IEC 61316

Edition 3.0 2021-07
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Industrial cable reels

IEC 61316:2021-07 RLV(en)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.060.01; 29.120.99

ISBN 978-2-8322-1002-6

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INDUSTRIAL CABLE REELS

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61316:1999. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 61316 has been prepared by subcommittee 23H: Plugs, socket-outlets and couplers for industrial and similar applications, and for electric vehicles, of IEC technical committee 23: Electrical accessories.

This third edition cancels and replaces the second edition, published in 1999. This edition constitutes a technical revision.

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

– Implementation of the latest tests and requirements previously included in IEC 60309-1.

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

FDIS	Report on voting
23H/483/FDIS	23H/489/RVD

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 International Standard 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 smaller roman type.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under 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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INDUSTRIAL CABLE REELS

1 Scope

This document applies to cable reels provided with a non-detachable flexible cable with a rated operating voltage not exceeding 690 V DC and/or 690 V AC with a frequency not exceeding 500 Hz and a rated current not exceeding 63 A, primarily intended for industrial use, either indoors or outdoors, for use with accessories complying with IEC 60309-1, IEC 60309-2 or IEC 60309-4.

This document applies to:

– portable cable reels equipped with one plug or appliance-inlet complying with IEC 60309-1 or IEC 60309-2 and at least one socket-outlet complying with IEC 60309-1, IEC 60309-2 or IEC 60309-4;

– fixed cable reels equipped with at least one socket-outlet complying with IEC 60309-1, IEC 60309-2 or IEC 60309-4;

– cable reels suitable for use at ambient temperature normally within the range of −25 °C to +40 °C.

The use of this equipment on construction sites and for agricultural, commercial and domestic appliances is not precluded.

This document also applies to cable reels intended to be used in extra-low voltage installations.

In locations where special conditions prevail, for example, on board ships, in vehicles and the like, or where explosions are liable to occur, additional requirements ~~may~~ can be necessary.

NOTE 1 This document was not developed for Electric Vehicle (EV) application, but it can be used as guide for cable reels for EV application

NOTE 2 Additional requirements for cable reels for currents higher than 63 A are under consideration.

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 60050(195):1998, *International Electrotechnical Vocabulary (IEV) – Part 195: Earthing and protection against electric shock*~~

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

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

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

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

IEC 60245-4~~:1994~~, *Rubber insulated cables – Rated voltages up to and including 450/750 V – Part 4: Cords and flexible cables*

IEC 60309-1:~~1999~~2021, *Plugs, fixed or portable socket-outlets and ~~couplers~~ appliance inlets for industrial purposes – Part 1: General requirements*

IEC 60309-2~~:1999~~, *Plugs, fixed or portable socket-outlets and ~~couplers~~ appliance inlets for industrial purposes – Part 2: Dimensional ~~interchangeability~~ compatibility requirements for pin and contact-tube accessories*

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

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

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

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

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

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

IEC 60730-2-9, *Automatic electrical controls – Part 2-9: Particular requirements for temperature sensing control*

IEC 61000-6-1, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity standard for residential, commercial and light-industrial environments*

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

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

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

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

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

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

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

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

3.1
rated operating voltage
voltage assigned to the cable reel by the manufacturer

3.2
rated current
current assigned to the cable reel by the manufacturer

3.3
cable reel
device comprising a flexible cable attached to a reel, so constructed that the cable may be wound on to the reel

Note 1 to entry: Plugs ~~and~~, socket-outlets and appliance inlets ~~or connectors~~, if any, supplied with cable reels are considered as part of the reel.

3.3.1
portable cable reel
cable reel which can be moved easily from one place to another

3.3.2
fixed cable reel
cable reel intended for mounting on a fixed support

3.4
non-detachable flexible cable
flexible cable which is fixed to a cable reel

3.5
rewireable cable reel
cable reel so constructed that the flexible cable can be replaced with the aid of a general-purpose tool

3.6
non-rewireable cable reel
cable reel so constructed that it forms a complete unit with the flexible cable, the plug and the socket-outlets, fixed by the manufacturer of the cable reel in such a manner that, after dismantling, the cable reel is rendered unfit for any further purpose

3.7
accessible part
part which can be touched by means of the standard test finger

3.8
detachable part
part which can be removed without the aid of a general-purpose tool

3.9
creepage distance
shortest path along the surface of an insulating material between two conductive parts

3.10
clearance
shortest distance in air between two conductive parts

3.11
thermal cut-out
temperature-sensing control device intended to switch off automatically under abnormal operating conditions and which has no provision for adjustment by the user

3.12
current cut-out
current-sensing control device intended to switch off automatically under abnormal operating conditions and which has no provision for adjustment by the user

3.13
trip-free mechanism
mechanism designed so that disconnection can neither be prevented nor inhibited by a reset mechanism, and so that the contacts can neither be prevented from opening nor be maintained closed against a continuation of excess temperature or current

3.14
non-self-resetting thermal or current cut-out
thermal or current cut-out which can only be reset by a manual action directly acting on the device which is used exclusively for this purpose and which is mounted in the cable reel or for fixed cable reel as a separate unit within sight of the cable reel

3.15
basic insulation
insulation of hazardous-live-partswhich provides basic protection ~~against electric shock~~

[SOURCE: IEC 60050-195:1998, 195-06-06, modified – note to entry omitted.]

3.16
supplementary insulation
~~independent insulation provided in addition to the basic insulation, in order to ensure protection against electric shock in the event of a failure of the basic insulation~~
independent insulation applied in addition to the basic insulation, for fault protection

[SOURCE: IEC 60050-195:1998, 195-06-07~~, modified~~]

3.17
double insulation
insulation comprising both basic insulation and supplementary insulation ~~in order to provide protection against electric shock if basic insulation fails~~

[SOURCE: IEC 60050-195:1998, 195-06-08~~, modified~~]

3.18
reinforced insulation
~~single~~ insulation ~~system~~ of hazardous-live-parts which provides a degree of protection against electric shock equivalent to double insulation

Note 1 to entry: Reinforced insulation may comprise several layers which cannot be tested singly as basic insulation or supplementary insulation.

[SOURCE: IEC 60050-195:1998, 195-06-09~~, modified~~]

3.19
termination
insulated or non-insulated connecting device~~s serving~~ for non-reusable connection of the conductors of the supply cable

3.20
terminal
conductive part of one pole, composed of one or more clamping unit(s) and insulation if necessary

3.20.1
pillar terminal
terminal in which the conductor is inserted into a hole or cavity, where it is clamped under the shank of the screw or screws

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

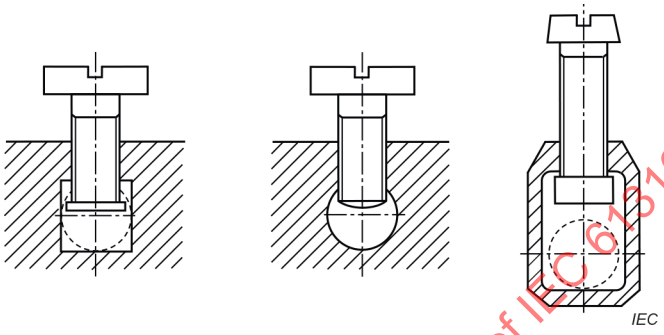


Figure 1 – Pillar terminals

3.20.2
screw terminal
terminal in which the conductor is clamped under the head of the screw

Note 1 to entry: The clamping pressure may be applied directly by the head of the screw or through an intermediate part, such as a washer, clamping plate or anti-spread device (see Figure 2).

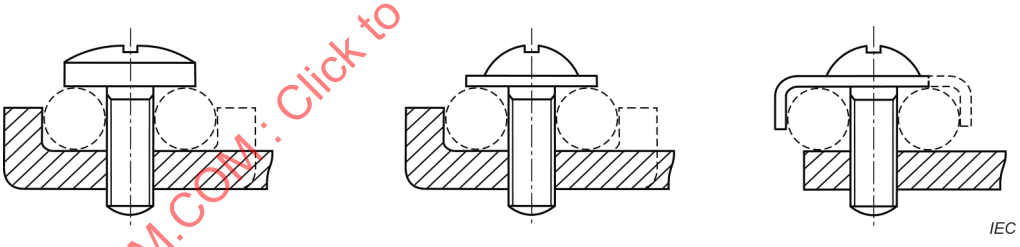


Figure 2 – Screw terminals

3.20.3
stud terminal
terminal in which the conductor is clamped under a nut

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

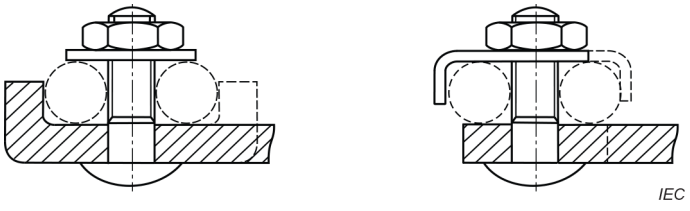


Figure 3 – Stud terminals

3.20.4
saddle terminal
terminal in which the conductor is clamped under a saddle by means of two or more screws or nuts

Note 1 to entry: See Figure 4.

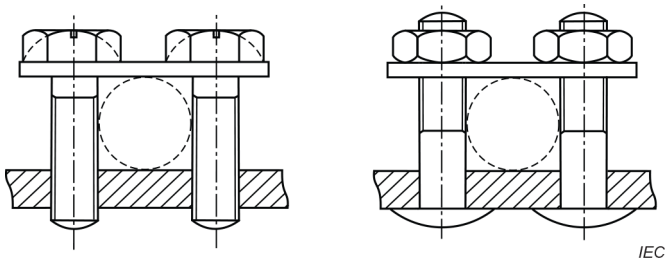


Figure 4 – Saddle terminals

3.20.5
lug terminal
screw terminal or a stud terminal, designed for clamping a cable lug or bar by means of a screw or nut

Note 1 to entry: See Figure 5.

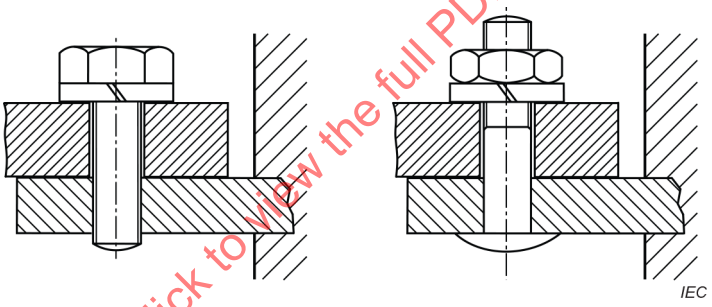


Figure 5 – Lug terminals

3.20.6
mantle terminal
terminal in which the conductor is clamped against the base of a slot in a threaded stud by means of a nut

Note 1 to entry: The conductor is clamped against the base of the slot by a suitably shaped washer under the nut, by a central peg if the nut is a cap nut, or by equally effective means for transmitting the pressure from the nut to the conductor within the slot (see Figure 6).

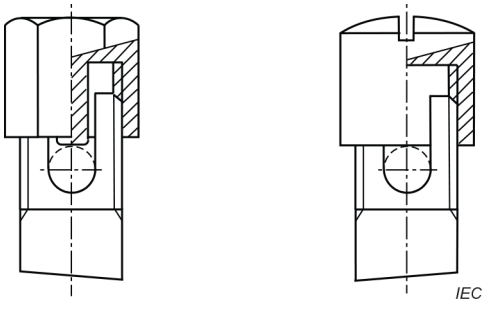


Figure 6 – Mantle terminals

3.20.7
screwless type terminal
terminal for the connection and subsequent disconnection of one or more conductors, the connection being made, directly or indirectly, by means other than screws

Note 1 to entry: Examples of screwless type terminals are given in Figure 7.

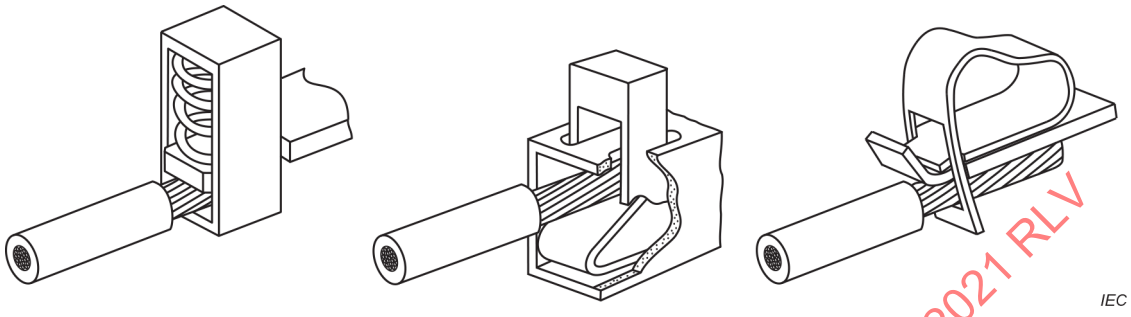
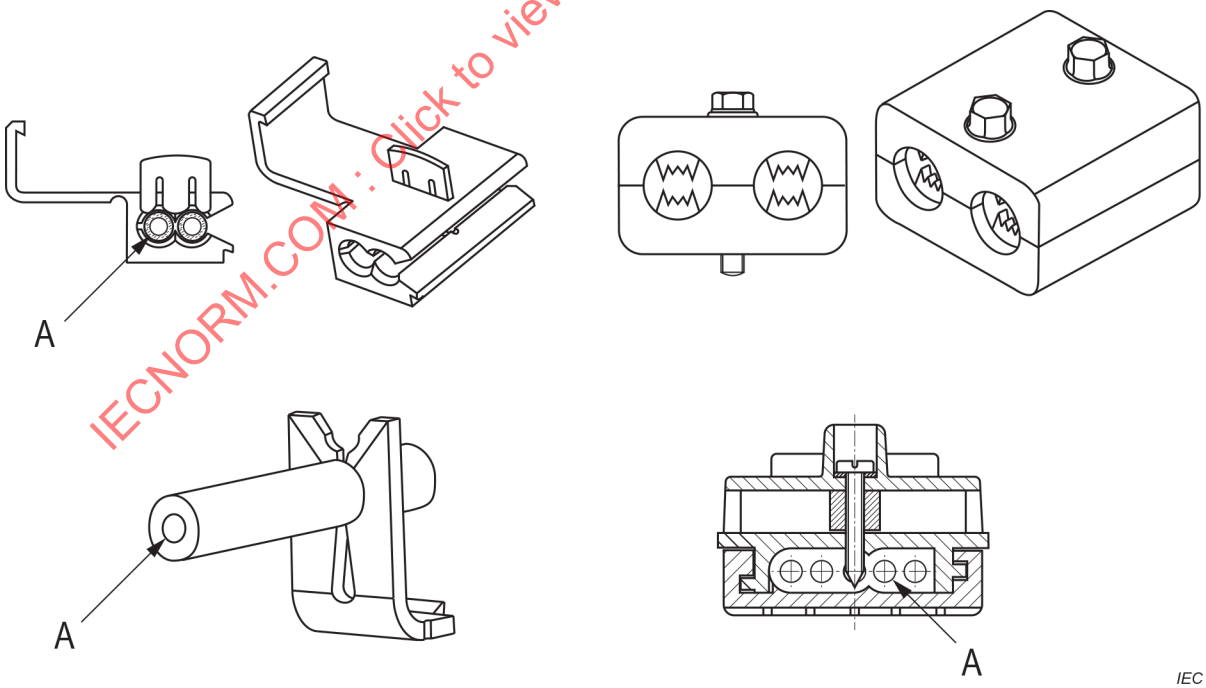


Figure 7 – Screwless terminals

3.20.8
insulation piercing terminal
IPT
terminal for the connection and subsequent disconnection of one or more conductors, the connection being made by piercing, boring through, cutting through, displacing or making ineffective in some other manner the insulation of the conductor(s) without previous stripping

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

Note 2 to entry: Examples of IPT are given in Figure 8.



Key

A Conductor

Figure 8 – Insulation piercing terminals

3.21
clamping unit
part(s) of the terminal necessary for mechanical clamping and electrical connection of the conductor(s), including the parts which are necessary to ensure the correct contact pressure

3.22
connecting device
device for the electrical connection of one (or more) conductor(s), either fixed to a base or forming an integral part of the equipment

4 General requirements

4.1 ~~General requirements~~

Industrial cable reels shall be so designed and constructed that, in normal use, their performance is reliable ~~and without danger to user or surroundings~~, and safety is achieved by reducing risk to a tolerable level, as defined in ISO/IEC Guide 51.

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

If other pollution degrees are needed, creepage distances and clearances shall be in accordance with IEC 60664-1. The comparative tracking index (CTI) value shall be evaluated in accordance with IEC 60112. Test and requirements are specified in 21.3.

Cable reels shall have a minimum degree of protection IP24D (see 6.3) according to IEC 60529.

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

~~4.2.4 General notes on tests~~

~~This subclause of IEC 60309-1 is applicable, except as follows:~~

4.2~~.4~~ ~~*Replacement:*~~

Unless otherwise stated, one sample is submitted to all the tests, and the requirements are satisfied if all the tests are met. The sample is tested as delivered and under normal conditions of use, at an ambient temperature of (20 ± 5) °C. Tests are carried out in the order of the clauses of this document.

~~4.2.5 *Replacement:*~~

4.3 If the sample does not satisfy a test due to an assembly or manufacturing fault which is not representative of the design, that test and any preceding one which may have influenced the results of the test shall be repeated in the required sequence. Tests which follow shall be made on another sample, which shall comply with the requirements of this document.

5 Standard ratings

~~This clause of IEC 60309-1 is applicable except as follows:~~

~~5.2 *Replacement:*~~

The rated current shall not be higher than the maximum rated current of ~~the inlet or of the connector~~ the plug or the appliance inlet or the socket-outlet.

Preferred rated currents are given in Table 1.

Table 1 – Preferred rated currents

Series I A	Series II A
16	20
32	30
63	60

NOTE 1 "Preferred ratings" do not exclude other ratings.

NOTE 2 This table does not provide correspondence between series I and series II values.

Compliance is checked by inspection of the marking.

6 Classification

6.1 Cable reels are classified according to the type of construction:

- portable cable reels;
- fixed cable reels.

6.2 Cable reels are classified according to the method of winding the flexible cable:

- hand-operated cable reels;
- spring-operated cable reels;
- motor-driven cable reels.

6.3 Cable reels are classified according to the degree of protection according to IEC 60529:

- the minimum degree of protection shall be IP24D.

6.4 Cable reels are classified according to their protection against excessive temperatures:

- cable reels incorporating thermal cut-out;
- cable reels incorporating current cut-out;
- cable reels incorporating both thermal and current cut-outs.

6.5 Cable reels are classified according to the method of connecting the cable:

- rewireable cable reels;
- non-rewireable cable reels.

6.6 Cable reels are classified according to the material of the drum:

- cable reels with drum made of insulating material;
- cable reels with drum made of other material.

6.7 Cable reels are classified according to the type of conductors for screwless type and insulation piercing terminals, if any:

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

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

7 Marking

7.1 Cable reels shall be marked with:

– rated current(s) in amperes;
– rated operating voltage(s) or voltage range(s) in volts;
– symbol for the nature of supply;
– either the name~~, trade mark or identification mark~~ or trademark of the manufacturer, or of the responsible vendor;
– type reference, which may be a catalogue number;
– ~~symbol for~~ degree of protection according to IEC 60529;

~~NOTE – The degrees of protection are based on IEC 60529.~~

– maximum load which may be connected to the cable reel in fully reeled and fully unreeled condition:

EXAMPLE: 1 000 W 400 V fully reeled cable 
3 500 W 400 V fully extended cable 

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

A	amperes	
V	volts	
Hz	hertz	
W	watts	
	alternating current	IEC 60417-5032 (2002-10)
	direct current	IEC 60417-5031 (2002-10)
	protective earth	IEC 60417-5019 (2006-08)
IPXXD*	degree of protection	
	fully reeled cable reel	
	fully extended cable reel	

* For IP codes, the two characteristic numerals (XX) shall be specified. The supplementary letter D shall not be marked if the first characteristic numeral is a 4 or greater.

For the marking of rated current(s) and rated operating voltage(s) or voltage range(s), figures may be used alone. The figure for DC rated operating voltage, if any, shall then be placed before the figure for the AC rated operating voltage and separated from it by a line or a dash.

Compliance is checked by inspection.

7.3 Cable reels shall be marked with an instruction clearly stating how to reset the thermal and/or current cut-out device(s).

Compliance is checked by inspection.

7.4 If marking plates or labels are used, they shall be reliably secured. After all the tests of this document, marking shall be easily legible with normal or corrected vision, without additional magnification, and labels shall show no curling or loosening at the corners or edges.

Compliance is checked by inspection.

7.5 ~~Marking shall be durable and easily legible with normal or corrected vision, without additional magnification.~~

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

~~*The test is made by rubbing the marking by hand for 15 s with a piece of cotton cloth soaked in water and again for 15 s with a piece of cotton cloth soaked in petroleum spirit.*~~

~~NOTE 1 – Marking made by impression, molding, pressing or engraving is not subjected to this test.~~

~~NOTE 2 – It is recommended that the petroleum spirit used is of a type consisting of a solvent hexane with an aromatic content of maximum 0,1 % volume, a kauributanol value of approximately 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.~~

Marking shall be easily legible.

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

Marking shall be durable and indelible.

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

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

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

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

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

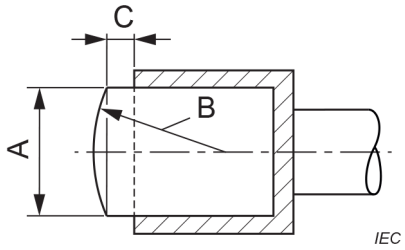
The marking surface to be tested shall be dried after the test with water.

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

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

The test piston shall have the dimensions specified in Figure 9 and shall be made of an elastic material which is inert against the test liquids and has a Shore-A hardness of 47 ± 5 (for example synthetic rubber).

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



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

Figure 9 – Test piston

8 Dimensions

~~This clause of IEC 60309-1 is applicable except as follows:~~

~~**8.1** *Addition:*~~

The surface on which the cable is wound shall be at least eight times the maximum diameter of the cable as given in IEC 60245-4, as appropriate.

For cable reels using flat cable, the surface on which the cable is wound shall have a diameter of at least 10 times the average of the upper and lower dimensions of the cable.

~~**8.2** This subclause of IEC 60309-1 is not applicable.~~

~~**8.3** This subclause of IEC 60309-1 is not applicable.~~

9 Protection against electric shock

~~This clause of IEC 60309-1 is applicable except as follows:~~

9.1 ~~*Replacement:*~~

Cable reels shall be designed so that live parts are not accessible when the cable reel is in normal use and when parts which can be removed without the aid of a tool, have been removed.

Compliance is checked by inspection and, if necessary, by the tests of 9.2 and 9.3.

These tests shall be made immediately after the cable reel has passed a current having a value corresponding to the maximum load, when fully reeled, for 1 h at an ambient temperature of (20 ± 5) °C.

9.2 *The standard test finger ~~shown in figure 2 of IEC 60309-1~~ according to IEC 61032 Probe B is applied with a force of (10 ± 1) N in every possible position; an electrical indicator with a voltage not less than 40 V and not more than 50 V is used to show contact with the relevant part.*

For cable reels, where the use of elastomeric or thermoplastic material is likely to influence compliance with the requirement, the test is repeated but at an ambient temperature of (35 ± 2) °C, the cable reels being at this temperature.

During this additional test, the parts of elastomeric or thermoplastic material of the cable reel are subjected for 1 min to a force of 75 N, applied through the tip of a straight unjointed test finger of the same dimensions as the standard test finger. This finger, with an electrical indicator as described above, is applied to all places where yielding of the insulating material could impair the safety of the cable reel.

During this test, the cable reel shall not deform to such an extent that those dimensions which ensure safety are unduly altered and no live part shall be accessible.

9.3 *The test is made with a straight rigid steel wire of (1 ± 0,015) mm as shown in Figure 10, applied with a force of* $(1^{+0,1}_{0})$ *N. The end of the wire shall be free from burrs and be at right angles to its length.*

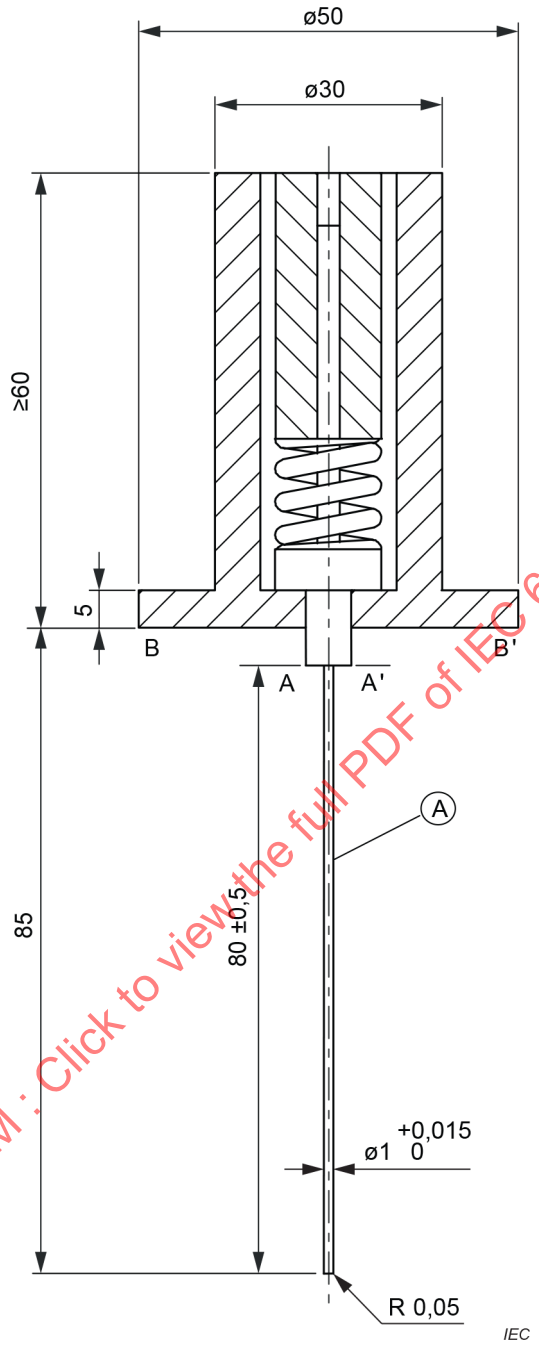
~~NOTE – This test does not apply to the accessories fitted to the cable reel.~~

This test does not apply to the plug, appliance inlet and socket-outlets, if any, fitted to the cable reel.

The test wire is provided with an electrical indicator, with a voltage not less than 40 V and not more than 50 V, to show contact with relevant part.

The protection is satisfactory if the wire cannot enter the enclosure, or if it enters, it does not touch live parts inside the enclosure.

Dimensions in millimetres



Key

A Rigid steel wire

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

Figure 10 – Standard 1 mm gauge

9.4 ~~*Addition:*~~

Parts providing protection against electric shock shall have adequate mechanical strength and shall be reliably secured by means of screws or in a similar reliable manner so that they will not work loose in normal use.

Compliance is checked by inspection and by the tests of Clause 19 and Clause 20.

10 Provisions for earthing

10.1 Accessible metal parts

For rewireable cable reels having accessible metal parts insulated from live parts by basic insulation only:

– the earthing terminal shall comply with the requirements of Clause 11;

– the earthing terminal shall be located in proximity to the terminals for current-carrying conductors;

– internal connections between the earthing terminal and accessible metal parts shall be independent of the connection of the flexible cable in order to prevent loosening of internal connections during the replacement of the flexible cable;

– when terminals of live conductors are accessible, no additional dismantling shall be necessary to reach the earthing terminal. Moreover, the earthing terminal shall not be more than 50 mm distance from the other terminals.

10.2 Corrosion resistance of earth terminal

All parts of the earthing terminal shall be such that there is no risk of corrosion resulting from contact between these parts and the copper of the earthing conductor, or any other metal that is in contact with these parts.

The body of the earthing terminal shall be of brass or other metal no less resistant to corrosion, unless it is a part of the metal frame or enclosure, when the screw or nut shall be of brass or plated steel complying with Clause ~~25~~ 23, or other metal no less resistant to corrosion.

10.3 Corrosion resistance of screws and nuts

Screws and nuts of plated steel withstanding the test of Clause 20 are considered to be of a metal no less resistant to corrosion than brass.

Compliance with the requirements of 10.1 to 10.3 is checked by inspection.

10.4 Earth connections

10.4.1 Accessible metal parts which may become live in the event of an insulation fault shall be permanently and reliably connected to the earthing terminal or termination.

~~NOTE 1~~ For the purpose of this document, screws and the like for fixing bases or covers are not deemed to be parts which ~~may~~ can become live in the event of a fault.

~~NOTE 2 –~~ If accessible metal parts are screened from live parts by metal parts which are connected to the earthing terminal or termination, or if they are separated from live parts by double insulation or reinforced insulation, they are not, for the purpose of this requirement, regarded as likely to become live in the event of an insulation fault.

Compliance is checked by inspection and by the following test:

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

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

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

~~NOTE 3 –~~ *Care ~~should~~ shall be taken that the contact resistance between the measuring probe and the metal part under test does not influence the test results.*

10.4.2 The earth connection shall be effectively ensured under all conditions which may occur in normal use, including loosening of fixing screws for covers, careless mounting of the cover or the like.

Compliance is checked by inspection.

10.4.3 Earthing terminals intended for the connection of flexible external conductors shall be designed with ample space for slack of the earthing conductor in such a way that, if the strain relief should fail, the connection of the earthing conductor is subjected to strain after connection of the current-carrying conductors and that, in case of excessive stresses, the earthing conductor will not break before the current-carrying conductors break.

Compliance is checked by the following test:

The flexible cable is connected to the cable reels in such a way that the current-carrying conductors are led from the strain relief to the corresponding terminals along the shortest possible path. After they are correctly connected, the core of the earthing conductor is led to its terminal and cut off at a distance 8 mm longer than necessary for its correct connections.

The earthing conductor is then connected to its terminal. It shall then be possible to house the loop, which is formed by the protective conductor owing to its surplus length, freely in the wiring space without squeezing or pressing the core when the cover of the cable reel is put on again and fixed correctly.

10.5 Internal earthing circuit

The internal earthing circuit in cable reels including any joints, contacts and the like shall be of low electrical resistance.

Compliance is checked by the following measurement which is made after the test specified in Clause 19.

A current derived from an AC source, having a no-load voltage not exceeding 12 V, and equal to 1,5 times the rated current of the cable reel or 25 A, whichever is the greater, is passed through the earthing circuit.

The voltage drop is measured, and the resistance calculated from the current and this voltage drop.

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

10.6 Internal moveable earth connection and slip rings

~~Internal moveable earth connections of cable reels, e.g. slip rings, shall be as follows:~~

10.6.1 ~~Moveable earth connections between the terminal for the earthing conductor of the incoming cable and the earthing terminal for the outgoing cable, or that of the socket-outlet, shall be duplicated.~~ Two different and independent moveable earth connections shall be provided between the terminal for the earthing conductor of the incoming cable and the earthing terminal for the outgoing cable, or that of the socket-outlet. One of these connections shall be a slip ring or an equally effective contact, while the other connection may be a ball-bearing, a slip ring, a plain bearing, or the like, provided it is metallic.

Compliance is checked by inspection.

10.6.2 Moveable earth connections between the terminal for the earthing conductor of the incoming cable and accessible metal parts of the cable reel shall be duplicated, each of which may be a ball bearing, a plain bearing, or the like, provided it is metallic.

Compliance is checked by inspection.

11 Terminals and terminations

~~This clause of IEC 60309-1 is applicable except as follows:~~

~~**11.1** *Replacement:*~~

~~Rewireable cable reels shall be provided with terminals in which connection is made by means of screws, nuts or equally efficient devices.~~

~~Non-rewireable cable reels shall not be provided with screwed or snap-on connections.~~

~~NOTE 1 – Terminations used should be soldered, welded, crimped or have equally effective permanent connections.~~

~~NOTE 2 – It is permissible to use the rewireable terminals of the accessories, such as plugs and couplers as terminations for the flexible cable, if the conductors of the cable are permanently connected to the terminal by soldering or welding.~~

~~Connections made by crimping a pre-soldered flexible conductor are not permitted.~~

~~*Compliance is checked by inspection.*~~

~~**11.6** *Modification:*~~

~~Delete, in the first line, the words "to the accessory".~~

11.1 Common requirements for terminals and terminations

11.1.1 Rewireable cable reels shall be provided with terminals in which connection is made by means of screws, nuts or equally efficient devices.

11.1.2 Non-rewireable cable reels shall be provided with soldered, welded, crimped or equally effective permanent connections.

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

Non-rewireable cable reels shall not be provided with screwed or snap-on connections.

Compliance is checked by inspection.

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

This requirement is not applicable to lug terminals

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

Compliance is checked by inspection.

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

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

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

NOTE Given values are nominal values.

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

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

Compliance is checked by inspection and by chemical analysis.

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

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

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

Compliance is checked by inspection and by chemical analysis.

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

Terminals and terminations shall be protected against rotation.

Clamping means shall not serve to fix any other component.

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

Compliance is checked by inspection and, if necessary, by test of 20.2.

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

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

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

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

Compliance is checked by inspection.

11.1.8 Terminals shall be so located or shielded that:

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

– conductors becoming detached from live terminals cannot touch metal parts connected to the earthing terminal;

– conductors becoming detached from the earthing terminal cannot touch live parts.

Compliance is checked by inspection and by manual test.

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

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

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

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

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

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

11.2 Screw type terminals

11.2.1 Screw type terminals shall allow the proper connection of copper or copper-alloy conductors having the nominal cross-sectional area specified in Table 8.

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

Gauges as specified in Figure 11, having a measuring section for testing the insertability of the maximum specified cross-sectional area specified in Table 8, shall be able to penetrate into the terminal aperture, down to the designated depth of the terminal, under their own weight.

Screw type terminals that cannot be checked with the gauges specified in Figure 11, shall be tested by suitably shaped gauges, having the same cross-section as those of the appropriate gauges of Figure 11.

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

Compliance is checked by inspection.

11.2.2 Screw type terminals shall have appropriate mechanical strength.

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

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

Compliance is checked by inspection, measurement and the test of 20.2. In addition to the requirements of 20.2, the terminals shall not have undergone changes after the test, that would adversely affect their future use.

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

Compliance is checked by inspection.

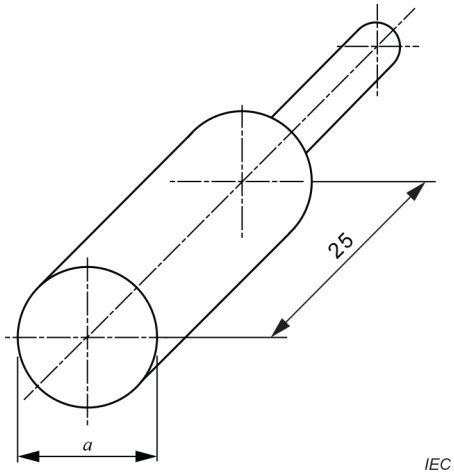
11.2.4 Lug terminals shall be used only for cable reels having a rated current of at least 60 A; if such terminals are provided, they shall be fitted with spring washers or equally effective locking means.

Compliance is checked by inspection.

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

Compliance is checked by inspection and by manual test.

Dimensions in millimetres



Flexible mm²	Rigid (solid or stranded) mm²	Diameter *a* mm	Tolerances for *a* mm
1	1	1,6	0 –0,05
1,5	1,5	1,9	0 –0,05
2,5	4	2,8	0 –0,05
4	6	3,4	0 –0,06
6	10	4,3	0 –0,06
10	16	5,4	0 –0,06
16	25	6,7	0 –0,07

Maximum cross-section of conductors and corresponding gauges.

Material: steel

Figure 11 – Gauges for testing insertability of round unprepared conductors

11.3 Screwless type terminals

11.3.1 Screwless type terminals shall allow the proper connection of copper or copper-alloy conductors having the minimum cross-sectional areas indicated in Table 8.

Gauges as specified in Figure 11, having a measuring section for testing the insertability of the nominal cross-sectional area of Table 8, shall be able to penetrate into the terminal aperture to the designated depth of the terminal.

Screwless type terminals that cannot be checked with the gauges specified in Figure 11, shall be tested by suitably shaped gauges, having the same nominal cross-sectional area as those of the appropriate gauges given in Figure 11.

Compliance is checked by inspection.

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

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

11.3.3 Screwless type terminals shall have appropriate mechanical strength.

Compliance is checked by the following test:

Five insertions and disconnections are made with each type of conductor for which the terminal is intended to be used, with conductor nominal cross-sectional area specified in Table 8.

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

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

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

11.3.4 The connection or disconnection of conductors shall be made:

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

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

Compliance is checked by inspection.

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

Compliance is checked by inspection.

11.3.6 Terminals shall be so designed and constructed that:

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

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

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

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

Compliance is checked by inspection.

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

NOTE 1 This test is intended to simulate the bending forces on the conductor being transferred to the terminal during installation.

Compliance is checked by the following test:

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

The test apparatus, the principle of which is shown in Figure 12, shall be constructed so that:

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

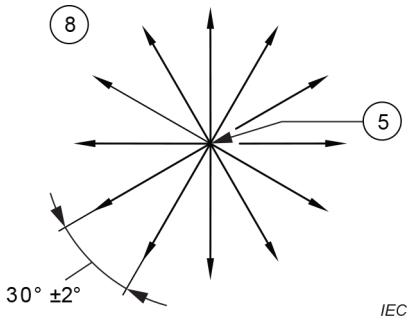
NOTE 2 A reference direction and starting point are not specified.

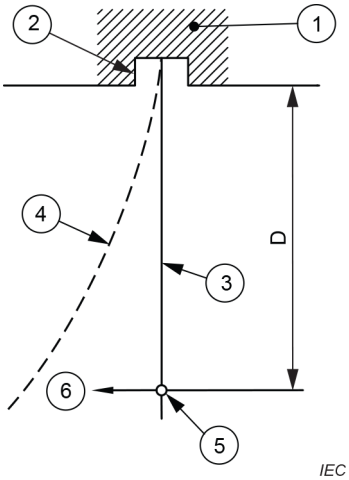
The bending of the conductor from its straight position to the testing positions shall be performed by means of a suitable device applying a force as specified in Table 2 to the conductor, at a specified distance from the clamping unit of the connecting device.

The bending apparatus shall be so designed that:

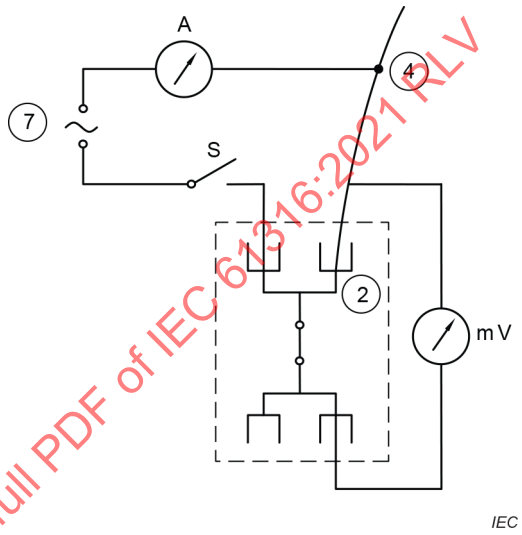
- *the force is applied in the direction perpendicular to the conductor;*
- *the bending is attained without rotation of the conductor within the clamping unit;*
- *the force remains applied while the required voltage drop measurement is made.*

The force for bending the conductor is specified in Table 2. The distance "D" shall be measured from the extremity of the connecting device, including the guidance for the conductor, if any, to the point of application of the force to the conductor.





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



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

Key

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

Figure 12 – Information for the bending test

Table 2 – Deflection test forces

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

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

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

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

Provisions shall be made so that the voltage drop across the clamping units under test can be measured when the conductor is connected, as shown for example in Figure 12b).

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

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

A clamping terminal is fitted, as for normal use, with a rigid solid copper conductor having the smallest cross-sectional area specified in Table 8 and is submitted to a first test sequence; the same clamping terminal is submitted to a second test sequence using the conductor having the largest cross-sectional area, unless the first test sequence has failed.

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

A tenth of the test current assigned to the connected conductor, according to Table 5, shall flow through the connecting devices. A bending force shall be applied as shown in Figure 12a), in one of the 12 directions and the voltage drop across this clamping unit shall be measured.

The force shall then be applied successively in each of the remaining 11 directions shown in Figure 12a) following the same test procedure.

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

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

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

11.4 Insulation piercing terminals (IPT)

11.4.1 Insulation piercing terminals shall allow the proper connection of copper or copper-alloy conductors having a nominal cross-sectional area as shown in Table 8.

Compliance is checked by inspection and by introducing the largest insulated conductor according to Table 8.

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

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

Alternatively, insulation piercing terminals may clamp the conductor between the metal part and the insulated part provided they comply with the test of 11.7.

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

11.4.3 Insulation piercing terminals shall have appropriate mechanical strength.

Compliance is checked by the following test:

Five insertions and disconnections are made with conductors having the nominal cross-sectional area indicated in Table 8.

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

If insulation piercing terminals use screws for wire connection, the torque value of Table 11 shall be used. Higher values of torque may be used if so stated by the manufacturer in its technical documentation.

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

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

11.4.4 The connection or disconnection of conductors shall be made using a general-purpose tool or a convenient integrated device in the terminal assisting the insertion or the withdrawal of the conductors.

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

Compliance is checked by inspection.

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

Compliance is checked by inspection.

11.4.6 Terminals shall be so designed and constructed that:

– each conductor is clamped individually in a separate independent clamping unit (not necessarily in separate holes);

– during the connection or disconnection, the conductors can be connected or disconnected either at the same time or separately.

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

Compliance is checked by inspection

11.5 Mechanical tests on terminals

11.5.1 New terminals are fitted with new conductors and of the minimum and the maximum cross-sectional areas and are tested with the apparatus shown in Figure 13.

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

The length of the test conductor shall be 75 mm longer than the height H specified in Table 3.

Clamping screws, if any, are tightened with the torque according to Table 11. Otherwise the terminals are connected according to the manufacturer's instructions.

Where there is a guidance for the conductor at the clamping unit, the terminal shall be tested while installed in the cable reel.

Each conductor is subjected to the following test:

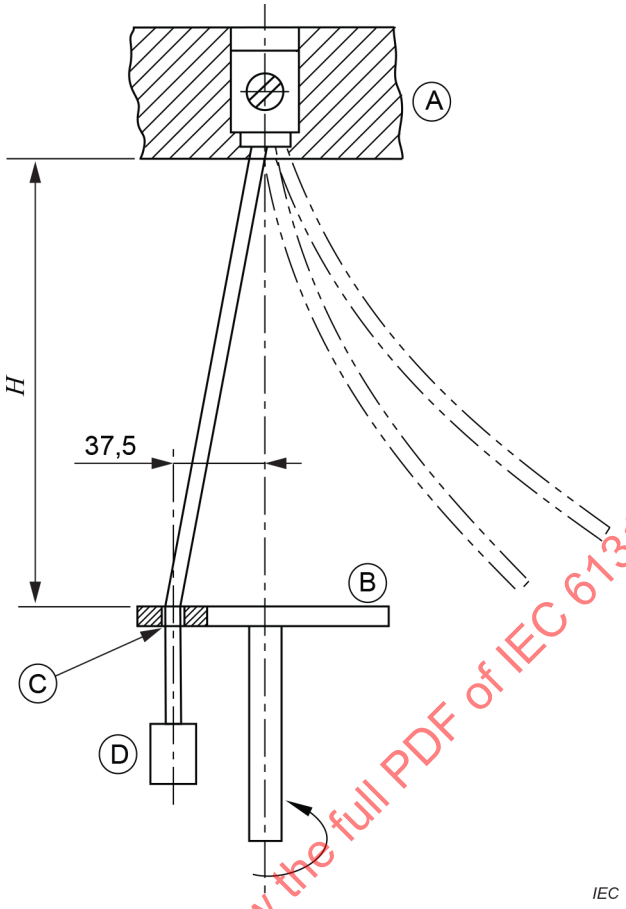
The end of the conductor is passed through an appropriate-sized bushing in a platen, positioned at a height H below the equipment, as given in Table 3. The bushing is positioned in a horizontal plane, such that its centre line describes a circle of 75 mm diameter, concentric with the centre of the clamping unit in the horizontal plane. The platen is then rotated at a rate of (10 ± 2) r/min.

The distance between the mouth of the clamping unit and the upper surface of the bushing shall be within 15 mm of the height in Table 3. The bushing may be lubricated to prevent binding, twisting or rotation of the insulated conductor. A mass, as specified in Table 3, is suspended from the end of the conductor. The duration of the test is 15 min.

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

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

Dimension in millimetres



Key

A Clamping unit
B Platen
C Bushing hole
D Mass

Figure 13 – Test arrangement for terminals

Table 3 – Pulling test values on terminals

Nominal cross-sectional area mm²	Diameter of bushing mm	Height[a] mm	Mass kg
1,0	6,5	260	0,4
1,5	6,5	260	0,4
2,5	9,5	280	0,7
4,0	9,5	280	0,9
6,0	9,5	280	1,4
10,0	9,5	280	2,0
16,0	13,0	300	2,9
If a bushing with the given hole diameter is not adequate to accommodate the conductor without binding, a bushing having the next largest hole may be used.			
[a] Tolerance for height *H:* ±15 mm.			

11.5.2 Verification is carried out successively with conductors of the largest and smallest cross-sectional areas specified in Table 8, using class 1 or class 2 conductors for terminals of fixed socket-outlets or appliance inlets, and class 5 conductors for terminals of plugs or portable socket-outlets.

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

The conductors shall be connected to the clamping unit, and the clamping screws or nuts tightened to two-thirds of the torque indicated in Table 11, unless the torque is specified by the manufacturer on the product or in an instruction sheet.

Each conductor is subjected to a pull according to the value in Table 4 exerted in the opposite direction to that in which the conductor was inserted. The pull is applied without jerks for 1 min. The maximum length of the test conductor shall be 1 m.

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

Table 4 – Pulling force

Nominal cross-sectional area mm^2	Pulling force N
1	35
1,5	40
2,5	50
4	60
6	80
10	90
16	100

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

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

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

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

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

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

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

The clamping screws or nuts, if any, are tightened with the torque according to Table 10, unless the torque is specified by the manufacturer on the product or in an instruction sheet.

The use of AC is preferable, but DC is acceptable.

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

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

Except during the cooling period, the test current, as defined in Table 5, is applied through the series circuit. The test current shall be applied for the initial 30 min of each cycle.

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

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

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

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

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

The maximum allowable voltage drop of each clamping unit, measured with the current as specified in Table 5, shall not exceed the smaller of the two following values:

- *either 22,5 mV, or*
- *1,5 times the value measured after the 24th cycle.*

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

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

Table 5 – Test current

Nominal cross-sectional area mm²	Test current[a)] A
1,0	13,5
1,5	17,5
2,5	24,0
4,0	32,0
6,0	41,0
10,0	57,0

[a] Test current is only acceptable if the same or less than the test current of the cable reel.

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

11.7.1 Temperature-cycling test

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

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

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

- *either 22,5 mV, or*
- *1,5 times the value measured after the 48th cycle.*

11.7.2 Short-time withstand current test

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

Screws, if any, are tightened with two thirds of torques as stated in Table 11.

The terminal shall withstand a current of 120 A/mm² of the cross-sectional area of the connected conductor, for 1 s. The test is performed once.

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

In order to limit additional heating, the current for measuring the voltage drop before and after the test shall be one-tenth of the value shown in Table 5.

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

~~12 Interlocks~~

~~This clause of IEC 60309-1 is not applicable.~~

~~13~~12 Resistance to ageing of rubber and thermoplastic material

~~This clause of IEC 60309-1 is applicable.~~

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

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

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

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

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

After the samples have been allowed to attain approximately room temperature, they are examined and shall show no crack visible with normal or corrected vision, without additional magnification. After the test, the samples shall show no damage which would lead to non-compliance with this document.

The use of an electrically heated cabinet is recommended.

Natural circulation may be provided by holes in the walls of the cabinet.

~~14~~13 ~~General~~ Construction

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

Compliance is checked by inspection.

13.2 Rewireable cable reels shall be so constructed as to permit:

– the conductors to be easily introduced into the terminals;

– the correct positioning of the conductors without their insulation coming into contact with bare metal parts of a polarity different from that of the conductor, or with accessible metal parts;

– internal wiring to remain securely fixed whilst the flexible cable is connected;

– an adequate arrangement of the terminals allowing the flexible cable to be easily introduced and connected without the risk of damaging the insulation of the flexible cable.

Compliance is checked by inspection and by disconnecting and reconnecting, using the flexible cables as delivered with the cable reel.

13.3 Inlet openings in metal through which flexible cables pass, shall be provided with a bushing of insulating material.

13.4 Non-rewireable cable reels shall be such that:

– the flexible cable cannot be separated from the cable reel without making it permanently useless;

– the cable reel cannot be opened by hand or by using a general-purpose tool, for example a screwdriver;

– winding of the flexible cable is done in a smooth space without sharp edges, burrs and the like which might cause damage to the insulation of the flexible cable.

A cable reel is considered to be permanently useless when, for re-assembling the cable reel, parts or materials other than the original have to be used.

13.5 Flexible cables shall be effectively prevented from coming into contact with moving parts which might cause damage to their insulation.

13.6 Bare live conductors shall be reliably secured so that the distance between them, and the distances to accessible metal parts, cannot be reduced below the values given in Clause 21.

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

13.7 Cable reels incorporating one or more socket-outlets shall ensure continuity to the earth contacts.

Compliance is checked by inspection and by manual test.

13.8 Cable reels shall be so constructed that there is no risk of short-circuit between live parts and accessible metal parts due to loosened internal wiring, screws or the like.

Compliance is checked by inspection and by manual test.

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

Compliance is checked by inspection and by manual test.

13.10 A cable reel shall be fitted with a thermal cut-out and/or a current cut-out, which shall be:

– trip-free;
– non-self-resetting ~~type~~ thermal or current cut-out;
– constructed so that when resetting, live parts shall not become accessible;
– constructed so that the setting of temperature or current cannot be altered by the user;
– and which shall disconnect
  a) at least one pole in two-pole cable reels, which shall be the phase pole on polarized cable reels; or
  b) all poles, except the neutral pole on other cable reels.

Fuses are only allowed when it is not possible for the user to replace them with fuses of higher rating than those originally fitted. The protective conductor, if any, shall not be interrupted.

Compliance is checked by inspection and by manual test.

NOTE In the following country, fuses are not allowed: Denmark.

13.11 Cable entry shall be reliably fixed and be so shaped as to prevent damage from the material in which it is mounted. Cable entry shall not be made of natural elastomeric material, for example, rubber.

Compliance is checked by inspection and by manual test and by test of Clause 12.

13.12 Cable reels incorporating a residual current device with $I_{\Delta n} \leq 30$ mA shall be so constructed that no more than 2 m of cable remains on the supply side of the residual current device.

Compliance ~~for subclauses 14.6 to 14.11~~ is checked by inspection and by manual test ~~and furthermore, for 14.10, by the test of clause~~.

13.13 Cut-outs shall not self-reset at low temperature.

Compliance is checked by the following test:

The cut-out shall be caused to operate, and it shall be checked that it does not self-reset when kept at a low temperature of (−25 ± 2) °C for approximately 18 h.

13.14 Components incorporated or integrated in cable reels, such as flexible cable, current cut-outs, thermal cut-outs, safety transformers, motors, switches, fuses, residual current devices, lampholders and connecting devices shall comply with the relevant standards as far as they reasonably apply.

Components according to IEC 60730-2-9 shall be of Type 1.D, 2.D, 1.E or 2.E with a minimum number of cycles equal to 300.

13.15 Plugs and appliance inlets shall be in accordance with IEC 60309-1 or IEC 60309-2. At least one of the socket-outlets ~~or connectors~~ shall be in accordance with IEC 60309-1, IEC 60309-2 or IEC 60309-4. Other socket-outlets shall either be in accordance with another harmonized system or in accordance with the system of socket-outlets in the country where the cable reel is intended to be used.

Socket-outlets shall be of a type which prevents the insertion of plugs used with class 0 equipment.

~~NOTE~~ The plugs for equipment of class 0 can be used only as far as national wiring rules permit.

13.16 Portable cable reels shall be equipped with one plug or appliance inlet and at least one socket-outlet. Fixed cable reels shall be equipped with at least one fixed or portable socket-outlet.

The rated current of fixed or portable socket-outlets ~~or connectors~~ shall not be higher than the rated current of the cable reel. Fixed or portable socket-outlets ~~or connectors~~ with a rated current lower than the rated current of the cable reel shall be protected by a suitable protecting device.

The rated current of the plug, if any, shall not be less than the rated current of the cable reel.

Components shall suit operating conditions specified for the cable reel.

Compliance is checked by inspection.

~~15 Construction of socket-outlets~~

~~This clause of IEC 60309-1 is not applicable.~~

~~16 Construction of plugs and connectors~~

~~This clause of IEC 60309-1 is not applicable.~~

~~17 Construction of appliance inlets~~

~~This clause of IEC 60309-1 is not applicable.~~

~~18~~14 Degrees of protection

~~This clause of IEC 60309-1 is applicable except as follows:~~

14.1 ~~*Replacement of the first two paragraphs by the following:*~~

Cable reels shall have the degrees of protection marked on the products.

Socket-outlets of domestic type are tested without the plug inserted and with the lid, if any, closed.

Compliance is checked by the appropriate tests mentioned in 14.2 and 14.3.

14.2 ~~*Replacement:*~~

Cable reels shall be tested in accordance with ~~18.1 and~~ IEC 60529 in fully unreeled condition ~~for portable cable reels~~, in the most unfavourable position. Fixed cable reels shall be tested as above but mounted as specified by the manufacturer's instructions.

Immediately after the tests, the samples shall withstand the dielectric strength test specified in 15.3, and inspection shall show that water has not entered the samples to such an extent that could impair their further use.

~~**18.3** This subclause of IEC 60309-1 is not applicable.~~

~~**18.4** This subclause of IEC 60309-1 is not applicable.~~

~~**18.5** *Replacement*~~

14.3 All cable reels shall be proofed against humid conditions which may occur in normal use.

Compliance is checked by the humidity treatment described in 14.3, followed immediately by the measurement of the insulation resistance and by the dielectric strength test, specified in Clause 15.

Cable entries, if any, are left open. If knock-outs are provided, one of them is opened.

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

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

The sample is kept in the cabinet for seven days (168 h) ~~*for IPX4 and IPX5 cable reels*~~.

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

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

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

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

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

~~19~~15 Insulation resistance and dielectric strength

15.1 The insulation resistance and the dielectric strength of cable reels shall be adequate.

Compliance is checked by the tests specified in 15.2 and 15.3 which are made immediately after the test of 14.3 in the humidity cabinet or in the room in which the samples were brought to the ~~*prescribed*~~ *required temperature, after reassembly of those parts which may have been removed. Cable reels shall be unreeled prior to carrying out the tests.*

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

For non-rewireable and rewireable cable reels the insulation resistance shall not be less than 5 MΩ and shall be measured consecutively:

a) between all poles connected together and the body;

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

NOTE The term "body" includes all accessible metal parts, handles, knobs, grips and the like and their shafts, if these shafts become live in the event of an insulating fault, and metal foil in contact with all accessible surfaces of insulating material; it does not include metal parts which are not accessible.

15.3 *A voltage of substantially sine-wave form, having a frequency of 50 Hz/60 Hz and the value shown in Table 2, is applied for 1 min between the parts indicated in 15.2.*

Table 6 – Test voltage for dielectric strength test

Insulation voltage[a] of the cable reels V	Test voltage V
Up to and including 50	500
Over 50 up to and including 415	2 000[b]
Over 415 up to and including 500	2 500
Over 500 up to and including 690	3 000

[a] The insulation voltage is at least equal to the highest rated operating voltage.

[b] This value is increased to 2 500 V for metal enclosures lined with insulating material.

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

No flash-over or breakdown shall occur during the test.

Glow discharges without a drop in voltage are neglected.

~~20 Breaking capacity~~

~~This clause of IEC 60309-1 does not apply to cable reels. Accessories used shall comply with their relevant product standards.~~

~~21~~16 Normal operation

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

Compliance is checked by the following test.

16.2 *In cable reels incorporating contacts intended to make connection between fixed and moving parts (e.g. slip rings), each phase conductor, neutral conductor and earthing conductor, if any, is loaded with the rated current related to the ~~minimum~~ nominal cross-~~section~~ sectional area indicated in Table 8 and derived from an AC source with a no-load voltage not exceeding 12 V. The voltage drop is measured adjacent to the contact-making members.*

This measurement shall be made immediately after the cable reel, under rated load, has reached its steady thermal condition. In no case shall the resistance exceed 0,05 Ω. The test is repeated after the cable reel has been subjected to the test for normal operation described in 16.3 to 16.6 and to the electric strength test of 16.7. The increase of resistance shall not be more than 50 % with a maximum of 0,075 Ω for the phase conductor(s) and the neutral conductor, and a maximum of 0,05 Ω for the earthing conductor.

~~NOTE – This test may need revising when more experience has been gained.~~

16.3 *The flexible cable is unreeled and fully reeled on to the cable reel as in normal use at a rate of approximately 0,5 m/s, in the direction most likely to occur in normal use. The test is carried out as described in 16.4 to 16.6.*

16.4 *For hand-operated cable reels not incorporating movable contacts (slip rings or the like):*

– *the total length of the flexible cable is unreeled;*

– *the number of cycles of operation is 100.*

16.5 *For hand-operated cable reels incorporating movable contacts, the test shall be carried out at the rated current of the fully reeled cable reel*:

– *the flexible cable is unreeled in such a way that the rotating part of the reel makes approximately two revolutions, and such that at least two turns of the cable remain on the reel;*

– *during the recoiling, the flexible cable is held under tension applying a force of 10 N/mm^2 of the ~~total~~ nominal cross-sectional area of the conductors of the cable up to a maximum of 100 N;*

– *the number of cycles of operation for a 16 A cable reel is 10 000 (ten thousand) and for 32 A and 63 A cable reels the number of cycles shall be 4 000 (four thousand).*

NOTE One cycle ~~contains~~ consists of one unreeling followed by one reeling.

16.6 *For spring and motor-operated cable reels*:

- *the flexible cable is unreeled in such a way that the rotating part of the reel makes approximately two revolutions, and such that at least two turns of cable remain on the reel;*
- *during the recoiling, the flexible cable is held under tension applying a force which is adapted to the reeling force of the cable reel;*
- *the number of cycles of operation for 16 A cable reels is 10 000 (ten thousand);*
- *for 32 A and 63 A cable reels the number of cycles shall be 4 000 (four thousand);*
- *the cable of a reel incorporating an automatic return mechanism shall be fully unreeled and allowed to return unhindered 100 times using the automatic system incorporated.*

After this test, the cable reel shall show no damage impairing safety and its further use.

In particular, the cable reel shall show:

- no loosening of electrical connections;
- no loosening of mechanical parts or connections;
- no damage to the sheath or insulation of the cable.

16.7 Immediately after the tests of 16.3 to 16.6, the cable reels shall withstand an electric strength test, as described in 15.3 but with the test voltage reduced by 500 V for cable reels having an insulation voltage exceeding 50 V. The test is made without a preceding humidity treatment.

No flash-over or breakdown shall occur during the test. In addition, there shall be no breakage of electrical connections or conductors.

~~22~~17 Temperature rise

17.1 Temperature rise in normal use

17.1.1 Cable reels shall not attain excessive temperatures in normal use, such that they cause a danger to persons or surroundings.

17.1.2 *Compliance is checked by determining the temperature rise of the various parts stated in Table 7.*

Portable cable reels are placed in their normal position of use in a test corner as near to the walls as possible. The test corner consists of a floor and two walls at right angles, all of a dull black-painted plywood having a thickness of 20 mm. Cable reels for fixed mounting are mounted on the wall or the ceiling in a test corner as near to the ceiling and wall as possible. The test corner consists of a ceiling and two walls at right angles, all of dull black-painted plywood having a thickness of 20 mm.

Temperature rises are determined by means of fine wire thermocouples, chosen and positioned so that they have the minimum effect on the temperature of the part under test.

Thermocouples used for determining the temperature rise of the surface of walls, ceiling and floor are embedded in the surface or attached to the back of small blackened disks of copper or brass, 15 mm in diameter and 1 mm thick, which are flush with the surface.

So far as it is possible, the cable reel is positioned so that parts likely to attain highest temperatures touch the disks.

In determining the temperature rises of handles, knobs, grips and the like, consideration is given to all parts which are gripped in normal use and, if of insulating material, to parts in contact with hot metal.

The temperature rise of electrical insulation is determined at places where failure could cause a short-circuit, a contact between live parts and accessible metal parts, or a reduction of creepage distances or clearances below the values specified in Clause 21.

The test is made both with cable reels fully reeled and unreeled. Cable reels loaded with the rated power corresponding respectively to the marking for unreeled and reeled condition, are operated until steady conditions are established.

The test current corresponds to cos φ = 1.

Table 7 – Permissible temperature rise

Parts	Temperature rise K
Rubber insulation of internal and external wiring and flexible cable	35
Polyvinyl chloride insulation of internal wiring	45
Cord-sheath used as supplementary insulation	35
Silicone rubber insulation of internal wiring and flexible cables	145
Rubber used for gaskets or other parts, the deterioration of which could affect safety:	
– when used as supplementary insulation or as reinforced insulation	40
– in other cases	50
Material used as insulation other than for wires:	
– Moulding of:	
• phenol-formaldehyde with cellulose fillers	85
• phenol-formaldehyde with mineral fillers	100
• melamine-formaldehyde	75
• urea-formaldehyde	65
• polyester with glass-fibre reinforcement	110
• silicone rubber	145
• polytetrafluoroethylene	265
• pure mica and tightly sintered ceramic material when such products are used as supplementary or reinforced insulation	400
• thermoplastic material	a)
Supports, walls, ceiling and floor of the test corner	60
Sliding contacts	65
Handles and similar parts which, in normal use, are touched by hand	
– of metal	40
– of insulating material	50
Terminals, including earthing terminals for external conductors	60
Lampholder E27:	
– metal or ceramic type	160
– insulated type, other than ceramic	120
Lampholder E14, B15, B22:	
– metal or ceramic type	130
– insulated type, other than ceramic	90
with T-marking	T-25

[a] Owing to the great number of thermoplastic insulating materials, it is not possible to specify permissible temperature rises for such materials. Provisionally, the ball pressure test described in IEC 60309-1:2021, 27.1 shall be carried out.

During the test, the thermal cut-out or current ~~sensing devices~~ cut-out shall not operate.

After the test, the cable reel shall show no deformation or damage within the meaning of this document.

NOTE Experience has shown that the hottest point of flexible cable insulation is likely to occur between the second and third layers, in the central area, of the cable reel when carefully reeled.

17.2 Temperature rise under overload conditions

17.2.1 Cable reels shall be so constructed that there is no risk of fire or electric shock as a result of abnormal electrical load.

Compliance is checked by the tests of 17.2.2 and 17.2.3.

17.2.2 *Cable reels are tested under the conditions described in 17.1.2 and are loaded with the highest possible current at which the thermal cut-out or current-sensing device will not operate, until steady conditions are established, or for 4 h, whichever is the shortest period.*

NOTE Steady conditions are reached when the temperature does not vary by more than 1 K/h.

The temperature rise of the parts of the cable reels, shown in Table 7 shall not exceed by more than 25 K the relevant values in that table.

After the test, the following conditions shall be fulfilled.

a) The cable reel shall show no deformation affecting the protection against electric shock. There shall be no short-circuit or damage to the insulation of the cable reel or to the cable, and the further use of the cable reel shall not be impaired.

Compliance is checked by inspection, by a test with the standard test finger ~~shown in figure 2 of IEC 60309-1~~ according to IEC 61032 Probe B and by the dielectric strength test specified in 15.3, the test voltage being reduced by 500 V.

The humidity treatment is not repeated before the dielectric strength test is carried out.

b) The thermal or current cut-out shall not be deformed or damaged, and the present value shall not be changed.

Compliance is checked by inspection and by a comparison release test on a cable reel that has not been subjected to the test of 17.1.2.

c) The earth connection shall not be impaired.

Compliance is checked by the test specified in 10.4.

17.2.3 *The cable reel is tested fully reeled under the condition described in 17.1.2, the test load being that corresponding to 1,5 times the rated current of the socket-outlets in which the plug of the cable reel may be inserted or 1,5 times the rated current of the protective device in the case of fixed cable reels.*

The load is applied until steady conditions are reached, or thermal or current cut-out has operated. After the test:

a) the cable reel shall show no deformation affecting the protection against electric shock.

Compliance is checked by inspection and by a test with the standard test finger ~~shown in figure 2 of IEC 60309-1~~ according to IEC 61032 Probe B. It shall not be possible to touch live parts;

b) the earth connection shall not be impaired.

Compliance is checked by the test specified in 10.4.

~~23~~18 Flexible cables and their connection

18.1 Cable reels shall be provided with a flexible cable complying with IEC 60245-4 of one of the types specified in Table 8, the nominal cross-sectional area being not less than the value shown.

~~NOTE –~~ Flexible cables having nominal cross-sections other than those specified in Table 8 may be used if the load is known.

18.2 Minimum cable sizes shall be based on the lowest current rating of the plug or the protection device, incorporated in the cable reel, as shown in Table 8.

Table 8 – Minimum cable sizes

~~Preferred rated current~~ A		~~Type of cable~~	~~Nominal cross-section area~~
~~Series I~~	~~Series II~~	~~IEC 60245~~	~~mm²~~
~~16~~	~~20~~	~~53[1] 57[1] 66~~	~~2,5[2]~~
~~32~~	~~30~~	~~53 66~~	~~6~~
~~63~~	~~60~~	~~66~~	~~16~~
~~[1] Not applicable to cable reels having a rated operating voltage exceeding 415 V.~~ ~~[2] For cable reels having a rated operating voltage not exceeding 50 V, the value is increased to 4 mm².~~			

Rated operating voltage	Nominal current A		Other ratings	Type of cable IEC 60245 (all parts)	Nominal cross-sectional area mm²
	Preferred rated current				
	Series I	Series II			
Not exceeding 50	16	20		66	10
	32	30		66	10
Over 50			6	53[b], 57[b], 66	1
			10	53[b], 57[b], 66	1,5
	16	20		53[a] 57[a] 66	2,5[b)]
			25	66	4
	32	30		53, 66	6
			40	66	10
			50	66	10
	63	60		66	16
[a] Not applicable to cable reels having a rated operating voltage exceeding 415 V. [b] For cable reels having a rated operating voltage not exceeding 50 V, the value is increased to 4 mm².					

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

The pilot conductor, if any, shall have a nominal cross-sectional area of at least 2,5 mm².

Compliance is checked by inspection ~~and by the test of 23~~.

18.3 Flexible cables shall have the same number of conductors as there are poles in the cable reel and in the socket-outlets except for voltage not exceeding 50 V, fitted earthing contacts, if any, being considered as one pole, irrespective of their number. The conductor connected to the earthing contact shall be identified by the colour combination green/yellow.

Compliance is checked by inspection.

18.4 The maximum length of the flexible cable shall be as shown in Table 9.

Table 9 – Maximum length of cable

Nominal cross-sectional area mm^2	Maximum length of cable m
Up to and including 6	80
Over 6 up to and including 16	100

Compliance ~~with the requirements of 23.1~~ is checked by inspection, by measurement and by checking that the flexible cables are in accordance with IEC 60245-4.

18.5 Cable reels shall be provided with a cable anchorage so that the conductors are relieved from strain, including twisting, where they are connected to the terminals, and that their covering is protected from abrasion.

The cable anchorage shall be of insulating material or be provided with an insulating lining and be so designed that the cable cannot touch clamping screws, if any, of the cable anchorage, if these screws are accessible or electrically connected to accessible metal parts.

Glands shall not be used as cable anchorage. Makeshift methods, such as tying the cable into a knot or tying the ends with string, shall not be used.

Compliance with this requirement is checked by inspection.

18.6 It shall be made clear how relief from strain and prevention from twisting are intended to be ~~effected~~ performed.

The cable anchorage, or parts of it, shall be integral with or fixed to one of the parts of the cable reel.

Cable anchorage shall be suitable for the different types of flexible cables declared by the manufacturer, and insulating linings, if any, shall be securely fixed to the metal parts; metal parts of the cable anchorage shall be insulated from the earthing circuit.

The cable anchorage of rewireable cable reels shall be so designed and located that replacement of the flexible cable is easily possible.

Clamping screws, if any, which ~~have to be~~ are operated when replacing the flexible cable, shall not serve to fix any other component.

Compliance is checked by inspection and by the test of 18.7.

18.7 The cable anchorage of cable reels is subjected to a pull test followed by a torque test.

For rewireable cable reels, the conductors are introduced into the terminals, the terminal screw being tightened just sufficiently to prevent the conductors from easily changing their

position. The cable anchorage is used in the normal way, any clamping screws being tightened with a torque equal to two-thirds of that specified in Table 7.

After reassembly of the cable reel, the parts shall fit snugly, and it shall not be possible to push the cable into the cable reel to any appreciable extent.

Non-rewireable cable reels are tested with the flexible cable as delivered, but with the conductors of flexible cable cut adjacent to the terminations.

The flexible cable is then subjected 100 times to pulling, using the values specified below. The pulls are applied in the most unfavourable direction in the immediate vicinity of the cable anchorage. The pull values applied are as follows:

a) 80 N for cable reels with flexible cable having a nominal cross-sectional area up to 4 mm^2;

b) 100 N for cable reels with flexible cable having a nominal cross-sectional area from 6 mm^2 to 10 mm^2;

c) 120 N for cable reels with flexible cable greater than or equal to 16 mm^2.

The pulls are applied without jerks, each time for 1 s. Immediately afterwards, the flexible cable is subjected for 1 min to a torque of:

– *0,35 Nm for cable reels with flexible cable less than 16 mm^2 nominal cross-sectional area;*

– *0,425 Nm for cable reels with flexible cable having a nominal cross-sectional area greater than or equal to 16 mm^2.*

During the test, the flexible cable shall not be damaged.

After the test, the flexible cable shall not have been displaced by more than 2 mm, the ends of the conductors shall not have moved noticeably in the terminals or at the terminations.

18.8 Cable reels shall be so designed that the flexible cable is protected against damage caused by the opening for the passage of the cable.

Compliance is checked by inspection and by the following test. The cable is subjected 25 times to a pull of 100 N. The pulls are applied in the most unfavourable direction without jerks, each time for 1 s.

After the test, the cable shall not be damaged.

Compliance is checked by inspection.

~~24~~19 Mechanical strength

19.1 Cable reels shall have adequate mechanical strength and be so constructed as to withstand such rough handling as may be expected in normal use.

Compliance is checked by the tests of 19.2, 19.3, 19.4 and 19.5.

19.2 *Cable reels are mounted at an angle of 15° from the perpendicular. For this test, the cable reel shall not overturn. These tests are carried out with the cable reel in a fully reeled condition.*

19.3 *Portable cable reels are subjected to blows by means of the spring-hammer according to IEC 60068-2-75.*

The cable reels are kept in a refrigerator at a temperature of −25 °C for at least 16 h, the cable reels being subjected to the test within 1 min after their removal from the refrigerator.

19.4 *Portable cable reels are ~~allowed to fall~~ dropped 10 times from a carrying handle height of 0,75 m on to a concrete floor. During the test, the total length of the flexible cable shall be wound on to the reel.*

NOTE The term "carrying handle height" denotes the vertical distance from the floor up to the handle of the cable reel which is normally used for carrying the cable reel over a short distance.

19.5 *Portable cable reels are overturned 10 times in their normal position on to a concrete floor in the most unfavourable direction. During the test, the total length of the flexible cable shall be wound on to the reel.*

19.6 *After the tests of 19.2 to 19.5, protection against electric shock shall not be affected, and the cable reel shall show no damage which may affect safety or impair the further use of the cable reel. In particular:*

- *~~socket-outlets and electrical connectors~~ fixed and portable socket-outlets shall not have worked loose or been damaged;*
- *covers or enclosures shall show no cracks visible to normal or corrected vision without additional magnification;*
- *the effectiveness of insulating barriers or other parts of insulating material shall not have been damaged.*

Damage to the finish, small dents which do not affect creepage distances or clearances, and small chips which do not adversely affect the protection against electric shock or moisture are neglected. Cracks not visible with normal or corrected vision without additional magnification and surface cracks in fibre-reinforced mouldings and the like, are ignored.

19.7 Screwed glands shall withstand the mechanical stresses occurring in normal use.

Compliance is checked by the following test:

Screwed glands are fitted with a cylindrical metal rod having a diameter, in millimetres, equal to the nearest whole number below the internal diameter of the packing, in millimetres. The glands are then tightened by means of a suitable spanner, the force shown in Table 10 being applied to the spanner for 1 min, at a point 25 cm from the axis of the gland.

Table 10 – Gland tightening force

Diameter of test rod	**Force** N	
mm	**Metal glands**	**Glands of moulded material**
Up to and including 20	30	20
Over 20 up to and including 30	40	30
Over 30	50[a]	40[a]
[a] These values are provisional.		

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

~~25~~20 Screws, current-carrying parts and connections

~~This clause of IEC 60309-1 is applicable except as follows:~~

20.1 ~~*Addition:*~~

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 great difference in electrochemical potential with respect to each other shall not be used in contact with each other.

Compliance is checked by ~~*a test which is currently under consideration*~~ *inspection.*

The requirements of 20.1 do not apply to screws, nuts, washers, clamping plates and similar parts of terminals.

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

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

Compliance is checked by inspection and, for screws and nuts transmitting contact pressure or which are operated when connecting the cable reel, by the following test:

The screws or nuts are tightened and loosened:

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

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

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

When testing terminal screws and nuts, a copper conductor having the largest cross-sectional area in Table 8, *flexible for cable reels, is placed in the terminal.*

The test is carried out by means of a suitable screwdriver or spanner. The maximum torque applied when tightening is equal to that shown in Table 11, *except that the torque is increased by 20 % for screws in engagement with a thread in a hole which is obtained by plunging, if the length of the extrusion exceeds 80 % of the original thickness of the metal.*

When the manufacturer specifies, for terminal screws, a torque greater than the values given in Table 11, *this specified torque shall be applied for the test.*

Table 11 – Tightening torques

Metric standard values	Nominal diameter of thread mm	Torque Nm		
		I	II	III
2,5	Up to and including 2,8	0,2	0,4	0,4
3,0	over 2,8 up to and including 3,0	0,25	0,5	0,5
–	over 3,0 up to and including 3,2	0,3	0,6	0,6
3,5	over 3,2 up to and including 3,6	0,4	0,8	0,8
4,0	over 3,6 up to and including 4,1	0,7	1,2	1,2
4,5	over 4,1 up to and including 4,7	0,8	1,8	1,8
5,0	over 4,7 up to and including 5,3	0,8	2,0	2,0
6,0	over 5,3 up to and including 6,0	1,2	2,5	3,0
8,0	over 6,0 up to and including 8,0	2,5	3,5	6,0

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

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

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

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

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

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

NOTE 1 For mantle terminals, the specified nominal diameter is that of the slotted stud.

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

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

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

The screws and nuts shall not be tightened in jerks.

NOTE 2 Damage to covers is neglected.

Screwed connections will have been partially checked by the test of Clause 16 and Clause 19.

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

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

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

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

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

Compliance is checked by inspection.

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

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

Example of satisfactory solutions are:

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

Compliance is checked by inspection and by manual test.

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

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

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

NOTE The requirements for terminals are included in Clause 11.

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

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

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

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

~~26~~21 Creepage distances, clearances and distances through sealing compound

~~This clause of IEC 60309-1 is applicable.~~

21.1 Creepage distances, clearances through air and distances through sealing compound shall be evaluated with one of the alternative methods according to 21.2 or 21.3.

21.2 Creepage distances, clearances through air and distances through sealing compound shall be not less than the values in millimetres shown in Table 12.

Table 12 – Creepage distances, clearances and distances through sealing compound

	Insulation voltage of the cable reel V				
	Up to and including 50	**Over 50 up to and including 415**	**Over 415 up to and including 500**	**Over 500 up to and including 690**	**Over 690 up to and including 1 000 [a]**
Creepage distance:					
1. between live parts of different polarity	3	4	6	10	16
2. between live parts and:					
– accessible metal parts,					
– earthing contacts, fixing screws and similar devices,					
– external assembly screws, other than screws which are on the engagement face of plugs and are isolated from the earthing contacts	3	4	6	10	16
Clearance:					
3. between live parts of different polarity	2,5	4	6	8	8
4. between live parts and:					
– accessible metal parts not listed under item 5,					
– earthing contacts, fixing screws and similar devices,					
– external assembly screws, other than screws which are on the engagement face of plugs and are isolated from the earthing contacts	2,5	4	6	8	8
5. between live parts and:					
– metal enclosures, if not lined with insulating material,					
– surface on which the base of a socket-outlet is mounted	4	6	10	10	10
6. between live parts and the bottom of any conductor recess in the base of a socket-outlet	4	5	10	10	10
Distance through sealing compound:					
7. between live parts covered with at least 2,5 mm of sealing compound and the surface on which the base of a socket-outlet is mounted	2,5	4	6	6	6
8. between live parts covered with at least 2 mm of sealing compound and the bottom of any conductor recess in the base of a socket-outlet	2,5	4	5	5	5
[a] Alternatively, creepage distances may be according to IEC 60664-1.					

Compliance is checked by measurement.

For rewireable cable reels, the measurements are made on the sample fitted with the conductors specified in Table 8, and also without conductors. For non-rewireable cable reels, the measurements are made on the sample as delivered.

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

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

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

21.3 Creepage distances, clearances and distances through sealing compound:

– between live parts of different polarity;
– between live parts and
  - accessible metal parts;
  - protective earthing contacts, fixing screws and similar devices;
  - external assembly screws, other than screws which are on the engagement face of plugs and are isolated from the protective earthing contacts;
  - metal enclosures, if not lined with insulating material, including fittings for conduit or armoured cable;
  - the surface on which the base of a socket-outlet is mounted;
  - the bottom of any conductor recess in the base of a socket-outlet;
– through sealing compound (as solid insulation);
– between live parts covered with at least 2,5 mm of sealing compound and the surface on which the base of a socket-outlet is mounted;
– between live parts covered with at least 2 mm of sealing compound and the bottom of any conductor recess in the base of a socket-outlet;

shall be evaluated in accordance with IEC 60664-1 and with IEC 60664-3, and according to 21.5

The control pilot and signal circuits shall be treated as "accessible metal parts" for the purpose of 21.3.

For rewireable cable reels, compliance is checked using samples fitted with conductors specified in Table 8, and also without conductors. For non-rewireable cable reels, compliance is checked using samples as delivered.

Fixed and portable socket-outlets are checked when in engagement with a plug or appliance inlet respectively, and also without a plug or appliance inlet.

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

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

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

Compliance is checked by inspection.

21.5 Cable reels shall be designed for pollution degree 3 according to IEC 60664-1.

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

21.7 In conducting evaluations in accordance with IEC 60664-1 and IEC 60664-3, all cable reels shall be considered overvoltage Category II.

21.8 Determination of the dimensions of clearance and creepage distances shall be conducted in accordance with IEC 60664-1:2020, 6.2 and 6.3.

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

Compliance is checked by inspection.

~~27~~22 Resistance to heat, to fire and to tracking

~~This clause of IEC 60309-1 is applicable.~~

22.1 Cable reels shall be sufficiently resistant to heat.

Compliance is checked by the tests of 22.2 and 22.3.

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

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

Marking shall still be easily legible.

NOTE A slight displacement of the sealing compound is neglected.

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

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

- *(125 ± 5) °C for parts supporting live parts of rewireable cable reels;*
- *(80 ± 3) °C for other parts.*

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

NOTE For elastomeric materials, a test is under consideration.

The test is not made on parts of ceramic material.

22.4 External parts of the insulating material and insulating parts supporting live parts of cable reels shall be resistant to abnormal heat and to fire.

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

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

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

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

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

  Tests are not made on glands and sealing compounds.

– *(850 ± 15) °C for parts of insulating material necessary to retain current-carrying parts and parts of the earthing circuits in position with the exception of parts of insulating material needed to retain the earthing terminal in position in an enclosure, which shall be tested at a temperature of 650 °C.*

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

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

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

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

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

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

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

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

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

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

~~28~~23 Corrosion and resistance to rusting

~~This clause of IEC 60309-1 is applicable.~~

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

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

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

Compliance is checked by the following test:

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

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

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

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

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

~~30~~24 Electromagnetic compatibility

24.1 Immunity

~~Cable reels, as defined within the scope of this standard, are not, in normal use, affected by electromagnetic disturbances. Electronic components incorporated in cable reels, if any, shall comply with the relevant EMC requirements.~~

~~NOTE – Glow lamps, e.g. neon indicators and the like, are not considered to be electronic components in this context.~~

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

Cable reels incorporating electronic components shall comply with IEC 61000-6-1.

Compliance is checked by inspection.

24.2 Emission

~~Cable reels, as defined within the scope of this standard, do not, in normal use, generate electromagnetic disturbances. Electronic components incorporated in cable reels, if any, shall comply with the relevant EMC requirements.~~

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

NOTE 1 These cable reels will 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.

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

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

Compliance is checked by inspection.

Bibliography

IEC 60352-7, *Solderless connections – Part 7: Spring clamp connections – General requirements, test methods and practical guidance*

IEC 60998-2-2, *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-2: Particular requirements for connecting devices as separate entities with screwless-type clamping units*

IEC 61316

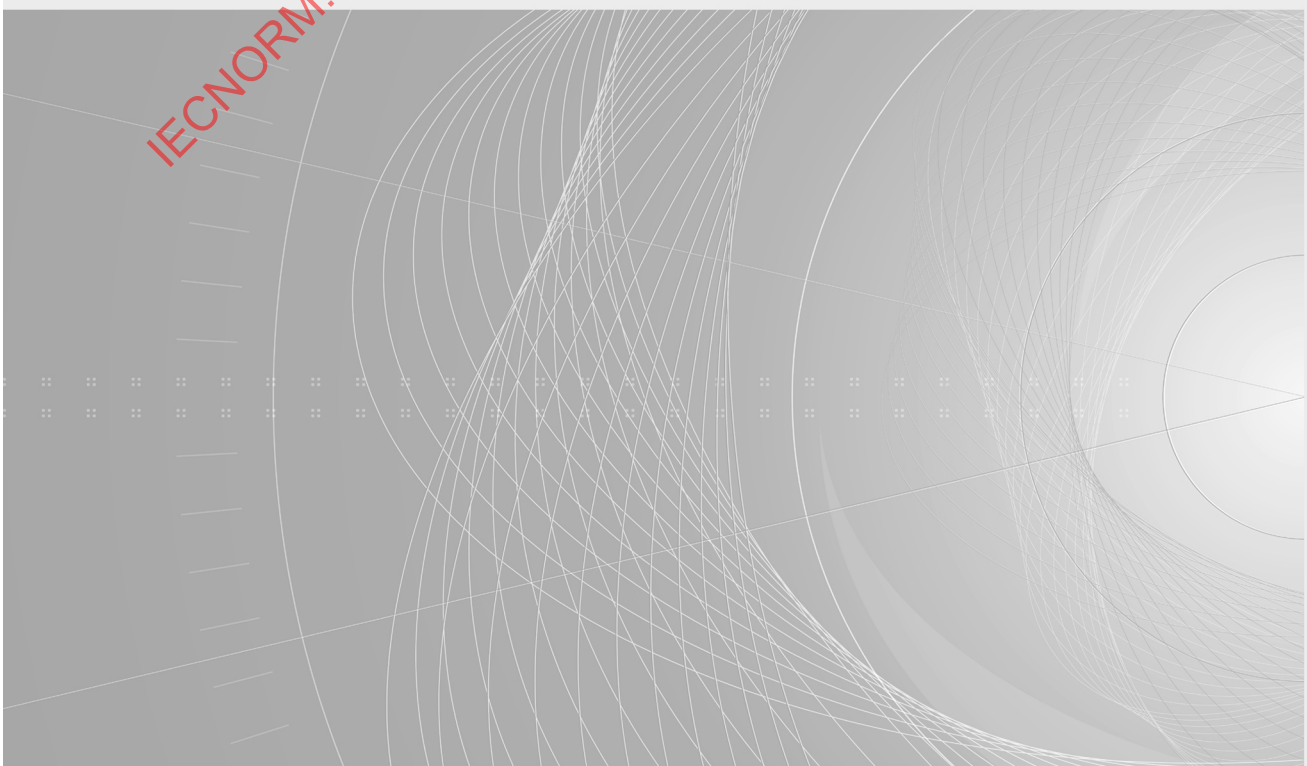
Edition 3.0 2021-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Industrial cable reels

Enrouleurs de câble industriels



IEC 61316:2021-07(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INDUSTRIAL CABLE REELS

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61316 has been prepared by subcommittee 23H: Plugs, socket-outlets and couplers for industrial and similar applications, and for electric vehicles, of IEC technical committee 23: Electrical accessories.

This third edition cancels and replaces the second edition, published in 1999. This edition constitutes a technical revision.

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

– Implementation of the latest tests and requirements previously included in IEC 60309-1.

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

FDIS	Report on voting
23H/483/FDIS	23H/489/RVD

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 International Standard 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 smaller roman type.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under 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.

INDUSTRIAL CABLE REELS

1 Scope

This document applies to cable reels provided with a non-detachable flexible cable with a rated operating voltage not exceeding 690 V DC and/or 690 V AC with a frequency not exceeding 500 Hz and a rated current not exceeding 63 A, primarily intended for industrial use, either indoors or outdoors, for use with accessories complying with IEC 60309-1, IEC 60309-2 or IEC 60309-4.

This document applies to:

– portable cable reels equipped with one plug or appliance-inlet complying with IEC 60309-1 or IEC 60309-2 and at least one socket-outlet complying with IEC 60309-1, IEC 60309-2 or IEC 60309-4;

– fixed cable reels equipped with at least one socket-outlet complying with IEC 60309-1, IEC 60309-2 or IEC 60309-4;

– cable reels suitable for use at ambient temperature normally within the range of −25 °C to +40 °C.

The use of this equipment on construction sites and for agricultural, commercial and domestic appliances is not precluded.

This document also applies to cable reels intended to be used in extra-low voltage installations.

In locations where special conditions prevail, for example, on board ships, in vehicles and the like, or where explosions are liable to occur, additional requirements can be necessary.

NOTE 1 This document was not developed for Electric Vehicle (EV) application, but it can be used as guide for cable reels for EV application

NOTE 2 Additional requirements for cable reels for currents higher than 63 A are under consideration.

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

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

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

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

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

IEC 60309-1:2021, *Plugs, fixed or portable socket-outlets and appliance inlets for industrial purposes – Part 1: General requirements*

IEC 60309-2, *Plugs, fixed or portable socket-outlets and appliance inlets for industrial purposes – Part 2: Dimensional compatibility requirements for pin and contact-tube accessories*

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

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

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

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

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

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

IEC 60730-2-9, *Automatic electrical controls – Part 2-9: Particular requirements for temperature sensing control*

IEC 61000-6-1, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity standard for residential, commercial and light-industrial environments*

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

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

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

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

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

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

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

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

3.1
rated operating voltage
voltage assigned to the cable reel by the manufacturer

3.2
rated current
current assigned to the cable reel by the manufacturer

3.3
cable reel
device comprising a flexible cable attached to a reel, so constructed that the cable may be wound on to the reel

Note 1 to entry: Plugs, socket-outlets and appliance inlets, if any, supplied with cable reels are considered as part of the reel.

3.3.1
portable cable reel
cable reel which can be moved easily from one place to another

3.3.2
fixed cable reel
cable reel intended for mounting on a fixed support

3.4
non-detachable flexible cable
flexible cable which is fixed to a cable reel

3.5
rewireable cable reel
cable reel so constructed that the flexible cable can be replaced with the aid of a general-purpose tool

3.6
non-rewireable cable reel
cable reel so constructed that it forms a complete unit with the flexible cable, the plug and the socket-outlets fixed by the manufacturer of the cable reel in such a manner that, after dismantling, the cable reel is rendered unfit for any further purpose

3.7
accessible part
part which can be touched by means of the standard test finger

3.8
detachable part
part which can be removed without the aid of a general-purpose tool

3.9
creepage distance
shortest path along the surface of an insulating material between two conductive parts

3.10
clearance
shortest distance in air between two conductive parts

3.11
thermal cut-out
temperature-sensing control device intended to switch off automatically under abnormal operating conditions and which has no provision for adjustment by the user

3.12
current cut-out
current-sensing control device intended to switch off automatically under abnormal operating conditions and which has no provision for adjustment by the user

3.13
trip-free mechanism
mechanism designed so that disconnection can neither be prevented nor inhibited by a reset mechanism, and so that the contacts can neither be prevented from opening nor be maintained closed against a continuation of excess temperature or current

3.14
non-self-resetting thermal or current cut-out
thermal or current cut-out which can only be reset by a manual action directly acting on the device which is used exclusively for this purpose and which is mounted in the cable reel or for fixed cable reel as a separate unit within sight of the cable reel

3.15
basic insulation
insulation of hazardous-live-parts which provides basic protection

[SOURCE: IEC 60050-195:1998, 195-06-06, modified – note to entry omitted.]

3.16
supplementary insulation
independent insulation applied in addition to the basic insulation, for fault protection

[SOURCE: IEC 60050-195:1998, 195-06-07]

3.17
double insulation
insulation comprising both basic insulation and supplementary insulation

[SOURCE: IEC 60050-195:1998, 195-06-08]

3.18
reinforced insulation
insulation of hazardous-live-parts which provides a degree of protection against electric shock equivalent to double insulation

Note 1 to entry: Reinforced insulation may comprise several layers which cannot be tested singly as basic insulation or supplementary insulation.

[SOURCE: IEC 60050-195:1998, 195-06-09]

3.19
termination
insulated or non-insulated connecting device for non-reusable connection of the conductors of the supply cable

3.20
terminal
conductive part of one pole, composed of one or more clamping unit(s) and insulation if necessary

3.20.1
pillar terminal
terminal in which the conductor is inserted into a hole or cavity, where it is clamped under the shank of the screw or screws

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

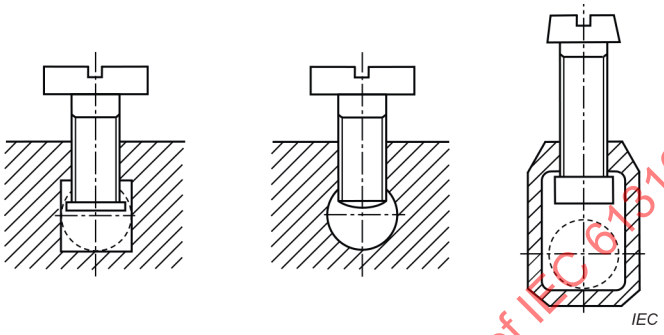


Figure 1 – Pillar terminals

3.20.2
screw terminal
terminal in which the conductor is clamped under the head of the screw

Note 1 to entry: The clamping pressure may be applied directly by the head of the screw or through an intermediate part, such as a washer, clamping plate or anti-spread device (see Figure 2).

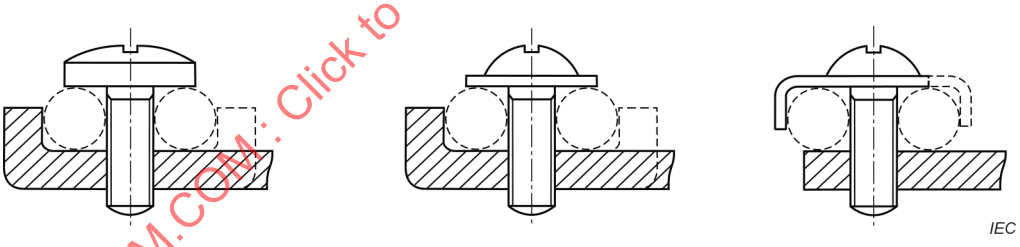


Figure 2 – Screw terminals

3.20.3
stud terminal
terminal in which the conductor is clamped under a nut

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

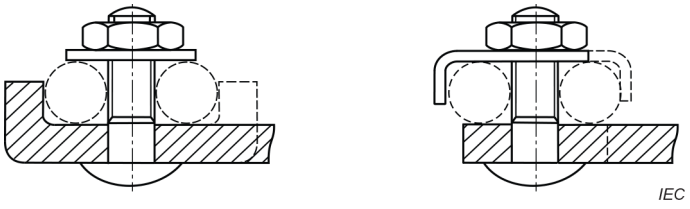


Figure 3 – Stud terminals

3.20.4
saddle terminal
terminal in which the conductor is clamped under a saddle by means of two or more screws or nuts

Note 1 to entry: See Figure 4.

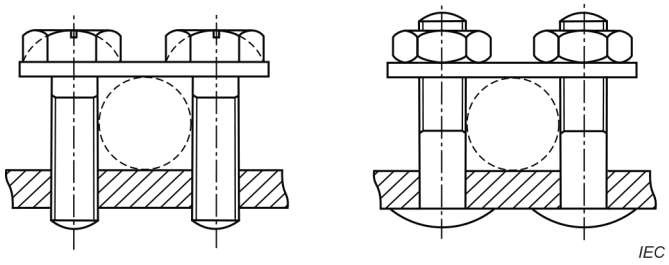


Figure 4 – Saddle terminals

3.20.5
lug terminal
screw terminal or a stud terminal, designed for clamping a cable lug or bar by means of a screw or nut

Note 1 to entry: See Figure 5.

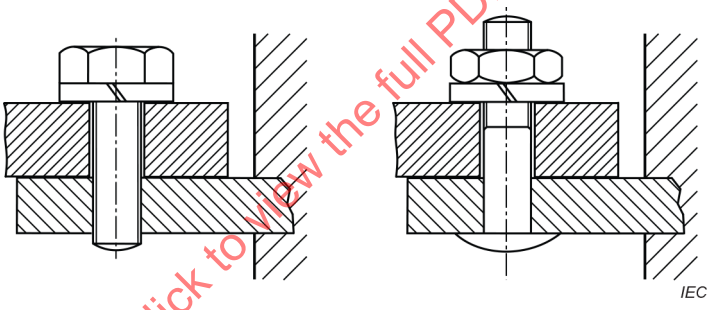


Figure 5 – Lug terminals

3.20.6
mantle terminal
terminal in which the conductor is clamped against the base of a slot in a threaded stud by means of a nut

Note 1 to entry: The conductor is clamped against the base of the slot by a suitably shaped washer under the nut, by a central peg if the nut is a cap nut, or by equally effective means for transmitting the pressure from the nut to the conductor within the slot (see Figure 6).

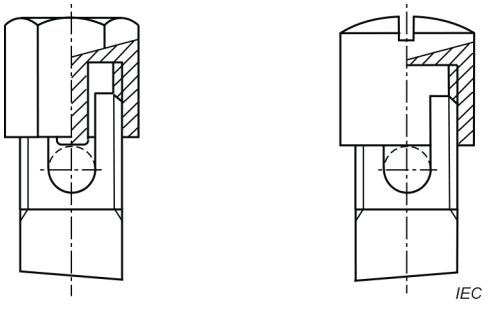


Figure 6 – Mantle terminals

3.20.7
screwless type terminal
terminal for the connection and subsequent disconnection of one or more conductors, the connection being made, directly or indirectly, by means other than screws

Note 1 to entry: Examples of screwless type terminals are given in Figure 7.

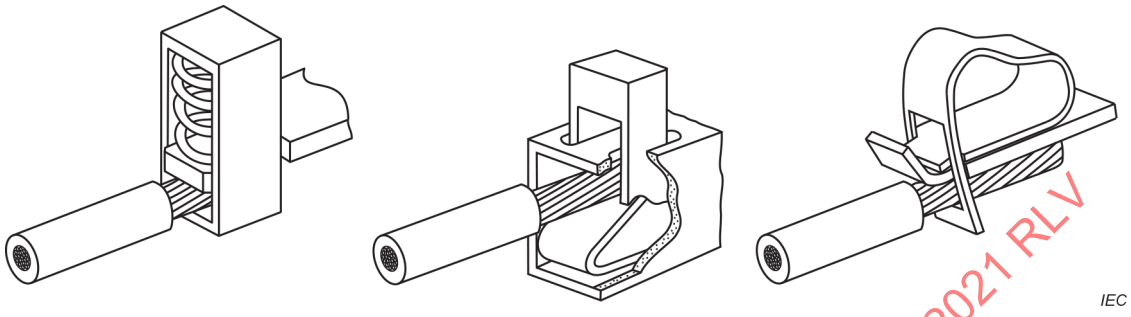
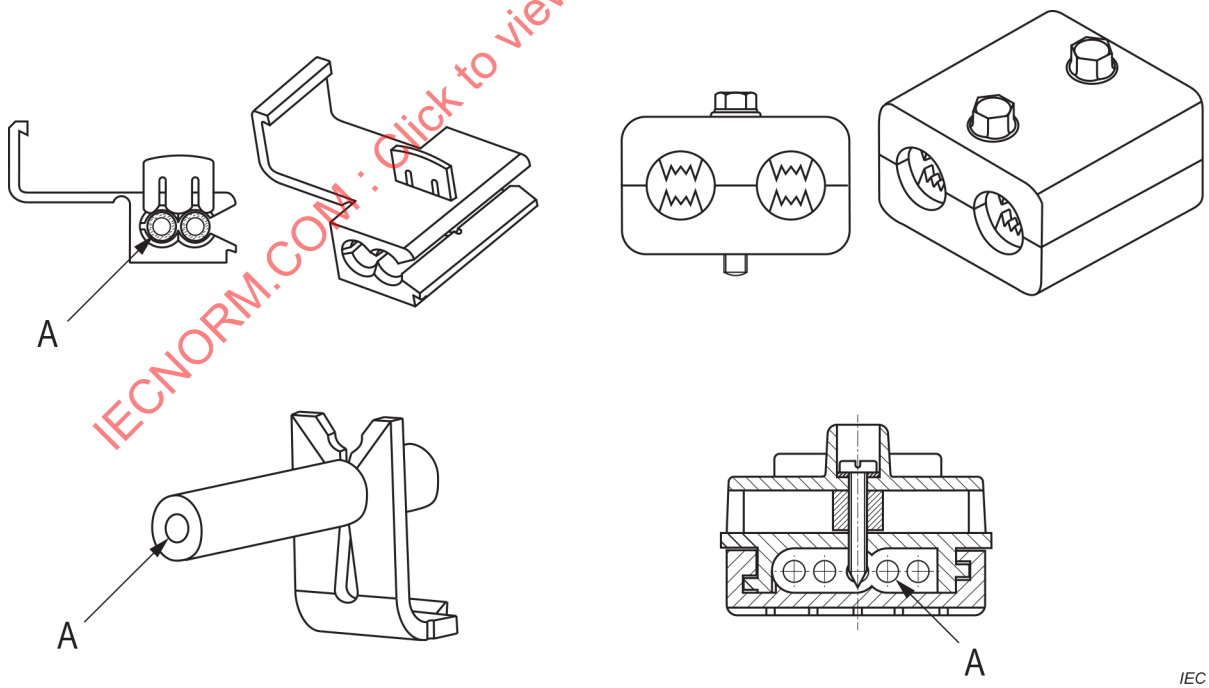


Figure 7 – Screwless terminals

3.20.8
insulation piercing terminal
IPT
terminal for the connection and subsequent disconnection of one or more conductors, the connection being made by piercing, boring through, cutting through, displacing or making ineffective in some other manner the insulation of the conductor(s) without previous stripping

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

Note 2 to entry: Examples of IPT are given in Figure 8.



Key

A Conductor

Figure 8 – Insulation piercing terminals

3.21
clamping unit
part(s) of the terminal necessary for mechanical clamping and electrical connection of the conductor(s), including the parts which are necessary to ensure the correct contact pressure

3.22
connecting device
device for the electrical connection of one (or more) conductor(s), either fixed to a base or forming an integral part of the equipment

4 General requirements

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

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

If other pollution degrees are needed, creepage distances and clearances shall be in accordance with IEC 60664-1. The comparative tracking index (CTI) value shall be evaluated in accordance with IEC 60112. Test and requirements are specified in 21.3.

Cable reels shall have a minimum degree of protection IP24D (see 6.3) according to IEC 60529.

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

4.2 Unless otherwise stated, one sample is submitted to all the tests, and the requirements are satisfied if all the tests are met. The sample is tested as delivered and under normal conditions of use, at an ambient temperature of (20 ± 5) °C. Tests are carried out in the order of the clauses of this document.

4.3 If the sample does not satisfy a test due to an assembly or manufacturing fault which is not representative of the design, that test and any preceding one which may have influenced the results of the test shall be repeated in the required sequence. Tests which follow shall be made on another sample, which shall comply with the requirements of this document.

5 Standard ratings

The rated current shall not be higher than the maximum rated current of the plug or the appliance inlet or the socket-outlet.

Preferred rated currents are given in Table 1.

Table 1 – Preferred rated currents

Series I	Series II
A	A
16	20
32	30
63	60

NOTE 1 "Preferred ratings" do not exclude other ratings.

NOTE 2 This table does not provide correspondence between series I and series II values.

Compliance is checked by inspection of the marking.

6 Classification

6.1 Cable reels are classified according to the type of construction:

- portable cable reels;
- fixed cable reels.

6.2 Cable reels are classified according to the method of winding the flexible cable:

- hand-operated cable reels;
- spring-operated cable reels;
- motor-driven cable reels.

6.3 Cable reels are classified according to the degree of protection according to IEC 60529:

- the minimum degree of protection shall be IP24D.

6.4 Cable reels are classified according to their protection against excessive temperatures:

- cable reels incorporating thermal cut-out;
- cable reels incorporating current cut-out;
- cable reels incorporating both thermal and current cut-outs.

6.5 Cable reels are classified according to the method of connecting the cable:

- rewireable cable reels;
- non-rewireable cable reels.

6.6 Cable reels are classified according to the material of the drum:

- cable reels with drum made of insulating material;
- cable reels with drum made of other material.

6.7 Cable reels are classified according to the type of conductors for screwless type and insulation piercing terminals, if any:

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

7 Marking

7.1 Cable reels shall be marked with:

- rated current(s) in amperes;
- rated operating voltage(s) or voltage range(s) in volts;
- symbol for the nature of supply;
- either the name or trademark of the manufacturer, or of the responsible vendor;
- type reference, which may be a catalogue number;
- degree of protection according to IEC 60529;

– maximum load which may be connected to the cable reel in fully reeled and fully unreeled condition.

EXAMPLE: 1 000 W 400 V fully reeled cable 

3 500 W 400 V fully extended cable

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

A	amperes	
V	volts	
Hz	hertz	
W	watts	
	alternating current	IEC 60417-5032 (2002-10)
	direct current	IEC 60417-5031 (2002-10)
	protective earth	IEC 60417-5019 (2006-08)
IPXXD*	degree of protection	
	fully reeled cable reel	
	fully extended cable reel	

* For IP codes, the two characteristic numerals (XX) shall be specified. The supplementary letter D shall not be marked if the first characteristic numeral is a 4 or greater.

For the marking of rated current(s) and rated operating voltage(s) or voltage range(s), figures may be used alone. The figure for DC rated operating voltage, if any, shall then be placed before the figure for the AC rated operating voltage and separated from it by a line or a dash.

Compliance is checked by inspection.

7.3 Cable reels shall be marked with an instruction clearly stating how to reset the thermal and/or current cut-out device(s).

Compliance is checked by inspection.

7.4 If marking plates or labels are used, they shall be reliably secured. After all the tests of this document, marking shall be easily legible with normal or corrected vision, without additional magnification, and labels shall show no curling or loosening at the corners or edges.

Compliance is checked by inspection.

7.5 Marking shall be easily legible.

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

Marking shall be durable and indelible.

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

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

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

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

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

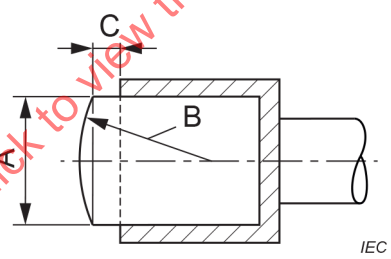
The marking surface to be tested shall be dried after the test with water.

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

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

The test piston shall have the dimensions specified in Figure 9 and shall be made of an elastic material which is inert against the test liquids and has a Shore-A hardness of 47 ± 5 (for example synthetic rubber).

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



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

Figure 9 – Test piston

8 Dimensions

The surface on which the cable is wound shall be at least eight times the maximum diameter of the cable as given in IEC 60245-4, as appropriate.

For cable reels using flat cable, the surface on which the cable is wound shall have a diameter of at least 10 times the average of the upper and lower dimensions of the cable.

9 Protection against electric shock

9.1 Cable reels shall be designed so that live parts are not accessible when the cable reel is in normal use and when parts which can be removed without the aid of a tool, have been removed.

Compliance is checked by inspection and, if necessary, by the tests of 9.2 and 9.3.

These tests shall be made immediately after the cable reel has passed a current having a value corresponding to the maximum load, when fully reeled, for 1 h at an ambient temperature of (20 ± 5) °C.

9.2 *The standard test finger according to IEC 61032 Probe B is applied with a force of (10 ± 1) N in every possible position; an electrical indicator with a voltage not less than 40 V and not more than 50 V is used to show contact with the relevant part.*

For cable reels, where the use of elastomeric or thermoplastic material is likely to influence compliance with the requirement, the test is repeated but at an ambient temperature of (35 ± 2) °C, the cable reels being at this temperature.

During this additional test, the parts of elastomeric or thermoplastic material of the cable reel are subjected for 1 min to a force of 75 N, applied through the tip of a straight unjointed test finger of the same dimensions as the standard test finger. This finger, with an electrical indicator as described above, is applied to all places where yielding of the insulating material could impair the safety of the cable reel.

During this test, the cable reel shall not deform to such an extent that those dimensions which ensure safety are unduly altered and no live part shall be accessible.

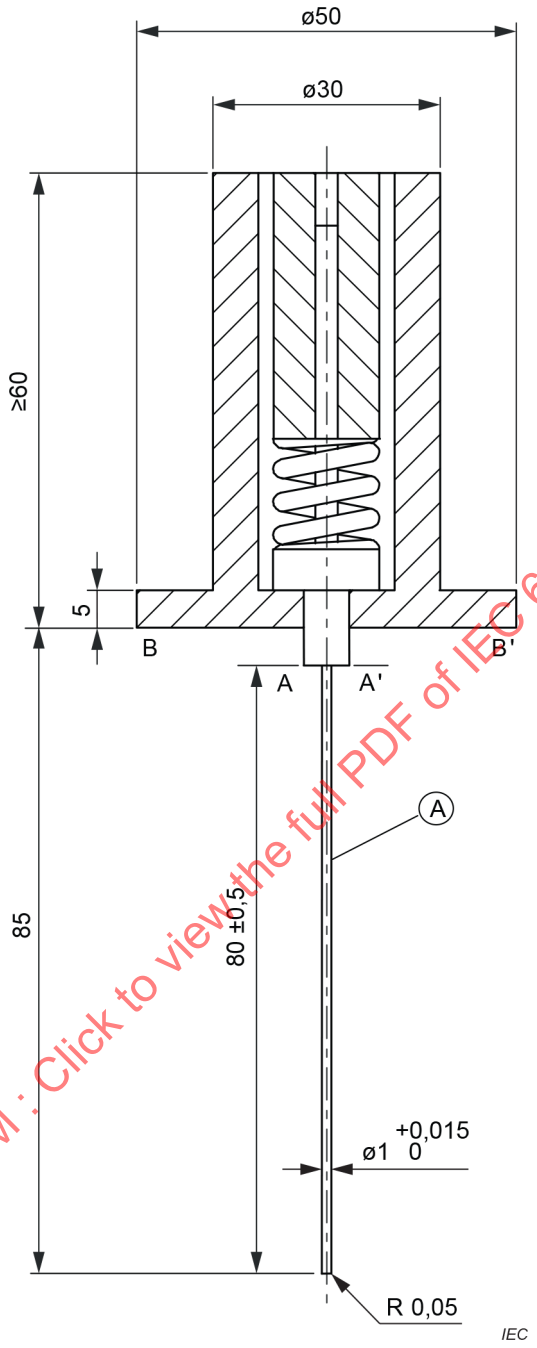
9.3 *The test is made with a straight rigid steel wire of (1 ± 0,015) mm as shown in Figure 10, applied with a force of* $(1^{+0,1}_{0})$ *N. The end of the wire shall be free from burrs and be at right angles to its length.*

This test does not apply to the plug, appliance inlet and socket-outlets, if any, fitted to the cable reel.

The test wire is provided with an electrical indicator, with a voltage not less than 40 V and not more than 50 V, to show contact with relevant part.

The protection is satisfactory if the wire cannot enter the enclosure, or if it enters, it does not touch live parts inside the enclosure.

Dimensions in millimetres



Key

A Rigid steel wire

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

Figure 10 – Standard 1 mm gauge

9.4 Parts providing protection against electric shock shall have adequate mechanical strength and shall be reliably secured by means of screws or in a similar reliable manner so that they will not work loose in normal use.

Compliance is checked by inspection and by the tests of Clause 19 and Clause 20.

10 Provisions for earthing

10.1 Accessible metal parts

For rewireable cable reels having accessible metal parts insulated from live parts by basic insulation only:

– the earthing terminal shall comply with the requirements of Clause 11;

– the earthing terminal shall be located in proximity to the terminals for current-carrying conductors;

– internal connections between the earthing terminal and accessible metal parts shall be independent of the connection of the flexible cable in order to prevent loosening of internal connections during the replacement of the flexible cable;

– when terminals of live conductors are accessible, no additional dismantling shall be necessary to reach the earthing terminal. Moreover, the earthing terminal shall not be more than 50 mm distance from the other terminals.

10.2 Corrosion resistance of earth terminal

All parts of the earthing terminal shall be such that there is no risk of corrosion resulting from contact between these parts and the copper of the earthing conductor, or any other metal that is in contact with these parts.

The body of the earthing terminal shall be of brass or other metal no less resistant to corrosion, unless it is a part of the metal frame or enclosure, when the screw or nut shall be of brass or plated steel complying with Clause 23, or other metal no less resistant to corrosion.

10.3 Corrosion resistance of screws and nuts

Screws and nuts of plated steel withstanding the test of Clause 20 are considered to be of a metal no less resistant to corrosion than brass.

Compliance with the requirements of 10.1 to 10.3 is checked by inspection.

10.4 Earth connections

10.4.1 Accessible metal parts which may become live in the event of an insulation fault shall be permanently and reliably connected to the earthing terminal or termination.

For the purpose of this document, screws and the like for fixing bases or covers are not deemed to be parts which can become live in the event of a fault.

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

Compliance is checked by inspection and by the following test:

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

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

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

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

10.4.2 The earth connection shall be effectively ensured under all conditions which may occur in normal use, including loosening of fixing screws for covers, careless mounting of the cover or the like.

Compliance is checked by inspection.

10.4.3 Earthing terminals intended for the connection of flexible external conductors shall be designed with ample space for slack of the earthing conductor in such a way that, if the strain relief should fail, the connection of the earthing conductor is subjected to strain after connection of the current-carrying conductors and that, in case of excessive stresses, the earthing conductor will not break before the current-carrying conductors break.

Compliance is checked by the following test:

The flexible cable is connected to the cable reels in such a way that the current-carrying conductors are led from the strain relief to the corresponding terminals along the shortest possible path. After they are correctly connected, the core of the earthing conductor is led to its terminal and cut off at a distance 8 mm longer than necessary for its correct connections.

The earthing conductor is then connected to its terminal. It shall then be possible to house the loop, which is formed by the protective conductor owing to its surplus length, freely in the wiring space without squeezing or pressing the core when the cover of the cable reel is put on again and fixed correctly.

10.5 Internal earthing circuit

The internal earthing circuit in cable reels including any joints, contacts and the like shall be of low electrical resistance.

Compliance is checked by the following measurement which is made after the test specified in Clause 19.

A current derived from an AC source, having a no-load voltage not exceeding 12 V, and equal to 1,5 times the rated current of the cable reel or 25 A, whichever is the greater, is passed through the earthing circuit.

The voltage drop is measured, and the resistance calculated from the current and this voltage drop.

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

10.6 Internal moveable earth connection and slip rings

10.6.1 Two different and independent moveable earth connections shall be provided between the terminal for the earthing conductor of the incoming cable and the earthing terminal for the outgoing cable, or that of the socket-outlet. One of these connections shall be a slip ring or an equally effective contact, while the other connection may be a ball-bearing, a slip ring, a plain bearing, or the like, provided it is metallic.

Compliance is checked by inspection.

10.6.2 Moveable earth connections between the terminal for the earthing conductor of the incoming cable and accessible metal parts of the cable reel shall be duplicated, each of which may be a ball bearing, a plain bearing, or the like, provided it is metallic.

Compliance is checked by inspection.

11 Terminals and terminations

11.1 Common requirements for terminals and terminations

11.1.1 Rewireable cable reels shall be provided with terminals in which connection is made by means of screws, nuts or equally efficient devices.

11.1.2 Non-rewireable cable reels shall be provided with soldered, welded, crimped or equally effective permanent connections.

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

Non-rewireable cable reels shall not be provided with screwed or snap-on connections.

Compliance is checked by inspection.

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

This requirement is not applicable to lug terminals

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

Compliance is checked by inspection.

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

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

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

NOTE Given values are nominal values.

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

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

Compliance is checked by inspection and by chemical analysis.

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

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

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

Compliance is checked by inspection and by chemical analysis.

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

Terminals and terminations shall be protected against rotation.

Clamping means shall not serve to fix any other component.

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

Compliance is checked by inspection and, if necessary, by test of 20.2.

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

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

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

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

Compliance is checked by inspection.

11.1.8 Terminals shall be so located or shielded that:

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

– conductors becoming detached from live terminals cannot touch metal parts connected to the earthing terminal;

– conductors becoming detached from the earthing terminal cannot touch live parts.

Compliance is checked by inspection and by manual test.

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

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

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

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

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

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

11.2 Screw type terminals

11.2.1 Screw type terminals shall allow the proper connection of copper or copper-alloy conductors having the nominal cross-sectional area specified in Table 8.

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

Gauges as specified in Figure 11, having a measuring section for testing the insertability of the maximum specified cross-sectional area specified in Table 8, shall be able to penetrate into the terminal aperture, down to the designated depth of the terminal, under their own weight.

Screw type terminals that cannot be checked with the gauges specified in Figure 11, shall be tested by suitably shaped gauges, having the same cross-section as those of the appropriate gauges of Figure 11.

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

Compliance is checked by inspection.

11.2.2 Screw type terminals shall have appropriate mechanical strength.

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

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

Compliance is checked by inspection, measurement and the test of 20.2. In addition to the requirements of 20.2, the terminals shall not have undergone changes after the test, that would adversely affect their future use.

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

Compliance is checked by inspection.

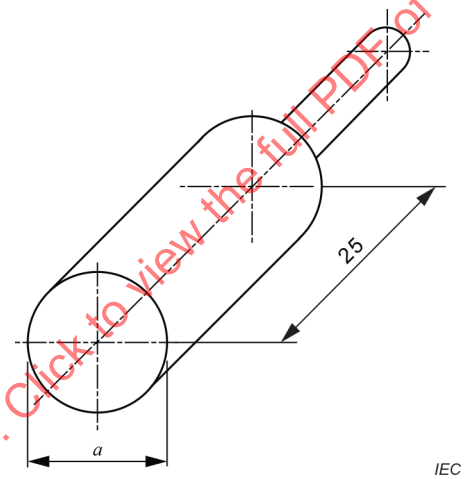
11.2.4 Lug terminals shall be used only for cable reels having a rated current of at least 60 A; if such terminals are provided, they shall be fitted with spring washers or equally effective locking means.

Compliance is checked by inspection.

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

Compliance is checked by inspection and by manual test.

Dimensions in millimetres



Flexible mm²	Rigid (solid or stranded) mm²	Diameter *a* mm	Tolerances for *a* mm
1	1	1,6	$^{0}_{-0,05}$
1,5	1,5	1,9	$^{0}_{-0,05}$
2,5	4	2,8	$^{0}_{-0,05}$
4	6	3,4	$^{0}_{-0,06}$
6	10	4,3	$^{0}_{-0,06}$
10	16	5,4	$^{0}_{-0,06}$
16	25	6,7	$^{0}_{-0,07}$

Maximum cross-section of conductors and corresponding gauges.

Material: steel

Figure 11 – Gauges for testing insertability of round unprepared conductors

11.3 Screwless type terminals

11.3.1 Screwless type terminals shall allow the proper connection of copper or copper-alloy conductors having the minimum cross-sectional areas indicated in Table 8.

Gauges as specified in Figure 11, having a measuring section for testing the insertability of the nominal cross-sectional area of Table 8, shall be able to penetrate into the terminal aperture to the designated depth of the terminal.

Screwless type terminals that cannot be checked with the gauges specified in Figure 11, shall be tested by suitably shaped gauges, having the same nominal cross-sectional area as those of the appropriate gauges given in Figure 11.

Compliance is checked by inspection.

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

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

11.3.3 Screwless type terminals shall have appropriate mechanical strength.

Compliance is checked by the following test:

Five insertions and disconnections are made with each type of conductor for which the terminal is intended to be used, with conductor nominal cross-sectional area specified in Table 8.

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

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

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

11.3.4 The connection or disconnection of conductors shall be made:

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

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

Compliance is checked by inspection.

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

Compliance is checked by inspection.

11.3.6 Terminals shall be so designed and constructed that:

– each conductor is clamped individually in a separate independent clamping unit (not necessarily in separate holes);

– during the connection or disconnection, the conductors can be connected or disconnected either at the same time or separately.

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

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

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

Compliance is checked by inspection.

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

NOTE 1 This test is intended to simulate the bending forces on the conductor being transferred to the terminal during installation.

Compliance is checked by the following test:

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

The test apparatus, the principle of which is shown in Figure 12, shall be constructed so that:

– *the test conductor, properly inserted into a clamping unit of the connecting devices, shall be allowed to be bent (deflected) in any of the 12 directions differing from each other by 30°± 5°;*

– *the starting point can be varied by 10° and 20° from the original point.*

NOTE 2 A reference direction and starting point are not specified.

The bending of the conductor from its straight position to the testing positions shall be performed by means of a suitable device applying a force as specified in Table 2 to the conductor, at a specified distance from the clamping unit of the connecting device.

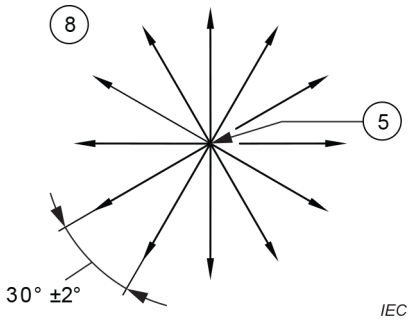
The bending apparatus shall be so designed that:

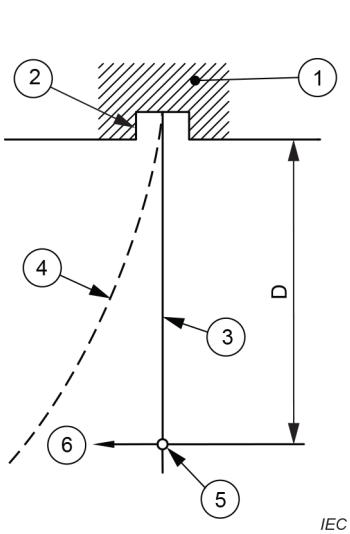
– *the force is applied in the direction perpendicular to the conductor;*

– *the bending is attained without rotation of the conductor within the clamping unit;*

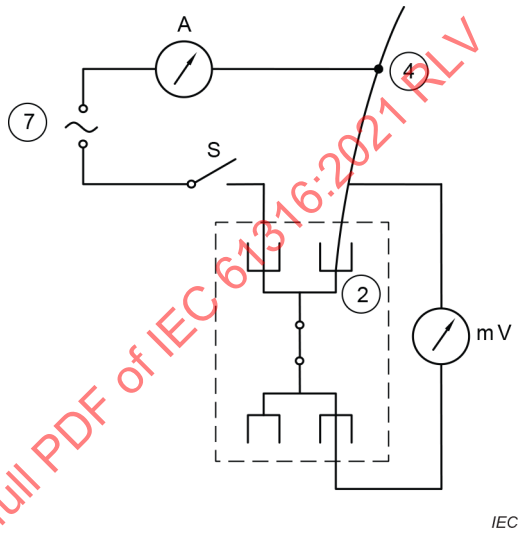
– *the force remains applied while the required voltage drop measurement is made.*

The force for bending the conductor is specified in Table 2. The distance "D" shall be measured from the extremity of the connecting device, including the guidance for the conductor, if any, to the point of application of the force to the conductor.





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



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

Key

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

Figure 12 – Information for the bending test

Table 2 – Deflection test forces

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

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

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

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

Provisions shall be made so that the voltage drop across the clamping units under test can be measured when the conductor is connected, as shown for example in Figure 12b).

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

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

A clamping terminal is fitted, as for normal use, with a rigid solid copper conductor having the smallest cross-sectional area specified in Table 8 and is submitted to a first test sequence; the same clamping terminal is submitted to a second test sequence using the conductor having the largest cross-sectional area, unless the first test sequence has failed.

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

A tenth of the test current assigned to the connected conductor, according to Table 5, shall flow through the connecting devices. A bending force shall be applied as shown in Figure 12a), in one of the 12 directions and the voltage drop across this clamping unit shall be measured.

The force shall then be applied successively in each of the remaining 11 directions shown in Figure 12a) following the same test procedure.

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

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

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

11.4 Insulation piercing terminals (IPT)

11.4.1 Insulation piercing terminals shall allow the proper connection of copper or copper-alloy conductors having a nominal cross-sectional area as shown in Table 8.

Compliance is checked by inspection and by introducing the largest insulated conductor according to Table 8.

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

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

Alternatively, insulation piercing terminals may clamp the conductor between the metal part and the insulated part provided they comply with the test of 11.7.

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

11.4.3 Insulation piercing terminals shall have appropriate mechanical strength.

Compliance is checked by the following test:

Five insertions and disconnections are made with conductors having the nominal cross-sectional area indicated in Table 8.

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

If insulation piercing terminals use screws for wire connection, the torque value of Table 11 shall be used. Higher values of torque may be used if so stated by the manufacturer in its technical documentation.

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

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

11.4.4 The connection or disconnection of conductors shall be made using a general-purpose tool or a convenient integrated device in the terminal assisting the insertion or the withdrawal of the conductors.

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

Compliance is checked by inspection.

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

Compliance is checked by inspection.

11.4.6 Terminals shall be so designed and constructed that:

– each conductor is clamped individually in a separate independent clamping unit (not necessarily in separate holes);

– during the connection or disconnection, the conductors can be connected or disconnected either at the same time or separately.

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

Compliance is checked by inspection

11.5 Mechanical tests on terminals

11.5.1 New terminals are fitted with new conductors and of the minimum and the maximum cross-sectional areas and are tested with the apparatus shown in Figure 13.

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

The length of the test conductor shall be 75 mm longer than the height H specified in Table 3.

Clamping screws, if any, are tightened with the torque according to Table 11. Otherwise the terminals are connected according to the manufacturer's instructions.

Where there is a guidance for the conductor at the clamping unit, the terminal shall be tested while installed in the cable reel.

Each conductor is subjected to the following test:

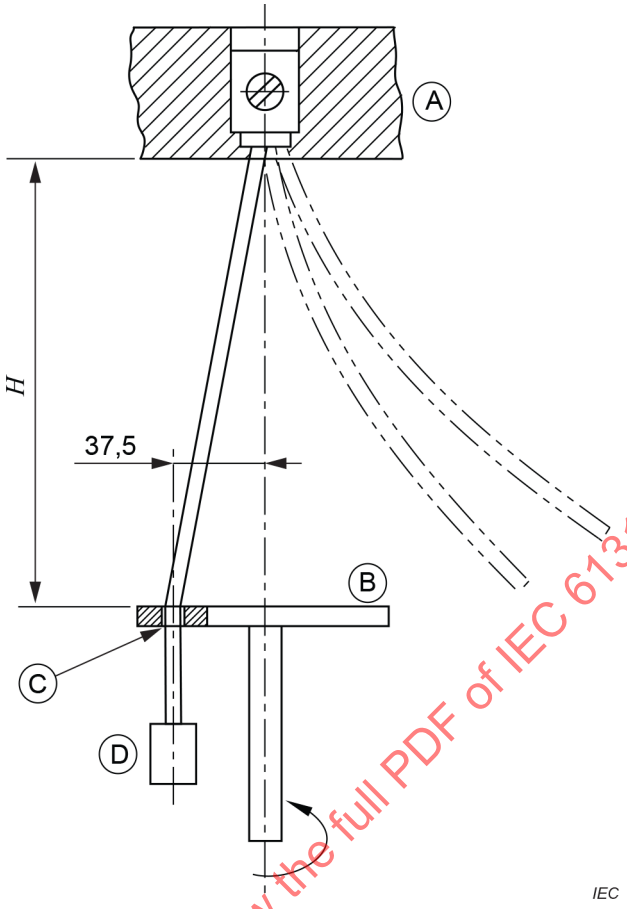
The end of the conductor is passed through an appropriate-sized bushing in a platen, positioned at a height H below the equipment, as given in Table 3. The bushing is positioned in a horizontal plane, such that its centre line describes a circle of 75 mm diameter, concentric with the centre of the clamping unit in the horizontal plane. The platen is then rotated at a rate of (10 ± 2) r/min.

The distance between the mouth of the clamping unit and the upper surface of the bushing shall be within 15 mm of the height in Table 3. The bushing may be lubricated to prevent binding, twisting or rotation of the insulated conductor. A mass, as specified in Table 3, is suspended from the end of the conductor. The duration of the test is 15 min.

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

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

Dimension in millimetres



Key

A Clamping unit
B Platen
C Bushing hole
D Mass

Figure 13 – Test arrangement for terminals

Table 3 – Pulling test values on terminals

Nominal cross-sectional area mm^2	Diameter of bushing mm	Height[a] mm	Mass kg
1,0	6,5	260	0,4
1,5	6,5	260	0,4
2,5	9,5	280	0,7
4,0	9,5	280	0,9
6,0	9,5	280	1,4
10,0	9,5	280	2,0
16,0	13,0	300	2,9
If a bushing with the given hole diameter is not adequate to accommodate the conductor without binding, a bushing having the next largest hole may be used.			
[a] Tolerance for height *H:* ±15 mm.			

11.5.2 Verification is carried out successively with conductors of the largest and smallest cross-sectional areas specified in Table 8, using class 1 or class 2 conductors for terminals of fixed socket-outlets or appliance inlets, and class 5 conductors for terminals of plugs or portable socket-outlets.

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

The conductors shall be connected to the clamping unit, and the clamping screws or nuts tightened to two-thirds of the torque indicated in Table 11, unless the torque is specified by the manufacturer on the product or in an instruction sheet.

Each conductor is subjected to a pull according to the value in Table 4 exerted in the opposite direction to that in which the conductor was inserted. The pull is applied without jerks for 1 min. The maximum length of the test conductor shall be 1 m.

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

Table 4 – Pulling force

Nominal cross-sectional area mm^2	Pulling force N
1	35
1,5	40
2,5	50
4	60
6	80
10	90
16	100

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

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

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

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

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

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

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

The clamping screws or nuts, if any, are tightened with the torque according to Table 10, unless the torque is specified by the manufacturer on the product or in an instruction sheet.

The use of AC is preferable, but DC is acceptable.

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

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

Except during the cooling period, the test current, as defined in Table 5, is applied through the series circuit. The test current shall be applied for the initial 30 min of each cycle.

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

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

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

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

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

The maximum allowable voltage drop of each clamping unit, measured with the current as specified in Table 5, shall not exceed the smaller of the two following values:

- *either 22,5 mV, or*
- *1,5 times the value measured after the 24th cycle.*

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

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

Table 5 – Test current

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

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

11.7.1 Temperature-cycling test

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

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

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

- *either 22,5 mV, or*
- *1,5 times the value measured after the 48th cycle.*

11.7.2 Short-time withstand current test

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

Screws, if any, are tightened with two thirds of torques as stated in Table 11.

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

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

In order to limit additional heating, the current for measuring the voltage drop before and after the test shall be one-tenth of the value shown in Table 5.

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

12 Resistance to ageing of rubber and thermoplastic material

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

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

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

– *(70 ± 2) °C and 10 days (240 h), for rubber;*
– *(80 ± 2) °C and 7 days (168 h), for thermoplastic material.*

After the samples have been allowed to attain approximately room temperature, they are examined and shall show no crack visible with normal or corrected vision, without additional magnification. After the test, the samples shall show no damage which would lead to non-compliance with this document.

The use of an electrically heated cabinet is recommended.

Natural circulation may be provided by holes in the walls of the cabinet.

13 Construction

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

Compliance is checked by inspection.

13.2 Rewireable cable reels shall be so constructed as to permit:

– the conductors to be easily introduced into the terminals;
– the correct positioning of the conductors without their insulation coming into contact with bare metal parts of a polarity different from that of the conductor, or with accessible metal parts;
– internal wiring to remain securely fixed whilst the flexible cable is connected;
– an adequate arrangement of the terminals allowing the flexible cable to be easily introduced and connected without the risk of damaging the insulation of the flexible cable.

Compliance is checked by inspection and by disconnecting and reconnecting, using the flexible cables as delivered with the cable reel.

13.3 Inlet openings in metal through which flexible cables pass, shall be provided with a bushing of insulating material.

13.4 Non-rewireable cable reels shall be such that:

– the flexible cable cannot be separated from the cable reel without making it permanently useless;
– the cable reel cannot be opened by hand or by using a general-purpose tool, for example a screwdriver;
– winding of the flexible cable is done in a smooth space without sharp edges, burrs and the like which might cause damage to the insulation of the flexible cable.

A cable reel is considered to be permanently useless when, for re-assembling the cable reel, parts or materials other than the original have to be used.

13.5 Flexible cables shall be effectively prevented from coming into contact with moving parts which might cause damage to their insulation.

13.6 Bare live conductors shall be reliably secured so that the distance between them, and the distances to accessible metal parts, cannot be reduced below the values given in Clause 21.

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

13.7 Cable reels incorporating one or more socket-outlets shall ensure continuity to the earth contacts.

Compliance is checked by inspection and by manual test.

13.8 Cable reels shall be so constructed that there is no risk of short-circuit between live parts and accessible metal parts due to loosened internal wiring, screws or the like.

Compliance is checked by inspection and by manual test.

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

Compliance is checked by inspection and by manual test.

13.10 A cable reel shall be fitted with a thermal cut-out and/or a current cut-out, which shall be:

– trip-free;
– non-self-resetting thermal or current cut-out;
– constructed so that when resetting, live parts shall not become accessible;
– constructed so that the setting of temperature or current cannot be altered by the user;
– and which shall disconnect
  a) at least one pole in two-pole cable reels, which shall be the phase pole on polarized cable reels; or
  b) all poles, except the neutral pole on other cable reels.

Fuses are only allowed when it is not possible for the user to replace them with fuses of higher rating than those originally fitted. The protective conductor, if any, shall not be interrupted.

Compliance is checked by inspection and by manual test.

NOTE In the following country, fuses are not allowed: Denmark.

13.11 Cable entry shall be reliably fixed and be so shaped as to prevent damage from the material in which it is mounted. Cable entry shall not be made of natural elastomeric material, for example, rubber.

Compliance is checked by inspection and by manual test and by test of Clause 12.

13.12 Cable reels incorporating a residual current device with $I_{\Delta n} \leq 30$ mA shall be so constructed that no more than 2 m of cable remains on the supply side of the residual current device.

Compliance is checked by inspection and by manual test.

13.13 Cut-outs shall not self-reset at low temperature.

Compliance is checked by the following test:

The cut-out shall be caused to operate, and it shall be checked that it does not self-reset when kept at a low temperature of (−25 ± 2) °C for approximately 18 h.

13.14 Components incorporated or integrated in cable reels, such as flexible cable, current cut-outs, thermal cut-outs, safety transformers, motors, switches, fuses, residual current devices, lampholders and connecting devices shall comply with the relevant standards as far as they reasonably apply.

Components according to IEC 60730-2-9 shall be of Type 1.D, 2.D, 1.E or 2.E with a minimum number of cycles equal to 300.

13.15 Plugs and appliance inlets shall be in accordance with IEC 60309-1 or IEC 60309-2. At least one of the socket-outlets shall be in accordance with IEC 60309-1, IEC 60309-2 or IEC 60309-4. Other socket-outlets shall either be in accordance with another harmonized system or in accordance with the system of socket-outlets in the country where the cable reel is intended to be used.

Socket-outlets shall be of a type which prevents the insertion of plugs used with class 0 equipment.

The plugs for equipment of class 0 can be used only as far as national wiring rules permit.

13.16 Portable cable reels shall be equipped with one plug or appliance inlet and at least one socket-outlet. Fixed cable reels shall be equipped with at least one fixed or portable socket-outlet.

The rated current of fixed or portable socket-outlets shall not be higher than the rated current of the cable reel. Fixed or portable socket-outlets with a rated current lower than the rated current of the cable reel shall be protected by a suitable protecting device.

The rated current of the plug, if any, shall not be less than the rated current of the cable reel.

Components shall suit operating conditions specified for the cable reel.

Compliance is checked by inspection.

14 Degrees of protection

14.1 Cable reels shall have the degrees of protection marked on the products.

Socket-outlets of domestic type are tested without the plug inserted and with the lid, if any, closed.

Compliance is checked by the appropriate tests mentioned in 14.2 and 14.3.

14.2 *Cable reels shall be tested in accordance with IEC 60529 in fully unreeled condition, in the most unfavourable position. Fixed cable reels shall be tested as above but mounted as specified by the manufacturer's instructions.*

Immediately after the tests, the samples shall withstand the dielectric strength test specified in 15.3, and inspection shall show that water has not entered the samples to such an extent that could impair their further use.

14.3 All cable reels shall be proofed against humid conditions which may occur in normal use.

Compliance is checked by the humidity treatment described in 14.3, followed immediately by the measurement of the insulation resistance and by the dielectric strength test, specified in Clause 15.

Cable entries, if any, are left open. If knock-outs are provided, one of them is opened.

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

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

The sample is kept in the cabinet for seven days (168 h).

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

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

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

15 Insulation resistance and dielectric strength

15.1 The insulation resistance and the dielectric strength of cable reels shall be adequate.

Compliance is checked by the tests specified in 15.2 and 15.3 which are made immediately after the test of 14.3 in the humidity cabinet or in the room in which the samples were brought to the required temperature, after reassembly of those parts which may have been removed. Cable reels shall be unreeled prior to carrying out the tests.

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

For non-rewireable and rewireable cable reels the insulation resistance shall not be less than 5 MΩ and shall be measured consecutively:

a) between all poles connected together and the body;

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

NOTE The term "body" includes all accessible metal parts, handles, knobs, grips and the like and their shafts, if these shafts become live in the event of an insulating fault, and metal foil in contact with all accessible surfaces of insulating material; it does not include metal parts which are not accessible.

15.3 *A voltage of substantially sine-wave form, having a frequency of 50 Hz/60 Hz and the value shown in Table 2, is applied for 1 min between the parts indicated in 15.2.*

Table 6 – Test voltage for dielectric strength test

Insulation voltage[a] of the cable reels V	Test voltage V
Up to and including 50	500
Over 50 up to and including 415	2 000[b]
Over 415 up to and including 500	2 500
Over 500 up to and including 690	3 000

[a] The insulation voltage is at least equal to the highest rated operating voltage.

[b] This value is increased to 2 500 V for metal enclosures lined with insulating material.

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

No flash-over or breakdown shall occur during the test.

Glow discharges without a drop in voltage are neglected.

16 Normal operation

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

Compliance is checked by the following test.

16.2 *In cable reels incorporating contacts intended to make connection between fixed and moving parts (e.g. slip rings), each phase conductor, neutral conductor and earthing conductor, if any, is loaded with the rated current related to the nominal cross-sectional area indicated in Table 8 and derived from an AC source with a no-load voltage not exceeding 12 V. The voltage drop is measured adjacent to the contact-making members.*

This measurement shall be made immediately after the cable reel, under rated load, has reached its steady thermal condition. In no case shall the resistance exceed 0,05 Ω. The test is repeated after the cable reel has been subjected to the test for normal operation described in 16.3 to 16.6 and to the electric strength test of 16.7. The increase of resistance shall not be more than 50 % with a maximum of 0,075 Ω for the phase conductor(s) and the neutral conductor, and a maximum of 0,05 Ω for the earthing conductor.

16.3 *The flexible cable is unreeled and fully reeled on to the cable reel as in normal use at a rate of approximately 0,5 m/s, in the direction most likely to occur in normal use. The test is carried out as described in 16.4 to 16.6.*

16.4 *For hand-operated cable reels not incorporating movable contacts (slip rings or the like):*

– *the total length of the flexible cable is unreeled;*
– *the number of cycles of operation is 100.*

16.5 *For hand-operated cable reels incorporating movable contacts, the test shall be carried out at the rated current of the fully reeled cable reel*:

– *the flexible cable is unreeled in such a way that the rotating part of the reel makes approximately two revolutions, and such that at least two turns of the cable remain on the reel;*

– *during the recoiling, the flexible cable is held under tension applying a force of 10 N/mm^2 of the nominal cross-sectional area of the conductors of the cable up to a maximum of 100 N;*

– *the number of cycles of operation for a 16 A cable reel is 10 000 (ten thousand) and for 32 A and 63 A cable reels the number of cycles shall be 4 000 (four thousand).*

NOTE One cycle consists of one unreeling followed by one reeling.

16.6 *For spring and motor-operated cable reels*:

– *the flexible cable is unreeled in such a way that the rotating part of the reel makes approximately two revolutions, and such that at least two turns of cable remain on the reel;*

– *during the recoiling, the flexible cable is held under tension applying a force which is adapted to the reeling force of the cable reel;*

– *the number of cycles of operation for 16 A cable reels is 10 000 (ten thousand);*

– *for 32 A and 63 A cable reels the number of cycles shall be 4 000 (four thousand);*

– *the cable of a reel incorporating an automatic return mechanism shall be fully unreeled and allowed to return unhindered 100 times using the automatic system incorporated.*

After this test, the cable reel shall show no damage impairing safety and its further use.

In particular, the cable reel shall show:

– no loosening of electrical connections;

– no loosening of mechanical parts or connections;

– no damage to the sheath or insulation of the cable.

16.7 Immediately after the tests of 16.3 to 16.6, the cable reels shall withstand an electric strength test, as described in 15.3 but with the test voltage reduced by 500 V for cable reels having an insulation voltage exceeding 50 V. The test is made without a preceding humidity treatment.

No flash-over or breakdown shall occur during the test. In addition, there shall be no breakage of electrical connections or conductors.

17 Temperature rise

17.1 Temperature rise in normal use

17.1.1 Cable reels shall not attain excessive temperatures in normal use, such that they cause a danger to persons or surroundings.

17.1.2 *Compliance is checked by determining the temperature rise of the various parts stated in Table 7.*

Portable cable reels are placed in their normal position of use in a test corner as near to the walls as possible. The test corner consists of a floor and two walls at right angles, all of a dull black-painted plywood having a thickness of 20 mm. Cable reels for fixed mounting are mounted on the wall or the ceiling in a test corner as near to the ceiling and wall as possible. The test corner consists of a ceiling and two walls at right angles, all of dull black-painted plywood having a thickness of 20 mm.

Temperature rises are determined by means of fine wire thermocouples, chosen and positioned so that they have the minimum effect on the temperature of the part under test.

Thermocouples used for determining the temperature rise of the surface of walls, ceiling and floor are embedded in the surface or attached to the back of small blackened disks of copper or brass, 15 mm in diameter and 1 mm thick, which are flush with the surface.

So far as it is possible, the cable reel is positioned so that parts likely to attain highest temperatures touch the disks.

In determining the temperature rises of handles, knobs, grips and the like, consideration is given to all parts which are gripped in normal use and, if of insulating material, to parts in contact with hot metal.

The temperature rise of electrical insulation is determined at places where failure could cause a short-circuit, a contact between live parts and accessible metal parts, or a reduction of creepage distances or clearances below the values specified in Clause 21.

The test is made both with cable reels fully reeled and unreeled. Cable reels loaded with the rated power corresponding respectively to the marking for unreeled and reeled condition, are operated until steady conditions are established.

The test current corresponds to cos φ = 1.

Table 7 – Permissible temperature rise

Parts	Temperature rise K
Rubber insulation of internal and external wiring and flexible cable	35
Polyvinyl chloride insulation of internal wiring	45
Cord-sheath used as supplementary insulation	35
Silicone rubber insulation of internal wiring and flexible cables	145
Rubber used for gaskets or other parts, the deterioration of which could affect safety:	
– when used as supplementary insulation or as reinforced insulation	40
– in other cases	50
Material used as insulation other than for wires:	
– Moulding of:	
• phenol-formaldehyde with cellulose fillers	85
• phenol-formaldehyde with mineral fillers	100
• melamine-formaldehyde	75
• urea-formaldehyde	65
• polyester with glass-fibre reinforcement	110
• silicone rubber	145
• polytetrafluoroethylene	265
• pure mica and tightly sintered ceramic material when such products are used as supplementary or reinforced insulation	400
• thermoplastic material	a)
Supports, walls, ceiling and floor of the test corner	60
Sliding contacts	65

Parts	Temperature rise K
Handles and similar parts which, in normal use, are touched by hand	
– of metal	40
– of insulating material	50
Terminals, including earthing terminals for external conductors	60
Lampholder E27:	
– metal or ceramic type	160
– insulated type, other than ceramic	120
Lampholder E14, B15, B22:	
– metal or ceramic type	130
– insulated type, other than ceramic	90
with T-marking	T-25
[a] Owing to the great number of thermoplastic insulating materials, it is not possible to specify permissible temperature rises for such materials. Provisionally, the ball pressure test described in IEC 60309-1:2021, 27.1 shall be carried out.	

During the test, the thermal cut-out or current cut-out shall not operate.

After the test, the cable reel shall show no deformation or damage within the meaning of this document.

NOTE Experience has shown that the hottest point of flexible cable insulation is likely to occur between the second and third layers, in the central area, of the cable reel when carefully reeled.

17.2 Temperature rise under overload conditions

17.2.1 Cable reels shall be so constructed that there is no risk of fire or electric shock as a result of abnormal electrical load.

Compliance is checked by the tests of 17.2.2 and 17.2.3.

17.2.2 *Cable reels are tested under the conditions described in 17.1.2 and are loaded with the highest possible current at which the thermal cut-out or current-sensing device will not operate, until steady conditions are established, or for 4 h, whichever is the shortest period.*

NOTE Steady conditions are reached when the temperature does not vary by more than 1 K/h.

The temperature rise of the parts of the cable reels, shown in Table 7 shall not exceed by more than 25 K the relevant values in that table.

After the test, the following conditions shall be fulfilled.

a) The cable reel shall show no deformation affecting the protection against electric shock. There shall be no short-circuit or damage to the insulation of the cable reel or to the cable, and the further use of the cable reel shall not be impaired.

Compliance is checked by inspection, by a test with the standard test finger according to IEC 61032 Probe B and by the dielectric strength test specified in 15.3, the test voltage being reduced by 500 V.

The humidity treatment is not repeated before the dielectric strength test is carried out.

b) The thermal or current cut-out shall not be deformed or damaged, and the present value shall not be changed.

Compliance is checked by inspection and by a comparison release test on a cable reel that has not been subjected to the test of 17.1.2.

c) The earth connection shall not be impaired.

Compliance is checked by the test specified in 10.4.

17.2.3 *The cable reel is tested fully reeled under the condition described in 17.1.2, the test load being that corresponding to 1,5 times the rated current of the socket-outlets in which the plug of the cable reel may be inserted or 1,5 times the rated current of the protective device in the case of fixed cable reels.*

The load is applied until steady conditions are reached, or thermal or current cut-out has operated. After the test:

a) the cable reel shall show no deformation affecting the protection against electric shock.

Compliance is checked by inspection and by a test with the standard test finger according to IEC 61032 Probe B. It shall not be possible to touch live parts;

b) the earth connection shall not be impaired.

Compliance is checked by the test specified in 10.4.

18 Flexible cables and their connection

18.1 Cable reels shall be provided with a flexible cable complying with IEC 60245-4 of one of the types specified in Table 8, the nominal cross-sectional area being not less than the value shown.

Flexible cables having nominal cross-sections other than those specified in Table 8 may be used if the load is known.

18.2 Minimum cable sizes shall be based on the lowest current rating of the plug or the protection device, incorporated in the cable reel, as shown in Table 8.

Table 8 – Minimum cable sizes

Rated operating voltage	Nominal current A			Type of cable IEC 60245 (all parts)	Nominal cross-sectional area mm²
	Preferred rated current		Other ratings		
	Series I	Series II			
Not exceeding 50	16	20		66	10
	32	30		66	10
Over 50	16	20	6	53[b], 57[b], 66	1
			10	53[b], 57[b], 66	1,5
				53[a] 57[a] 66	2,5[b)]
	32	30	25	66	4
				53, 66	6
			40	66	10
			50	66	10
	63	60		66	16

[a] Not applicable to cable reels having a rated operating voltage exceeding 415 V.

[b] For cable reels having a rated operating voltage not exceeding 50 V, the value is increased to 4 mm².

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

The pilot conductor, if any, shall have a nominal cross-sectional area of at least 2,5 mm².

Compliance is checked by inspection.

18.3 Flexible cables shall have the same number of conductors as there are poles in the cable reel and in the socket-outlets except for voltage not exceeding 50 V, fitted earthing contacts, if any, being considered as one pole, irrespective of their number. The conductor connected to the earthing contact shall be identified by the colour combination green/yellow.

Compliance is checked by inspection.

18.4 The maximum length of the flexible cable shall be as shown in Table 9.

Table 9 – Maximum length of cable

Nominal cross-sectional area mm²	Maximum length of cable m
Up to and including 6	80
Over 6 up to and including 16	100

Compliance is checked by inspection, by measurement and by checking that the flexible cables are in accordance with IEC 60245-4.

18.5 Cable reels shall be provided with a cable anchorage so that the conductors are relieved from strain, including twisting, where they are connected to the terminals, and that their covering is protected from abrasion.

The cable anchorage shall be of insulating material or be provided with an insulating lining and be so designed that the cable cannot touch clamping screws, if any, of the cable anchorage, if these screws are accessible or electrically connected to accessible metal parts.

Glands shall not be used as cable anchorage. Makeshift methods, such as tying the cable into a knot or tying the ends with string, shall not be used.

Compliance with this requirement is checked by inspection.

18.6 It shall be made clear how relief from strain and prevention from twisting are intended to be performed.

The cable anchorage, or parts of it, shall be integral with or fixed to one of the parts of the cable reel.

Cable anchorage shall be suitable for the different types of flexible cables declared by the manufacturer, and insulating linings, if any, shall be securely fixed to the metal parts; metal parts of the cable anchorage shall be insulated from the earthing circuit.

The cable anchorage of rewireable cable reels shall be so designed and located that replacement of the flexible cable is easily possible.

Clamping screws, if any, which are operated when replacing the flexible cable, shall not serve to fix any other component.

Compliance is checked by inspection and by the test of 18.7.

18.7 The cable anchorage of cable reels is subjected to a pull test followed by a torque test.

For rewireable cable reels, the conductors are introduced into the terminals, the terminal screw being tightened just sufficiently to prevent the conductors from easily changing their position. The cable anchorage is used in the normal way, any clamping screws being tightened with a torque equal to two-thirds of that specified in Table 7.

After reassembly of the cable reel, the parts shall fit snugly, and it shall not be possible to push the cable into the cable reel to any appreciable extent.

Non-rewireable cable reels are tested with the flexible cable as delivered, but with the conductors of flexible cable cut adjacent to the terminations.

The flexible cable is then subjected 100 times to pulling, using the values specified below. The pulls are applied in the most unfavourable direction in the immediate vicinity of the cable anchorage. The pull values applied are as follows:

a) 80 N for cable reels with flexible cable having a nominal cross-sectional area up to 4 mm^2;

b) 100 N for cable reels with flexible cable having a nominal cross-sectional area from 6 mm^2 to 10 mm^2;

c) 120 N for cable reels with flexible cable greater than or equal to 16 mm^2.

The pulls are applied without jerks, each time for 1 s. Immediately afterwards, the flexible cable is subjected for 1 min to a torque of:

– *0,35 Nm for cable reels with flexible cable less than 16 mm^2 nominal cross-sectional area;*

– *0,425 Nm for cable reels with flexible cable having a nominal cross-sectional area greater than or equal to 16 mm^2.*

During the test, the flexible cable shall not be damaged.

After the test, the flexible cable shall not have been displaced by more than 2 mm, the ends of the conductors shall not have moved noticeably in the terminals or at the terminations.

18.8 Cable reels shall be so designed that the flexible cable is protected against damage caused by the opening for the passage of the cable.

Compliance is checked by inspection and by the following test. The cable is subjected 25 times to a pull of 100 N. The pulls are applied in the most unfavourable direction without jerks, each time for 1 s.

After the test, the cable shall not be damaged.

Compliance is checked by inspection.

19 Mechanical strength

19.1 Cable reels shall have adequate mechanical strength and be so constructed as to withstand such rough handling as may be expected in normal use.

Compliance is checked by the tests of 19.2, 19.3, 19.4 and 19.5.

19.2 *Cable reels are mounted at an angle of 15° from the perpendicular. For this test, the cable reel shall not overturn. These tests are carried out with the cable reel in a fully reeled condition.*

19.3 *Portable cable reels are subjected to blows by means of the spring-hammer according to IEC 60068-2-75.*

The cable reels are kept in a refrigerator at a temperature of −25 °C for at least 16 h, the cable reels being subjected to the test within 1 min after their removal from the refrigerator.

19.4 *Portable cable reels are dropped 10 times from a carrying handle height of 0,75 m on to a concrete floor. During the test, the total length of the flexible cable shall be wound on to the reel.*

NOTE The term "carrying handle height" denotes the vertical distance from the floor up to the handle of the cable reel which is normally used for carrying the cable reel over a short distance.

19.5 *Portable cable reels are overturned 10 times in their normal position on to a concrete floor in the most unfavourable direction. During the test, the total length of the flexible cable shall be wound on to the reel.*

19.6 *After the tests of 19.2 to 19.5, protection against electric shock shall not be affected, and the cable reel shall show no damage which may affect safety or impair the further use of the cable reel. In particular:*

– *fixed and portable socket-outlets shall not have worked loose or been damaged;*
– *covers or enclosures shall show no cracks visible to normal or corrected vision without additional magnification;*
– *the effectiveness of insulating barriers or other parts of insulating material shall not have been damaged.*

Damage to the finish, small dents which do not affect creepage distances or clearances, and small chips which do not adversely affect the protection against electric shock or moisture are neglected. Cracks not visible with normal or corrected vision without additional magnification and surface cracks in fibre-reinforced mouldings and the like, are ignored.

19.7 Screwed glands shall withstand the mechanical stresses occurring in normal use.

Compliance is checked by the following test:

Screwed glands are fitted with a cylindrical metal rod having a diameter, in millimetres, equal to the nearest whole number below the internal diameter of the packing, in millimetres. The glands are then tightened by means of a suitable spanner, the force shown in Table 10 being applied to the spanner for 1 min, at a point 25 cm from the axis of the gland.

Table 10 – Gland tightening force

Diameter of test rod	**Force** N	
mm	**Metal glands**	**Glands of moulded material**
Up to and including 20	30	20
Over 20 up to and including 30	40	30
Over 30	50[a]	40[a]
[a] These values are provisional.		

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

20 Screws, current-carrying parts and connections

20.1 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 great difference in electrochemical potential with respect to each other shall not be used in contact with each other.

Compliance is checked by inspection.

The requirements of 20.1 do not apply to screws, nuts, washers, clamping plates and similar parts of terminals.

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

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

Compliance is checked by inspection and, for screws and nuts transmitting contact pressure or which are operated when connecting the cable reel, by the following test:

The screws or nuts are tightened and loosened:

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

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

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

When testing terminal screws and nuts, a copper conductor having the largest cross-sectional area in Table 8, flexible for cable reels, is placed in the terminal.

The test is carried out by means of a suitable screwdriver or spanner. The maximum torque applied when tightening is equal to that shown in Table 11, except that the torque is increased by 20 % for screws in engagement with a thread in a hole which is obtained by plunging, if the length of the extrusion exceeds 80 % of the original thickness of the metal.

When the manufacturer specifies, for terminal screws, a torque greater than the values given in Table 11, this specified torque shall be applied for the test.

Table 11 – Tightening torques

Metric standard values	Nominal diameter of thread mm	Torque Nm		
		I	II	III
2,5	Up to and including 2,8	0,2	0,4	0,4
3,0	over 2,8 up to and including 3,0	0,25	0,5	0,5
–	over 3,0 up to and including 3,2	0,3	0,6	0,6
3,5	over 3,2 up to and including 3,6	0,4	0,8	0,8
4,0	over 3,6 up to and including 4,1	0,7	1,2	1,2
4,5	over 4,1 up to and including 4,7	0,8	1,8	1,8
5,0	over 4,7 up to and including 5,3	0,8	2,0	2,0
6,0	over 5,3 up to and including 6,0	1,2	2,5	3,0
8,0	over 6,0 up to and including 8,0	2,5	3,5	6,0

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

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

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

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

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

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

NOTE 1 For mantle terminals, the specified nominal diameter is that of the slotted stud.

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

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

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

The screws and nuts shall not be tightened in jerks.

NOTE 2 Damage to covers is neglected.

Screwed connections will have been partially checked by the test of Clause 16 and Clause 19.

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

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

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

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

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

Compliance is checked by inspection.

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

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

Example of satisfactory solutions are:

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

Compliance is checked by inspection and by manual test.

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

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

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

NOTE The requirements for terminals are included in Clause 11.

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

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

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

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

21 Creepage distances, clearances and distances through sealing compound

21.1 Creepage distances, clearances through air and distances through sealing compound shall be evaluated with one of the alternative methods according to 21.2 or 21.3.

21.2 Creepage distances, clearances through air and distances through sealing compound shall be not less than the values in millimetres shown in Table 12.

Table 12 – Creepage distances, clearances and distances through sealing compound

	Insulation voltage of the cable reel V				
	Up to and including 50	**Over 50 up to and including 415**	**Over 415 up to and including 500**	**Over 500 up to and including 690**	**Over 690 up to and including 1 000 [a]**
Creepage distance:					
1. between live parts of different polarity	3	4	6	10	16
2. between live parts and:					
– accessible metal parts,					
– earthing contacts, fixing screws and similar devices,					
– external assembly screws, other than screws which are on the engagement face of plugs and are isolated from the earthing contacts	3	4	6	10	16
Clearance:					
3. between live parts of different polarity	2,5	4	6	8	8
4. between live parts and:					
– accessible metal parts not listed under item 5,					
– earthing contacts, fixing screws and similar devices,					
– external assembly screws, other than screws which are on the engagement face of plugs and are isolated from the earthing contacts	2,5	4	6	8	8
5. between live parts and:					
– metal enclosures, if not lined with insulating material,					
– surface on which the base of a socket-outlet is mounted	4	6	10	10	10
6. between live parts and the bottom of any conductor recess in the base of a socket-outlet	4	5	10	10	10
Distance through sealing compound:					
7. between live parts covered with at least 2,5 mm of sealing compound and the surface on which the base of a socket-outlet is mounted	2,5	4	6	6	6
8. between live parts covered with at least 2 mm of sealing compound and the bottom of any conductor recess in the base of a socket-outlet	2,5	4	5	5	5
[a] Alternatively, creepage distances may be according to IEC 60664-1.					

Compliance is checked by measurement.

For rewireable cable reels, the measurements are made on the sample fitted with the conductors specified in Table 8, and also without conductors. For non-rewireable cable reels, the measurements are made on the sample as delivered.

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

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

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

21.3 Creepage distances, clearances and distances through sealing compound:

– between live parts of different polarity;
– between live parts and
  - accessible metal parts;
  - protective earthing contacts, fixing screws and similar devices;
  - external assembly screws, other than screws which are on the engagement face of plugs and are isolated from the protective earthing contacts;
  - metal enclosures, if not lined with insulating material, including fittings for conduit or armoured cable;
  - the surface on which the base of a socket-outlet is mounted;
  - the bottom of any conductor recess in the base of a socket-outlet;
– through sealing compound (as solid insulation);
– between live parts covered with at least 2,5 mm of sealing compound and the surface on which the base of a socket-outlet is mounted;
– between live parts covered with at least 2 mm of sealing compound and the bottom of any conductor recess in the base of a socket-outlet;

shall be evaluated in accordance with IEC 60664-1 and with IEC 60664-3, and according to 21.5

The control pilot and signal circuits shall be treated as "accessible metal parts" for the purpose of 21.3.

For rewireable cable reels, compliance is checked using samples fitted with conductors specified in Table 8, and also without conductors. For non-rewireable cable reels, compliance is checked using samples as delivered.

Fixed and portable socket-outlets are checked when in engagement with a plug or appliance inlet respectively, and also without a plug or appliance inlet.

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

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

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

Compliance is checked by inspection.

21.5 Cable reels shall be designed for pollution degree 3 according to IEC 60664-1.

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

21.7 In conducting evaluations in accordance with IEC 60664-1 and IEC 60664-3, all cable reels shall be considered overvoltage Category II.

21.8 Determination of the dimensions of clearance and creepage distances shall be conducted in accordance with IEC 60664-1:2020, 6.2 and 6.3.

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

Compliance is checked by inspection.

22 Resistance to heat, to fire and to tracking

22.1 Cable reels shall be sufficiently resistant to heat.

Compliance is checked by the tests of 22.2 and 22.3.

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

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

Marking shall still be easily legible.

NOTE A slight displacement of the sealing compound is neglected.

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

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

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

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

NOTE For elastomeric materials, a test is under consideration.

The test is not made on parts of ceramic material.

22.4 External parts of the insulating material and insulating parts supporting live parts of cable reels shall be resistant to abnormal heat and to fire.

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

In case of doubt, to determine whether an insulating part is necessary to retain the current-carrying parts or the parts of the earthing circuit in position, the cable reel is examined without

conductors while held in positions most likely to cause displacement of the current-carrying parts or parts of the earthing circuit, with the insulating material in question removed.

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

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

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

  Tests are not made on glands and sealing compounds.

– *(850 ± 15) °C for parts of insulating material necessary to retain current-carrying parts and parts of the earthing circuits in position with the exception of parts of insulating material needed to retain the earthing terminal in position in an enclosure, which shall be tested at a temperature of 650 °C.*

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

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

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

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

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

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

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

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

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

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

23 Corrosion and resistance to rusting

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

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

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

Compliance is checked by the following test:

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

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

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

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

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

24 Electromagnetic compatibility

24.1 Immunity

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

Cable reels incorporating electronic components shall comply with IEC 61000-6-1.

Compliance is checked by inspection.

24.2 Emission

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

NOTE 1 These cable reels will 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.

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

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

Compliance is checked by inspection.

Bibliography

IEC 60352-7, *Solderless connections – Part 7: Spring clamp connections – General requirements, test methods and practical guidance*

IEC 60998-2-2, *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-2: Particular requirements for connecting devices as separate entities with screwless-type clamping units*

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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ENROULEURS DE CÂBLE INDUSTRIELS

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La Norme internationale IEC 61316 a été établie par le sous-comité 23H: Prises de courant pour usages industriels et analogues, et pour Véhicules Électriques, du Comité d'études 23 de l'IEC: Petit appareillage.

Cette troisième édition annule et remplace la deuxième édition parue en 1999. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

– Mise en œuvre des derniers essais et exigences précédemment inclus dans l'IEC 60309-1.

Le texte de cette Norme internationale est issu des documents suivants:

FDIS	Rapport de vote
23H/483/FDIS	23H/489/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La version française de cette norme n'a pas été soumise au vote.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/standardsdev/publications.

Dans le présent document, les caractères suivants sont utilisés:

– exigences proprement dites: en caractères romains;
– *spécifications d'essai: en italique*;
– notes: en petits caractères romains.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous webstore.iec.ch dans les données relatives au document recherché. A cette date, le document sera

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- amendée.

ENROULEURS DE CÂBLE INDUSTRIELS

1 Domaine d'application

Le présent document s'applique aux enrouleurs de câble munis d'un câble souple non détachable ayant une tension nominale d'emploi ne dépassant pas 690 V en courant continu et/ou 690 V en courant alternatif, avec une fréquence maximale de 500 Hz et un courant nominal ne dépassant pas 63 A, essentiellement destinés aux usages industriels, à l'intérieur ou à l'extérieur des bâtiments, et devant être utilisés avec des appareils conformes à l'IEC 60309-1, l'IEC 60309-2 ou l'IEC 60309-4.

Le présent document s'applique aux:

– enrouleurs de câble mobiles équipés d'une fiche ou d'un socle de connecteur conforme à l'IEC 60309-1 ou à l'IEC 60309-2 et d'au moins un socle de prise de courant conforme à l'IEC 60309-1, l'IEC 60309-2 ou l'IEC 60309-4;

– enrouleurs de câble fixes équipés d'au moins un socle de prise de courant conforme à l'IEC 60309-1, l'IEC 60309-2 ou l'IEC 60309-4;

– enrouleurs de câble convenant pour une utilisation à une température ambiante normalement comprise entre –25 °C et +40 °C.

L'utilisation de cet équipement sur les chantiers, dans les domaines de l'agriculture, du commerce, et des fonctions domestiques, n'est pas exclue.

Le présent document est aussi applicable aux enrouleurs de câble prévus pour la très basse tension.

Des exigences supplémentaires peuvent être nécessaires pour l'emploi dans des lieux présentant des conditions particulières, par exemple sur les bateaux, dans des véhicules ou autres, ou là où des explosions sont susceptibles de se produire.

NOTE 1 Le présent document n'a pas été conçu pour une application aux véhicules électriques (VE), mais il peut être utilisé comme guide pour les enrouleurs de câble destinés à cette application

NOTE 2 Des exigences supplémentaires pour les enrouleurs de câble prévus pour des courants supérieurs à 63 A sont à l'étude.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60068-2-75, *Essais d'environnement – Partie 2-75: Essais – Test Eh: Essais au marteau*

IEC 60068-2-78, *Essais d'environnement - Partie 2-78: Essais – Essai Cab: Chaleur humide, essai continu*

IEC 60112, *Méthode de détermination des indices de résistance et de tenue au cheminement des matériaux isolants solides*

IEC 60245 (toutes les parties), *Conducteurs et câbles isolés au caoutchouc – Tension assignée au plus égale à 450/750 V*

IEC 60245-4, *Conducteurs et câbles isolés au caoutchouc – Tension assignée au plus égale à 450/750 V – Partie 4: Câbles souples*

IEC 60309-1:2021, *Prises de courant pour usages industriels – Partie 1: Exigences générales*

IEC 60309-2, *Prises de courant pour usages industriels – Partie 2: Règles d'interchangeabilité dimensionnelle pour les appareils à broches et alvéoles*

IEC 60309-4, *Prises de courant pour usages industriels – Partie 4: Prises de courant et prises mobiles avec interrupteur, avec ou sans dispositif de verrouillage*

IEC 60529, *Degrés de protection procurés par les enveloppes (Code IP)*

IEC 60664-1:2020, *Coordination de l'isolement des matériels dans les réseaux d'énergie électrique à basse tension – Partie 1: Principes, exigences et essais*

IEC 60664-3, *Coordination de l'isolement des matériels dans les systèmes (réseaux) à basse tension – Partie 3: Utilisation de revêtement, d'empotage ou de moulage pour la protection contre la pollution*

IEC 60695-2-11, *Essais relatifs aux risques du feu – Partie 2-11: Essais au fil incandescent/chauffant – Méthode d'essai d'inflammabilité pour produits finis (GWEPT)*

IEC 60695-10-2, *Essais relatifs aux risques du feu – Partie 10-2: Chaleurs anormales – Essai à la bille*

IEC 60730-2-9, *Dispositifs de commande électrique automatiques – Partie 2-9: Exigences particulières pour les dispositifs de commande thermosensibles*

IEC 61000-6-1, *Compatibilité électromagnétique (CEM) – Partie 6-1: Normes génériques – Norme d'immunité pour les environnements résidentiels, commerciaux et de l'industrie légère*

IEC 61000-6-3, *Compatibilité électromagnétique (CEM) – Partie 6-3: Normes génériques – Norme sur l'émission relative aux appareils utilisés dans les environnements résidentiels*

IEC 61032, *Protection des personnes et des matériels par les enveloppes – Calibres d'essai pour la vérification*

ISO 1456, *Revêtements métalliques et autres revêtements inorganiques – Dépôts électrolytiques de nickel, de nickel plus chrome, de cuivre plus nickel et de cuivre plus nickel plus chrome*

ISO 2081, *Revêtements métalliques et autres revêtements inorganiques – Dépôts électrolytiques de zinc avec traitements supplémentaires sur fer ou acier*

ISO 2093, *Dépôts électrolytiques d'étain – Spécifications et méthodes d'essai*

ISO/IEC Guide 51, *Aspects liés à la sécurité – Principes directeurs pour les inclure dans les normes*

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes :

- IEC Electropedia : disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform : disponible à l'adresse http://www.iso.org/obp

NOTE Lorsque les termes "tension" et "courant" sont utilisés, ils impliquent la valeur efficace (RMS) du courant continu (CC) ou du courant alternatif (CA).

3.1
tension nominale d'emploi
tension assignée à l'enrouleur de câble par le fabricant

3.2
courant nominal
courant assigné à l'enrouleur de câble par le fabricant

3.3
enrouleur de câble
appareil comportant un câble souple fixé à un dévidoir et conçu de façon telle que le câble puisse être complètement enroulé sur le dévidoir

Note 1 à l'article: Les fiches, socles de prise de courant et socles de connecteur fournis, le cas échéant, avec l'enrouleur de câble sont considérés comme faisant partie du dévidoir.

3.3.1
enrouleur de câble mobile
enrouleur de câble qui peut être facilement déplacé d'un endroit à un autre

3.3.2
enrouleur de câble fixe
enrouleur de câble destiné à être monté sur un support fixe

3.4
câble souple non détachable
câble souple qui est fixé à un enrouleur de câble

3.5
enrouleur de câble démontable
enrouleur de câble construit de telle manière que le câble souple puisse être remplacé à l'aide d'un outil d'usage général

3.6
enrouleur de câble non démontable
enrouleur de câble construit de telle manière qu'il forme un ensemble complet avec le câble souple, la fiche et le socle de prise de courant étant assemblés par le fabricant d'enrouleur de câble de telle sorte qu'après démontage, l'enrouleur de câble soit rendu définitivement inutilisable

3.7
partie accessible
partie qui peut être touchée à l'aide du doigt d'épreuve normalisé

3.8
partie amovible
partie qui peut être enlevée sans l'aide d'un outil d'usage général

3.9
ligne de fuite
chemin le plus court, le long de la surface d'un matériau isolant, entre deux parties conductrices

3.10
distance dans l'air
plus courte distance dans l'air entre deux parties conductrices

3.11
coupe-circuit thermique
appareil de coupure sensible à la température, destiné à interrompre automatiquement un circuit dans des conditions de fonctionnement anormales, et qui ne peut pas être réglé par l'utilisateur

3.12
limiteur de courant
dispositif sensible au courant, destiné à interrompre automatiquement un circuit dans des conditions de fonctionnement anormales et qui ne peut pas être réglé par l'utilisateur

3.13
mécanisme à déclenchement libre
mécanisme conçu de façon telle que la déconnexion ne puisse être ni empêchée ni interdite par un organe de réenclenchement et que les contacts ne puissent pas avoir leur ouverture empêchée ou être maintenus collés lors du maintien d'une température ou d'un courant excessif

3.14
coupe-circuit thermique ou à limitation de courant à réarmement non automatique
coupe-circuit thermique ou limiteur de courant qui ne peut être réarmé que par une action manuelle directe sur le dispositif, qui n'est utilisé que dans ce but, et qui est monté sur l'enrouleur, ou qui est utilisé pour les enrouleurs de câble fixes et constitué d'un ensemble séparé situé à portée de l'enrouleur

3.15
isolation principale
isolation des parties actives dangereuses qui assure la protection principale

[SOURCE: IEC 60050-195:1998, 195-06-06, modifiée – note à l'article omise.]

3.16
isolation supplémentaire
isolation indépendante prévue, en plus de l'isolation principale, en tant que protection en cas de défaut

[SOURCE: IEC 60050-195:1998, 195-06-07]

3.17
double isolation
isolation comprenant à la fois une isolation principale et une isolation supplémentaire

[SOURCE: IEC 60050-195:1998, 195-06-08]

3.18
isolation renforcée
isolation des parties actives dangereuses assurant un degré de protection contre les chocs électriques équivalant à celui d'une double isolation

Note 1 à l'article: L'isolation renforcée peut comporter plusieurs couches qui ne peuvent pas être essayées séparément en tant qu'isolation principale ou isolation supplémentaire.

[SOURCE: IEC 60050-195:1998, 195-06-09]

3.19
terminaison
dispositif de connexion isolé ou non servant pour la connexion non réutilisable des conducteurs au câble d'alimentation

3.20
borne
partie conductrice unipolaire composée d'un ou plusieurs ensembles de serrage, et si nécessaire d'une isolation

3.20.1
borne à trou
borne dans laquelle le conducteur est introduit dans un trou ou une cavité et y serré par le bout de la (des) vis

Note 1 à l'article: La pression de serrage peut être appliquée directement par le bout de la vis ou par l'intermédiaire d'une pièce de serrage sur laquelle s'exerce la pression du bout de la vis (voir Figure 1).

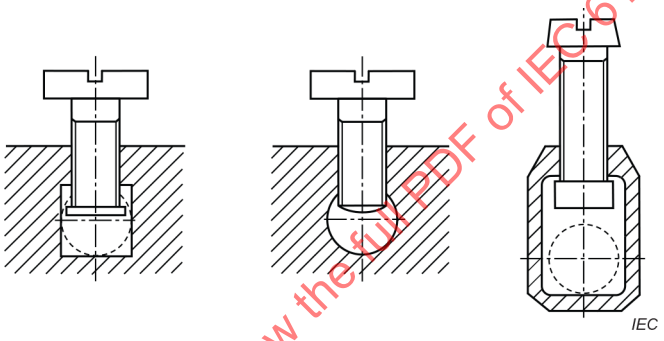


Figure 1 – Bornes à trou

3.20.2
borne à serrage sous tête de vis
borne dans laquelle l'âme d'un conducteur est serrée sous la tête de la vis

Note 1 à l'article: La pression de serrage peut être appliquée directement par la tête de la vis ou au moyen d'une partie intermédiaire, telle qu'une rondelle, une plaquette ou un dispositif empêchant le conducteur ou ses brins de s'échapper (voir Figure 2).

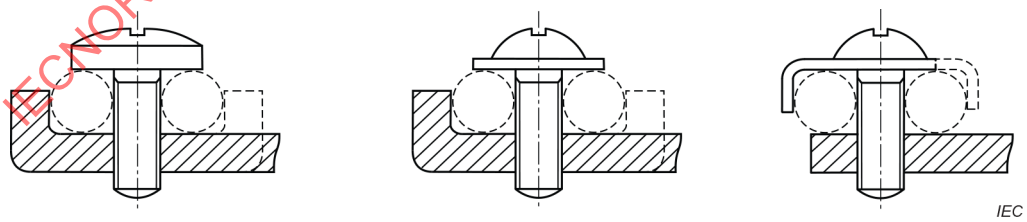


Figure 2 – Bornes à serrage sous tête de vis

3.20.3
borne à goujon fileté
borne dans laquelle l'âme d'un conducteur est serrée sous un écrou

Note 1 à l'article: La pression de serrage peut être appliquée directement par un écrou de forme appropriée ou au moyen d'une partie intermédiaire, telle qu'une rondelle, une plaquette ou un dispositif empêchant le conducteur ou ses brins de s'échapper (voir Figure 3).

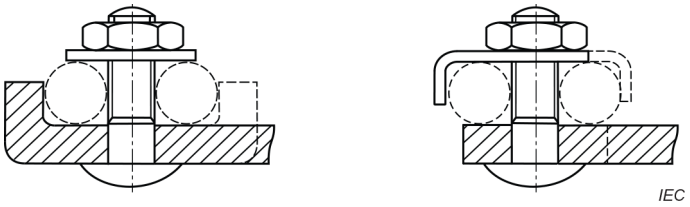


Figure 3 – Bornes à goujon fileté

3.20.4
borne à plaquette
borne dans laquelle l'âme d'un conducteur est serrée sous une plaquette au moyen de plusieurs vis ou écrous

Note 1 à l'article: Voir Figure 4.

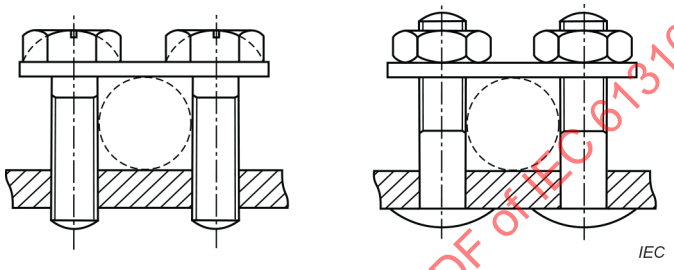


Figure 4 – Bornes à plaquette

3.20.5
borne pour cosses et barres
borne à serrage sous tête de vis ou borne à goujon fileté, prévue pour le serrage d'une cosse ou d'une barre au moyen d'une vis ou d'un écrou

Note 1 à l'article: Voir Figure 5.

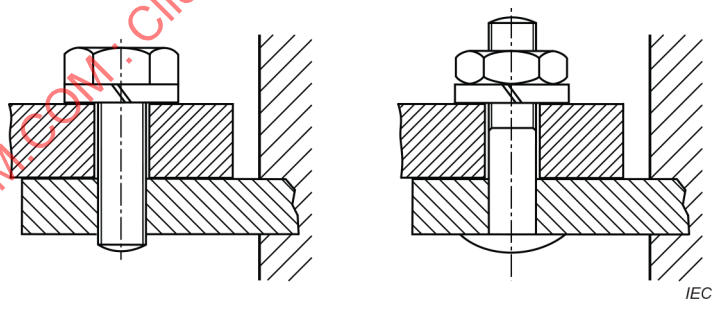


Figure 5 – Bornes pour cosses et barres

3.20.6
borne à capot taraudé
borne dans laquelle l'âme d'un conducteur est serrée contre le fond d'une fente pratiquée dans un goujon fileté au moyen d'un écrou

Note 1 à l'article: L'âme du conducteur est serrée contre le fond d'une fente au moyen d'une rondelle de forme appropriée placée sous l'écrou, ou d'un téton central si l'écrou est un écrou borgne ou par d'autres moyens aussi efficaces pour transmettre la pression à l'âme à l'intérieur de la fente (voir Figure 6).

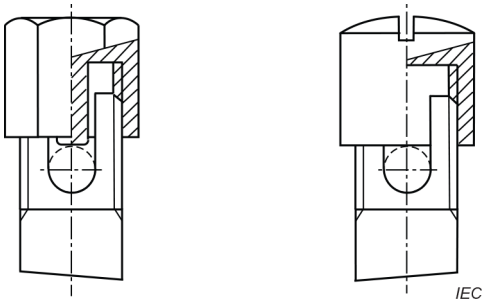


Figure 6 – Bornes à capot taraudé

3.20.7
borne sans vis
borne pour la connexion et la déconnexion d'un ou de plusieurs conducteurs, la connexion étant réalisée directement ou indirectement par un moyen autre que par vis

Note 1 à l'article: Des exemples de bornes sans vis sont donnés à la Figure 7.

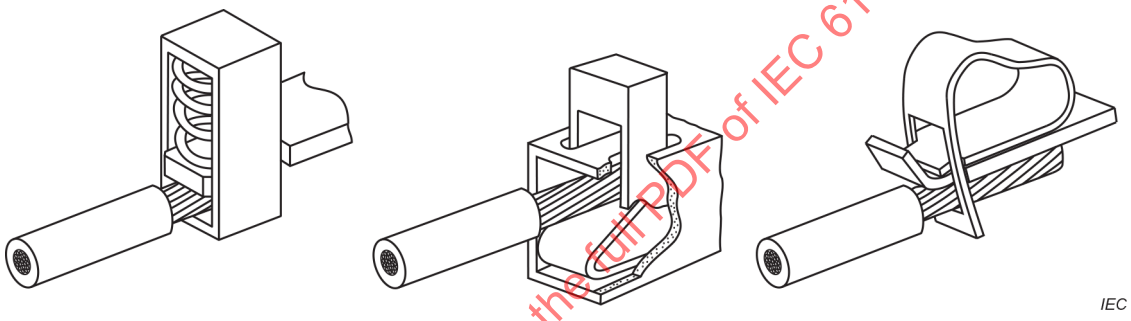
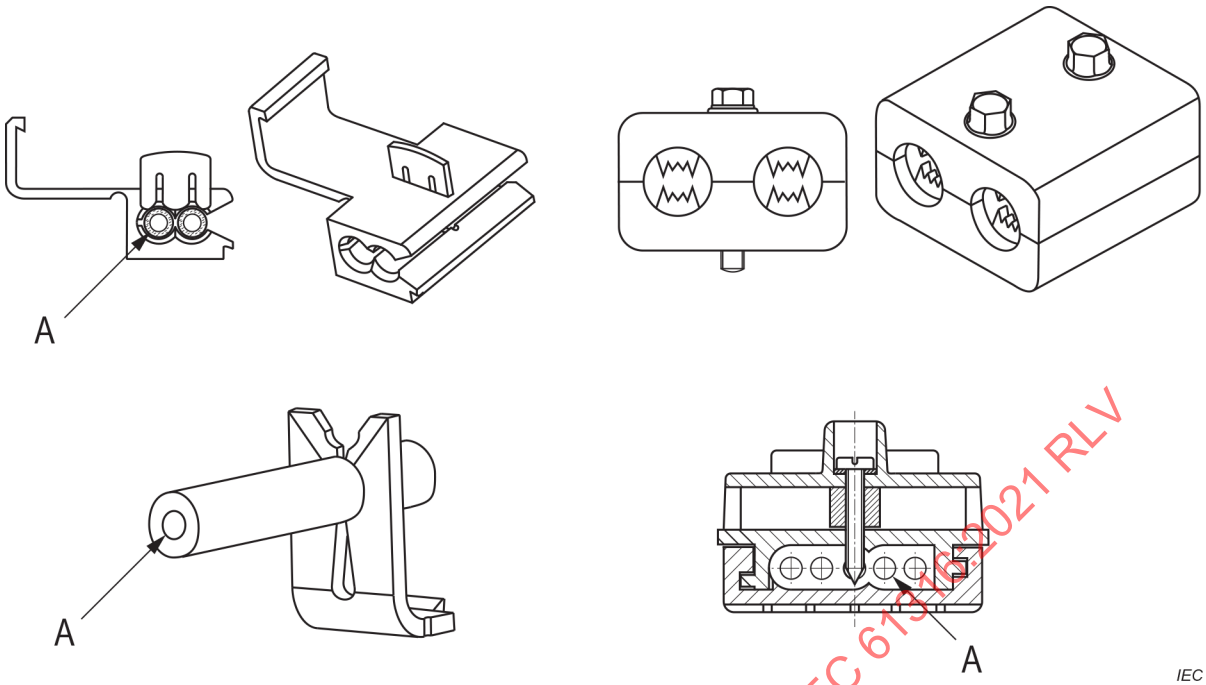


Figure 7 – Bornes sans vis

3.20.8
borne à perçage d'isolant
BPI
borne pour la connexion et la déconnexion d'un ou de plusieurs conducteurs, le raccordement étant réalisée par perçage, perforation, coupure, enlèvement ou déplacement, ou en rendant inopérante de toute une autre façon l'isolation du ou des conducteurs sans dénudage préalable

Note 1 à l'article: L'enlèvement de la gaine du câble, si nécessaire, n'est pas considéré comme un dénudage préalable.

Note 2 à l'article: Des exemples de BPI sont donnés à la Figure 8.



Légende

A Conducteur

Figure 8 – Bornes à perçage d'isolant

3.21
élément de serrage
partie(s) de la borne nécessaire(s) pour le serrage mécanique et la connexion électrique du (des) conducteur(s), y compris les parties nécessaires pour assurer une pression de contact correcte

3.22
dispositif de connexion
dispositif destiné au raccordement électrique d'un ou plusieurs conducteurs, soit fixé à une embase, soit faisant corps avec l'équipement

4 Exigences générales

4.1 Les enrouleurs de câble industriels doivent être conçus et construits de telle façon qu'en usage normal, leurs performances soient fiables, et que la sécurité soit obtenue en réduisant les risques jusqu'à un niveau raisonnable, comme défini dans le Guide ISO/IEC 51.

Sauf spécification contraire, l'environnement d'usage normal au sein duquel les enrouleurs de câble conformes au présent document sont habituellement utilisés est le degré de pollution 3 conformément à l'IEC 60664-1.

Si d'autres degrés de pollution sont nécessaires, les lignes de fuite et les distances d'isolement doivent être conformes à l'IEC 60664-1. La valeur de l'indice de résistance au cheminement (IRC) doit être évaluée conformément à l'IEC 60112. L'essai et les exigences sont spécifiés en 21.3.

Les enrouleurs de câble doivent avoir un degré de protection minimal IP24D (voir 6.3) conformément à l'IEC 60529.

En général, la conformité est vérifiée en faisant tous les essais prescrits.

4.2 Sauf spécification contraire, un échantillon est soumis à tous les essais et les exigences sont satisfaites si tous les essais sont réussis. L'échantillon est soumis à l'essai en l'état de livraison et dans des conditions normales d'utilisation, à une température ambiante de (20 ± 5) °C. Les essais sont effectués en suivant l'ordre des articles du présent document.

4.3 Si l'échantillon ne satisfait pas à un essai à cause d'un défaut d'assemblage ou de fabrication, qui n'est pas représentatif de la conception, cet essai et ceux qui l'ont précédé et qui peuvent avoir influencé les résultats de cet essai doivent être répétés dans l'ordre exigé. Les essais qui suivent doivent être réalisés sur un autre échantillon, qui doit satisfaire aux exigences du présent document.

5 Caractéristiques normalisées

Le courant nominal ne doit pas dépasser le courant nominal maximal de la fiche, du socle de connecteur ou du socle de prise de courant.

Les courants nominaux préférentiels sont donnés dans le Tableau 1.

Tableau 1 – Courants nominaux préférentiels

Série I	Série II
A	A
16	20
32	30
63	60

NOTE 1 Les "caractéristiques nominales préférentielles" n'excluent pas d'autres caractéristiques nominales.

NOTE 2 Ce tableau ne donne pas de correspondance entre les valeurs des séries I et II.

La conformité est vérifiée par examen du marquage.

6 Classification

6.1 Les enrouleurs de câble sont classés selon le type de construction:

– enrouleurs de câble mobiles;
– enrouleurs de câble fixes.

6.2 Les enrouleurs de câble sont classés selon la méthode d'enroulement du câble souple:

– enrouleurs de câble manuels;
– enrouleurs de câble à ressort;
– enrouleurs de câble à moteur.

6.3 Les enrouleurs de câble sont classés selon le degré de protection conformément à l'IEC 60529:

– le degré minimal de protection doit être IP24D.

6.4 Les enrouleurs de câble sont classés selon leur protection contre les températures excessives:

– enrouleurs de câble comportant des coupe-circuit thermiques;
– enrouleurs de câble comportant des limiteurs de courant;

– enrouleurs de câble comportant à la fois des coupe-circuit thermiques et à limitation de courant.

6.5 Les enrouleurs de câble sont classés selon la méthode de raccordement du câble souple:

– enrouleurs de câble démontables;
– enrouleurs de câble non démontables.

6.6 Les enrouleurs de câble sont classés selon le matériau du tambour:

– enrouleurs de câble à tambour en matériaux isolants;
– enrouleurs de câble à tambour en autres matériaux.

6.7 Les enrouleurs de câble sont classés selon le type de conducteurs pour bornes sans vis et bornes à perçage d'isolant, le cas échéant:

– pour les conducteurs massifs uniquement;
– pour les conducteurs rigides (massifs et câblés) uniquement;
– pour les conducteurs souples uniquement;
– pour les conducteurs rigides (massifs et câblés) et souples.

7 Marquage et indications

7.1 Les enrouleurs de câble doivent porter les indications suivantes:

– le ou les courant(s) nominal(aux) en ampères;
– la ou les tension(s) nominale(s) d'emploi ou la ou les plage(s) de tension en volts;
– le symbole pour la nature du courant;
– le nom ou la marque commerciale du fabricant ou du vendeur responsable;
– la référence du type, qui peut être un numéro de catalogue;
– le degré de protection selon l'IEC 60529;
– la charge maximale qui peut être connectée à l'enrouleur de câble, dans les conditions totalement enroulées et totalement déroulées.

EXEMPLE: 1 000 W 400 V câble complètement enroulé 
3 500 W 400 V câble complètement déroulé

7.2 Lorsqu'il est fait usage de symboles, ils doivent être comme suit:

A	pour ampères	
V	pour volts	
Hz	pour hertz	
W	pour watts	
	pour courant alternatif	IEC 60417-5032 (2002-10)
	pour courant continu	IEC 60417-5031 (2002-10)
	pour terre	IEC 60417-5019 (2006-08)
IPXXD*	degrés de protection	
	enrouleur de câble complètement enroulé	
	enrouleur de câble complètement déroulé	

* Pour les codes IP, les deux chiffres caractéristiques (XX) doivent être indiqués. La lettre D supplémentaire ne doit pas être marquée si le premier chiffre caractéristique est 4 ou supérieur à 4.

Pour l'indication du ou des courants nominal(aux), de la ou des tensions nominales d'emploi, ou de la ou des plages de tension, les chiffres peuvent être employés seuls. Le nombre indiquant la tension nominale d'emploi en courant continu, s'il y a lieu, doit alors être placé avant le nombre indiquant la tension nominale d'emploi en courant alternatif et séparé de celui-ci par une ligne ou un tiret.

La conformité est vérifiée par examen.

7.3 Les enrouleurs de câble doivent être marqués avec des instructions spécifiant clairement comment réarmer le(s) coupe-circuit thermique(s) et/ou à limitation de courant.

La conformité est vérifiée par examen.

7.4 Si des plaques signalétiques ou des étiquettes sont utilisées, elles doivent être fixées de manière fiable. Après tous les essais du présent document, le marquage doit être parfaitement lisible à la vision normale ou corrigée, sans grossissement supplémentaire, et les étiquettes ne doivent présenter aucun décollement ou enroulement dans les coins ou les bordures.

La conformité est vérifiée par examen.

7.5 Le marquage doit être parfaitement lisible.

La conformité est vérifiée par examen, à la vision normale ou corrigée, sans grossissement supplémentaire.

Le marquage doit être durable et indélébile.

La conformité est vérifiée par l'essai suivant devant être effectué après l'épreuve hygroscopique de l'Article 14.

Le marquage laser directement sur le produit et le marquage obtenu par moulage, compression ou gravure sont considérés comme durables et indélébiles et ne sont pas soumis à cet essai.

L'essai est réalisé en frottant le marquage pendant 15 s avec un chiffon imbibé d'eau et à nouveau pendant 15 s avec un chiffon imbibé de n-Hexane 95 % (numéro de registre CAS: 110-54-3).

NOTE Le n-Hexane 95 % (numéro de registre CAS: 110-54-3) est disponible auprès d'une multitude de fournisseurs de substances chimiques en tant que solvant pour chromatographie liquide sous haute pression (HPLC).

Lors de l'utilisation du liquide spécifié pour l'essai, les précautions énoncées dans la fiche de sécurité du matériau fournie par le fournisseur de substances chimiques doivent être respectées pour protéger les techniciens de laboratoire.

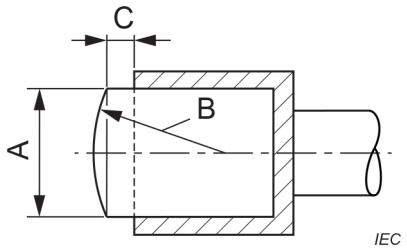
La surface de marquage soumise à l'essai doit être séchée après l'essai avec l'eau.

Le frottement doit débuter juste après le trempage du chiffon, en appliquant une force de A compression de (5 ± 1) N à une vitesse d'environ un cycle par seconde (un cycle comprend un mouvement de va-et-vient sur la longueur du marquage). Pour les marquages dépassant 20 mm, le frottement peut être limité à l'une de ses parties, sur une distance d'au moins 20 mm.

La force de compression est appliquée par un piston d'essai enveloppé avec du coton composé d'un coton hydrophile recouvert d'une gaze à usage médical en coton.

Le piston d'essai doit avoir les dimensions spécifiées à la Figure 9 et doit être constitué d'une matière élastique insensible aux liquides d'essai et disposer d'une dureté Shore-A de 47 ± 5 (le caoutchouc synthétique par exemple).

Lorsqu'il est impossible d'effectuer l'essai sur les spécimens du fait de la forme/taille du produit, une partie appropriée disposant des mêmes caractéristiques que le produit peut être soumise à l'essai.



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

Figure 9 – Piston d'essai

8 Dimensions

La surface sur laquelle le câble est enroulé doit être d'au moins huit fois le diamètre maximal du câble comme indiqué dans l'IEC 60245-4, selon le cas.

Pour les enrouleurs de câble qui utilisent des câbles plats, la surface sur laquelle le câble est enroulé doit avoir un diamètre d'au moins 10 fois la moyenne des dimensions inférieure et supérieure du câble.

9 Protection contre les chocs électriques

9.1 Les enrouleurs de câble doivent être conçus de telle sorte que les parties actives ne soient pas accessibles quand l'enrouleur de câble est utilisé normalement et quand les parties démontables sans l'aide d'un outil ont été enlevées.

La conformité est vérifiée par examen et, si nécessaire, par les essais décrits en 9.2 et 9.3.

Ces essais doivent être réalisés immédiatement après que l'enrouleur de câble a été parcouru par un courant correspondant à la charge maximale en position complètement enroulé, pendant 1 h à une température ambiante de (20 ± 5) °C.

9.2 *Le doigt d'épreuve normalisé, conformément à l'IEC 61032, Calibre d'essai B est appliqué avec une force de (10 ± 1) N dans toutes les positions possibles; un indicateur électrique, ayant une tension comprise entre 40 V et 50 V, est utilisé pour indiquer s'il y a contact avec la partie concernée.*

Pour les enrouleurs de câble pour lesquels l'utilisation d'un matériau élastomère ou thermoplastique est susceptible d'influencer la satisfaction à l'exigence, l'essai est répété à une température ambiante de (35 ± 2) °C, l'enrouleur de câble étant à cette température.

Pendant cet essai complémentaire, les parties en matériaux élastomères ou thermoplastiques de l'enrouleur de câble sont soumises pendant 1 min à une force de 75 N appliquée par l'extrémité d'un doigt d'épreuve droit non articulé de mêmes dimensions que le doigt d'épreuve

normalisé. Ce doigt comportant un indicateur électrique comme décrit ci-dessus est appliqué à tous les endroits où l'affaissement du matériau isolant pourrait diminuer la sécurité de l'enrouleur de câble.

Pendant cet essai, l'enrouleur de câble ne doit pas se déformer au point que les dimensions qui assurent la sécurité soient altérées exagérément et aucune partie active ne doit être accessible.

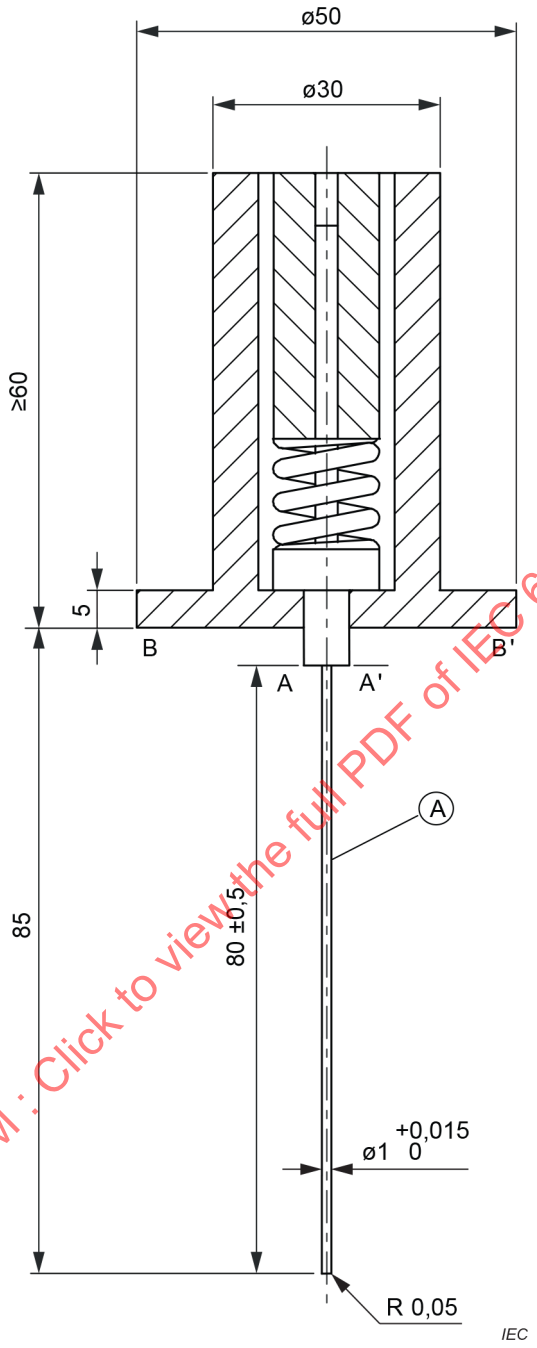
9.3 *L'essai est effectué avec un fil d'acier rigide de (1 ± 0,015) mm comme représenté à la Figure 10, appliqué avec une force de* $(1^{+0,1}_{0})$ *N. L'extrémité du fil doit être sans bavures et perpendiculaire à son axe.*

Cet essai ne s'applique pas aux fiches, aux socles de connecteur et aux socles de prise de courant fixés sur l'enrouleur de câble, le cas échéant.

Le fil d'essai est équipé d'un indicateur électrique ayant une tension comprise entre 40 V et 50 V pour indiquer un contact avec la partie correspondante.

La protection est satisfaisante si le fil ne peut pas pénétrer dans l'enveloppe, ou s'il entre, s'il ne touche aucune partie active à l'intérieur de l'enveloppe.

Dimensions en millimètres



Légende

A Fil d'acier rigide

Pour étalonner le calibre, une force de poussée de 1 N est appliquée au fil d'acier rigide dans le sens de son axe: les caractéristiques du ressort interne du calibre doivent être telles que la surface A-A' est portée pratiquement au même niveau que la surface B-B' lorsque cette force est appliquée.

Figure 10 – Calibre standard de 1 mm

9.4 Les parties qui assurent la protection contre les chocs électriques doivent avoir une résistance mécanique suffisante et doivent être fixées de façon sûre au moyen de vis, ou de tout autre moyen similaire sûr, de telle sorte qu'elles ne puissent pas se desserrer en usage normal.

La conformité est vérifiée par examen et par les essais décrits à l'Article 19 et à l'Article 20.

10 Dispositions en vue de la mise à la terre

10.1 Parties métalliques accessibles

Pour les enrouleurs de câble démontables comportant des parties métalliques accessibles isolées des parties actives par l'isolation principale seulement:

– la borne de terre doit satisfaire aux exigences décrites de l'Article 11;

– la borne de terre doit être située à proximité des bornes des conducteurs transportant le courant;

– les connexions internes, entre la borne de terre et les parties métalliques accessibles, doivent être indépendantes de la connexion du câble souple afin d'éviter que les connexions internes ne se desserrent pendant le remplacement du câble souple;

– quand les bornes des conducteurs sous tension sont accessibles, aucun démontage supplémentaire ne doit être nécessaire pour atteindre la borne de terre. De plus, la borne de terre ne doit pas être à plus de 50 mm de distance des autres bornes.

10.2 Résistance à la corrosion de la borne de terre

Toutes les parties de la borne de terre doivent être telles qu'il n'y ait pas de risque de corrosion résultant du contact entre ces parties et le cuivre du conducteur de terre ou toute autre pièce métallique qui est en contact avec ces parties.

Le corps de la borne de terre doit être en laiton ou en tout autre métal au moins aussi résistant à la corrosion, à moins qu'il ne constitue une partie du bâti métallique ou l'enveloppe, auquel cas la vis ou l'écrou doivent être en laiton, acier plaqué comme indiqué à l'Article 23 ou tout autre métal au moins aussi résistant à la corrosion.

10.3 Résistance à la corrosion des vis et des écrous

Les vis et écrous en acier revêtu, résistants aux essais de l'Article 20, sont considérés comme étant d'un métal aussi résistant à la corrosion que le laiton.

La conformité aux exigences de 10.1 à 10.3 est vérifiée par examen.

10.4 Liaisons équipotentielles

10.4.1 Les parties métalliques accessibles qui pourraient devenir actives dans l'éventualité d'un défaut d'isolation doivent être connectées de façon permanente et fiable à la borne de terre ou à la terminaison.

Au sens du présent document, les vis et organes équivalents destinés à la fixation des bases et des couvercles ne sont pas considérés comme des parties pouvant devenir actives dans l'éventualité d'un défaut d'isolation.

Si des parties métalliques accessibles sont masquées par rapport aux parties actives par des parties métalliques qui sont connectées à la terminaison ou à la borne de terre, ou si elles sont séparées des parties actives par une double isolation ou une isolation renforcée, elles ne sont pas, au sens de la présente exigence, considérées comme étant susceptibles de devenir actives dans l'éventualité d'un défaut d'isolation.

La conformité est vérifiée par examen et par l'essai suivant:

Un courant de 25 A fourni par une source à courant alternatif dont la tension à vide ne dépasse pas 12 V parcourt le circuit compris entre la borne de terre et chacune des parties métalliques l'une après l'autre.

La chute de tension entre la borne de terre et la partie métallique est mesurée, et la résistance calculée à partir du courant et de la chute de tension.

En aucun cas la résistance ne doit dépasser 0,05 Ω.

Des précautions doivent être prises pour que la résistance de contact entre la sonde de mesure et la partie métallique à l'essai n'influence pas les résultats de l'essai.

10.4.2 La connexion de terre doit être assurée de façon sûre dans toutes les conditions qui peuvent se produire en usage normal, y compris lorsque les vis de fixation du couvercle sont desserrées ou que le couvercle est mal monté.

La conformité est vérifiée par examen.

10.4.3 Les bornes de terre destinées à la connexion de conducteurs souples externes doivent être conçues avec un logement assez grand pour permettre de donner du mou au conducteur de terre, de telle sorte qu'en cas de défaut du dispositif d'arrêt du câble, la connexion du conducteur de terre ne soit soumise à une traction qu'après la connexion des conducteurs transportant le courant, et qu'en cas de traction excessive, le conducteur de terre ne se casse qu'après la rupture des conducteurs transportant le courant.

La conformité est vérifiée avec l'essai suivant:

Le câble souple est raccordé à l'enrouleur de câble de telle sorte que les conducteurs transportant le courant suivent, entre l'amarrage et les bornes, la plus courte distance possible. Après raccordement correct des conducteurs, l'âme du conducteur de terre est positionnée dans sa borne, coupée à une longueur supérieure de 8 mm à celle qui serait nécessaire pour son raccordement correct.

Le conducteur de terre est ensuite raccordé à sa borne. Il doit être possible de loger la boucle qui est formée par le conducteur de protection, compte tenu de son surplus de longueur, librement dans l'espace pour câblage sans serrer ou presser le conducteur quand le couvercle de l'enrouleur est remonté et fixé correctement.

10.5 Circuit interne de terre

Dans les enrouleurs de câble, le circuit interne de terre comprenant tous les joints, contacts ou autres, doit avoir une faible résistance électrique.

La conformité est vérifiée par la mesure suivante qui est effectuée après l'essai indiqué à l'Article 19.

Un courant, fourni par une source à courant alternatif dont la tension à vide ne dépasse pas 12 V, et d'intensité égale à la plus grande des deux valeurs suivantes: soit 1,5 fois le courant nominal du câble, soit 25 A, parcourt le circuit de terre.

La chute de tension est mesurée, et la résistance est calculée à partir du courant et de cette chute de tension.

En aucun cas la résistance ne doit dépasser 0,05 Ω.

10.6 Connexions de terre internes mobiles et bagues à friction

10.6.1 Deux connexions de terre mobiles, différentes et indépendantes, doivent être fournies entre la borne pour le conducteur de terre du câble entrant et la borne de terre pour le câble sortant ou celle du socle de prise de courant. Une de ces connexions doit être une bague à friction ou un contact d'une efficacité équivalente, alors que l'autre connexion peut être un palier à bille, une bague à friction, un palier lisse, ou autre s'il est métallique.

La conformité est vérifiée par examen.

10.6.2 La connexion de terre mobile, entre la borne pour le conducteur de terre du câble entrant et les parties métalliques accessibles de l'enrouleur, doit être doublée, chaque connexion pouvant être un palier à bille, ou un palier lisse, ou autre s'il est métallique.

La conformité est vérifiée par examen.

11 Bornes et terminaisons

11.1 Exigences communes pour les bornes et les terminaisons

11.1.1 Les enrouleurs de câble démontables doivent être équipés de bornes où le raccordement est fait au moyen de vis, écrous ou autres moyens aussi efficaces.

11.1.2 Les enrouleurs de câble non démontables doivent être équipés de raccordements à souder, à braser, à sertir, ou de tout autre moyen de connexion permanente aussi efficace.

Les raccordements effectués par sertissage d'un conducteur souple présoudé ne sont pas permis sauf si la zone de soudage est en dehors de la zone de sertissage.

Les enrouleurs de câble non démontables ne doivent pas être équipés de connexions à vis ou à pression.

La conformité est vérifiée par examen.

11.1.3 Les bornes doivent permettre le raccordement de conducteurs sans préparation particulière.

Cette exigence ne s'applique pas aux bornes pour cosses et barres.

NOTE Le terme "préparation particulière" couvre la soudure des brins du conducteur, l'utilisation d'embouts, etc., mais pas la mise en forme du conducteur avant son introduction dans la borne ou la torsade des brins des conducteurs souples pour en consolider l'extrémité.

La conformité est vérifiée par examen.

11.1.4 Les parties des bornes et des terminaisons autres que les vis, les écrous, les rondelles, les étriers, les plaques de serrage et les autres parties semblables, doivent être d'un métal ayant, dans les conditions de l'équipement, une force mécanique, une conduction électrique et une résistance à la corrosion adéquates pour l'utilisation prévue.

Des exemples de métaux appropriés, lorsqu'ils sont utilisés dans les limites permises de température et dans des conditions normales de pollution chimique, sont:

– le cuivre;
– un alliage contenant au moins 58 % de cuivre pour les pièces travaillées à froid ou au moins 50 % de cuivre pour les autres pièces;
– l'acier inoxydable contenant au moins 13 % de chrome et pas plus de 0,09 % de carbone;
– l'acier recouvert d'un revêtement électrolytique de zinc conforme à l'ISO 2081, revêtement ayant une épaisseur d'au moins:
  - 8 µm (condition de service ISO 2) pour les enrouleurs de câble IP ≤ X4;
  - 12 µm (condition de service ISO 3) pour les enrouleurs de câble IP ≥ X5;

– l'acier recouvert d'un revêtement électrolytique de nickel et de chrome conformément à l'ISO 1456, le revêtement ayant une épaisseur au moins égale à celle spécifiée:
  - 20 µm (condition de service ISO 2) pour les enrouleurs de câble IP < X4;
  - 30 µm (condition de service ISO 3) pour les enrouleurs de câble IP > X5;
– acier disposant d'un revêtement électrolytique d'étain conforme à l'ISO 2093, revêtement ayant une épaisseur d'au moins:
  - 20 µm (condition de service ISO 2) pour les enrouleurs de câble IP < X4;
  - 30 µm (condition de service ISO 3) pour les enrouleurs de câble IP > X5;

NOTE Les valeurs données sont des valeurs nominales.

– d'autres métaux aussi résistants à la corrosion que le cuivre et disposant de propriétés mécaniques aussi appropriées doivent faire l'objet d'une recherche.

Les parties des bornes et des terminaisons autres que les vis, les écrous, les rondelles, les étriers, les plaques de serrage et les autres parties semblables pouvant être soumises à l'usure mécanique ne doivent pas être constituées d'acier avec revêtement électrolytique.

La conformité est vérifiée par examen et par une analyse chimique.

11.1.5 Si le corps d'une borne de terre ne fait pas partie intégrante de l'armature ou de l'enveloppe métallique de l'enrouleur de câble, le corps doit être en l'une des matières spécifiées en 11.1.4 pour les parties des bornes. Si le corps fait partie intégrante de l'armature ou de l'enveloppe métallique, le moyen de serrage doit être en une de ces matières.

Si le corps de la borne de terre fait partie intégrante d'une armature ou d'une enveloppe en aluminium ou en alliage d'aluminium, des dispositions doivent être prises pour éliminer le risque de corrosion résultant du contact entre le cuivre et l'aluminium ou ses alliages.

NOTE L'exigence visant à éliminer le risque de corrosion n'exclut pas l'emploi de vis ou écrous en métal convenablement protégé.

La conformité est vérifiée par examen et par une analyse chimique.

11.1.6 Les bornes et les terminaisons doivent être fixées correctement sur l'enrouleur de câble et ne doivent pas prendre de jeu lors de la connexion ou de la déconnexion des conducteurs.

Les bornes et les terminaisons doivent être protégées contre les rotations.

Les moyens de serrage ne doivent pas servir à fixer d'autres composants.

Le moyen de serrage du conducteur peut être utilisé pour arrêter la rotation ou le déplacement.

La conformité est vérifiée par examen et, si nécessaire, par l'essai décrit en 20.2.

Ces exigences n'excluent pas les bornes flottantes ni les bornes conçues de façon que la rotation ou le déplacement de la borne soit empêché par la vis ou l'écrou de serrage, pourvu que leur mobilité soit limitée de façon appropriée et ne nuise pas au bon fonctionnement de l'enrouleur de câble.

Les bornes peuvent être protégées contre le desserrage par fixation à l'aide de deux vis, par fixation à l'aide d'une vis dans un logement de façon qu'il n'y ait pas de jeu significatif, ou par un autre dispositif approprié.

Le fait de les recouvrir d'une matière de remplissage sans autre moyen de blocage n'est pas considéré comme étant suffisant. Des résines durcissant à l'air peuvent cependant être utilisées

pour bloquer des bornes ou des terminaisons qui ne sont pas soumises à des efforts de torsion en usage normal.

11.1.7 Chaque borne doit être placée à proximité des autres bornes et de la borne de terre interne éventuelle, sauf raison technique valable pour qu'il n'en soit pas ainsi.

La conformité est vérifiée par examen.

11.1.8 Les bornes doivent être placées ou abritées de façon que:

– des vis ou autres pièces se détachant des bornes ne puissent établir une connexion électrique quelconque entre des parties actives et des parties métalliques reliées à la borne de terre;
– des conducteurs se détachant des bornes actives ne puissent toucher des parties métalliques reliées à la borne de terre;
– des conducteurs se détachant de la borne de terre ne puissent toucher des parties actives.

La conformité est vérifiée par examen et par un essai à la main.

11.1.9 Après raccordement correct des conducteurs, il ne doit pas y avoir de risque de contact accidentel entre des parties actives de polarités différentes ou entre de telles parties et des parties métalliques accessibles, et si un brin d'un conducteur câblé vient à se détacher d'une borne, il ne doit pas y avoir de risque de voir des brins sortir de l'enveloppe.

L'exigence concernant le risque de contact accidentel entre des parties actives et des parties métalliques accessibles ne s'applique pas aux enrouleurs de câble dont les tensions nominales d'emploi ne dépassent pas 50 V.

La conformité est vérifiée par examen et, en ce qui concerne le risque de contact accidentel entre des parties actives et d'autres parties métalliques, par l'essai qui suit:

L'extrémité d'un conducteur souple dont la section nominale spécifiée dans le Tableau 8 est dépouillée de son enveloppe isolante sur une longueur de 8 mm. Un brin du conducteur est décâblé et les autres brins sont introduits complètement et serrés dans la borne. Le brin décâblé est plié, sans déchirer l'enveloppe isolante, dans toutes les directions possibles, mais sans angles vifs le long des cloisons.

Le brin décâblé d'un conducteur relié à une borne active ne doit toucher aucune partie métallique qui n'est pas une partie active, ni sortir de l'enveloppe. Le brin décâblé d'un conducteur relié à la borne de terre ne doit toucher aucune partie active.

Si nécessaire, l'essai est répété, le brin décâblé étant dans une autre position.

11.2 Bornes à vis

11.2.1 Les bornes à vis doivent permettre le raccordement adéquat de conducteurs en cuivre ou alliage de cuivre ayant la section nominale indiquée dans le Tableau 8.

Pour les bornes autres que les bornes pour cosses et barres, la conformité est vérifiée par l'essai qui suit et par ceux de 11.5.

Les calibres spécifiés à la Figure 11, ayant une section de mesure pour soumettre à essai l'insérabilité de la section maximale spécifiée dans le Tableau 8, doivent pouvoir pénétrer dans les ouvertures des bornes sous leur propre poids jusqu'à la profondeur prévue de la borne.

Les bornes à vis qui ne peuvent pas être vérifiées par les calibres spécifiés à la Figure 11 doivent être soumises à l'essai au moyen de calibres de forme spécialement adaptée ayant les mêmes sections que celles des calibres appropriés donnés à la Figure 11.

Pour les bornes à trou dans lesquelles l'extrémité du conducteur n'est pas visible, le trou destiné à recevoir le conducteur doit avoir une profondeur telle que la distance entre le fond du trou et la dernière vis soit au moins égale à la moitié du diamètre de la vis et en aucun cas inférieure à 1,5 mm.

La conformité est vérifiée par examen.

11.2.2 Les bornes à vis doivent avoir une résistance mécanique appropriée.

Les vis et écrous pour le serrage doivent avoir un filetage ISO ou un filetage comparable en pas et en résistance mécanique.

NOTE Les filetages SI, BA et UN sont considérés comme comparables en pas et en résistance mécanique.

La conformité est vérifiée par examen, par des mesures et par l'essai décrit en 20.2. En plus des exigences de 20.2, les bornes ne doivent pas, après les essais, avoir subi de changements qui nuiraient à leur emploi ultérieur.

11.2.3 Les bornes à vis doivent être conçues de façon que le conducteur soit serré entre des surfaces métalliques avec une pression de contact suffisante, sans dommage pour le conducteur.

La conformité est vérifiée par examen.

11.2.4 Les bornes pour cosses et barres doivent être réservées aux enrouleurs de câble dont le courant nominal est d'au moins 60 A. Si de telles bornes sont fournies, elles doivent posséder des rondelles élastiques ou de moyens de blocage aussi efficace.

La conformité est vérifiée par examen.

11.2.5 Les vis ou écrous de serrage des bornes de terre doivent être protégés efficacement contre un desserrage accidentel et il ne doit pas être possible de les desserrer sans l'aide d'un outil.

La conformité est vérifiée par examen et par un essai à la main.