After the test, the test samples shall withstand an electric strength test as specified in 14.3. The test voltage is reduced to 2 125 V DC 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.

20 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, 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 4.

Connectors are fitted with insulated conductors according to Table 4.

The terminal screws, if any, are tightened with two-thirds of the torque specified in the appropriate column of Table 9.

Table 4 – Cords and conductors for the tests of Clause 20

Type of coupler	Conductor [mm^2]	Test current [A]
Non-rewirable connectors	with cableas delivered	11,6
Rewirable connectors	1,0 (or 16 AWG)	11,6

The connector is inserted into an appliance inlet having brass pins with the minimum dimensions specified in the standard sheet 1 (Figure D.1) of IEC TS 63236-3:2020, a tolerance of +0,02 mm being allowed, the distance between pin centres having the value specified in that standard sheet.

A direct current according to Table 4 is passed through the current-carrying contacts for 1 h.

For connectors 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, terminations and contacts shall not exceed 45 K. The temperature rise of the conductor at the conductor insulation shall not exceed 30 K.

After this test, the test samples shall withstand the test of Clause 15.

21 Cords and their connections

21.1 Cords for non-rewirable connectors

Non-rewirable connectors shall be provided with a cable complying with Table 5 or equivalent.

Table 5 – Type and nominal cross-sectional area of cords

Type of connector	Type of cord	Length in m	Minimum nominal cross-sectional area
2,6 kW	60227 IEC 57	≤ 2 m	0,75 mm^2 or 18 AWG
		> 2 m	1 mm^2 or 16 AWG
If a rubber cable is to be used, the insulation shall be rated 90°C or higher.			

Non-rewirable connectors with earthing contact shall be provided with a three-core cable and proper polarity shall be maintained.

Compliance is checked by inspection and by measurement.

21.2 Cable anchorage

21.2.1 General

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

Cable anchorages of the "labyrinth" type are allowed, on the condition they shall withstand the relevant tests.

21.2.2 Additional requirements for rewirable connectors

Additional requirements for rewirable connectors:

- it shall be clear how the relief from strain and the prevention of twisting are intended to be effected;
- the cable anchorage, or at least a part of it, shall be integral with or fixed to one of the other component parts of the connector;
- makeshift methods, such as tying the cable into a knot or tying the ends with string, shall not be used;
- cable anchorages shall be suitable for the different types of cable which may be connected, and their effectiveness shall not depend upon the assembly of the parts of the body;
- cable 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 cable to touch the clamping screws of the cable 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 cable anchorage, including its screws, shall be insulated from the earthing circuit.

21.2.3 Pull test for cable anchorage

Compliance with the requirements of 21.2.1 and 21.2.2 is checked by inspection and by a pull test in an apparatus similar to that shown in Figure 4, followed by a torque test.

Dimensions in millimetres

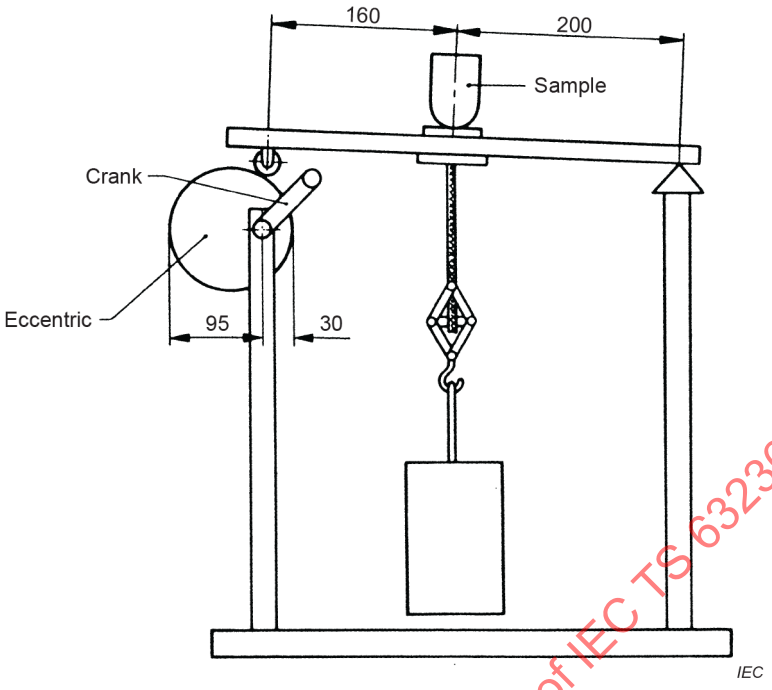


Figure 4 – Apparatus for testing the cable anchorage

Non-rewirable connectors are tested with the cable as delivered; rewirable connectors are tested first with one and then with the other type of cord, as specified in Table 6.

Table 6 – Types of cable for the rewirable connector test

Type of connector	Type of cord[a]	Cross-sectional area	
		Pull test according to 21.2.3	Flexing test according to 21.3
2,6 kW	60227 IEC 57 60227 IEC 57	1,5 mm^2 or 16 AWG	1,5 mm^2 or 16 AWG
If a rubber cable is to be used, the insulation shall be rated 90°C or higher. [a] Other cables or cables with equivalent properties may also be used.			

Conductors of the cable of rewirable 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 cable 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 8. After assembly of the test sample, the component parts shall fit snugly and it shall not be possible to push the cable into the connector to any appreciable extent.

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

The cable is then subjected 100 times to a pull of 60 N. The pulls are applied without jerks, each time for 1 s.

Immediately afterwards, the cable is subjected for 1 min to a torque of 0,25 N·m.

During the tests, the cabe shall not be damaged.

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

For the measurement of the longitudinal displacement, a mark is made on the cable 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 or the cable guard. If, for non-rewirable connectors, there is no definite end to the connector or the cable 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 cable in relation to the connector or the cable guard is measured while the cable is subjected to a pull of the value specified.

21.3 Flexing test

Connectors shall be so designed that the cable cannot be subjected to excessive bending where it enters the 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 cable guards.

Compliance is checked by inspection and the following test.

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

- *23.2.2, if of elastomeric material;*
- *23.2.3, if of thermoplastic material.*

Connectors are subjected to a test in an apparatus having an oscillating member similar to that shown in Figure 5.

Dimensions in millimetres

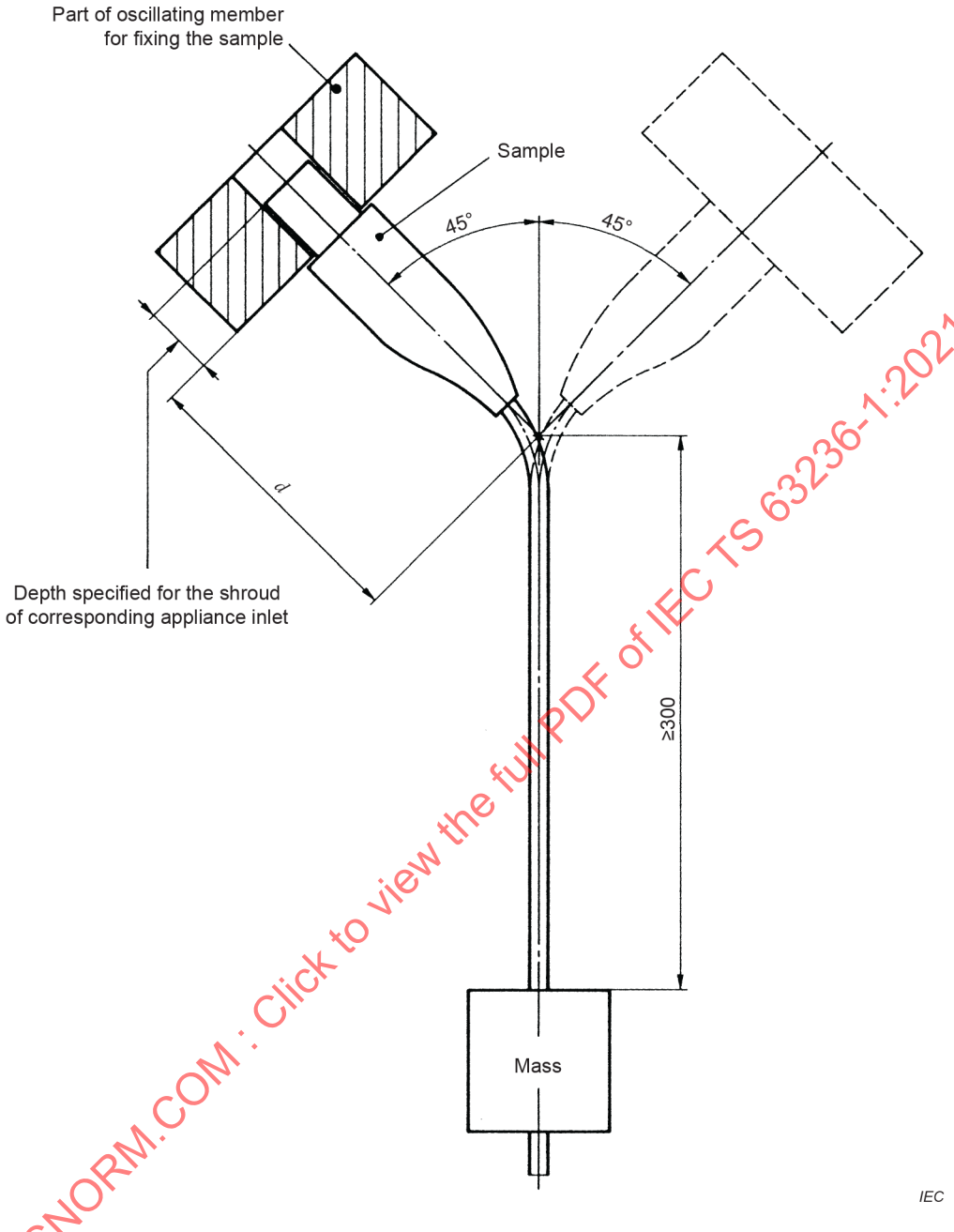


Figure 5 – Apparatus for the flexing test

Rewirable connectors are fitted with a cable as specified in Table 7, having an appropriate length and strands of the largest diameter allowed for that type of flexible cord. The cable guard, if any, is put in place.

Non-rewirable connectors are tested with the cable as delivered.

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

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

The oscillating member is, by variation of distance d shown in Figure 5, so positioned that the cable makes the minimum lateral movement when the oscillating member of the test apparatus is moved over its full travel.

The cable is loaded so that the force applied is

- *20 N for rewirable connectors, and for non-rewirable connectors with cords having a nominal cross-sectional area exceeding 0,75 mm^2;*
- *10 N for other non-rewirable connectors.*

A current equal to 8,8 A is passed through the conductors, the voltage between them being equal to 294 V. 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/min.

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 document, the guard, if any, shall not have separated from the body, and the insulation of the cable shall show no sign of abrasion or wear; moreover, for non-rewirable 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 cable is considered to occur if the current attains a value equal to twice the rated current of the connector.

22 Mechanical strength

22.1 General

Appliance couplers shall have adequate mechanical strength.

Compliance is checked

- *for connectors, by the tests of 22.2, 22.3 and 22.5;*
- *for appliance couplers intended for surface mounting, by the test of 22.4.*

22.2 Free fall test

Rewirable connectors are fitted with the cord, specified in 21.3, 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 9.

Non-rewirable connectors are tested with the cable as delivered, the cable 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 cable or cable 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 can 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 25 are neglected.

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

22.3 Lateral pull test for contacts

The purpose of this test is to verify that the contacts of connectors have sufficient mechanical strength.

For testing connectors, a corresponding appliance inlet is mounted in an appropriate test apparatus and the connector is inserted. An example of the test apparatus is shown in Figure 6a).

Dimensions in millimetres

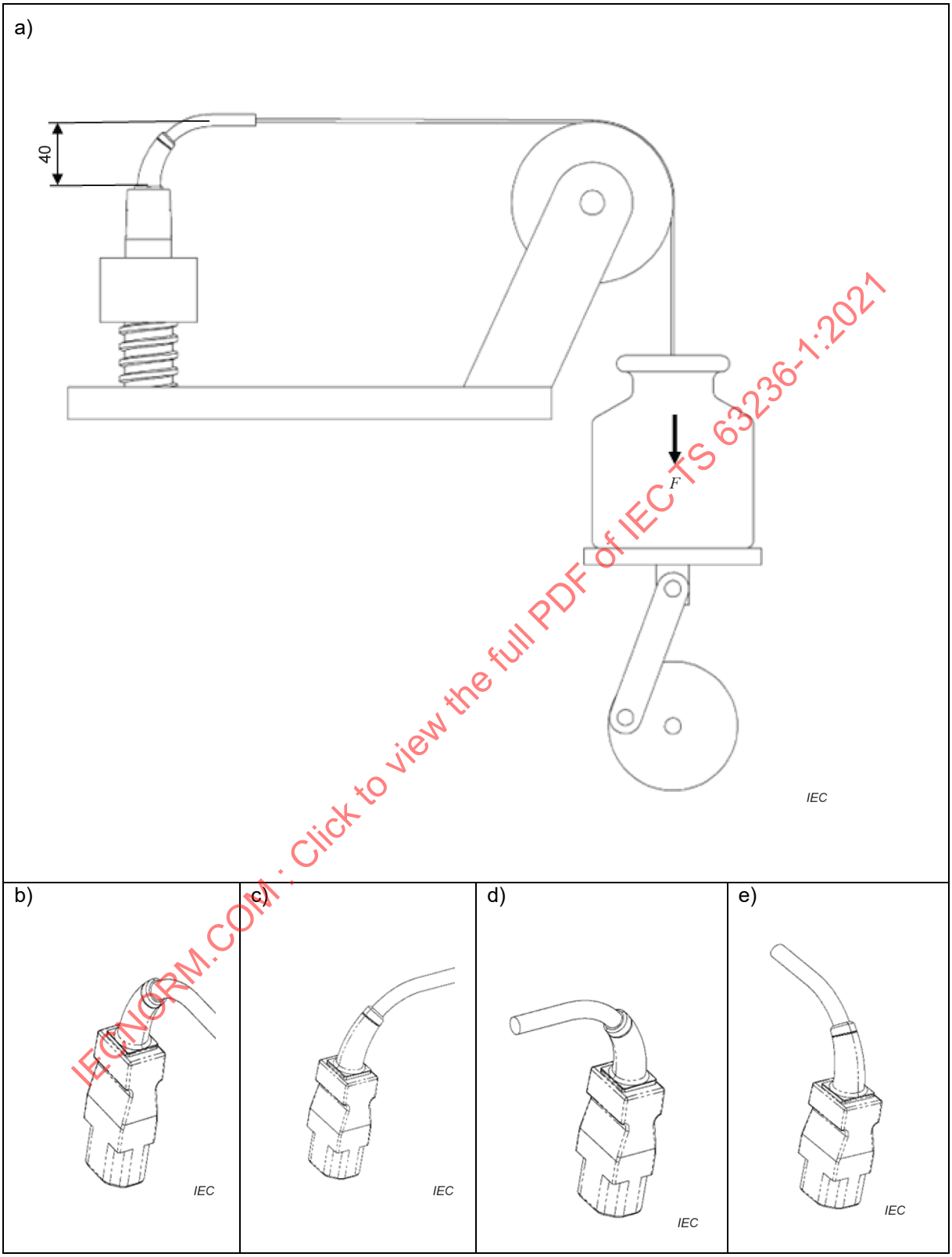


Figure 6 – Example of apparatus for pull test

A lateral pull force, in parallel with the engagement face, is applied to the cable of the connector in four directions in steps of 90° ± 5°, as shown in Figure 6a), b), c), d) and e).

A pull force according to Table 7 is applied 50 times in each direction to the cable for 1 s ± 0,5 s.

Table 7 – Values for the lateral pulls applied

Rated power kW	Pull N
2,6	35

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

After the test, the connector shall show no damage and the test samples shall comply with 15.3.

22.4 Impact test

Appliance inlets designed for surface-mounting are tested by means of a 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 J ± 0,05 J.

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

22.5 Pull tests for connectors with a separate front part

22.5.1 General

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

Compliance is checked for all connectors by the following tests.

22.5.2 Straight pull test

The front part and the rear part of the 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 according to Table 8 is applied in the direction of the axes of the pins/contacts without jerks to the claws. The force is maintained for minimum 60 s.

22.5.3 Lateral pull test

The front part of the connectors is clamped to a test fixture. A lateral pull force according to Table 8, in parallel with the engagement face, is applied to the cable of the connector in four directions in steps of 90° ± 5°, as shown in Figure 6b), c), d) and e).

The force is maintained for minimum 60 $^{+5}_{0}$ *s in each direction.*

NOTE For angled connectors, the force is not applied in the opposite direction of the cable entry.

After the test of 22.3 and 22.5, the two parts of the connectors shall neither have been detached, nor shall parts providing protection against electric shock have been loosened or live parts have become accessible.

Table 8 – Values for torque and pull forces

Rated power kW	Straight pull forces N	Lateral pull forces N
2,6	100 ± 2	75 ± 2

23 Resistance to heat and ageing

23.1 Resistance to heat

Appliance couplers shall be sufficiently resistant to heat.

Parts of the cable anchorage and the cable 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 in accordance with IEC 60695-10-2 at the following temperatures:

- *125 °C for all insulating parts of appliance couplers in contact with current carrying parts and the front parts of connectors;*
- *105 °C for all insulating parts of appliance couplers not in contact with current carrying parts.*

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

NOTE The front part is that part of a connector or a plug connector which can be fully engaged with its counterpart.

23.2 Resistance to ageing

23.2.1 General

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

Compliance is checked:

- *for connectors of elastomeric material, by the tests of 23.2.2 and 23.2.4;*
- *for connectors of thermoplastic material, by the tests of 23.2.3 and 23.2.4.*

For the tests of 23.2.2 to 23.2.4, two new test samples are used, which are first subjected to the test of Clause 15.

For the tests of 23.2.2 and 23.2.3, 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.

23.2.2 Ageing test for elastomeric materials

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 90 °C ± 2 °C, for 240 h (10 days).

23.2.3 Ageing test for thermoplastic materials

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 100 °C ± 2 °C, for 240 h (10 days).

During the test, the connectors are in engagement with a corresponding appliance inlet according to the relevant standard sheet or according to the manufacturer's information.

23.2.4 Ageing test assessment

After the tests of 23.2.2 or 23.2.3, the test samples are allowed to attain approximately ambient temperature and are then examined. They shall show no visible crack, 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 document.

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.

24 Screws, current-carrying parts and connections

24.1 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 on an appliance can be any type. Screws of insulating material shall not be used in cases where 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 9 are used.

When testing the terminal screws of 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^2 or 16 AWG for 2,6 kW connectors.

The screws and nuts shall be tightened smoothly.

Table 9 – 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.

24.2 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 or other material with characteristics no less suitable, 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.

24.3 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.

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

24.4 Current-carrying parts

Current-carrying parts, including those of terminals (as well as earthing terminals), shall be of metal having, under the conditions occurring in the accessory, mechanical strength, electrical conductivity and resistance to corrosion adequate for their intended use. Metals showing a difference of electrochemical potential greater than 0,030 V with respect to each other shall not be used in contact with each other. Under moist conditions, metals showing a difference of electrochemical potential greater than 0,030 V with respect to each other shall not be used.

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

This requirement is deemed to be met if one of the following suitable metals is used within the permissible temperature range and under normal conditions of chemical pollution:

– *copper, with or without electroplated coating of silver or nickel;*
– *an alloy containing at least 58 % copper for parts made from cold-rolled sheet or at least 50 % copper for other parts, with or without electroplated coating of silver or nickel;*
– *stainless steel containing at least 13 % chromium and not more than 0,09 % carbon;*
– *steel provided with an electroplated coating of nickel and chromium according to ISO 1456, the coating having a thickness of at least 20 µm, service condition number 2 according to ISO 1456, for accessories classified IP code IPX0. Current-carrying parts which can be subjected to mechanical wear shall not be made of steel provided with an electroplated coating.*

This requirement does not apply to screws, nuts, washers, clamping plates and similar parts of terminals.

25 Creepage distances, clearances and distances through sealing compound

Creepage distances, clearances and distances through the sealing compound shall be not less than the values shown in Table 10.

Table 10 – Creepage distances, clearances and distances through insulating sealing compound

Description	mm
Creepage distance:	
1 between live parts of different polarity;	4
2 between live parts and	
– accessible surface of parts of insulating material,	4
– earthed metal parts including parts of earthing circuit,	4
– metal frames supporting the base of appliance inlets,	4
– metal parts of inlet;	4
3 between pins of connectors and metal parts connected to them, when fully engaged, and an appliance inlet, of the same system having accessible unearthed metal parts[a], made according to the most unfavourable construction[b];	8
4 between the accessible unearthed metal parts[a] of appliance inlets and a fully engaged connector of the same system having pins and metal parts connected to them made according to the most unfavourable construction[b];	8
5 between live parts of an appliance inlet, (without a connector) or of a connector and its accessible unearthed or functional earthed metal parts[a].	8
Clearance:	
6 between live parts of different polarity;	4
7 between live parts and	
– accessible surface of parts of insulating material,	4
– earthed metal parts not mentioned under items 8 and 9 including parts of earthing circuit,	4
– metal frames supporting the base of flush-type appliance inlets,	4
– metal parts of inlet;	4
8 between live parts and	
– metal boxes intended to be earthed, with the appliance inlet in the most unfavourable position,	4
– unearthed metal boxes, without insulating lining, with the appliance inlet in the most unfavourable position,	8
– accessible unearthed or functional earthed metal parts [a] of appliance inlets and connectors;	8
9 between live parts and the surfaces on which the base of an appliance inlet for surface mounting is mounted;	8
10 between live parts and the bottom of any conductor recess, if any, in the base of an appliance inlet for surface mounting.	4
Distance through insulating sealing compound:	
11 between live parts covered with at least 2 mm of sealing compound and the surface on which the base of an appliance inlet for surface mounting is mounted;	4
12 between live parts covered with at least 2 mm of sealing compound and the bottom of any conductor recess, if any, in the base of an appliance inlet for surface mounting.	4
[a] With the exception of screws and the like.	
[b] The most unfavourable construction may be checked by means of a gauge which is based on the standard sheets relevant to the system concerned.	

Compliance is checked by measurement.

For rewirable accessories, the measurements are made on the specimen fitted with conductors of the largest nominal cross-sectional area specified in Table 1 and also without conductors.

The conductor shall be inserted into the terminal and connected in such a way that the core insulation touches the metal part of the clamping unit or, where the core insulation is prevented by construction from touching the metal part, the outside of the obstruction.

For non-rewirable accessories, the measurements are made on the specimen as delivered.

Inlets are checked when in engagement with a connector and also without a connector.

Distances through slots or openings in external parts of insulating material are measured using a metal foil in contact with the accessible surface other than the engagement face of plugs. The foil is pushed into corners and the like by means of the test probe 11 of IEC 61032, but is not pressed into openings.

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

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

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

26 Resistance of insulating material to heat, fire and tracking

26.1 Resistance to heat and fire

26.1.1 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.

Compliance is checked by the glow-wire flammability test method for end-products (GWEPT) according to IEC 60695-2-11.

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

26.1.2 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 causes parts to burn, or drops to fall down from the part under test.

26.1.3 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 only once. 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 can 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 60695-2-11 are not subjected to this test.

26.1.4 Degree of severity

The following test temperatures 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.*

26.1.5 Evaluation of test results

The test specimen is considered to pass the test if:

1) there is no ignition, or

2) all of the following situations apply when ignition has occurred:

a) if flames or glowing combustion of the test specimen extinguish within 30 s after removal of the glow wire,

b) the specified layer placed underneath the test specimen does not ignite.

26.2 Resistance to tracking

Insulating parts supporting, or in contact with, live parts shall be of material resistant to tracking.

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

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

Minimum PTI is 175.

NOTE The end product standard can require a higher PTI value.

27 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 °C ± 5 °C.

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

After the parts have been dried for 10 min in a heating cabinet at a temperature of 100 °C ± 5 °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.

For small springs and the like, and for inaccessible parts exposed to abrasion, a layer of grease can 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.

28 Electromagnetic compatibility (EMC) requirements

28.1 General

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

28.2 Immunity – Accessories not incorporating electronic components

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

28.3 Emission – Accessories not incorporating electronic components

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

NOTE These accessories might 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)

Safety-related routine tests for factory-wired accessories (protection against electric shock and correct polarity)

A.1 General remarks

All factory-wired appliance couplers shall be subjected to all of the following tests.

The test equipment or manufacturing systems shall be such that failed products are either made unfit for use or separated from satisfactory products in such a way that they cannot be released for sale.

"Unfit for use" means that the accessory is treated in such a way that it cannot fulfil the intended function. It is, however, accepted that repairable products (by a reliable system) may be repaired and re-tested.

The process or manufacturing system shall enable the identification that accessories released for sale have been subjected to all the appropriate tests.

The manufacturers shall maintain records of the tests carried out which show

- the type of product;
- the date of test;
- the place of manufacture (if manufactured in more than one place);
- the quantity tested;
- the 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 once 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 equipment shall be verified (calibrated) at least once a year. Records shall be kept of all checks and any adjustments found necessary.

A.2 Polarized systems, "+" and "−" : Correct connection

For polarized systems the test shall be made using SELV applied for a period of not less than 2 s:

- *for connectors and inlets, between the remote end of the "+" and "−" conductors of the flexible cable independently, and the corresponding "+" and "−" pin or contact of the accessory;*
- *for cord extension sets, between the "+" and "−" pin at one end of the flexible cable and the corresponding "+" and "−" contact at the other end of the flexible cable.*

Polarity shall be correct.

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

A.3 Earth continuity

The test shall be made using SELV applied for a period of not less than 2 s:

- *for connectors and inlets, between the remote end of the earth conductor of the flexible cable, and the earth pin or contact of the accessory, as appropriate;*
- *for cord extension sets, between the corresponding earth pin or earth contact of the accessory at each end of the flexible cable.*

Continuity shall be present.

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.

A.4 Short-circuit/wrong connection and reduction of creepage distance and clearances between "+" and "−" to earth

A.4.1 Accessible surface safety check

For non-rewirable appliance coupler it shall be checked that live parts, for example 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 is scanned by adjusted electrodes and a pressure force of 20 N.

Through the live parts and the surface of the appliance coupler an AC voltage of 2 000 V ± 10 % shall be applied for at least 1 s.

Neither a flashover nor a breakdown shall occur.

A.4.2 Short-circuit/wrong connection

The test shall be made by

- *applying at the supply end, for example to a plug, for a period of not less than 2 s an AC voltage of 2 000 V ± 10 %, 50 Hz or 60 Hz.*

Alternatively, an equivalent DC voltage may be applied.

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

Or

- *by applying an impulse voltage test using a 1,2/50 µs waveform of 4 kV peak value and three impulses for each pole, with intervals of not less than 1 s,*
  - *between "+" and ⏚, and*
  - *between "−" and ⏚.*

"+" and "−" may be connected together for this test.

No flashover shall occur.

Annex B
(normative)

Test schedule

See Table B.1.

Table B.1 – Test schedule

Group	Clause/subclause	Description of the tests	Appliance inlet	Connector
1 *3 samples*	8	Marking	X	X
	9	Dimensions and compatibility	X	X
	10	Protection against electrical shock	X	X
	11	Provision for earthing	X	X
	12	Terminals and terminations	X	X
	13	Construction	X	X
	15	Forces necessary to insert and to withdraw the connector		X
	16	Operation of contacts	X	X
	17	Resistance to heating of appliance couplers	X	X
	22.2	Free fall test		X
	22.3	Lateral pull test for contacts		X
	22.4	Impact test	X	
	22.5	Pull tests for connectors with a separate front part		X
	24	Screws, current-carrying parts and connections	X	X
	25	Clearances, creepage distances and solid insulation	X	X
	27	Resistance to rusting	X	X
	28	Electromagnetic compatibility (EMC) requirements	X	X
2 *3 samples*[a]	14	Insulation resistance and electrical strength	X	X
	15	Forces necessary to insert and to withdraw the connector		X
	17	Resistance to heating of appliance couplers for hot and very hot conditions	X	X
	18	Breaking capacity		X
	19	Normal operation		X
	20	Temperature rise		X
3 *3 samples* [b]	21	Cords and their connections		X
4 *3 samples*[b]	21.3	Flexing test		X

Group	Clause/subclause	Description of the tests	Appliance inlet	Connector
5 *2 samples*[a]	23	Resistance to heat and ageing	X	X
6 *2 samples*[a]	23.2.2or 23.2.3	Ageing test for appliance couplers made of rubber or thermoplastic materials	X	X
7 *2 samples*[a]	26	Resistance of insulating material to heat, fire and tracking		
	26.1.4	Degree of severity (glow-wire test 750 °C (sample 1))	X	X
	26.1.4	Degree of severity (glow-wire test 650 °C (sample 2))	X	X
8 *3 samples*[a]	26	Resistance of insulating material to heat, fire and tracking		
	26.2	Resistance to tracking	X	X

[a] Sample of each different material.

[b] Sample of each type of cable, cross-sectional area and manufacturer of the cable.

Annex C
(informative)

Alternative gripping tests

C.1 Gripping test C1

Prior to testing, the reference connector shown in Figure C.1 shall be cleaned with a metal cleaner.

The reference connector, the connector to be tested, and the hands of each person conducting the test shall be washed with soap and water, rinsed, and then dried.

The test apparatus consists of a measuring device equipped with a means to securely attach both the reference connector and the connector to be tested, in a manner that reduces the likelihood of rotational movement during the pulls. An engagement face simulating the use of a connector in a socket-outlet of the same system, having an opening for the connector pins, shall be secured to the movable member.

NOTE Other methods for measuring force can be used.

The mounting arrangements for the connector being tested shall be such that the face of the connector is flush with the faceplate.

A typical apparatus is shown in Figure C.2.

The connector to be tested with the flexible cable cut off close to the connector shall be securely attached to the test apparatus.

The person performing the test shall grip the connector to be tested with either hand in a manner intended to apply the maximum pull force.

A steady straight pull shall be applied until the connector pulls free from the person's hand. The person applying the force shall not view the force indicator during the pull.

The maximum pull force applied during the pull shall be recorded.

Immediately following the pull test, the reference connector shall be attached to the test apparatus and a comparison pull made using the same hand.

The maximum pull force shall be recorded.

The ratio of the force for the connector under test to that for the reference connector shall be calculated and recorded.

The comparison of the pull procedure described above shall be repeated on the same connector an additional two times by the same person.

The ratio for each pair of pulls (test connector/reference connector) shall be calculated and recorded.

One person shall test three connectors (a total of nine comparison pulls) as described above with the ratio for each pair of pulls being calculated and recorded for all three connectors. If the ratio of the pull force (connector under test/reference connector) for each pair of pulls resulting from the tests carried out by this person is 0,8 or greater, the test shall be stopped and the results considered acceptable.

If the ratio is lower than 0,8, two additional people shall test three connectors each (for a total of nine comparison pulls per person), as described above.

The ratio for each pair of pulls (connector under test/reference connector) shall be calculated and recorded.

The results are considered acceptable if all of the following conditions are met:

a) the ratio for each pair of pulls (test/reference connector) is 0,55 or greater for at least two pulls (of the three pulls performed) on each connector;

b) at least two (of the three) connectors tested by each person comply with item a); and

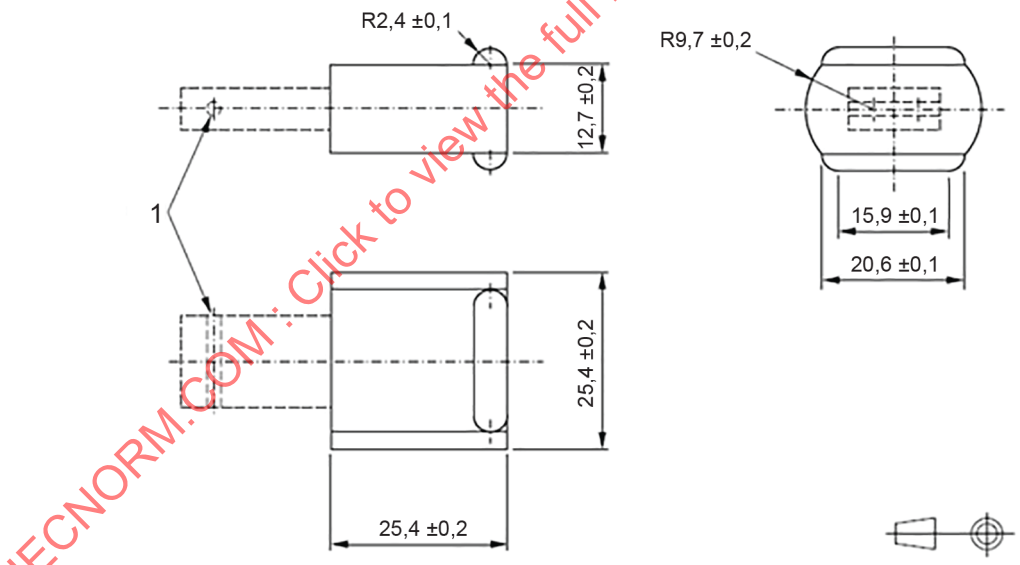
c) at least two persons' test results comply with item b).

If only one person obtains results that comply with item b) then, at the manufacturer's request, two persons not previously involved in the testing may test three connectors each as previously described.

The results are considered acceptable if both of the additional persons' test results comply with items a) and b).

No result should be lower than the maximum withdrawal force for the relevant socket-outlet as specified in Table 3.

Dimensions in millimetres



Material: for example heat-treated steel.
Surface roughness of the gripping surface: between 0,6 µm and 0,8 µm.

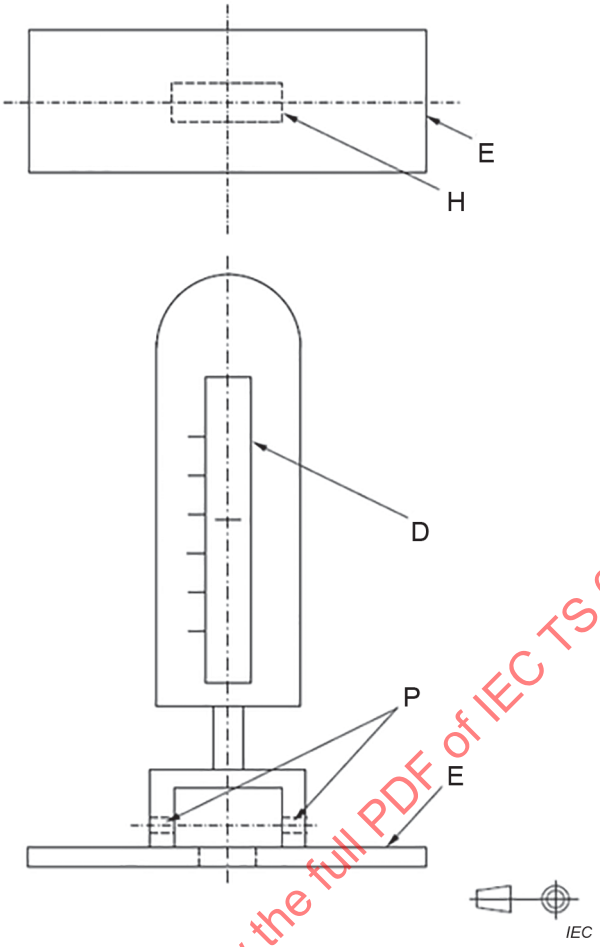
IEC

Key

1 Hole for retaining pins

NOTE The dimensions are to suit the test specimen and those of Figure C.2.

Figure C.1 – Reference gauge for gripping test



Key

E Simulated engagement face

H Hole for introduction of fixing means

P Holes for pins for retention of fixing means

D Measuring device

NOTE The Figure is for guidance only and is not intended to govern the design of the test apparatus.

Figure C.2 – Example of the test apparatus for connector gripping test

C.2 Gripping test C2

This test consists of a verification of one of the following characteristics of the connector under test:

– *the connector has a usable length for gripping of at least 55 mm in the axial direction; or*

– *the connector has such indent(s) that a ball with a diameter of (12 ± 0,1) mm can penetrate radially into the body at least 2 mm from two opposite directions or at least 4 mm from one direction; or*

– *the connector has special means for withdrawal (e.g. hooks, rings).*

The results are considered acceptable if at least one of the above conditions is fulfilled.

Annex D
(normative)

Standard sheets and gauges

D.1 Standard sheets

General tolerances according to ISO 2768-1; tolerance class medium.

For symbols of geometric tolerances, see ISO 1101.