BRITISH STANDARD

BS EN
60998-1:2004

Connecting devices for low-voltage circuits for household and similar purposes —

Part 1: General requirements

The European Standard EN 60998-1:2004 has the status of a British Standard

ICS 29.120.20

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 60998-1:2004. It was derived by CENELEC from IEC 60998-1:2002. It supersedes BS EN 60998-1:1993 which will be withdrawn on 1 April 2006.

The CENELEC common modifications have been implemented at the appropriate places in the text and are indicated by tags 〚C〉 〈C〛.

The UK participation in its preparation was entrusted by Technical Committee PEL/23, Electrical accessories, to Subcommittee PEL/23/2, Connecting devices, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

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EUROPEAN STANDARD **EN 60998-1**

NORME EUROPÉENNE

EUROPÄISCHE NORM April 2004

ICS 29.120.20 Supersedes EN 60998-1:1993 + A1:2001

English version

Connecting devices for low-voltage circuits for household and similar purposes Part 1: General requirements

(IEC 60998-1:2002, modified)

Dispositifs de connexion
pour circuits basse tension
pour usage domestique et analogue
Partie 1: Règles générales
(CEI 60998-1:2002, modifiée)

Verbindungsmaterial
für Niederspannungs-Stromkreise
für Haushalt und ähnliche Zwecke
Teil 1: Allgemeine Anforderungen
(IEC 60998-1:2002, modifiziert)

CENELEC

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

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Foreword

The text of the International Standard IEC 60998-1:2002, prepared by SC 23F, Connecting devices, of IEC TC 23, Electrical accessories, together with common modifications prepared by the CENELEC Reporting Secretariat SR 23F, was submitted to the formal vote and was approved by CENELEC as EN 60998-1 on 2004-03-01.

This European Standard supersedes EN 60998-1:1993 + A1:2001.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2005-03-01

– latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2007-03-01

In this standard, the following print types are used:

- requirements proper: in roman type;
- *test specifications: in italic type;*
- explanatory matter: in smaller roman type.

Annexes ZA and ZB have been added by CENELEC.

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Endorsement notice

The text of the International Standard IEC 60998-1:2002 was approved by CENELEC as a European Standard with agreed common modifications.

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CONTENTS

CONNECTING DEVICES FOR LOW-VOLTAGE CIRCUITS FOR HOUSEHOLD AND SIMILAR PURPOSES –

Part 1: General requirements

1 Scope

This part of IEC 60998 applies to connecting devices as separate entities for the connection of two or more electrical copper conductors (complying with IEC 60228 or IEC 60344) rigid (solid or stranded) or flexible, having a cross-sectional area of 0,2 mm^2 up to and including 35 mm^2 〖C〗 *text deleted* 〖C〗 with a rated voltage not exceeding 1 000 V a.c. up to and including 1 000 Hz and 1 500 V d.c. where electrical energy is used for household and similar purposes.

NOTE Rated connecting capacities lower than 0,5 mm^2 are referred to IEC 60344 and rated connecting capacities equal to, or higher than, 0,5 mm^2 are referred to IEC 60228.

Connecting devices that require the use of special tools other than for twist-on connecting devices and insulation piercing connecting devices do not comply with this standard.

This standard contains the general requirements to be used together with the relevant Part 2, containing detailed particular requirements for

– devices with screw-type clamping units (IEC 60998-2-1);
– devices with screwless-type clamping units (IEC 60998-2-2);
– devices with insulation piercing clamping units (IEC 60998-2-3);
– devices with twist-on connecting devices (IEC 60998-2-4);
– devices with connecting boxes (junction and/or tapping) (IEC 60998-2-5).

2 Normative references

The following referenced documents are indispensable for the application 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 60068-2-32:1975, *Basic environmental testing procedures – Part 2: Tests – Test Ed: Free fall*

IEC 60068-2-75:1997, *Environmental testing – Part 2: Tests – Test Eh: Hammer tests*

IEC 60112:1979, *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions*

IEC 60228:1978, *Conductors of insulated cables*
Amendment 1 (1993)

IEC 60344:1980, *Guide to the calculation of resistance of plain and coated copper conductors of low-frequency cables and wires*

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

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

IEC 60695-10-2:1995, *Fire hazard testing – Part 10: Guidance and test methods for the minimization of the effects of abnormal heat on electrotechnical products involved in fires – Section 2: Method for testing products made from non-metallic materials for resistance to heat using the ball pressure test – Basic safety publication*

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

ISO 1456:1988, *Metallic coatings – Electrodeposited coatings of nickel plus chromium and of copper plus nickel plus chromium*

ISO 2081:1986, *Metallic coatings – Electroplated coatings of zinc on iron or steel*

ISO 2093:1986, *Electroplated coatings of tin – Specification and test methods*

3 Terms and definitions

For the purpose of this standard, the following definitions apply.

3.1
connection
electrical connection between two or more conductors or between a conducting part and one or more conductors

3.2
junction
connection between two or more conductor ends

3.3
tapping
connection of a conductor end (called “tapped conductor”) on any point of another conductor (called “main conductor”)

3.4
connecting device
device for the electrical connection of two or more conductors comprising one or more terminals and, if necessary, insulation and/or ancillary parts (see Annex A)

3.5
terminal
conductive part of one pole composed of one or more clamping unit(s) and insulation if necessary (see Annex A)

3.6
clamping unit
part(s) of a terminal necessary for the mechanical clamping and the electrical connection of the conductor(s), including the parts which are necessary to ensure correct contact pressure (see Annex A)

3.7
ancillary part
part of a connecting device providing electrical and mechanical protection and/or mounting, for example, a base, an enclosure, a mounting rail, etc. (see Annex A)

3.8
rated connecting capacity
cross-sectional area of the largest rigid conductor(s) to be connected as stated by the manufacturer of the connecting device. In the case of a connecting device for flexible conductors only, the rated connecting capacity is the cross-sectional area of the largest flexible conductor to be connected

3.9
rated insulation voltage
voltage of a component, device or piece of equipment to which dielectric voltage tests and creepage distances are referred

3.10
rated current
current assigned to the device by the manufacturer

3.11
clearance
shortest distance in air between two conductive parts

3.12
creepage distance
shortest distance along the surface of an insulating material between two conductive parts

3.13
ambient temperature
temperature of the air surrounding the connecting device together with its enclosure, if any

3.14
temperature rise
difference between the temperature of the part under test, together with its enclosure, if any, measured under load according to the test specification and the ambient temperature

3.15
multiway terminal device
connecting device that consists of several terminals, insulated from each other in a common housing of insulating material, which are capable of being subdivided by the user to make connecting devices consisting of one or more terminals

3.16
unprepared conductor
conductor which has been cut and the insulation of which has been removed over a certain length for insertion into a terminal

NOTE A conductor, the shape of which is arranged for introduction into a terminal, or of which the strands are twisted to consolidate the end, is considered to be an unprepared conductor.

4 General

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

Compliance is checked by carrying out all tests specified.

5 General notes on tests

5.1 *Tests according to this standard are type tests.*

5.2 *Unless otherwise specified, the samples are tested as delivered and installed as in normal use, at an ambient temperature of 20 °C ± 5 °C.*

5.3 *The tests are carried out in the order of the clauses*.

5.4 Unless otherwise stated, three samples are submitted to all the tests and the requirements are satisfied if all the tests are met. If only one of the samples does not satisfy a test due to an assembly or manufacturing fault, that test and any preceding ones which may have influenced the results of the test shall be repeated and also the tests which follow shall be made in the required sequence on another full set of samples, all of which shall comply with the requirements.

NOTE The applicant may submit, together with the number of samples specified in 5.4, the additional set of samples which may be wanted, should one sample fail. The testing station will then, without further request, test additional samples and will reject only if a further failure occurs. If the additional set of samples is not submitted at the same time, the failure of one sample will entail rejection.

6 Main characteristics

6.1 The preferred values of the rated insulation voltage of the connecting device are 125 V, 250 V, 300 V, 400 V, 500 V, 600 V, 690 V, 800 V, 1 000 V a.c. and d.c., and 1 500 V d.c

6.2 The standard rated connecting capacities are 0,2 mm^2, 0,34 mm^2, 0,5 mm^2, 0,75 mm^2, 1 mm^2, 1,5 mm^2, 2,5 mm^2, 4 mm^2, 6 mm^2, 10 mm^2, 16 mm^2, 25 mm^2 and 35 mm^2.

〖C〉 *text deleted*. 〈C〗

NOTE 2 In the United Kingdom, 1,25 mm^2 is a standard rated connecting capacity.

6.3 Ambient temperatures above 40 °C require *T* marking.

The preferred values are 55 °C, 85 °C, 110 °C, 140 °C and 200 °C. If other values are used, they shall be multiples of 5 °C.

7 Classification

Connecting devices as separate entities are classified as follows.

7.1 Classification according to the number of terminals

– single terminal devices;
– multiway terminal devices.

7.2 Classification according to function

– junction devices;
– tapping devices;
– junction and tapping devices.

7.3 Classification according to protection against electric shock

– devices without protection;
– devices with protection.

7.4 Classification according to means of fixing

– devices without means of fixing (location is only ensured by the stiffness of the conductors which are connected to them);
– devices with means of fixing (location is ensured by their own fixing means or by associated means, such as screws, rails supports or similar).

7.5 Classification according to the maximum ambient temperature of use of the connecting device (rated temperature)

– devices without *T* marking for ambient temperatures not higher than 40 °C;
– devices with *T* marking for ambient temperatures higher than 40 °C.

7.6 Classification according to protection against harmful ingress of water and humidity and against solid foreign objects

For the description of the IP degrees, see IEC 60529.

8 Marking

8.1 The following markings shall be put on the main part:

a) rated connecting capacity in square millimetres (see 6.2 and 8.3);
b) rated insulation voltage in volts (if any);
c) maximum ambient temperature of use in degrees Celsius if greater than 40 °C, expressed as a *T* marking (see 6.3 and 8.3);
d) type reference (for example, a catalogue number);
e) manufacturer's or responsible vendor's name or trade mark or identification mark;
f) IP code, if greater than IP20.

For very small devices with a surface insufficient for marking, only the markings stated in d) and e) need to be indicated on the device. In such cases all the marks specified shall be visible on the smallest package unit.

8.2 For multiway terminal devices the required marking shall be complete on at least any two adjacent devices.

8.3 When symbols are used they shall be as follows:

V for volts;

mm^2 or ☐ for rated connecting capacity in square millimetres;

T for maximum ambient temperature. For example, *T* 55.

〖C〉 *text deleted* 〈C〗

8.4 Marking on the product shall be durable and easily legible.

Compliance with 8.1 to 8.4 is checked by inspection and by the following test on the device. The test is made by rubbing the marking 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 these tests the marking shall still be legible.

NOTE 1 Markings made by moulding, pressing or engraving are not subjected to this test.

NOTE 2 The petroleum spirit used should consist of a solvent hexane with a content of aromatics of maximum 0,1 % volume, a kauri-butanol value of 29, an initial boiling-point of approximately 65 °C, a dry-point of approximately 69 °C and a density of approximately 0,68 g/cm³.

9 Protection against electric shock

Connecting devices with protection against electrical shock shall be constructed as specified in the relevant Part 2, such that live parts are not accessible when correctly installed and fitted with an insulated conductor of the smallest and/or largest cross-sections.

Each clamping unit of the connecting device shall be connected alternatively with a conductor of the smallest and largest specified cross-section, or the minimum and maximum combination accommodated by the clamping unit.

Compliance is checked unless otherwise specified in the relevant Part 2 by the following test carried out for connecting devices with ancillary parts intended for protection against electric shock.

In the case of T-marked products the connecting device is brought to a temperature of T ± 2 °C.

The standard test finger, according to IEC 61032, is applied with a force of 10 N to any openings on the connecting device and, if it penetrates fully or partially, it is placed in every possible position. The test probe shall be applied to the connecting device immediately upon removal from the heating cabinet.

An extra-low voltage supply (between 40 V and 50 V) in series with a suitable lamp is connected between the test finger and the live parts. Conducting parts covered only with varnish or paint, or protected by oxidation or by a similar process, shall be covered with a metal foil and electrically connected to those parts which are normally live in service.

Protection is satisfactory if the lamp does not light.

10 Connection of conductors

Connecting devices shall allow the correct connection of conductors, which are specified in the relevant section of the particular requirements of the relevant Part 2.

11 Construction

11.1 The constructional requirements are given in the relevant Part 2.

11.2 Clamping units shall be so designed and constructed that they clamp the conductors reliably and between metal surfaces, with the exception of specific cases subject to requirements of the relevant Part 2.

Compliance is checked by inspection and by the relevant test specified in the relevant Part 2.

11.3 Connecting devices shall be so designed and constructed that conductors may be installed without the insulation of any one of them being in contact with live parts connected to another conductor of different polarity.

Compliance is checked by inspection and, if necessary, by mounting the connecting device with the least favourable conductors or combinations thereof.

11.4 Insulating linings, barriers and the like shall have adequate mechanical strength and shall be secured in a reliable manner.

Compliance is checked by inspection after the tests of Clause 14.

11.5 Current-carrying parts, including all terminals, shall be of a metal having, under the conditions occurring in the equipment, mechanical strength, electrical conductivity and resistance to corrosion adequate for their intended use.

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

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

– copper;
– an alloy containing at least 58 % copper for parts that are worked cold or at least 50 % copper for other parts;
– stainless steel containing at least 13 % chromium and not more than 0,09 % carbon;

– steel provided with an electroplated coating of zinc according to ISO 2081, the coating having a thickness of at least
  - 5 μm (ISO service condition 1) for ordinary equipment;
  - 8 μm (ISO service condition 2) for drip-proof and splash-proof equipment;
  - 12 μm (ISO service condition 3) for jet-proof and watertight equipment;
– steel provided with an electroplated coating of nickel and chromium according to IS0 1456, the coating having a thickness of at least
  - 10 μm (ISO service condition 1) for ordinary equipment;
  - 20 μm (ISO service condition 2) for drip-proof and splash-proof equipment;
  - 30 μm (ISO service condition 3) for jet-proof and watertight equipment;
– steel provided with an electroplated coating of tin according to ISO 2093, the coating having a thickness equal to at least that specified for
  - 12 μm (ISO service condition 1) for ordinary equipment;
  - 20 μm (ISO service condition 2) for drip-proof and splash-proof equipment;
  - 30 μm (ISO service condition 3) for jet-proof and watertight equipment.

Current-carrying parts, which may be subjected to mechanical wear, shall not be made of steel provided with an electroplated coating.

Under moist conditions, metals showing a large difference of electrochemical potential with respect to each other shall not be used in contact with each other.

Compliance will be checked by a test which is under consideration.

NOTE 1 Springs, resilient parts, clamping units, clamping screws, and the like are not considered as parts mainly intended for carrying current.

NOTE 2 The use of aluminium alloy for current-carrying parts requires additional tests according to IEC 61545[1].

11.6 Terminals, according to their rated connecting capacity, shall accept the connection of the number and the cross-sections of rigid (solid or stranded) and flexible conductors of class 5 according to IEC 60228, or IEC 60344, 〚C〉 *text deleted* 〈C〛 conductors as specified by the manufacturer.

Compliance is checked by connecting the appropriate conductors and by inspection.

11.7 The fixing means of bases shall not serve any other purpose.

Compliance is checked by inspection.

12 Resistance to ageing, to humidity conditions, to ingress of solid objects and to harmful ingress of water

12.1 Connecting devices shall be resistant to ageing.

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1 IEC 61545:1996, *Connecting devices – Devices for the connection of aluminium conductors in clamping units of any material and copper conductors in aluminium bodied clamping units.*

Unless otherwise specified in the relevant Part 2, the following test is carried out:

Connecting devices with insulating material other than ceramic and thermosetting material are subjected to a test in a heating cabinet with an atmosphere having the composition and pressure of the ambient air and which is ventilated.

NOTE 1 The ventilation may be provided by natural circulation through holes in the walls of the heating cabinet.

The samples are kept in the cabinet for 7 days (168 h) the temperature of which being (70 ± 2) °C for non-T-marked connecting devices or T + 30 °C ± 2 °C for T-marked devices (for example, for T = 85 the cabinet temperature shall be 115 °C ± 2 °C).

NOTE 2 The use of an electrically heated cabinet is recommended.

After this treatment, the samples are removed from the cabinet and left at room temperature for at least 4 h.

The samples shall show no cracks visible to the naked eye with normal or corrected vision without additional magnification nor shall the material have become sticky or greasy, this being judged as follows.

The sample is placed on one of the pans of a balance and the other pan is loaded with a mass equal to the mass of the sample plus 500 g. Equilibrium is then restored by pressing the sample with the forefinger, wrapped in a dry piece of rough cloth.

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

12.2 Connecting devices shall be designed to withstand humid conditions which may occur in normal use.

Unless otherwise specified in the relevant Part 2, the following test is carried out.

The test is made using the humidity treatment described below immediately followed by the measurement of insulation resistance and the electrical strength test specified in Clause 13.

The humidity treatment is carried out in a humidity cabinet containing air with relative humidity maintained between 91 % and 95 %. The temperature of the air, at all places where samples can be located, is maintained within 1 °C of any convenient value of t between 20 °C and 30 °C. Before being placed in the humidity cabinet, the samples are brought to a temperature between t and t + 4 °C.

The samples are kept in a cabinet for

- *168 h for connecting devices where protection against ingress of water as specified in the relevant Part 2 is higher than IPX2;*
- *48 h for all other products.*

NOTE A relative humidity between 91 % and 95 % can be obtained by placing in the humidity cabinet a saturated solution of sodium sulphate (Na_2SO_4) or potassium nitrate (KNO_3) in water, the solution having a sufficiently large contact surface with the air.

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

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

12.3 The connecting device shall provide an IP degree of protection against harmful ingress of water in accordance with the classification of the devices.

Compliance is checked by the appropriate test according to IEC 60529 which is made on connecting devices fitted with the cables for which they are designed. Immediately after this test the samples shall withstand an electric strength test as specified in 13.4 and an inspection shall show that water has not entered the samples to any appreciable extent and not reached live parts.

13 Insulation resistance and electric strength

13.1 The insulation resistance and electric strength of insulated connecting devices shall be adequate.

Unless otherwise specified in the relevant Part 2, compliance is checked by the tests of 13.3 and 13.4 which are made immediately after the test of 12.2 in the humidity cabinet or in the room in which the samples were brought to the prescribed temperature.

13.2 The insulation between the connected conductors and the external surface of the connecting device shall be adequate for all the combinations of conductors for which the connecting device is designed.

Compliance is checked by the test of 13.3.

13.3 Each clamping unit of a connecting device shall be connected alternatively with conductors of the smallest and the largest cross-sectional area.

The insulation resistance is then measured with a d.c. voltage of approximately 500 V applied, the measurement being made 1 min after application of the voltage.

The measurements are made consecutively as indicated below:

a) between all clamping units connected together and the body for connecting devices without fixing means or between all clamping units connected together and the mounting base for connecting devices with fixing means;

b) between each clamping unit and all others connected to the body for connecting devices without fixing means or between each clamping unit and all others connected to the mounting base for connecting devices with fixing means;

c) between metal foil in contact with the internal surface of the internal insulating lining of metal enclosures and the body, if this lining is necessary to ensure conformity with the required clearance between live parts and

- *metal covers and enclosures without insulating lining;*
- *the surface on which the base is mounted.*

NOTE The term “body” includes all accessible metal parts, metal foil in contact with the outer surface of external parts of insulating material, fixing screws of bases or covers and external assembly screws.

For the measurements according to items a) and b), the metal foil is applied in such a way that the sealing compound, if any, is effectively tested.

The insulation resistance shall be not less than 5 MΩ.

13.4 *The electric strength is tested by applying a voltage of substantially sine-wave form, having a frequency of 50 Hz or 60 Hz and a value as specified in table 1, for 1 min between the parts listed in 13.3.*

Initially, not more than half the prescribed voltage is applied, then it is raised rapidly to the full value.

No flashover or breakdown shall occur during the test.

NOTE The high-voltage transformer used for the test should be so designed that when the output terminals are short-circuited after the output voltage has been adjusted to the appropriate test voltage, the output current is at least 200 mA.

The overcurrent relay shall not trip when the output current is less than 100 mA.

Care is taken that the r.m.s. value of the test voltage applied is measured within ±3 %.

Glow discharges without a drop in voltage are disregarded.

Table 1 – Relationship between rated insulation voltage and test voltage

Rated insulation voltage V	**Test voltage** V
≤130	1 250
>130 and ≤250	2 000
>250 and ≤450	2 500
>450 and ≤750	3 000
>750	3 500

14 Mechanical strength

14.1 Connecting devices shall have adequate mechanical strength. Protective enclosures, in particular, shall withstand the stresses imposed during installation and use.

Unless otherwise specified in the relevant Part 2, compliance is checked by the tests of 14.2 for connecting devices having a mass less than 50 g or 14.3 for connecting devices having a mass equal to or greater than 50 g. Tests are carried out without conductors fitted unless otherwise stated in the relevant Part 2.

14.2 *Samples are tested in the tumbling barrel according to IEC 60068-2-32.*

Screws, if any, are tightened with a torque specified in the relevant Part 2.

The barrel is turned for a total of 50 falls.

After the test, the sample shall show no damage within the meaning of this standard. In particular, the device shall not show any breaks, cracks or deformation which would prevent it from continuing to maintain live parts in place or from ensuring their protection against electric shock.

NOTE Small pieces broken off without affecting this protection are disregarded.

14.3 *The samples with insulation are subjected to blows by means of the pendular hammer according to IEC 60068-2-75.*

The striking element shall have a mass of 150 g ± 1 g.

Before applying the blows, fixing screws of bases and covers are tightened with a torque specified in the relevant Part 2.

The samples are mounted on the plywood as in normal use so that the point of impact lies in the vertical plane through the axis of the pivot.

The striking element is allowed to fall from a height of

– *7,5 cm for those parts of covers which are recessed to a depth of at least one-sixth of the largest dimension of the recessed part;*
– *10 cm for flat surfaces of cover plates of flush-type connecting devices;*
– *20 cm for parts projected from the mounting surfaces (for example, rims extending 20 mm from the walls) of cover plates of flush-type connecting devices and for enclosures of surface types;*
– *25 cm for enclosures of any other type.*

NOTE 1 Certain devices, for example multiway terminal devices intended to be fitted into enclosures providing mechanical protection, need to be tested using a fall height of 7,5 cm.

The height of fall is the vertical distance between the position of a checking point, when the pendulum is released and the position of that point at the moment of impact. The checking point is marked on the surface of the striking element where the line through the point of intersection of the axes of the steel tube of the pendulum and the striking element and meets the surface perpendicular to the plane through both axes.

NOTE 2 Theoretically the centre of gravity of the striking element should be the checking point. As, in practice, the centre of gravity is difficult to determine, the checking point is chosen as described above.

The samples are subjected to 10 blows which are evenly distributed over the sample.

In general, 5 of the blows are applied as follows:

– *for flush-type connecting devices, one blow in the centre, one at each extremity of the area over the recess in the block and the other two approximately midway between the previous blows, preferably on the ridge, if any, the sample being moved horizontally;*
– *for other connecting devices, one blow in the centre, one on each side of the sample after it has been turned as far as possible but not through more than 60°, about a vertical axis and the other two approximately midway between the previous blows, preferably on the ridge, if any.*

The remaining blows are then applied in the same way, after the sample has been turned through 90° about its axis, perpendicular to the plywood.

Cover plates are treated as though they were the corresponding number of separate covers but only one blow is applied to any one point.

After the test, the samples shall show no damage within the meaning of this standard. In particular, live parts shall not become accessible.

In case of doubt, it is verified that it is possible to remove and replace external parts such as boxes, enclosures, covers and cover plates without these parts or their insulating lining being broken.

If, however, a cover plate backed by an inner cover is broken, the test is repeated on the inner cover, which shall remain unbroken.

Damage to the finish, small dents which do not reduce creepage distances or clearances below the value specified in Clause 17, and small chips which do not adversely affect the protection against electric shocks are ignored.

Cracks not visible to the naked eye with normal or corrected vision without additional magnification and surface cracks in fibre-reinforced mouldings and the like are ignored.

Cracks or holes in the outer surface of any part of the sample are ignored if the sample complies with this standard even if this part is omitted. If a decorative cover is backed by an inner cover, fracture of the decorative cover is ignored if the inner cover withstands the test after removal of the decorative cover.

15 Temperature rise

15.1 Connecting devices shall be so constructed that the temperature rise in normal use does not exceed the values specified in 15.4.

Compliance is checked by the tests according to the relevant Part 2.

15.2 Connecting devices with a single terminal (see Figure 1) having one or more clamping units shall be connected to conductors in the intended manner and the most unfavourable conditions.

Conductor length shall be 1 m for a cross-sectional area up to and including 10 mm^2 and 2 m for a cross-sectional area above 10 mm^2. Conductor length may be reduced in agreement with manufacturer.

15.3 For multiway terminal devices a maximum of 3 adjacent terminals are connected in series. If single-pole connecting devices are designed to be mounted side by side, 3 devices are placed in the intended manner and connected together (see Figure 2).

Conductor length shall be 1 m for a cross-sectional area up to and including 10 mm^2 and 2 m for a cross-sectional area above 10 mm^2. Conductor length may be reduced in agreement with manufacturer.

15.4 The connections are made with new conductors of the largest cross-sectional area appropriate to the clamping units, the clamping units being connected according to the specifications of the relevant Part 2. For devices with a *T* marking, measurement shall be made at a temperature equal to the *T* marking with a tolerance of ±2 °C.

Temperature-rise measurements are made when the device under test has reached thermal equilibrium. It is generally accepted that the temperature is stable when the temperature of the part under test does not increase by more than 1 K/h. During the whole of the testing the devices are loaded with alternating current having the value shown in Table 2.

Table 2 – Relationship between rated connecting capacity and test current

Rated connecting capacity mm^2	Test current A
0,2	4
0,34	5
0,5	6
0,75	9
1	13,5
1,5	17,5
2,5	24
4	32
6	41
10	57
16	76
25	101
35	125

The temperature is determined by means of colour-changing indicators or thermocouples, so chosen and positioned that they have a negligible effect on the temperature being determined (for example, on the metallic part in contact with the conductor).

The temperature rise of current-carrying parts of the clamping unit shall not exceed 45 K, it being understood that in the case of an insulated device the temperature rise of the conductor shall be measured as close as possible to the clamping unit.

The temperature rise measurement in the case of devices for a rated temperature not exceeding 40 °C is made at 20 °C ± 5 °C. In the case of devices T-marked for higher rated temperature, the temperature rise measurement is made at a temperature equal to the T marking with a tolerance of ±2 °C.

〖C〉 *text deleted* 〈C〗

16 Resistance to heat

16.1 Connecting devices having parts in insulating material shall be sufficiently resistant to heat.

Unless otherwise specified in the relevant Part 2, compliance is checked by the tests of 16.2 and 16.3.

16.2 *The samples or portions of the samples as specified in the relevant Part 2 are kept for 1 h in a heating cabinet at a temperature of 85 °C or a temperature equal to their T rating +45 K, whichever is the higher, with a tolerance of ±5 °C.*

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

After the test and after the samples have been allowed to cool to approximately ambient temperature, there shall be no access to live parts which are normally not accessible when the samples are mounted as in normal use, even if the standard test finger is applied with a force not exceeding 5 N.

After the test, markings shall still be legible.

16.3 *Parts of insulating material necessary to retain current-carrying parts and parts of the earthing circuit in position are subjected to a ball-pressure test by means of the apparatus according to IEC 60695-10-2.*

When it is not possible to carry out the test on the sample under test, the test has to be carried out on a plain piece of plastic part cut out from the sample with a minimum thickness of 2 mm. If it is not possible, up to four layers, each cut out from the sample with a minimum total thickness of 2,5 mm, or a sample of material at least 2 mm thick may be used.

The surface of the part to be tested is placed in the horizontal position on a base of steel at least 3 mm thick.

The test is made in a heating cabinet at a temperature of 125 °C ± 2 °C or at the T rating plus 45 °C, whichever is the higher. After 1 h, the ball is removed from the sample, which is then cooled down within 10 s to approximately ambient temperature by immersion in cold water.

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

Parts of the insulating material not necessary to retain current-carrying parts and parts of the earthing circuit in position, even though they are in contact with them, are subjected to a ball-pressure test as described above but at a temperature of 70 °C ± 2° C or 40 °C ± 2 °C, plus the highest temperature rise determined for the relevant part during the test of Clause 15, whichever is the higher.

17 Clearances and creepage distances

Unless otherwise specified in the relevant Part 2, creepage distances, clearances and distances through sealing compound shall not be less than the value shown in Table 3.

Table 3 – Clearances and creepage distances

Rated insulation voltage V	**Creepage and clearances distances** [a] mm
≤130	1,5
>130 and ≤250	3,0
>250 and ≤450	4,0
>450 and ≤750	6,0
>750	8,0
[a] These values are under consideration.	

Compliance is checked by measurement between the following parts:

Creepage distances and clearances:

– *between live parts of different polarity;*
– *between live parts and*
  - *metal covers and enclosures without insulating lining;*
  - *the surface on which the base is mounted.*

Distances through sealing compound:

– *between live parts covered with sealing compound and the surface on which the base is mounted.*

For multiway terminal devices and terminals without fixing means but with protection, distances are measured between live parts and any opening which represents the closest point liable to touch any other part when the terminal is fitted with conductors having the largest cross-sectional area.

18 Resistance of insulating material to abnormal heat and fire

Unless otherwise specified in the relevant Part 2, compliance is checked by the glow-wire test.

The test is performed according to Clauses 4 to 10 of IEC 60695-2-10, under the following conditions:

– *for parts of insulating material necessary to retain current-carrying parts and parts of the earthing circuit in position, by the test made at a temperature of 850 °C;*
– *for parts of insulating material not necessary to retain current-carrying parts and parts of the earthing circuit in position, even though they are in contact with them and for enclosures retaining in position only earthing clamping units by the test made at a temperature of 650 °C.*

If the tests specified have to be made at more than one place on the same sample, care must be taken to ensure that any deterioration caused by previous tests does not affect the result of the test to be made.

NOTE 1 Small parts, such as washers, are not subjected to this test.

NOTE 2 The tests are not made on parts of ceramic material.

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 of insulating material, which can be ignited by the heated test wire under defined conditions, has a limited time to burn without spreading fire by flame or burning parts or droplets falling from the tested part onto the pinewood board covered with a tissue paper.

If possible, the sample shall be a complete connecting device.

If the test cannot be made on a complete connecting device, a suitable part may be cut from it for the purpose of the test.

The test is made on one sample.

In case of doubt, the test shall be repeated on two further samples, both of which shall then pass the test.

The test is made applying the glow-wire once for 5 s with a tolerance of $^{-0}_{+1}$ *s.*

The 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 sample taking into account the conditions of the intended use under which a heated or glowing element may come into contact with the sample.

The sample is regarded as having passed the glow-wire test if

– *there is no visible flame and no sustained glowing,*

or if

– *flames and glowing on the sample extinguish within 30 s after the removal of the glow-wire.*

There shall be no ignition of the tissue paper or scorching of the board.

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

19 Resistance of insulating material to tracking

Unless otherwise specified parts of insulating material retaining live parts in position shall be of material resistant to tracking.

For materials other than ceramic and where the creepage distances are less than twice the values specified in Clause 17, compliance is checked by the following test on three samples.

The test is performed according to IEC 60112.

A flat surface of the part to be tested at least 15 mm × 15 mm and at least 3 mm thick is placed in the horizontal position on the apparatus.

The material under test shall pass at a proof tracking index of 175 V using the test solution A with an interval between drops of 30 s ± 5 s.

NOTE If the part requiring test does not meet the dimensional criteria, it is permitted to stack samples to reach the 3 mm thickness value or else a plaque of the identical material 3 mm thick may be used.

In case of doubt, the test shall be repeated on a new set of samples, which shall then pass the test.

20 EMC requirements

Unless otherwise specified in the relevant Part 2, the following requirements for immunity and emission apply.

20.1 Immunity

The operation of connecting devices within the scope of this standard in normal use is not affected by electromagnetic disturbances.

20.2 Emission

Connecting devices within the scope of this standard are intended for continuous use, in normal use they do not generate electromagnetic disturbances.

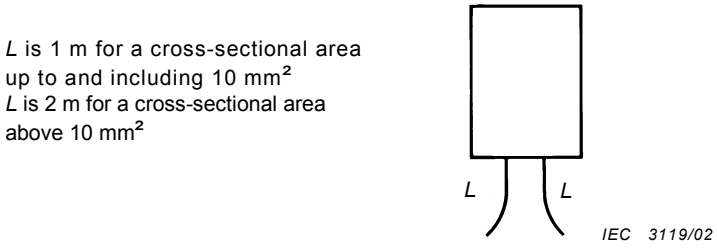


Figure 1 – Single terminal device

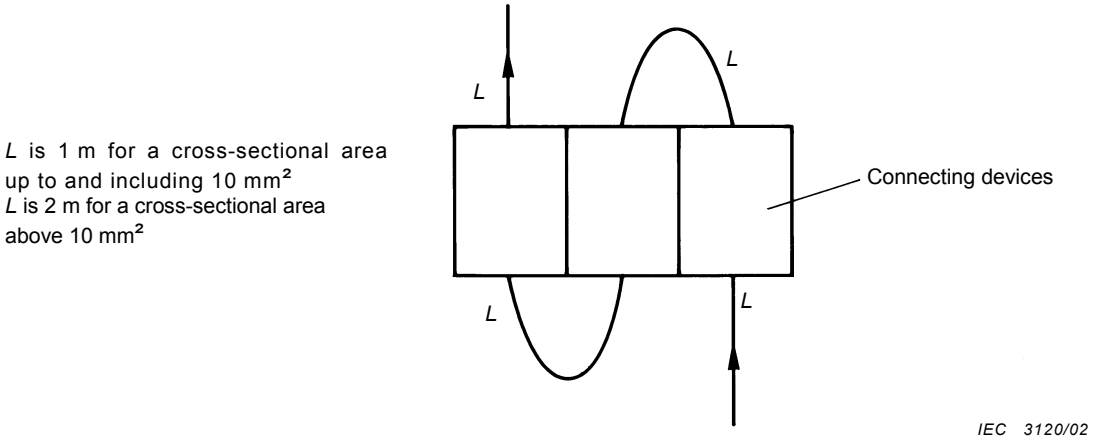
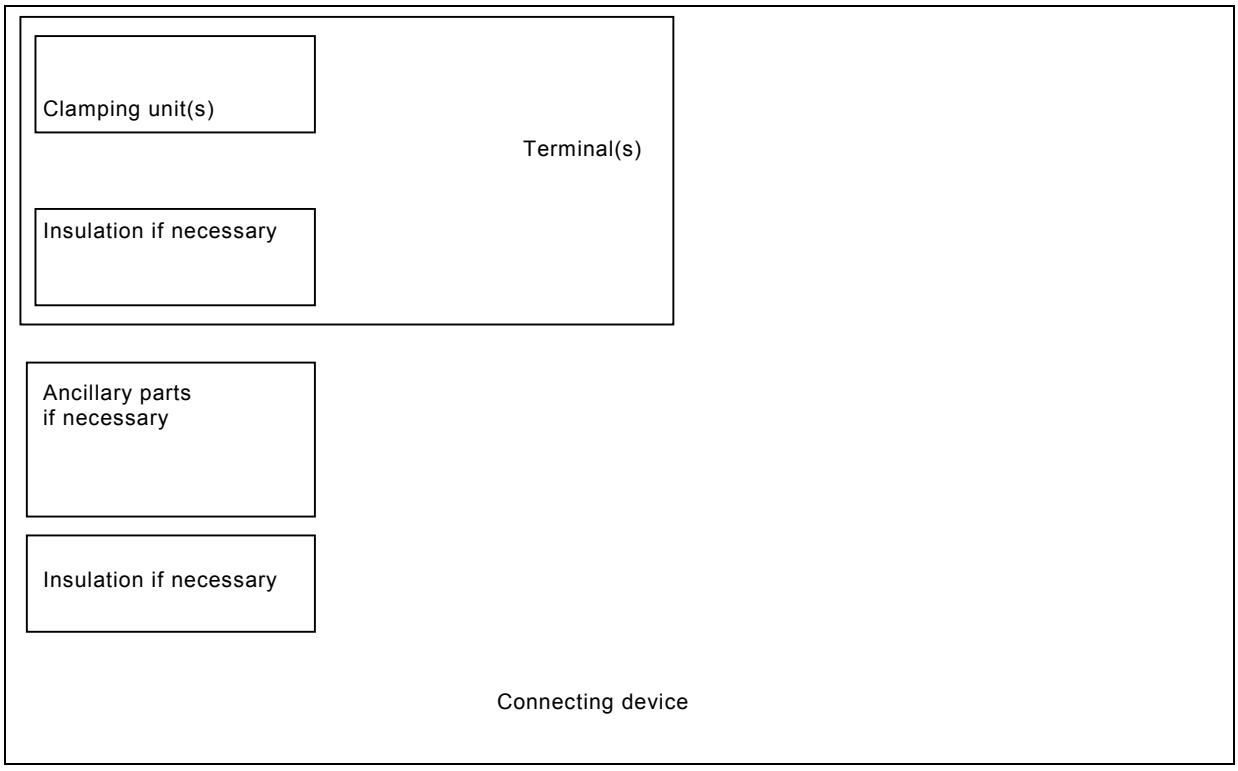


Figure 2 – Multiway terminal device

Annex A
(informative)

Schematic presentation of connecting devices as a basis for the definitions



Annex B
(informative)

[C〉 *text deleted* 〈C]

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application 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.

NOTE Where an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60068-2-32	1975	Basic environmental testing procedures Part 2: Tests - Test Ed: Free fall (Procedure 1)	EN 60068-2-32 [1)]	1993
IEC 60068-2-75	1997	Part 2-75: Tests - Test Eh: Hammer tests	EN 60068-2-75	1997
IEC 60112	1979	Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions	HD 214 S2 [2)]	1980
IEC 60228 (mod)	1978	Conductors of insulated cables - First supplement: Guide to the dimensional limits of circular conductors	HD 383 S2 [3)]	1986
IEC 60344	1980	Guide to the calculation of resistance of plain and coated copper conductors of low-frequency cables and wires	-	-
IEC 60529	1989	Degrees of protection provided by enclosures (IP Code)	EN 60529 + corr. May	1991 1993
IEC 60695-2-10	2000	Fire hazard testing Part 2-10: Glowing/hot-wire based test methods - Glow-wire apparatus and common test procedure	EN 60695-2-10	2001
IEC 60695-10-2	1995 [4)]	Part 10-2: Guidance and test methods for the minimization of the effects of abnormal heat on electrotechnical products involved in fires - Method for testing products made from non-metallic materials for resistance to heat using the ball pressure test	-	-

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1) EN 60068-2-32:1993 includes A2:1990 to IEC 60068-2-32:1975.

2) HD 214 S2:1980 is superseded by EN 60112:2003, which is based on IEC 60112:2003.

3 HD 383 S2:1986 is based on IEC 60228:1978 + supplement A:1982, modified.

4) IEC 60695-10-2 is superseded by IEC 60695-10-2:2003, which is harmonized as EN 60695-10-2:2003.

Publication	Year	Title	EN/HD	Year
IEC 61032	1997	Protection of persons and equipment by enclosures - Probes for verification	EN 61032	1998
ISO 1456	1988	Metallic coatings - Electrodeposited coatings of nickel plus chromium and of copper plus nickel plus chromium	-	-
ISO 2081	1986	Metallic coatings - Electroplated coatings of zinc on iron or steel	-	-
ISO 2093	1986	Electroplated coatings of tin - Specification and test methods	-	-

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Annex ZB
(normative)

Special national conditions

Special national condition: National characteristic or practice that cannot be changed even over a long period, e.g. climatic conditions, electrical earthing conditions.

NOTE If it affects harmonization, it forms part of the European Standard.

For the countries in which the relevant special national conditions apply these provisions are normative, for other countries they are informative.

Clause Special national condition

6.2 United Kingdom

Replace the entire subclause by:

6.2 The standard rated connecting capacities are 0,2 mm^2, 0,34 mm^2, 0,5 mm^2, 0,75 mm^2, 1 mm^2, 1,25 mm^2, 1,5 mm^2, 2,5 mm^2, 4 mm^2, 6 mm^2, 10 mm^2, 16 mm^2, 25 mm^2 and 35 mm^2.

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