

# INTERNATIONAL STANDARD



**Switches for household and similar fixed electrical installations –  
Part 1: General requirements**

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# INTERNATIONAL STANDARD



**Switches for household and similar fixed electrical installations –  
Part 1: General requirements**

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

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International Standard IEC 60669-1 has been prepared by subcommittee 23B: Plugs, socket-outlets and switches, of IEC technical committee 23:

This fourth edition cancels and replaces the third edition published in 1998, Amendment 1:1999 and Amendment 2:2006. This edition constitutes a technical revision.

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

- a) change of the scope for motor load switches;
- b) deletion of some dated normative references;
- c) changes to the definitions;
- d) in Clause 5 the number of specimens to be used for the tests are clearly given in Table 1 (Corresponding Annex A of IEC 60669-1:1998 was therefore deleted);
- e) in Clause 5 it was clarified on which switches the tests of Clause 19 shall be carried out;
- f) requirements concerning 13 A switches have been included;
- g) mandatory indication that a terminal is suitable for rigid conductor only;
- h) requirements and test conditions for flexible conductors have been included in Clause 12;
- i) requirements for pilot light units have been included;
- j) new test for self-ballasted lamp loads in 19.3;
- k) Table 20 has been completely redrawn to cover normal, mini and micro-gap switches and renumbered Table 23;
- l) new informative Annex B including changes planned for the future in order to align IEC 60669-1 with the requirements of IEC 60998 (all parts), IEC 60999 (all parts) and IEC 60228;
- m) new informative Annex C about the circuit development for 19.3;
- n) new informative Annex D including additional requirements for insulation-piercing terminals;
- o) new informative Annex E including additional requirements and tests for switches intended to be used at a temperature lower than  $-5^{\circ}\text{C}$ .

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

| FDIS          | Report on voting |
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| 23B/1235/FDIS | 23B/1241/RVD     |

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

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A list of all parts in the IEC 60669 series, published under the general title *Switches for household and similar fixed electrical installations*, can be found on the IEC website.

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

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The contents of the corrigendum of January 2020 have been included in this copy.

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# SWITCHES FOR HOUSEHOLD AND SIMILAR FIXED ELECTRICAL INSTALLATIONS –

## Part 1: General requirements

### 1 Scope

This part of IEC 60669 applies to manually operated general purpose functional switches, for alternating current (AC) only with a rated voltage not exceeding 440 V with a rated current not exceeding 63 A, intended for household and similar fixed electrical installations, either indoors or outdoors.

For switches provided with screwless terminals, the rated current is limited to 16 A.

NOTE 1 ~~An extension of the scope to switches for rated voltages higher than 440 V is under consideration.~~ The rated current is limited to 16 A for switches provided with insulation piercing terminals (IPT's) according to Annex D.

Switches covered by this document are, where applicable, intended for the control in normal use of all of the following loads:

- a circuit for a tungsten filament lamp load;
- a circuit for an externally ballasted lamp load (for example LED, CFL, fluorescent lamp load);
- a circuit for a self ballasted lamp load (for example LEDi or CFLi);
- a circuit for a substantially resistive load with a power factor not less than 0,95;
- a single phase circuit for motor load with a rated current not exceeding 3 A at 250 V (750 VA) and 4,5 A at 120 V (540 VA) and a power factor not less than 0,6. This applies to both switches rated not less than 10 A that have not undergone additional tests and to momentary switches rated not less than 6 A that have not undergone additional tests.

NOTE 2 In the following country the suitability of a switch intended to control the inrush current of a motor shall be tested: AU.

This document also applies to boxes for switches, with the exception of mounting boxes for flush-type switches.

NOTE 3 ~~In this standard specific requirements are given for boxes, while~~ General requirements for boxes for ~~ordinary~~\* flush-type switches are given in IEC 60670-1.

It also applies to switches such as:

- switches incorporating pilot lights;
- electromagnetic remote control switches (particular requirements are given in ~~part 2~~ IEC 60669-2-2);
- switches incorporating a time-delay device (particular requirements are given in ~~part 2~~ IEC 60669-2-3);
- combinations of switches and other functions (with the exception of switches combined with fuses);
- electronic switches (particular requirements are given in ~~part 2~~ IEC 60669-2-1);
- switches having facilities for the outlet and retention of flexible cables (see Annex A);

\* ~~See note 1 to 7.1.4.~~



- isolating switches (particular requirements are given in IEC 60669-2-4);
- switches and related accessories for use in home and building electronic systems (particular requirements are given in IEC 60669-2-5);
- firemen's switches (particular requirements are given in IEC 60669-2-6).

~~NOTE 3 — The minimum length of the flexible cable used with these switches may be governed by National Wiring Rules.~~

Switches complying with this document are suitable for use at ambient temperatures not normally exceeding +25 °C, but ~~occasionally reaching~~ their average over a period of 24 h does not exceed +35 °C, with a lower limit of the ambient air temperature of –5 °C.

~~NOTE 4 Additional requirements for flush-type non-ordinary switches are under consideration.~~ For lower temperatures see Annex E.

~~NOTE 5~~ Switches complying with this document are suitable only for incorporation in equipment in such a way and in such a place that it is unlikely that the surrounding ambient temperature exceeds +35 °C.

In locations where special conditions prevail, such as in ships, vehicles and the like and in hazardous locations, for example where explosions are liable to occur, special construction and/or additional requirements may be required.

~~This standard does not include requirements and tests for switches with protection against ingress of solid foreign bodies. These 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 60038:2009, *IEC standard voltages*

IEC 60068-2-75:2014, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

IEC 60112: ~~1979~~ 2009, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials* ~~under moist conditions~~

IEC 60212: ~~1974~~ 2010, *Standard conditions for use prior to and during the testing of solid electrical insulation materials*

~~IEC 60227 1:1993, Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 1: General requirements~~

~~IEC 60227 3:1993, Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 3: Non-sheathed cables for fixed wiring~~

~~IEC 60227 4:1992, Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 4: Sheathed cables for fixed wiring~~

IEC 60227-5: ~~1979~~ 2011, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 5: Flexible cables (cords)*  
*Amendment 1 (1987)*

IEC 60228:2004, *Conductors of insulated cables*

~~IEC 60245-1:1994, Rubber insulated cables – Rated voltages up to and including 450/750 V – Part 1: General requirements~~

IEC 60245-4:1994 2011, Rubber insulated cables – Rated voltages up to and including 450/750 V – Part 4: Cords and flexible cables

~~IEC 60364-4-46: 1981, Electrical installations of buildings – Part 4: Protection for safety – Chapter 46: Isolation and switching~~

IEC 60417:1973, Graphical symbols for use on equipment. ~~Index, survey and compilation of the single sheets~~ (available from: <http://www.graphical-symbols.info/equipment>)

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

IEC 60529:1989/AMD1:1999

IEC 60529:1989/AMD2:2013

IEC 60669-2-1:2002, Switches for household and similar fixed electrical installations – Part 2-1: Particular requirements – Electronic switches

IEC 60669-2-1:2002/AMD1:2008

IEC 60669-2-1:2002/AMD2:2015

~~IEC 60670:1989, General requirements for enclosures for accessories for household and similar fixed electrical installations~~

~~IEC 60695-2-1: 1991, Fire hazard testing – Part 2: Test methods – Section 1: Glow-wire test and guidance~~

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

IEC 60695-2-11:2014, Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products (GWEPT)

~~IEC 60998: Connecting devices for low voltage circuits for household and similar purposes~~

IEC 60998-1:1990 2002, Connecting devices for low voltage circuits for household and similar purposes – Part 1: General requirements

IEC 60998-2-1:1990, Connecting devices for low voltage circuits for household and similar purposes – Part 2-1: Particular requirements for connecting devices as separate entities with screw-type clamping units

IEC 60998-2-2:1991, 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 60998-2-3, Connecting devices for low-voltage circuits for household and similar purposes – Part 2-3: Particular requirements for connecting devices as separate entities with insulation-piercing clamping units

IEC 60998-2-4, Connecting devices for low-voltage circuits for household and similar purposes – Part 2-4: Particular requirements for twist-on connecting devices

~~IEC 60999-1: 1990, Connecting devices – Safety requirements for screw type and screwless-type clamping units for electrical copper conductors – Part 1: General requirements and particular requirements for conductors from 0,5 mm<sup>2</sup> up to 35 mm<sup>2</sup> (included)~~

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

ISO 1456:1988 2009, *Metallic and other inorganic coatings – Electrodeposited coatings of nickel, nickel plus chromium, copper plus nickel and of copper plus nickel plus chromium*

~~ISO 2039-2:1987, *Plastics – Determination of hardness – Part 2: Rockwell hardness*~~

ISO 2081:1986 2008, *Metallic and other inorganic coatings – Electroplated coatings of zinc with supplementary treatments on iron or steel*

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

### 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~~ are rms values unless otherwise specified.

#### 3.1

##### switch

device designed to make or break the current in one or more electric circuits

##### ~~3.1.1~~

##### ~~push-button switch~~

~~control switch having one actuator intended to be operated by force exerted by a part of human body, usually the finger or the palm of the hand, having stored energy return, for instance a spring~~

##### 3.1.1

##### on/off switch

switch for alternatively closing and opening one or more electric circuits.

[SOURCE: IEC 60050-151:2001, 151-12-23]

##### 3.1.2

##### momentary contact switch

switching device which returns its contacts automatically to the initial state after operation.

Note 1 to entry: Momentary contact switches are intended to operate, for example, bells, electromagnetic remote control switches, time-delay switches and electronic switches.

##### ~~3.1.3~~

##### ~~momentary push-button switch~~

~~push-button switch which returns automatically to the initial state after operation~~

##### 3.1.3

##### push-button switch

switch having a single actuator which moves with a single motion when operated by an external, manual force usually applied by the finger or palm of the hand and having stored energy return

### 3.1.4

#### **cord-operated switch**

switch the operating means of which is a cord which has to be pulled in order to change its contact state

### 3.1.5

#### **switch of normal-gap construction**

switch construction having a clearance between the contacts in the open position of not less than 3 mm

### 3.1.6

#### **switch of mini-gap construction**

switch construction having a clearance between the contacts which is less than 3 mm but is ~~at least~~ not less than 1,2 mm

~~NOTE — Switches of mini-gap construction are for functional purposes and they are not intended to be used for safety isolation purposes (see IEC 60364-4-46).~~

### 3.1.7

#### **switch of micro-gap construction**

switch construction having a clearance between the contacts in the open position of less than 1,2 mm

## 3.2

### **one operation**

transfer of the moving contacts from one operating position to another

## 3.3

### **terminal**

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

## 3.4

### **clamping unit**

part or parts of a terminal necessary for the mechanical clamping and the electrical connection of the conductor(s)

## 3.5

### **screw-type terminal ~~with screw clamping~~**

terminal intended for the connection, by clamping only, of (an) external rigid or flexible conductor(s)

### 3.5.1

#### **pillar terminal**

~~screw-type terminal ~~with screw clamping~~~~ in which the conductor(s) is (are) inserted into a hole or cavity, where it is clamped under the ~~end~~ shank of the screw or screws.

Note 1 to entry: The clamping pressure ~~may~~ can be applied directly by the ~~end~~ shank of the screw or through an intermediate clamping ~~member~~ part to which pressure is applied by the ~~end~~ shank of the screw.

Note 2 to entry: Examples of pillar terminals are shown in Figure 1.

[SOURCE: IEC 60050-442:1998, 442-06-22, modified — “or screws” has been added because in some constructions there is more than one screw.]

### 3.5.2

#### **screw head terminal**

~~screw-type terminal ~~with screw clamping~~~~ in which the conductor is clamped under the head of the screw.

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

**Note 2 to entry:** Examples of screw head terminals are shown in Figure 2.

### 3.5.3

#### **stud terminal**

screw-type terminal ~~with screw clamping~~ in which the conductor is clamped under a nut.

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

**Note 2 to entry:** Examples of stud terminals are shown in Figure 2.

[SOURCE: IEC 60050-442:1998, 442-06-23]

### 3.5.4

#### **saddle terminal**

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

**Note 1 to entry:** Examples of saddle terminals are shown in Figure 3.

[SOURCE: IEC 60050-442:1998, 442-06-09, modified — "screw-type" has been added.]

### 3.5.5

#### **lug terminal**

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

**Note 1 to entry:** Examples of lug terminals are shown in Figure 4.

[SOURCE: IEC 60050-442:1998, 442-06-16, modified — "screw-type terminal" is replaced with "screw head terminal or stud terminal" and "directly and indirectly" has been deleted.]

### 3.5.6

#### **mantle terminal**

screw-type terminal ~~with screw clamping~~ 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

**Note 2 to entry:** Examples of mantle terminals are shown in Figure 5.

[SOURCE: IEC 60050-442:1998, 442-06-14, modified — "screw-type" has been added and the last part of the definition is included in a note.]

### 3.6

#### **screwless-type terminal**

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

[SOURCE: IEC 60050-442:1998, 442-06-11, modified]

### 3.7

#### **thread-forming screw**

screw having an uninterrupted thread which, by screwing in, forms a thread by displacing material in the cavity

Note 1 to entry: An example of a thread-forming screw is shown in Figure 6.

[SOURCE: IEC 60050-442:1998, 442-06-04]

### 3.8

#### **thread-cutting screw**

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

Note 1 to entry: An example of a thread-cutting screw is shown in Figure 7.

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

### 3.9

#### **mechanical time-delay device**

device which, through a mechanical auxiliary, operates some time after the instant at which the conditions which cause it to operate are established

### 3.10

#### **base**

part of the switch retaining current-carrying parts and ~~in general~~, which normally retains the mechanism in position

### 3.11

#### **rated voltage**

voltage assigned ~~to the switch~~ by the manufacturer for a specific operating condition of the switch

[SOURCE: IEC 60050-442:1998, 442-01-03, modified — "accessory" has been replaced with "switch".]

### 3.12

#### **rated current**

current assigned ~~to the switch~~ by the manufacturer for a specific operating condition of the switch

[SOURCE: IEC 60050-442:1998, 442-01-02, modified — "accessory" has been replaced with "switch".]

### 3.13

#### **operating member**

part of a cord-operated switch which connects the internal mechanism with a pull cord and is usually attached to the actuating member of the switch

### 3.14

#### **pole of a switching device**

~~part of a switch associated with one conductive path (way) of its circuit provided with contacts intended to connect and disconnect the circuit itself and excluding those portions which provide a means for connecting and operating the poles together~~

portion of a switching device associated exclusively with one electrically separated conducting path of its main circuit and excluding those portions which provide a means for mounting and operating all poles together

Note 1 to entry: A switching device is called single-pole if it has only one pole. If it has more than one pole, it may be called multipole (two-pole, three-pole, etc.) provided the poles are or can be coupled in such a manner as to operate together.

[SOURCE: IEC 60050-441:2000, 441-15-01]

### 3.15

#### **actuating member**

part which is pulled, pushed, turned or otherwise moved to cause an operation of the switch

[SOURCE: IEC 60050-442:1998, 442-04-14]

### 3.16

#### **pilot light**

device incorporating a light source either integral or designed to be installed with the switch and intended to give for example an indication of the switch state or to indicate the switch location

### 3.17

#### **main part**

assembly consisting of the base and other parts which is not intended to be dismantled at any time after manufacture

### 3.18

#### **grommet**

component used to support and protect the wires or cable or conduit at the point of entry

Note 1 to entry: A grommet may also prevent the ingress of moisture or contaminants.

Note 2 to entry: Examples are shown in Figure 23.

[SOURCE: IEC 60050-581:2008, 581-27-19, modified — "part of a component or an accessory" has been replaced with "component", "or conduit" has been added and part of the definition is included in a note.]

### 3.19

#### **entry membrane**

component or integral part of the switch used to protect the wires or cable which may be used to support the cable or conduit at the point of entry

Note 1 to entry: An entry membrane may also prevent the ingress of moisture or contaminants and may be part of a grommet.

Note 2 to entry: Examples are shown in Figure 23.

### 3.20

#### **protecting membrane**

component or integral part of the switch that is not intended to be penetrated in normal use and is intended to provide protection against ingress of water or solid objects and/or to allow the operation of an accessory

Note 1 to entry: Examples are shown in Figure 23

### 3.21

#### **self ballasted lamp**

#### **SBL**

unit which cannot be dismantled without being permanently damaged, which is provided with a lamp cap or caps and which incorporates a light source and any additional elements necessary for starting and stable operation of the light source

Note 1 to entry: In the text, a self ballasted lamp is also called CFLi or LEDi, where:



- CFL stands for Compact Fluorescent Lamp;
- LED stands for Light Emitting Diode;
- “i” means that the control gear is incorporated in the lamp.

Note 2 to entry: This note applies to the French language only.

### 3.22

#### externally ballasted lamp

lamp other than an incandescent lamp which cannot be dismantled without being permanently damaged, which is provided with a lamp cap and which incorporates a light source to be controlled by a separate lamp control gear

Note 1 to entry: For lamp control gear, see definitions in IEC 61347-1.

## 4 General requirements

Switches and boxes of surface mounting accessories shall be so designed and constructed that, in normal use, their performance is reliable and ~~without danger to the user or the surroundings~~ safety is achieved by reducing risk to a tolerable level as defined in ISO/IEC Guide 51:2014.

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

## 5 General ~~notes~~ remarks on tests

*Tests according to this document are type tests.*

*Unless otherwise specified, the specimens are tested as delivered and under normal conditions of use.*

~~Flush-type switches which do not comply with any accepted standard sheet are tested together with the corresponding boxes.~~

*Switches having provision for pilot lights shall be tested with pilot lights fitted, unless otherwise stated. The results of the tests shall be considered to apply to switches of the same type which do not have provision for pilot lights.*

*Flush and semi-flush type switches shall be tested when installed in a box complying with the applicable standard sheet(s), if any. In case the switch is manufactured for a specific box, the tests shall be conducted when the switch is installed in the corresponding box as specified by the manufacturer.*

*Unless otherwise specified, the tests are carried out in the order of the clauses, at an ambient temperature between +15 °C and +35 °C.*

*In case of doubt, the tests are made at an ambient temperature of (+20 ± 5) °C.*

~~For switches which are marked with one rated voltage and one rated current, nine specimens are necessary.~~

~~Three specimens are subjected to all the relevant tests, except the tests of 19.2, where one further set of three specimens is used (or two further sets for switches of pattern number 2), and the test of clause 24, where another three specimens are used.~~

~~For the test of 24.2, three additional specimens may be required.~~



~~For the tests of 12.3.2, three additional specimens of switches are necessary.~~

~~For the tests of 12.3.11, additional specimens of switches having in total at least five screwless terminals are required.~~

~~For the tests of 12.3.12, three additional specimens of switches are necessary; in each specimen, one clamping unit is tested.~~

~~For each of the tests of 13.15.1 and 13.15.2, three additional specimens of separate membranes, or of switches incorporating membranes, are required.~~

~~For cord-operated switches, three further specimens are used for the test of 20.9.~~

~~For switches marked with two rated voltages and corresponding rated currents, fifteen specimens are necessary.~~

For each of the two combinations of rated voltages and rated currents marked on the switch, three specimens are subjected to all the relevant tests except the test of 19.2 and 19.3, where two ~~(or four for switches of pattern number 2)~~ further sets of three specimens are used.

For switches with a rated current up to and including 16 A the tests of 19.1, 19.2 and 19.3 shall be carried out.

For switches with a rated current above 16 A and up to and including 20 A the tests of 19.1 and 19.3 shall be carried out.

For switches with a rated current above 16 A and up to 20 A inclusive the test of 19.2 shall be carried out only if the manufacturer has assigned the switch with an externally ballasted lamp current rating.

For switches with a rated current above 20 A, only the tests of 19.1 shall be carried out.

A switch marked 250 V/~~380~~ 400 V is tested as a ~~380~~ 400 V switch.

Momentary contact switches ~~intended to operate bells, electromagnetic remote control switches or time-delay switches,~~ are not to be submitted to the tests of 18.3, 19.2 and 19.3.

Switches of pattern 3 and 03 are submitted to the tests of 18.3 if they have a rated voltage over 250 V, but are not to be submitted to the tests of 19.2 and 19.3.

**NOTE** The number of specimens ~~needed~~ required for the tests shall be as specified in ~~Annex A~~ Table 1.

**Table 1 – Number of specimens needed for the tests**

| Clauses and subclauses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                        | Number of specimens | Number of additional specimens for dual current rating |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|---------------------|--------------------------------------------------------|
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Ratings                                                                                                                                | A                   | JKL                                                    |
| 7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Classification                                                                                                                         | A                   |                                                        |
| 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Marking                                                                                                                                | A                   |                                                        |
| 9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Checking of dimensions                                                                                                                 | ABC                 |                                                        |
| 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Protection against electric shock                                                                                                      | ABC                 |                                                        |
| 11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Provision for earthing                                                                                                                 | ABC                 |                                                        |
| 12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Terminals <sup>a, f, l</sup>                                                                                                           | ABC                 |                                                        |
| 13                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Constructional requirements <sup>b, m</sup>                                                                                            | ABC                 |                                                        |
| 14                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Mechanism                                                                                                                              | ABC                 |                                                        |
| 15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Resistance to ageing, <del>to harmful ingress of water</del> protection provided by enclosures of switches, and resistance to humidity | ABC                 |                                                        |
| 16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Insulation resistance and electric strength <sup>c</sup>                                                                               | ABC                 |                                                        |
| 17                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Temperature rise                                                                                                                       | ABC                 | JKL                                                    |
| 18                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Making and breaking capacity                                                                                                           | ABC <sup>i</sup>    | JKL                                                    |
| 19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Normal operation <sup>a</sup>                                                                                                          | ABC <sup>i</sup>    | JKL                                                    |
| 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Mechanical strength <sup>d, g</sup>                                                                                                    | ABC                 |                                                        |
| 21                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Resistance to heat <sup>h</sup>                                                                                                        | ABC                 |                                                        |
| 22                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Screws, current-carrying parts and connections                                                                                         | ABC                 |                                                        |
| 23                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Creepage distances, clearances and distances through sealing compound                                                                  | ABC                 |                                                        |
| 19.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <del>Normal operation for fluorescent lamp circuits</del> Test for switches intended for externally ballasted lamp loads               | DEF <sup>j</sup>    | MNO                                                    |
| 19.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Test for switches intended for self ballasted lamp loads                                                                               | UVW <sup>k</sup>    | XYZ                                                    |
| 24.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Resistance to abnormal heat and to fire                                                                                                | GHI                 |                                                        |
| 24.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Resistance to tracking <sup>e</sup>                                                                                                    | GHI                 |                                                        |
| 25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Resistance to rusting                                                                                                                  | GHI                 |                                                        |
| TOTAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                        | 9 12                | 6 9                                                    |
| <p><sup>a</sup> Five extra screwless terminals are used for the test of 12.3.11 and one extra set of specimens is used for the test of 12.3.12.</p> <p><sup>b</sup> An extra set of membranes are needed for each of the tests of 13.15.1 and 13.15.2.</p> <p><del><sup>a)</sup> For switches of pattern number No. 2 one extra set of specimens are used.</del></p> <p><sup>c</sup> One extra set of specimens of switches fitted with pilot light may be used for the tests of Clause 16.</p> <p><sup>d</sup> One extra set of specimens of cord-operated switches is needed for the test of 20.10.</p> <p><sup>e</sup> One extra set of specimens may be used.</p> <p><sup>f</sup> Two extra set of specimens of terminals suitable for rigid and flexible conductors are required for 12.2.5, 12.2.6 and 12.2.7.</p> <p><sup>g</sup> One extra set of specimens is needed for the tests of 20.5.1 and 20.5.2.</p> <p><sup>h</sup> One extra set of specimens may be used for the tests of 21.2 and 21.3. In this case the specimens shall be subjected first to the tests of 15.1.</p> <p><sup>i</sup> One extra set of specimens of switches of pattern number 7 are necessary for 18 and 19.1.</p> <p><sup>j</sup> One extra set of specimens of switches of pattern number 7 are necessary for 19.2.</p> <p><sup>k</sup> One extra set of specimens of switches of pattern number 7 are necessary for 19.3.</p> <p><sup>l</sup> Number of specimens required for insulation-piercing terminals (IPTs) are shown in Table D.1</p> <p><sup>m</sup> For switches with pilot light units if the electronic circuitry is so enclosed that the short-circuiting or disconnecting of components is impossible or difficult, the manufacturer shall provide additional prepared test specimens.</p> |                                                                                                                                        |                     |                                                        |

*The specimens are submitted to all the relevant tests and comply with this document if all the requirements ~~are satisfied if~~ of all the relevant tests are met.*

If one specimen does not satisfy a test due to an assembly or a manufacturing fault, that test and any preceding one which may have influenced the results of the test shall be repeated and also the tests which follow shall be made in the required sequence on another full set of specimens, all of which shall comply with the requirements.

**NOTE**– The applicant may submit, together with a number of specimens specified in Table 1, the additional set of specimens which may be ~~wanted~~ required, should one specimen fail. The ~~testing station will~~ test laboratory should then, without further request, test additional specimens and will reject them only if a further failure occurs. If the additional set of specimens is not submitted at the same time, the failure of one specimen will ~~entail rejection~~ result in non compliance.

## 6 Ratings

### 6.1 Rated voltage

~~Switches shall preferably have~~ Preferred values of rated voltage are 130 V, 220 V, 230 V, 240 V, 250 V, 277 V, 380 V, 400 V, 415 V or 440 V.

~~For momentary contact switches intended to operate bells, electromagnetic remote control switches or time-delay switches, the standard rated voltages are 130 V and 250 V.~~

If any other voltage rating is used, it shall not be less than ~~120 V~~ that specified in IEC 60038:2009, Table 1.

### 6.2 Rated current

~~Switches shall preferably have~~ Preferred values of rated current are 6 A, 10 A, 13 A, 16 A, 20 A, 25 A, 32 A, 40 A, 45 A, 50 A or 63 A.

The rated current of switches shall not be less than 6 A, except for momentary contact switches where a rated current of 1 A, 2 A or 4 A is allowed ~~for momentary contact switches intended to operate bells, electromagnetic remote control switches or time-delay switches.~~

Switches with a rated current not exceeding 16 A, ~~except switches of pattern numbers 3 and 03 and momentary contact switches,~~ shall have ~~fluorescent~~ an externally ballasted lamp current rating equal to the rated current. This requirement does not apply to switches of pattern numbers 3 and 03 or to momentary contact switches.

~~For switches with a rated current above 16 A and up to 25 A inclusive the test with fluorescent lamps can be carried out optionally.~~

Switches with a rated current not exceeding 20 A shall be tested with self ballasted lamp (SBL) circuits as given in 19.3.

Switches which are tested according to 19.3 are capable of switching the rated power of SBL circuits according to Table 2.

**NOTE** Higher values of rated power of SBL circuits can be declared by the manufacturer according to Table 19.

**Table 2 – Relationship between rated current of the switch and rated power of the SBL circuit**

| Rated current of the switch [A] | Distribution system [V]:           | Distribution system [V]:           |
|---------------------------------|------------------------------------|------------------------------------|
|                                 | Rated power of the SBL circuit [W] | Rated power of the SBL circuit [W] |
| Up to and including 10          | 100                                | 60                                 |
| Above 10 up to and including 13 | 150                                | 60                                 |
| Above 13 up to and including 16 | 200                                | 100                                |
| Above 16 up to and including 20 | 250                                | 150                                |

Compliance with the requirements of 6.1 and 6.2 is checked by inspection of the marking.

### 6.3 Preferred combinations of number of poles and ratings

Preferred combinations of number of poles and ratings are shown in Table 3.

**Table 3 – Preferred combinations of numbers of poles and ratings**

| Rated current<br>A                   | Number of poles                                |                             |
|--------------------------------------|------------------------------------------------|-----------------------------|
|                                      | Rated voltage from<br>120 V to 250 V inclusive | Rated voltage<br>over 250 V |
| 1, 2 and 4                           | 1                                              | –                           |
| 6                                    | 1<br>2                                         | 1<br>2                      |
| 10 and 13                            | 1<br>2                                         | 1<br>2<br>3<br>4            |
| 16, 20, 25, 32, 40, 45, 50<br>and 63 | 1<br>2<br>3<br>4                               | 1<br>2<br>3<br>4            |

## 7 Classification

Switches are classified

7.1 according to the possible connections (see Figure 8):

|                                                               | Pattern number |
|---------------------------------------------------------------|----------------|
| – single-pole switches .....                                  | 1              |
| – double-pole switches .....                                  | 2              |
| – three-pole switches .....                                   | 3              |
| – three-pole plus switched neutral switches .....             | 03             |
| – two-way switches .....                                      | 6              |
| – two-circuit switches with a common incoming line .....      | 5              |
| – two-way switches with one off-position .....                | 4              |
| – two-way double-pole switches .....                          | 6/2            |
| – two-way reversing switches (or intermediate switches) ..... | 7              |

NOTE 1 Two or more switches having the same or different pattern numbers ~~may~~ can be mounted on a common base.

NOTE 2 For the pattern number for which an off-position is considered, the above classification refers also to push-button switches and momentary contact switches.

7.2 according to the contact opening:

- switches of normal-gap construction;
- switches of mini-gap construction;
- switches of micro-gap construction;
- switches without contact gap (semiconductor switching devices).

~~NOTE 1 – Switches of mini-gap construction have a distance between contacts in the open position between 3 mm and 1,2 mm.~~

~~NOTE 2 – Switches of micro-gap construction have a distance between contacts in the open position less than 1,2 mm.~~

~~NOTE 3 – Switches having a semiconductor switching device have no contact gap.~~

~~NOTE 4 – Switches according to this standard are intended for functional purposes.~~

7.3 according to the degree of protection against ~~electric shock~~ access to hazardous parts and against harmful effects due to the ingress of solid foreign objects as described in IEC 60529.

~~— unenclosed switches;~~

~~— enclosed switches.~~

~~NOTE – For unenclosed switches, the protection against electric shock is given by the enclosure in which the switch is intended to be mounted. For enclosed switches, the protection against electric shock is provided by compliance with the requirements of clause 10.~~

7.4 according to the degree of protection against harmful ~~ingress of water~~ effects due to the ingress of water as described in IEC 60529.

~~— ordinary switches, i.e. with degree of protection IPX0;~~

~~— splash-proof switches with degree of protection IPX4;~~

~~— jet-proof switches with degree of protection IPX5.~~

~~NOTE 1 — For the purpose of this standard the term "ordinary" applies only to the degree of protection against harmful ingress of water.~~

~~NOTE 2 — For an explanation of IP codes see IEC 60529.~~

**7.5** according to the method of actuating the switch:

- rotary;
- tumbler;
- rocker;
- push-button;
- cord-operated.

**7.6** according to the method of mounting the switch:

- surface-type;
- flush-type;
- semi flush-type;
- panel-type;
- architrave-type.

**7.7** according to the method of installation, as a consequence of the design of the switch:

- switches where the cover or cover plate can be removed without displacement of the conductors (design A);
- switches where the cover or cover plate cannot be removed without displacement of the conductors (design B).

NOTE If a switch has a base ~~(main part)~~ which cannot be separated from the cover or cover plate, and requires a supplementary plate to meet the standard, which can be removed for redecorating the wall without displacement of the conductors, it is considered to be of design A, provided the supplementary plate meets the requirements specified for covers and cover plates.

**7.8** according to the type of terminal:

- switches with screw-type terminals;
- switches with screwless-type terminals.

**7.9** according to the suitability to accept conductors:

- switches with ~~screwless~~ terminals for rigid conductors only;
- switches with ~~screwless~~ terminals for rigid and flexible conductors.

NOTE 1 In the following country, switches with terminals for rigid conductors only are not allowed: ES, IN and IT.

NOTE 2 In the following countries, switches with screw terminals for rigid conductors only are not allowed: DE, DK, IN and ZA.

## 8 Marking

### 8.1 General

Switches shall be marked with

a) rated current(s)

- ~~– in amperes (A) or rated fluorescent load in amperes (AX), or a combination of both if the two ratings are different (see 6.2 and examples of marking in 8.2);~~
- in amperes (A) if the switch is tested according to 19.1 only

- in amperes (A) if the switch is tested according to 19.1 and 19.3 only or
  - in amperes (AX) if the switch is tested according to 19.1, 19.2 and 19.3 when the rated currents in amperes (A) and (AX) are equal or
  - in amperes (A and AX) if the switch is tested according to 19.1, 19.2 and 19.3 when the rated currents in amperes (A) and (AX) are not equal;
- b) rated voltage(s) in volts;
- c) symbol for nature of supply;
- d) manufacturer's or responsible vendor's name, trade mark or identification mark;
- e) type reference, which may be a catalogue number;
- f) symbol for switches of mini-gap construction, if applicable;
- g) symbol for switches of micro-gap construction, if applicable;
- ~~— symbol for semiconductor switching device, if applicable;~~
- ~~— symbol for degree of protection against harmful ingress of water, if applicable.~~
- h) symbol for switches without contact gap (semiconductor switching device), if applicable;
- i) first characteristic numeral for the degree of protection against access to hazardous parts and against harmful effects due to ingress of solid foreign objects, if declared to be higher than 4 in which case the second characteristic numeral shall also be marked;
- i) second characteristic numeral for the degree of protection against harmful effects due to ingress of water, if declared to be higher than 2 in which case the first characteristic numeral shall also be marked;
- j) length of insulation to be removed before the insertion of the conductor into the screwless-type terminal;
- l) symbol for the suitability to accept rigid conductors only.

In addition the following information shall be given in the manufacturer's documentation:

- m) for SBL loads: the rated power in watts and the type of load if the switch is tested according to 19.3.

NOTE 1 Marking of the pattern number given in 7.1 ~~is recommended~~ can be made if the connections are not clear from an inspection of the switch; this pattern number may be part of the type reference.

NOTE 2 If a base carries two or more switches with separate operating devices, marking with the pattern numbers ~~is recommended~~ can be made, for example 1+6 or 1+1+1.

NOTE 3 If there is no marking on the terminals, they are suitable to accept both rigid and flexible conductors.

NOTE 4 In the following country, the marking of the type reference is not used: UK.

NOTE 5 In the following countries, the symbol that electrotechnical expertise is required (see IEC 60417-6182:2013-09) is to be placed on the packaging: DE.

~~In addition, switches with screwless terminals shall be marked with an indication of the suitability to accept rigid conductors only, for those switches having this restriction. This information may be put on the switch and/or the packaging unit.~~

## 8.2 Symbols

When symbols are used, they shall be as follows:

|                     |                                                                                          |    |
|---------------------|------------------------------------------------------------------------------------------|----|
| Amperes             | <del>(fluorescent lamp current</del> Rated current for externally ballasted loads) ..... | AX |
|                     | (other currents) .....                                                                   | A  |
| Volts               | .....                                                                                    | V  |
| Alternating current | .....                                                                                    | ~  |

|               |   |
|---------------|---|
| Watt .....    | W |
| Neutral ..... | N |
| Line .....    | L |

Protective earth (IEC 60417-5019:2006-08) ..... 

"open" position (off) ..... O

"closed" position (on) ..... I

Mini-gap construction ..... m

Micro-gap construction ..... μ

Without contact gap (semiconductor switching device) ..... ~~(under consideration)~~ ε

~~NOTE 1 — The symbol "O" shall only be used for switches of normal gap construction.~~

~~Splash-proof construction ..... IPX4~~

~~Jet-proof construction ..... IPX5~~

Degree of protection, when relevant ..... IPXX

Degree of protection for fixed accessories to be installed on rough surfaces

(test wall of Figure 21) ..... 

Suitability to accept rigid conductors only ..... r

NOTE 1 Details of construction of certain symbols are given in IEC 60417.

NOTE 2 In the IP code the letter "X", ~~concerning protection against ingress of solid objects,~~ is replaced by the relevant number.

~~NOTE 3 — Ordinary switches are not marked with any symbol for protection against harmful ingress of water.~~

NOTE 3 Lines formed by the construction of the tool are not considered as part of the marking.

~~For the marking with fluorescent lamp current,~~ The symbol "AX" may be replaced by the symbol "X". For the marking with rated current and rated voltage the figures may be used alone.

The marking for the nature of supply shall be placed next to the marking for rated current and rated voltage.

NOTE 4 The marking for current, voltage and nature of supply ~~may~~ can be, for example, as follows:



|                      |    |                |    |                              |
|----------------------|----|----------------|----|------------------------------|
| 10 AX 250 V ~        | or | 10 X/250 ~     | or | $\frac{10 X}{250} \sim$      |
| 20 A – 16 AX 250 V ~ | or | 20 -16 X/250 ~ | or | $\frac{20 - 16 X}{250} \sim$ |
| 10 AX 400 V ~        | or | 10 X/400 ~     | or | $\frac{10 X}{400} \sim$      |
| 25 AX 400 V ~        | or | 25 X/400 ~     | or | $\frac{25 X}{400} \sim$      |
| 25 A 250 V ~         | or | 25/250 ~       | or | $\frac{25}{250} \sim$        |
| 25 AX 440 V ~        | or | 25 X/440 ~     | or | $\frac{25 X}{440} \sim$      |

### 8.3 Visibility of markings

~~The following marking shall be placed on the main part of the switch:~~

- ~~— rated current, rated voltage and nature of supply;~~
- ~~— either the name, trade mark or identification mark, of the manufacturer or of the responsible vendor;~~
- ~~— length of insulation to be removed before the insertion of the conductor into the screwless terminal, if any;~~
- ~~— if applicable, symbol for mini-gap construction, micro-gap construction or semiconductor switching device;~~
- ~~— the type reference.~~

Markings shall be clearly visible with normal or corrected vision, without additional magnification, ~~marked either on the front of the switch or on the inner part of its associated enclosure, or on the main part of the switch so that it is easily legible on removal of any cover or cover plate which may be present when the switch is mounted and wired as in normal use.~~

Markings as given in 8.1 a), b), c), d), e) and, if applicable, f), g), h), k), and l) shall be placed on the main part of the switch.

NOTE 1 ~~The type reference may~~ Marking e) can be the series reference only.

NOTE 2 In the following country, the marking of the type reference is not used: UK.

Parts such as cover plates, which are necessary for safety purposes and are intended to be sold separately, shall be marked with the manufacturer's or responsible vendor's name, trade mark or identification mark and type reference.

~~The symbol for the degree of protection against harmful ingress of water, if applicable, shall be marked on the outside of its associated enclosure so as to be easily discernible when the switch is mounted and wired as in normal use.~~

Markings i) and j), when applicable, shall be marked so as to be easily discernible when the switch is mounted and wired as in normal use. These markings shall ~~not~~ be placed on parts which cannot be removed without the use of a tool.

NOTE 3 Additional type references ~~may~~ can be marked on the main part, or on the outside or the inside of the associated enclosure.

NOTE 3 – The term "main part" means the part carrying the contacts and any part integral with them; it does not include the knob, handle and the like, or parts intended to be sold separately.

#### 8.4 Marking on terminals for phase conductors

Terminals intended for the connection of phase conductors (supply conductors) shall be identified unless the method of connection is of no importance, is self-evident or is indicated on a wiring diagram. Such identification may take the form of a letter L or, in the case of more than one of such terminals, the letters L1, L2, L3, etc. The letters L1, L2, L3 may be accompanied by an arrow or arrows pointing to the relevant terminal or terminals.

These indications shall not be placed on screws or any other easily removable part.

Alternatively, the surface of such terminals shall be bare brass or copper, other terminals being covered with a metallic layer of another colour.

For switches of pattern numbers 2, 3, 03 and 6/2, terminals associated with any one pole shall have similar identification, if applicable, differing from that of the terminals associated with the other poles, unless the relationship is self-evident.

NOTE 1 The wiring diagram ~~may~~ can be an instruction sheet which accompanies the switch.

NOTE 2 "Easily removable parts" are those parts which can be removed during the normal installation of the switch.

#### 8.5 Marking on terminals for neutral and earth conductors

Terminals intended exclusively for the neutral conductor shall be indicated by the letter N.

Earthing terminal for the connection of the protective conductor shall be indicated by the symbol  (IEC 60417-5019:2006-08).

These markings shall not be placed on screws or any other easily removable part.

NOTE "Easily removable parts" are those parts which can be removed during the normal installation of the switch.

Terminals provided for the connection of conductors not forming part of the main function of the switch shall be clearly identified unless their purpose is self-evident, or indicated in a wiring diagram which shall be fixed to the accessory.

The identification of switch terminals may be achieved by:

- their marking with graphical symbols according to IEC 60417 or colours and/or alpha-numeric system;
- their physical dimension or relative location.

Leads of ~~neons or indicators~~ pilot lights are not considered to be conductors for the purpose of 8.5.

#### 8.6 Marking of the switch position

~~Switches of pattern numbers 2, 3 and 03 and switches having a rated voltage exceeding 250 V or rated current exceeding 16 A~~ If switches are marked to indicate the switch position, they shall be so marked that the direction of movement of the actuating member to its different positions or the actual position is clearly indicated. For switches having more than one actuating member, this marking shall indicate, for each of the actuating members, the effect achieved by its operation.

The marking shall be clearly visible on the front of the switch when fitted with its cover or cover plate.

If this marking is placed on the cover, cover plate, or removable actuating members, it shall not be possible to fix them in a position such that the marking is incorrect.

The symbols for "on" and "off" shall not be used for the indication of the switch positions unless, at the same time, they clearly indicate the direction of the movement of the actuating members.

NOTE 1 Other suitable means for the indication of the switch position ~~may~~ can be used, for example ~~indicator lamps~~ pilot lights.

The short straight line indicating the "on" position, shall be radial for rotary switches, perpendicular to the axis of rotation of the dolly for tumbler switches and rocker switches and vertical for push-button switches when mounted vertically.

These requirements do not apply to cord-operated switches and to switches of pattern numbers 6, 6/2 and 7.

NOTE 2 ~~It is not necessary to have such~~ This indication can be avoided for push-button switches.

*Compliance with the requirements of 8.1 to 8.6 is checked by inspection.*

## 8.7 Additional requirements for marking

~~A push button shall be coloured red only if it serves to open the circuit to be controlled. In addition, it may serve to close auxiliary contacts for control circuits, pilot lamps, etc.~~

If it is necessary to take special precautions when installing the switch, details of these shall be given in an instruction sheet which accompanies the switch.

Instruction sheets shall be written in the official language(s) of the country in which the switch is to be sold.

~~Compliance with the requirements of 8.7 and 8.8 is checked by inspection.~~

NOTE 1 Special precautions ~~may~~ can, for example, be necessary for unenclosed switches and for switches for panel mounting.

NOTE 2 ~~In order to ensure that~~, After installation, the conditions necessary to meet the requirements of this document are achieved when the instruction sheet ~~should~~ includes clear information with regard to the following:

- dimensions of the space to be provided for each switch;
- dimensions and position of the means for supporting and fixing the switch within this space;
- minimum clearance between the various parts of the switch and the surrounding parts where fitted;
- minimum dimensions of ventilating openings, if needed, and their correct arrangement.

NOTE 3 If necessary, information concerning the connection between the earthing terminal and accessible metal parts can be given.

## 8.8 Durability

Marking shall be durable and easily legible.

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

*The marking is rubbed by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with ~~petroleum spirit~~ 95 % n-hexane.*

NOTE 1 Marking made by impression, moulding, pressing, laser marking or engraving is not subjected to this test.

NOTE 2 ~~It is recommended that the petroleum spirit used consist of a solvent hexane with an aromatic content of maximum 0,1 in volume percentage, 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/cm<sup>3</sup>~~ 95 % n-hexane

(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.

## 9 Checking of dimensions

Switches and boxes shall comply with the appropriate standard sheets, if any.

*Compliance is checked by measurement.*

## 10 Protection against electric shock

### 10.1 Prevention of access to live parts

Switches shall be so designed that when they are mounted and wired as in normal use, live parts are not accessible even after removal of parts which can be removed without the use of a tool.

Switches which are designed to be fitted with pilot lights supplied at voltages other than ELV shall have means to prevent direct contact with the lamp.

*Compliance is checked by inspection and, if necessary, by the following test:*

*The specimen is mounted as in normal use and fitted with conductors of the smallest cross-sectional area specified in Clause 12; the test is repeated using conductors of the largest cross-sectional area specified in Clause 12.*

~~The standard test finger shown in figure 9. Test probe B of IEC 61032 is applied in every possible position, an electrical indicator with a voltage not less than between 40 V and not more than 50 V being used to show contact with the relevant part.~~

*Switches having enclosures or covers in thermoplastic or elastomeric material are subjected to the following additional test, which is carried out at an ambient temperature of  $(35 \pm 2) ^\circ\text{C}$ , the switches being at this temperature.*

*During the additional test, the switches 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 test probe 11 of IEC 61032.*

*This finger, with an electrical indicator as described above, is applied to all places where yielding of insulating material could impair the safety of the switch, but is not applied to membranes or the like and is applied to thin-walled knock-outs with a force of only 10 N.*

*During this test, switches with their associated mounting means shall not deform to such an extent that live parts can be touched with the unjointed test finger probe 11 of IEC 61032.*

NOTE Membranes or the like are tested according to 13.15.1 only.

### 10.2 Requirements for operating parts

Knobs, operating levers, push-buttons, rockers and the like shall be of insulating material, unless their accessible metal parts are separated from the metal parts of the mechanism by double insulation or reinforced insulation, or, as an alternative, they are reliably connected to earth.

*Compliance is checked by inspection and by the tests of Clauses 16 and 23.*

**NOTE** This requirement does not apply to removable keys or intermediate parts, such as chains or rods.

### 10.3 Requirements for accessible metal parts

**10.3.1** Accessible parts of ~~ordinary switches having rated current not exceeding 16 A~~ when in normal use shall be made of insulating material with the exception of the following:

- small screws and the like which are isolated from live parts and which are used for the fixing of the base and of covers, cover plates and other parts of the enclosure;
- actuating members complying with 10.2;
- the covers, cover plates and other parts of the enclosure made of metal which comply with the requirements of 10.3.2 or 10.3.3.

**10.3.2** Covers or cover plates of metal shall be protected by additional insulation made by insulating linings or insulating barriers. The insulating linings or insulating barriers shall either

- be fixed to covers or cover plates or the body of the switches in such a way that they cannot be removed without being permanently damaged, or
- be so designed that
  - they cannot be replaced in an incorrect position;
  - if they are omitted, the accessories are rendered inoperable or manifestly incomplete;
  - there is no risk of accidental contact between live parts and metal covers or cover plates, for example through their fixing screws, even if a conductor should come away from its terminal;
  - precautions are taken in order to prevent creepage distances or clearances becoming less than the values specified in Clause 23.

*Compliance is checked by inspection.*

The above linings or barrier shall comply with the tests of Clauses 16 and 23.

**NOTE** Insulating coating sprayed on the inside or on the outside of the metal cover or cover plate is not deemed to be an insulating lining or barrier for the purpose of 10.3.2.

**10.3.3** The earthing of metal covers or cover plates ~~is can be made while fixing the covers or cover plates and may be made without requiring the use of means other than the fixing means~~ with fixing screws or other integral means; the resulting connection shall be of low resistance.

**NOTE** ~~Fixing screws or other means are allowed.~~

*Compliance is checked by inspection and by the tests of 11.4.*

### 10.4 Requirements for insulation of the mechanism

Metal parts of the mechanism, such as the spindle or the pivot of the dolly or rocker, that are not insulated from live parts, shall not protrude from the enclosure.

However, for switches operated by means of a removable key or similar device, such metal parts of the mechanism shall be insulated from live parts.

*Compliance is checked by inspection and, if necessary, after the actuating member has been removed or broken.*

**NOTE** *If the actuating member has to be broken, compliance is checked by the test of Clause 23.*

## 10.5 Requirements for insulation of the mechanism with respect to the surrounding environment

Metal parts of the mechanism, ~~such as the spindle or the pivot of the dolly or rocker,~~ shall not be accessible and shall be insulated from accessible metal parts when the switch is fixed as in normal use.

~~In addition, they shall be insulated from accessible metal parts, including metal frames supporting the base of flush type switches, liable to be mounted in a metal box, and from screws for fixing the base to its support.~~

These ~~additional~~ requirements do not apply if the metal parts of the mechanism are separated from live parts in such a way that the creepage distances and clearances have at least twice the values specified in Clause 23, or, as an alternative, if they are reliably connected to earth.

*Compliance is checked by inspection and, if necessary, by measurement and by the tests of Clauses 10 and 16.*

NOTE When checking the inaccessibility of metal parts of the mechanism of unenclosed switches or architrave-type switches, the protection provided by the normal way of mounting the switch is taken into account.

**NOTE** For unenclosed stack-type switches having a metal spindle pivoting in a metal base plate, the additional requirement means that the creepage distances and clearances between live parts and the spindle, and between metal parts of the mechanism and base plate, ~~should~~ shall have at least twice the values specified in Clause 23.

## 10.6 Requirements for switches operated indirectly

Switches operated by means of a removable key or by means of an intermediate part, such as a cord, a chain or a rod, shall be so designed that the key or intermediate part can only touch parts which are insulated from live parts.

The key or intermediate part shall be insulated from metal parts of the mechanism, unless the creepage distances and clearances between live parts and metal parts of the mechanism have at least twice the values specified in Clause 23.

*Compliance is checked by inspection, by the test of 16.3 and, if necessary, by measurement.*

NOTE Lacquer or enamel is not considered to be insulating material for the purposes of 10.1 to 10.6.

## 10.7 Requirements for switches with replaceable pull cord

Where cord-operated switches are provided with a pull cord which can be fitted or replaced by the user, they shall be so designed that it is impossible to touch live parts when fitting or replacing the pull cord in the normal way.

*Compliance is checked by inspection.*

# 11 Provision for earthing

## 11.1 General

Accessible metal parts, which can become live in the event of an insulation fault, shall be provided with, or permanently and reliably connected to, an earthing terminal.

**NOTE 1** This requirement does not apply to the metal cover plates mentioned in 10.3.2.

~~NOTE 2~~ For the purpose of this requirement, small screws and the like, isolated from live parts, ~~for fixing bases, covers or cover plates~~, are not considered as accessible parts which can become live in the event of an insulation fault.

## 11.2 Earthing terminals

Earthing terminals shall be terminals with screw clamping or screwless terminals and shall comply with the appropriate requirements of Clause 12.

~~They shall be of the same size as the corresponding terminals for the supply conductors except that any additional external earthing terminal shall be of a size suitable for conductors of at least 6 mm<sup>2</sup>.~~

## 11.3 Requirements for surface-type switches

Surface-type switches ~~other than ordinary~~ with an enclosure of insulating material, having an IP code higher than IPX0 and more than one cable inlet, shall be provided with either an internal fixed earthing terminal or adequate space for a floating terminal allowing the connection of an incoming and outgoing conductor for the continuity of the earthing circuit.

Clause 12 does not apply to floating terminals which shall comply with IEC 60998-1 and the relevant sub-part of IEC 60998-2.

Compliance with ~~the requirements of~~ 11.1 to 11.3 is checked by inspection and by the tests of Clause 12.

*Compliance for adequate space for floating terminals is checked by performing a test connection using the type of terminal specified by the manufacturer.*

## 11.4 Test for earthing connection

The connection between the earthing terminal and accessible metal parts to be connected thereto shall be of low resistance.

*Compliance is checked by the following test:*

*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 or 25 A, whichever is the greater, 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  $\Omega$ .*

NOTE Care ~~should be~~ is taken that the contact resistance between the tip of the measuring probe and the metal part under test does not influence the test results.

# 12 Terminals

## 12.1 General

Switches shall be provided with terminals having screw clamping or with screwless terminals.

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



All the tests on terminals, with the exception of 12.3.11, shall be carried out after the test of 15.1. Rigid solid conductors shall be of Class 1, rigid stranded conductors shall be of Class 2 and flexible conductors shall be of Class 5 according to IEC 60228.

*Compliance is checked by inspection and by the tests of 12.2 or 12.3, as applicable.*

## 12.2 Terminals with screw clamping for external copper conductors

~~12.2.1 Switches shall be provided with terminals which shall allow the proper connection~~  
Terminals with screw clamping may be of the type suitable for rigid copper conductors only or of the type suitable for both rigid and flexible copper conductors having cross-sectional areas as shown in Table 4.

**Table 4 – Relationship between rated currents and connectable cross-sectional areas of copper conductors**

| Ranges of rated currents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Rigid conductors (solid or stranded) <sup>c</sup> |                               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|-------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Nominal cross-sectional areas                     | Diameter of largest conductor |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | mm <sup>2</sup>                                   | mm                            |
| up to and including 4 <sup>a</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | –                                                 | –                             |
| above 4 up to and including 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | From 0,75 up to 1,5 inclusive                     | 1,45                          |
| above 6 up to and including 13 <sup>b</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | From 1 up to 2,5 inclusive                        | 2,13                          |
| above <del>10</del> 13 up to and including 16 <sup>b</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | From 1,5 up to 4 inclusive                        | 2,72                          |
| above 16 up to and including 25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | From 2,5 up to 6 inclusive                        | 3,34                          |
| above 25 up to and including 32                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | From 4 up to 10 inclusive                         | 4,34                          |
| above 32 up to and including <del>40</del> 50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | From 6 up to 16 inclusive                         | 5,46                          |
| above <del>40</del> 50 up to and including 63                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | From 10 up to 25 inclusive                        | 6,85                          |
| <sup>a</sup> For special purposes such as ELV applications, where flexible conductors are used (from 0,5 mm <sup>2</sup> up to 1 mm <sup>2</sup> inclusive).<br><sup>b</sup> Each supply terminal of switches, other than those of pattern numbers 3, 03 and 7, shall allow the connection of two 2,5 mm <sup>2</sup> conductors. For switches having a rated voltage not exceeding 250 V a round hole is sufficient for the connection of two 2,5 mm <sup>2</sup> conductors.<br><sup>c</sup> The use of flexible conductors is permitted. |                                                   |                               |

The conductor space shall be at least that specified in Figures 1, 2, 3, 4 and 5.

*Compliance is checked by inspection and by fitting conductors of the smallest and largest cross-sectional areas specified.*

**12.2.2** Terminals with screw clamping shall allow the conductor to be connected without special preparation.

*Compliance is checked by inspection.*

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

**12.2.3** Terminals with screw clamping shall have adequate mechanical strength.

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

Screws shall not be of metal which is soft or liable to creep, such as zinc or aluminium.



*Compliance is checked by inspection and by the tests of 12.2.6 and 12.2.8.*

NOTE Provisionally SI, BA, and UN threads are considered to be comparable in pitch and mechanical strength to metric ISO thread.

**12.2.4** Terminals with screw clamping shall be resistant to corrosion.

Terminals, the body of which is made of copper or copper alloy as specified in 22.5 are considered as complying with this requirement.

**12.2.5** ~~Screw-type~~ Terminals with screw clamping shall be so designed and constructed that they clamp the conductor(s) without undue damage to the conductor(s).

*Compliance is checked by the following test:*

*Terminals suitable for rigid conductors only are checked with rigid solid conductors and on a new set of specimens with rigid stranded conductors, if existing.*

NOTE “if existing” means that the conductor is available in the market where the product is sold and installed.

*Terminals suitable for rigid and flexible conductors are checked with rigid conductors as above and on a new set of specimens with flexible conductors.*

*The terminal is placed in the test apparatus according to Figure 9. The terminal is fitted ~~with rigid (solid or stranded) conductor(s)~~, first with a conductor of the smallest and then with a conductor of the largest cross-sectional area according to Table 4, the clamping screw(s) or nut(s) being tightened with the torque according to Table 5.*

*Where a screw has a hexagonal head with a slot for tightening with a screwdriver and the values of columns 3 and 5 are different, the test is made twice, first applying to the hexagonal head the torque specified in column 5 and then applying the torque specified in column 3 by means of a screwdriver. If the values of columns 3 and 5 are the same, only the test with the screwdriver is made.*

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

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

*The screws and nuts shall be tightened in one smooth and continuous motion.*

**Table 5 – Tightening torque for the verification  
of the mechanical strength of screw-type terminals**

| Nominal diameter of thread<br>mm | Torque<br>Nm |     |     |     |     |     |
|----------------------------------|--------------|-----|-----|-----|-----|-----|
|                                  | 1            | 2   | 3   | 4   | 5   | 6   |
| Up to and including 2,8          | 0,2          | –   | 0,4 | –   | 0,4 | –   |
| Over 2,8 up to and including 3,0 | 0,25         | –   | 0,5 | –   | 0,5 | –   |
| Over 3,0 up to and including 3,2 | 0,3          | –   | 0,6 | –   | 0,6 | –   |
| Over 3,2 up to and including 3,6 | 0,4          | –   | 0,8 | –   | 0,8 | –   |
| Over 3,6 up to and including 4,1 | 0,7          | 1,2 | 1,2 | 1,2 | 1,2 | –   |
| Over 4,1 up to and including 4,7 | 0,8          | 1,2 | 1,8 | 1,8 | 1,8 | –   |
| Over 4,7 up to and including 5,3 | 0,8          | 1,4 | 2,0 | 2,0 | 2,0 | –   |
| Over 5,3 up to and including 6,0 | –            | 1,8 | 2,5 | 3,0 | 3,0 | –   |
| Over 6                           | –            | –   | –   | –   | –   | 0,8 |

**NOTE 1** Column 1 applies to screws without heads if the screw when tightened does not protrude from the hole, and to other screws which cannot be tightened by means of a screwdriver with a blade wider than the diameter of the screw.

Column 2 applies to nuts of mantle terminals which are tightened by means of a screwdriver.

Column 3 applies to other screws which are tightened by means of a screwdriver.

Column 4 applies to nuts of mantle terminals in which the nut is tightened by means other than a screwdriver.

Column 5 applies to screws or nuts, other than nuts of mantle terminals, which are tightened by means other than a screwdriver.

Column 6 applies to nuts of switches with central hole fixing.

~~Where a screw has a hexagonal head with a slot for tightening with a screwdriver and the values of columns 3 and 5 are different, the test is made twice, first applying to the hexagonal head the torque specified in column 5 and then applying the torque specified in column 3 by means of a screwdriver. If the values of columns 3 and 5 are the same, only the test with the screwdriver is made.~~

**NOTE 2** — For mantle terminals the specified nominal diameter is that of the slotted stud.

**NOTE 3** — The shape of the blade of the test screwdriver should suit the head of the screw to be tested.

**NOTE 4** — The screws and nuts should not be tightened in jerks.

**NOTE 5** — The values in table 3 are provisional.

The length of the test conductor shall be 75 mm longer than the height (H) specified in Table 6.

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 6. The bushing ~~is~~ shall be positioned in a horizontal plane such that its centre line describes a circle of 75 mm diameter, concentric with the centre of the clamping unit in the horizontal plane. The platen is then rotated at a rate of  $(10 \pm 2)$  r/min.

The distance between the mouth of the clamping unit and the upper surface of the bushing shall be within  $\pm 15$  mm of the height of Table 6. The bushing may be lubricated to prevent binding, twisting, or rotation of the insulated conductor.

A mass as specified in Table 6 is to be suspended from the end of the conductor. The duration of the test ~~is approximately~~ shall be 15 min.

During the test, the rigid conductor, or any wire of rigid stranded or flexible conductor, shall neither slip out of the clamping unit nor break near the clamping unit, nor shall the conductor be damaged in such a way as to render it unfit for further use.

~~The test shall be repeated with rigid solid conductors in the case they exist in the relevant IEC standard, if the first test has been made with rigid stranded conductors. In the case where rigid stranded conductors do not exist, the test may be made with rigid solid conductors only.~~

*In the case of the flexible conductor, the breakage of a few wires shall not be taken into account provided it does not exceed 15 % of the original number of wires.*

**Table 6 – Test values for flexion and pull out for copper conductors**

| Conductor cross-sectional area <sup>a</sup><br>mm <sup>2</sup> | Diameter of bushing hole <sup>b</sup><br>mm | Height <i>H</i> <sup>c</sup><br>mm | Mass for conductor<br>kg |
|----------------------------------------------------------------|---------------------------------------------|------------------------------------|--------------------------|
| 0,5                                                            | 6,5                                         | 260                                | 0,3                      |
| 0,75                                                           | 6,5                                         | 260                                | 0,4                      |
| 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                      |
| 25,0                                                           | 13,0                                        | 300                                | 4,5                      |

<sup>a</sup> AWG sizes corresponding to mm<sup>2</sup> can be found in IEC 60999-1.

<sup>b</sup> If the bushing hole diameter is not large enough to accommodate the conductor without binding, a bushing having the next larger hole size may be used.

<sup>c</sup> Tolerance for height *H* = ± 15 mm.

**12.2.6** Terminals with screw clamping shall be so designed that they clamp the conductor reliably between metal surfaces.

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

*Terminals suitable for rigid conductors only are checked with rigid solid conductors and on a new set of specimens with rigid stranded conductors, if existing.*

NOTE 1 “if existing” means that the conductor is available in the market where the product is sold and installed.

*Terminals suitable for rigid and flexible conductors are checked with rigid conductors as above and on a new set of specimens with flexible conductors.*

*The terminals are fitted first with ~~rigid stranded~~ conductors of the smallest and then with conductors of the largest cross-sectional area specified in Table 4, the terminal screws being tightened with a torque equal to two-thirds of the torque shown in the appropriate column of Table 5.*

*If the screw has a hexagonal head with a slot, the torque applied is equal to two-thirds of the torque shown in column 3 of Table 5.*

*The conductor is then subjected to a pull as specified in Table 7, applied without jerks, for 1 min, in the direction of the axis of the conductor space.*

*If the clamp is intended for two conductors, the appropriate pull is applied consecutively to each conductor.*

**Table 7 – Test values for pulling out test**

| Cross-section of conductors accepted by connected to the terminal<br>mm <sup>2</sup> | From 0,5 up to 1 inclusive<br>0,75 | 1  | From 0,75 up to 1,5 inclusive<br>1,5 | From 1,5 up to 2,5 inclusive<br>2,5 | From 2,5 up to 4 inclusive<br>4 | From 4 up to 6 inclusive<br>6 | From 6 up to 10 inclusive<br>10 | From 10 up to 16 inclusive<br>16 | From 16 up to 25 inclusive<br>25 |
|--------------------------------------------------------------------------------------|------------------------------------|----|--------------------------------------|-------------------------------------|---------------------------------|-------------------------------|---------------------------------|----------------------------------|----------------------------------|
| Pull N                                                                               | 30                                 | 35 | 40                                   | 50                                  | 50                              | 60                            | 80                              | 90                               | 100                              |

~~If the clamp is provided for two conductors, the appropriate pull is applied consecutively to each conductor.~~

During the test, the conductor shall not move noticeably in the terminal.

If the clamp is intended for connection of more than two conductors, reference is made for the testing to the requirements given in the appropriate part of IEC 60998.

~~The test is repeated with rigid solid conductors in the case where they exist in the relevant IEC standard, if the first test has been made with rigid stranded conductors. In the case where rigid stranded conductors do not exist, the test is made with rigid solid conductors only.~~

NOTE 2 In the following countries, terminals allowing connection of two conductors are additionally tested with one rigid solid conductor and one rigid stranded conductor with the same cross-sectional area connected at the same time: DK, FI, NO, SE and ZA.

**12.2.7** Terminals with screw clamping shall be so designed or placed that neither a rigid solid conductor nor a wire of a stranded conductor can slip out while the clamping screws or nuts are tightened.

This requirement does not apply to lug terminals.

Compliance is checked by the following test:

*Terminals suitable for rigid conductors only are checked with rigid solid conductors and on a new set of specimens with rigid stranded conductors, if existing.*

NOTE "if existing" means that the conductor is available in the market where the product is sold and installed.

*Terminals suitable for rigid and flexible conductors are checked with rigid conductors as above and on a new set of specimens with flexible conductors.*

The terminals are fitted with conductors having the largest cross-sectional area specified in Table 4.

~~The terminals are checked both with solid conductors and with stranded conductors.~~

Terminals intended for the looping-in of two or three conductors are checked, fitted with the permissible number of conductors.

The terminals are fitted with conductors having the composition given in ~~table 6~~ IEC 60228.

**Table 6 – Composition of conductors**

| Cross-sectional area<br>mm <sup>2</sup> | Number of wires and nominal diameter of wires<br>mm |                    |
|-----------------------------------------|-----------------------------------------------------|--------------------|
|                                         | Solid conductor                                     | Stranded conductor |
| 4                                       | 1 × 1,13                                            | 7 × 0,42           |
| 1,5                                     | 1 × 1,38                                            | 7 × 0,52           |
| 2,5                                     | 1 × 1,78                                            | 7 × 0,67           |
| 4                                       | 1 × 2,25                                            | 7 × 0,86           |
| 6                                       | 1 × 2,76                                            | 7 × 1,05           |
| 10                                      | 1 × 3,57                                            | 7 × 1,35           |
| 16                                      | –                                                   | 7 × 1,70           |
| 25                                      | –                                                   | 7 × 2,14           |

Before insertion into the clamping means of the terminal, wires of rigid (solid or stranded) conductors are straightened; rigid stranded conductors may, in addition, be twisted to restore them approximately to their original shape and flexible conductors are twisted in one direction so that there is a uniform twist of one complete turn in a length of approximately 20 mm.

The conductor is inserted into the clamping means of the terminal for the minimum distance prescribed or, where no distance is prescribed, until it just projects from the far side of the terminal and in the position most likely to allow the wire to escape.

The clamping screw(s) or nut(s) is (are) then tightened with a torque equal to two-thirds of the torque shown in the appropriate column of Table 5.

After the test, no wire of the conductors shall have escaped outside the clamping unit thus reducing creepage distances and clearances to values lower than those indicated in Table 23.

**12.2.8** Terminals with screw clamping shall be so fixed or located within the switch that, when the clamping screws or nuts are tightened or loosened, the terminals shall not work loose from their fixing to the switch.

~~NOTE 1 – These requirements do not imply that the terminals should be so designed that their rotation or displacement is prevented.~~

~~Any~~ Movement of the terminal ~~should be~~ is allowed as long as it is sufficiently limited so as to prevent non-compliance with this document.

~~NOTE 2~~ The use of sealing compound or resin is considered to be sufficient for preventing a terminal from working loose, provided that

- the sealing compound or resin is not subject to stress during normal use, and
- the effectiveness of the sealing compound or resin is not impaired by temperatures attained by the terminal under the most unfavourable conditions specified in this document.

Compliance is checked by inspection, by measurement and by the following test:

A solid rigid copper conductor of the largest cross-sectional area specified in Table 4 is placed in the terminal.

Screws and nuts are tightened and loosened five times by means of a suitable test screwdriver or spanner, the torque applied when tightening being equal to the torque shown in

*the appropriate column of Table 5 or in the table of the appropriate Figures 1 to 4, whichever is the highest.*

*The conductor is moved each time the screw or nut is loosened.*

During the test, terminals shall not work loose and there shall be no damage, such as breakage of screws or damage to the heads, slots, threads, washers or stirrups that will impair the further use of the terminals.

**12.2.9** Clamping screws or nuts of earthing terminals with screw clamping 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 manual test.*

*In general, the designs of terminals shown in Figures 1, 2, 3, 4 and 5 provide sufficient resiliency to comply with this requirement; for other designs, special provisions, such as the use of an adequately resilient part which is not likely to be removed inadvertently, may be necessary.*

**12.2.10** Earthing terminals with screw clamping 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 terminals 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 other metal no less resistant to corrosion.

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

*Compliance is checked by inspection.*

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

**12.2.11** For pillar terminals, the distance between the clamping screw and the end of the conductor, when fully inserted, shall be at least that specified in Figure 1.

NOTE The minimum distance between the clamping screw and the end of the conductor applies only to pillar terminals in which the conductor cannot pass right through.

For mantle terminals, the distance between the fixed part and the end of the conductor, when fully inserted, shall be at least that specified in Figure 5.

*Compliance is checked by measurement, after a solid conductor of the largest cross-sectional area specified for the appropriate rated current in Table 4 has been fully inserted and fully clamped.*

**12.2.12** Lug terminals shall be used only for switches having a rated current of 40 A or greater; if such terminals are provided, they shall be fitted with spring washers or equally effective locking means.

*Compliance is checked by inspection.*

### 12.3 Screwless terminals for external copper conductors

**12.3.1** Screwless terminals may be of the type suitable for rigid copper conductors only or of the type suitable for both rigid and flexible copper conductors.

*For the latter type, the tests are carried out with rigid conductors first and then repeated with flexible conductors.*

**NOTE** 12.3 is not applicable to switches provided with

- screwless terminals requiring the fixing of special devices to the conductors before clamping in the screwless terminal, for example flat push-on connectors;
- screwless terminals requiring twisting of the conductors, for example those with twisted joints;
- screwless terminals providing direct contact to the conductors by means of edges or points penetrating the insulation.

**12.3.2** Screwless terminals shall be provided with clamping units which allow the proper connection of rigid or of rigid and flexible copper conductors having nominal cross-sectional areas as shown in Table 8.

**Table 8 – Relationship between rated currents and connectable cross-sectional areas of copper conductors for screwless terminals**

| Rated current<br>A                                                                                                                                                                                                                                                  | Conductors                                       |                                           |                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|-------------------------------------------|----------------------------------------------|
|                                                                                                                                                                                                                                                                     | Nominal cross-sectional areas<br>mm <sup>2</sup> | Diameter of largest rigid conductor<br>mm | Diameter of largest flexible conductor<br>mm |
| Up to and including 4                                                                                                                                                                                                                                               | 0,75 to 1                                        | 1,19                                      | -                                            |
| Above 4 and including 6                                                                                                                                                                                                                                             | 1 to 1,5                                         | 1,45                                      | 1,73                                         |
| 10 up to Above 6 and including 16 <sup>a</sup>                                                                                                                                                                                                                      | 1,5 to 2,5                                       | 2,13                                      | 2,21                                         |
| <sup>a</sup> Each supply terminal of switches other than those of pattern numbers 3, 03 and 7 shall allow the connection of two 2,5 mm <sup>2</sup> conductors. In such cases a terminal with separate independent clamping means for each conductor shall be used. |                                                  |                                           |                                              |

*Compliance is checked by inspection and by fitting conductors of the smallest and largest cross-sectional areas specified.*

**12.3.3** Screwless terminals shall allow the conductor to be connected without special preparation.

*Compliance is checked by inspection.*

**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.

**12.3.4** Parts of screwless terminals mainly intended for carrying current shall be of materials as specified in 22.5.

*Compliance is checked by inspection and by chemical analysis.*

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



**12.3.5** Screwless terminals shall be so designed that they clamp the specified conductors with sufficient contact pressure and without undue damage to the conductor.

The conductor shall be clamped between metal surfaces.

*Compliance is checked by inspection and by the test of 12.3.10.*

**12.3.6** It shall be clear how the connection and disconnection of the conductors is to be made.

The disconnection of a conductor shall require an operation, other than a pull on the conductor, so that it can be made manually with or without the assistance of a general purpose tool.

It shall not be possible to confuse the opening for the use of a tool to assist the connection or disconnection with the opening intended for the insertion of the conductor.

*Compliance is checked by inspection and by the test of 12.3.10.*

**12.3.7** Screwless terminals which are intended to be used for the interconnection of two or more conductors shall be so designed that

- ~~during the insertion the operation of~~ the clamping ~~means~~ of one of the conductors is independent of the ~~operation of that~~ clamping of the other conductor(s);
- during the connection or disconnection the conductors can be connected or disconnected either at the same time or separately;
- each conductor ~~is~~ shall be introduced in a separate clamping unit (not necessarily in separate holes);
- it shall be possible to clamp securely any number of conductors up to the maximum as designed.

*Compliance is checked by inspection and by the tests with the appropriate conductors.*

**12.3.8** Screwless terminals shall be so designed that over-insertion of the conductor is prevented and adequate insertion is obvious.

~~NOTE — For the purpose of this requirement, an appropriate marking indicating the length of insulation to be removed before the insertion of the conductor into the screwless terminal may be put on the switch or given in an instruction sheet which accompanies the switch.~~

Screwless terminals of switches shall be so designed that undue insertion of the conductor is prevented by a stop if further insertion is liable to reduce the creepage distances and/or clearances required in Table 23, or to influence the mechanism of the switch.

*Compliance is checked by inspection and by the test of 12.3.10.*

**12.3.9** Screwless terminals shall be properly fixed to the switch.

They shall not work loose when the conductors are connected or disconnected during installation.

*Compliance is checked by inspection and by the test of 12.3.10.*

Covering with sealing compound without other means of locking is not sufficient. However, self-hardening resins may be used to fix terminals which are not subject to mechanical stress in normal use.



**12.3.10** Screwless terminals shall withstand the mechanical stresses occurring in normal use.

*Compliance is checked by the following tests which are carried out with uninsulated conductors on one screwless terminal of each specimen, using a new specimen for each test.*

*The test is carried out with solid copper conductors, first with conductors having the largest cross-sectional area, and then with conductors having the smallest cross-sectional area specified in 12.3.2.*

*Conductors are connected and disconnected five times, new conductors being used each time, except for the fifth time, when the conductors used for the fourth connection are clamped at the same place. For each connection the conductors are either pushed as far as possible into the terminal or are inserted so that adequate connection is obvious.*

*After each connection, the conductor is subjected to a pull of 30 N; the pull is applied without jerks, for 1 min, in the direction of the longitudinal axis of the conductor space.*

*During the application of the pull, the conductor shall not come out of the screwless terminal.*

*The test is then repeated with rigid stranded copper conductors having the largest and smallest cross-sectional areas specified in 12.3.2; these conductors are, however, connected and disconnected only once.*

*Screwless terminals, intended for both rigid and flexible conductors, shall also be tested with flexible conductors, applying five connections and disconnections.*

*Each conductor of screwless terminals is subjected for 15 min to a circular motion with  $(10 \pm 2)$  r/min using an apparatus, an example of which is shown in Figure 9. The conductor is subjected to a pull having a value shown in Table 6.*

*During the test, the conductors shall not move noticeably in the clamping unit.*

*After these tests, neither the terminals nor the clamping means shall have worked loose and the conductors shall show no deterioration impairing their further use.*

**12.3.11** Screwless terminals shall withstand the electrical and thermal stresses occurring in normal use.

*Compliance is checked by the following tests a) and b), which are carried out on five screwless terminals which have not been used for any other test.*

*Both tests are carried out with new copper conductors.*

a) *The test is carried out by loading the screwless terminals for 1 h with an alternating current as specified in Table 9 and connecting rigid solid conductors 1 m long having the cross-sectional area as specified in Table 9.*

b) *The test is carried out on each clamping unit.*

**Table 9 – Test current for the verification of electrical and thermal stresses in normal use of screwless terminals**

| Rated current<br>A                                                                                                                                                                                                                                                                                                             | Test current<br>A | Cross-sectional area<br>of the conductor<br>mm <sup>2</sup> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------|
| Up to including 4                                                                                                                                                                                                                                                                                                              | 9                 | 0,75                                                        |
| Above 4 and including 6                                                                                                                                                                                                                                                                                                        | 13,5              | 1                                                           |
| <del>10</del> Above 6 and including 13                                                                                                                                                                                                                                                                                         | 17,5              | 1,5                                                         |
| Above 13 and including 16                                                                                                                                                                                                                                                                                                      | 22                | 2,5                                                         |
| NOTE — <del>For switches having rated currents other than the preferred ones, the test current is determined by interpolation between the next lower and higher preferred rated currents and the cross-sectional area of the conductor is chosen equal to the one specified for the next higher preferred rated current.</del> |                   |                                                             |

*During the test, the current is not passed through the switch but only through the terminals.*

*Immediately after this period, the voltage drop across each screwless terminal is measured with rated current flowing.*

*In no case shall the voltage drop exceed 15 mV.*

*The measurements are made across each screwless terminal and as near as possible to the place of contact.*

*If the back connection of the terminal is not accessible, the second connecting point in the case of two-way switches may be used for the returning wire; in the case of one-way switches the specimens may be adequately prepared by the manufacturer; care ~~shall~~ *should* be taken not to affect the behaviour of the terminal.*

~~Care shall be taken that,~~ During the period of the test, including the measurements, the conductors and the measurement means ~~are~~ *shall not be moved noticeably so that the result of the test is affected.*

*The screwless terminals already subjected to the determination of the voltage drop specified in the previous test a) are tested as follows:*

- *During the test, a current equal to the test current value given in Table 9 is passed.*

*The whole test arrangement including the conductors shall not be moved until the measurements of the voltage drop have been completed.*

*The terminals are subjected to 192 temperature cycles, each cycle having a duration of approximately 1 h and being carried out as follows:*

- *the current is flowing for approximately 30 min;*
- *for a further approximately 30 min no current is flowing.*

*The voltage drop in each screwless terminal is determined as prescribed for the test of a) ~~after every 24 temperature cycles and after the 192 temperature cycles have been completed~~ and is done at the following moments:*

- *after the first 24 temperature cycles and after the 192 temperature cycles;*
- *additional measurements to be done after any three of the following temperature cycles: after the 48<sup>th</sup>, 72<sup>nd</sup>, 96<sup>th</sup>, 120<sup>th</sup>, 144<sup>th</sup> or 168<sup>th</sup> temperature cycles.*

*In no case shall the voltage drop exceed 22,5 mV or two times the value measured after the 24<sup>th</sup> cycle, whichever is the smaller.*

*After this test, an inspection by normal or corrected vision without additional magnification shall show no changes evidently impairing further use such as cracks, deformation or the like.*

*In addition, the mechanical strength test according to 12.3.10 is repeated and all specimens shall withstand this test.*

**12.3.12** Screwless terminals shall be so designed that the connected rigid solid conductor remains clamped, even when it has been deflected during normal installation, for example during mounting in a box, and the deflecting stress is transferred to the clamping unit.

*Compliance is checked by the following test which is made on three specimens of switches which have not been used for any other test.*

*The test apparatus, the principle of which is shown in Figure 10a, shall be so constructed that*

- *a specified conductor properly inserted into a terminal is allowed to be deflected in any of the 12 directions differing from each other by 30°, with a tolerance referred to each direction of  $\pm 5^\circ$ , and*
- *the starting point can be varied by 10° and 20° from the original point.*

**NOTE 1** A reference point need not be specified.

*The deflection of the conductor from its straight position to the testing positions shall be effected by means of a suitable device applying a specified force to the conductor at a certain distance from the terminal.*

*The deflecting device shall be so designed that*

- *the force is applied in the direction perpendicular to the undeflected conductor;*
- *the deflection is attained without rotation or displacement of the conductor within the clamping unit, and*
- *the force remains applied while the prescribed voltage drop measurement is made.*

*Provision shall be made so that the voltage drop across the clamping unit under test can be measured when the conductor is connected, as shown for example in Figure 10b.*

*The specimen is mounted on the fixed part of the test apparatus in such a way that the specified conductor inserted into the clamping unit under test can be freely deflected.*

*To avoid oxidation, the insulation of the wire shall be removed immediately before starting the test.*

**NOTE 1** If necessary, the inserted conductor ~~may~~ can be permanently bent around obstacles, so that these do not influence the results of the test.

**NOTE 2** In some cases, with the exception of the case of guidance for the conductor, it may be advisable to remove those parts of the specimens which do not allow the deflection of the conductor corresponding to the force to be applied.

*A clamping unit is fitted as for normal use with a rigid solid copper conductor having the smallest cross-sectional area specified in Table 10 and is submitted to a first test sequence. The same clamping unit is submitted to a second test sequence using the conductor having the largest cross-sectional area, unless the first test sequence has failed.*

The force for deflecting the conductor is specified in Table 11, the distance of 100 mm being measured from the extremity of the terminal, including the guidance, if any, for the conductor, to the point of application of the force to the conductor.

The test is made with continuous current (i.e. the current is not switched on and off during the test). A suitable power supply should be used and an appropriate resistance should be inserted in the circuit so that the current variations are kept within  $\pm 5\%$  during the test.

**Table 10 – Cross-sectional areas of rigid copper conductors  
for deflection test of screwless terminals**

| Rated current of the switch<br>A | Cross-sectional area of the test conductor<br>mm <sup>2</sup> |                   |
|----------------------------------|---------------------------------------------------------------|-------------------|
|                                  | 1st test sequence                                             | 2nd test sequence |
| $\leq 6$                         | 1,0 <sup>a</sup>                                              | 1,5               |
| Above 6 up to and including 16   | 1,5                                                           | 2,5               |

<sup>a</sup> Only for countries allowing the use of 1,0 mm<sup>2</sup> conductors in fixed installations.

**Table 11 – Deflection test forces**

| Cross-sectional area of the test conductor<br>mm <sup>2</sup> | Force for deflecting the test conductor <sup>a</sup><br>N |
|---------------------------------------------------------------|-----------------------------------------------------------|
| 1,0                                                           | 0,25                                                      |
| 1,5                                                           | 0,5                                                       |
| 2,5                                                           | 1,0                                                       |

<sup>a</sup> The forces are chosen so that they stress the conductors close to the limit of elasticity.

A test current equal to the rated current of the switch is passed through the clamping unit under test. A force according to Table 11 is applied to the test conductor inserted in the clamping unit under test in one of the 12 directions shown in Figure 10a and the voltage drop across this clamping unit is measured. The force is then removed.

The force is then applied successively in each one of the remaining 11 directions shown in Figure 10a following the same test procedure.

If for any of the 12 test directions the voltage drop is greater than 25 mV, the force is maintained in this direction until the voltage drop is reduced to a value below 25 mV, but for not more than 1 min. After the voltage drop has reached a value below 25 mV, the force is 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 specimens of switches of the set are tested following the same test procedure, but moving the 12 directions of the force so that they differ by approximately 10° for each specimen. If one specimen has failed at one of the directions of application of the test force, the tests are repeated on another set of specimens, all of which shall comply with the repeated tests.

## 13 Constructional requirements

### 13.1 Mechanical requirements for insulating means

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

*Compliance is checked by inspection after the tests of Clause 20.*

### 13.2 Installation requirements

Switches shall be constructed so as to permit

- easy introduction into the terminal and reliable connection of the conductors in the terminals, except for lead wires of pilot lights;  
NOTE 1 Screw terminals shown in Figures 1 to 5 are considered suitable for reliable connection of the conductors.
- correct positioning of the conductors;
- easy fixing of the switch to a wall or in a box;
- adequate space between the underside of the ~~base~~ main part and the surface on which the ~~base~~ main part is mounted or between the sides of the ~~base~~ main part and the enclosure (cover or box) so that, after installation of the switch, the insulation of the conductors is not necessarily pressed against live parts of different polarity or against moving parts of the mechanism, such as the spindle of a rotary switch.

NOTE 2 This requirement does not imply that the metal parts of the terminals are necessarily protected by insulation barriers or insulating shoulders, to avoid contact, due to incorrect installation of the terminal metal parts, with the insulation of the conductor.

~~In addition, switches classified as design A shall permit easy positioning and removal of the cover or cover plate, without displacing the conductors.~~

Surface-type switches shall be constructed so that the fixing means do not damage the insulation of the cables during the installation.

*Compliance is checked by inspection and by an installation test using conductors of the largest cross-sectional area specified, for the relevant ranges of rated currents, in Table 4.*

NOTE 3 For surface-type switches, mounted on a mounting plate, a wiring channel may be needed to comply with this requirement.

In addition, for switches comprising screwless terminals, the switches shall be so constructed that the connecting and/or disconnecting means of the screwless terminals cannot be activated by the conductors during and after installation of the switch in a box or on a wall.

NOTE 4 This requirement does not imply that the connecting and/or disconnecting means cannot be touched by the conductors.

NOTE 5 This requirement can be met by the placement of the connecting and/or disconnecting means and/or the use of protective barriers or shoulders placed around the connecting and/or disconnecting means.

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

*The test is carried out with a solid copper conductor having the smallest cross-sectional area specified in 12.3.2.*

*The conductor is pushed as far as possible into the terminal under test or is inserted so that adequate connection is obvious.*

*A test probe 1 of IEC 61032 is pushed against the connecting or disconnecting means with a force of 120 N in the direction opposite to the mounting direction as described in Figure 22a.*

*During the application of the force, the conductor, except for lead wires of pilot lights, is subjected to a pull of 30 N; the pull is applied in one smooth and continuous motion, for 1 min, in the direction of the longitudinal axis of the conductor space.*

*During the application of the pull, the conductor shall not come out of the screwless terminal.*

*The force of 120 N has to be applied before the force of 30 N is applied. The force of 30 N is maintained on the conductor during the complete test.*

*Care should be taken that the test probe does not touch the conductor during the application of the forces.*

*Where the axis between the application force and the axis through the force necessary to operate the connecting/disconnecting means deviates by more than 20°, it is allowed to exert the calculated resulting force directly onto the connecting/disconnecting means using the test probe. An example is shown in Figure 22b.*

*If the angle is greater than 60° no test is necessary and the product is deemed to comply with the requirements without further tests.*

*If it is not possible to exert a force onto the connecting/disconnecting device, the product is deemed to comply with the requirements without further tests.*

In addition, switches classified as design A shall permit easy positioning and removal of the cover or cover plate, without displacing the conductors or activating the connecting and/or disconnecting means of screwless terminals.

NOTE 6 This requirement does not imply that the connecting and/or disconnecting means cannot be touched by the cover or cover plate.

### **13.3 Fixing of covers, cover plates and actuating members**

**13.3.1** Covers, cover plates and actuating members or parts of them, which are intended to ensure protection against electric shock, shall be held in place at two or more points by effective fixing.

Covers, cover plates and actuating members or parts of them may be fixed by means of a single fixing, for example by a screw, provided that they are located by another means (for example by a shoulder).

NOTE 1 ~~It is recommended that~~ The most appropriate method for fixings ~~of~~ covers, cover plates or actuating members ~~be~~ is to ensure that they are captive. The use of tight fitting washers of cardboard or the like is deemed to be an adequate method for securing screws intended to be captive.

NOTE 2 Non-earthed metal parts, separated from live parts in such a way that creepage distances and clearances have values specified in Table 23, are not considered as accessible if the requirements of 13.3 are met.

Where the fixing of covers, cover plates or actuating members of switches of ~~type~~ design A serves to fix the ~~base~~ main part there shall be means to maintain the ~~base~~ main part in position, even after removal of the covers, cover plates or actuating members.

*Compliance is checked according to 13.3.2, 13.3.3 or 13.3.4.*

**13.3.2** *For covers, cover plates or actuating members whose fixing is of the screw-type: by inspection only.*

**13.3.3** For covers, cover plates or actuating members whose fixing is not dependent on screws and whose removal is obtained by applying a force in a direction approximately perpendicular to the mounting/supporting surface (see Table 12),

- when their removal may give access, with the ~~standard~~ test ~~finger~~ probe B of IEC 61032, to live parts:

by the tests of 20.5;

- when their removal may give access, with the ~~standard~~ test ~~finger~~ probe B of IEC 61032, to non-earthed metal parts separated from live parts in such a way that creepage distances and clearances have the values at least equal to those shown in Table 23:

by the test of 20.6;

- when their removal may give access, with the ~~standard~~ test ~~finger~~ probe B of IEC 61032, only to
  - insulating parts, or
  - earthed metal parts, or
  - metal parts separated from live parts in such a way that creepage distances and clearances have at least twice the values shown in Table 23, or
  - live parts of SELV circuits not greater than 25 V AC and 60 V DC:

by the test of 20.7.

**Table 12 – Forces to be applied to covers, cover-plates or actuating members whose fixing is not dependent on screws**

| Accessibility with the test <del>finger</del> probe B of IEC 61032 after removal of covers, cover plates or parts of them                                                                             | Test according to... | Force to be applied                   |                |                                           |                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|---------------------------------------|----------------|-------------------------------------------|----------------|
|                                                                                                                                                                                                       |                      | N                                     |                |                                           |                |
|                                                                                                                                                                                                       |                      | Switches complying with 20.8 and 20.9 |                | Switches not complying with 20.8 and 20.9 |                |
|                                                                                                                                                                                                       |                      | Shall not come off                    | Shall come off | Shall not come off                        | Shall come off |
| To live parts                                                                                                                                                                                         | 20.5                 | 40                                    | 120            | 80                                        | 120            |
| To non-earthed metal parts separated from live parts by creepage distances according to 23.1                                                                                                          | 20.6                 | 10                                    | 120            | 20                                        | 120            |
| To insulating parts, earthed metal parts, the live parts of SELV ≤ 25 V AC and 60 V DC or metal parts separated from live parts by creepage distances and by clearances twice those according to 23.1 | 20.7                 | 10                                    | 120            | 10                                        | 120            |

**13.3.4** For covers, cover plates or actuating members whose fixing is not dependent on screws and whose removal is obtained by using a tool, in accordance with the manufacturer's instructions given in an instruction sheet or catalogue:

by the same tests of 13.3.3 except that the covers, cover plates, actuating members or parts of them need not come out when applying a force not exceeding 120 N in directions perpendicular to the mounting/supporting surface.



### 13.4 Openings in normal use

**Ordinary** Switches shall be so constructed that, when they are fixed and wired as in normal use, there are no free openings in their enclosures according to their IP classification.

*Compliance is checked by inspection and by an installation test with conductors of the smallest cross-sectional area specified in Table 4.*

NOTE Drain holes, small gaps between enclosures and conduits or cables, or between enclosures and operating means ~~are~~ can be neglected if they comply with the relevant IP classification.

### 13.5 Attachment of knobs

Knobs of rotary switches shall be securely attached to the shaft or part operating the mechanism.

*Compliance is checked by the following test.*

~~The knob is subjected for 1 min to an axial pull of 100 N.~~

*Where it is possible to apply an axial pull in normal use, an axial pull shall be applied for 1 min to try to pull off the actuating member.*

*If the shape of the actuating member is such that an axial pull is likely to be applied in normal use, the force is 30 N.*

*If the shape of the actuating member is such that an axial pull is unlikely to be applied in normal use, the force is 15 N.*

*After this, knobs of switches having only one direction of operation are turned, if possible, without undue force, 100 times in the reverse direction.*

*During the test, the knob shall not become detached.*

### 13.6 Mounting means

Screws or other means for mounting the switch on a surface or in a box or enclosure shall be easily accessible from the front. These means shall not serve any other fixing purpose.

NOTE Switch mounting means, if used to lock the rotation of the box, do not constitute a use for “any fixing purpose”.

### 13.7 Combination of switches

Combinations of switches, or of switches and socket-outlets, comprising separate bases shall be so designed that the correct position of each ~~base~~ main part is ensured. The fixing of each ~~base~~ main part shall be independent of the fixing of the combination to the mounting surface.

*Compliance with the requirements of 13.6 and 13.7 is checked by inspection.*

### 13.8 Accessories combined with switches

Accessories combined with switches shall comply with their relevant standard, if any, unless a standard exists for the combination.

### 13.9 Surface-type switches having an IP code higher than IP20

~~Switches other than ordinary shall be totally enclosed when fitted with screwed conduits or with polyvinyl chloride (PVC) sheathed or similar type of cables.~~



~~Surface-type switches other than ordinary shall have provision for opening a drain hole of at least 5 mm in diameter, or 20 mm<sup>2</sup> in area with a width and a length of at least 3 mm.~~

Surface-type switches that have an IP code higher than IP20 shall be according to their IP classification when fitted with conduits or with sheathed cables as for normal use.

Surface-type switches that have degrees of protection IPX4, IPX5 and IPX6 shall have provisions for opening a drain hole.

If a switch is provided with a drain hole, it shall be not less than 5 mm in diameter, or 20 mm<sup>2</sup> in area with a width and a length not less than 3 mm.

If the design of the switch is such that only one mounting position is possible, the drain hole shall be effective in that position. Alternatively, the drain hole shall be effective in at least two positions of the switch when this is mounted on a vertical wall, one of these with the conductors entering at the top and the other with the conductors entering at the bottom.

Lid springs, if any, shall be of corrosion resistant material, such as bronze or stainless steel.

*Compliance is checked by inspection, by measurement and by the relevant tests of 15.2.*

NOTE A drain hole in the back of the enclosure is deemed to be effective only if the design of the enclosure ensures a clearance of at least 5 mm from the wall, or provides a drainage channel of at least the size specified.

### 13.10 Installation in a box

Switches to be installed in a box shall be so designed that the conductor ends can be prepared after the box is mounted in position, but before the switch is fitted in the box.

In addition, the ~~base~~ main part shall have adequate stability when mounted in the box.

*Compliance is checked by inspection and by an installation test with conductors of the largest cross-sectional area specified for the relevant current rating in Table 4.*

### 13.11 Connection of a second current-carrying conductor

Surface-type switches, ~~other than ordinary~~ that have an IP code higher than IPX0, of pattern numbers 1, 5 and 6 with an enclosure having more than one inlet opening shall be provided for maintaining the continuity of a second current-carrying conductor either with a fixed additional terminal complying with the requirements of Clause 12 or with adequate space for a floating terminal.

*Compliance is checked by inspection and by the relevant tests of Clause 12.*

### 13.12 Inlet openings

Inlet openings shall allow the introduction of the conduit or the sheath of the cable so as to afford complete mechanical protection.

~~Ordinary~~ Surface-type switches shall be so constructed that the intended conduit or ~~protective covering~~ the sheath of the cable can enter at least 1 mm into the enclosure.

In surface-type switches, the inlet opening for conduit entries, or at least two of them if there are more than one, shall be capable of accepting conduit sizes of 16, 20, 25 or 32 or a combination of at least two of any of these sizes not excluding two of the same size.

*Compliance is checked by inspection during the test of 13.10 and by measurement.*

In surface-type switches, the inlet opening for cable entries shall preferably be capable of accepting cables having the dimensions specified in Table 13 or be as specified by the manufacturer.

NOTE Inlet openings of adequate size ~~may~~ can also be obtained by the use of knock-outs or of suitable insertion pieces.

**Table 13 – External cable diameter limits for surface type switches**

| Rated current<br>A | Cross-sectional areas<br>mm <sup>2</sup> | Number of conductors | Limits of external diameter of cables |                      |
|--------------------|------------------------------------------|----------------------|---------------------------------------|----------------------|
|                    |                                          |                      | Minimum<br>mm                         | Maximum<br>mm        |
| 6                  | 1,5                                      | 2                    | 7,6                                   | <del>11,5</del> 11,0 |
|                    |                                          | 3                    |                                       | <del>12,5</del> 11,9 |
|                    |                                          | 4                    |                                       | <del>13,5</del> 13,1 |
|                    |                                          | 5                    |                                       | <del>15</del> 14,4   |
| 10 and 13          | 1,5 up to and including 2,5              | 2                    | 7,6                                   | <del>13,5</del> 13,1 |
|                    |                                          | 3                    |                                       | <del>14,5</del> 14,0 |
|                    |                                          | 4                    |                                       | 15,5                 |
|                    |                                          | 5                    |                                       | 17                   |
| 16                 | 1,5 up to and including 4                | 2                    | 7,6                                   | 15,1                 |
|                    |                                          | 3                    |                                       | 16,2                 |
|                    |                                          | 4                    |                                       | <del>18</del> 17,9   |
|                    |                                          | 5                    |                                       | <del>19,5</del> 19,9 |
| 20<br>25           | 2,5 up to and including 6                | 2                    | 8,6                                   | <del>18,5</del> 16,8 |
|                    |                                          | 3                    |                                       | <del>20</del> 18,0   |
|                    |                                          | 4                    |                                       | <del>22</del> 20,0   |
|                    |                                          | 5                    |                                       | <del>24,5</del> 22,2 |
| 32                 | 4 up to and including 10                 | 2                    | 9,6                                   | <del>24</del> 22,6   |
|                    |                                          | 3                    |                                       | <del>25,5</del> 24,2 |
|                    |                                          | 4                    |                                       | <del>28</del> 26,5   |
|                    |                                          | 5                    |                                       | <del>30,5</del> 29,1 |
| 40<br>45<br>50     | 6 up to and including 16                 | 2                    | 10,5                                  | <del>27,5</del> 25,7 |
|                    |                                          | 3                    |                                       | <del>29,5</del> 27,6 |
|                    |                                          | 4                    |                                       | <del>32</del> 30,1   |
|                    |                                          | 5                    |                                       | <del>35,5</del> 33,3 |
| 63                 | 10 up to and including 25                | 2                    | 13                                    | <del>31,5</del> 30,7 |
|                    |                                          | 3                    |                                       | <del>34</del> 33,0   |
|                    |                                          | 4                    |                                       | <del>37,5</del> 36,6 |
|                    |                                          | 5                    |                                       | <del>41,5</del> 40,4 |

NOTE The limits of external diameter of cables specified in this table are based on type 60227 IEC 10 according to IEC 60227-4 and type 60245 IEC 66 according to IEC 60245-4 and are given for information.

### 13.13 Provision for back entry from a conduit

If ~~ordinary~~ surface-type switches are intended for back entry from a conduit, they shall be so designed that they have provision for back entry from a conduit perpendicular to the mounting surface of the switch.

*Compliance is checked by inspection.*

### 13.14 Switch provided with membranes or the like for inlet openings

If the switch is provided with membranes or the like for inlet openings, they shall be replaceable.

*Compliance is checked by inspection.*

### 13.15 Requirements for membranes in inlet openings

**13.15.1** Membranes shall be reliably fixed and shall not be displaced by the mechanical and thermal stresses occurring in normal use.

*Compliance is checked by the following test:*

*Membranes are tested when assembled in the switches.*

*First the switches are fitted with membranes which have been subjected to the treatment specified in 15.1.*

*The switches are then placed for 2 h in a heating cabinet as described in 15.1, the temperature being maintained at  $(40 \pm 2) ^\circ\text{C}$ .*

*Immediately after this period, a force of 30 N is applied for 5 s to various parts of the membranes by means of the tip of ~~a straight unjointed test finger of the same dimensions as the standard test finger shown in figure 9~~ test probe 11 of IEC 61032.*

*During these tests, the membranes shall not deform to such an extent that the live parts become accessible.*

*For membranes likely to be subjected to an axial pull in normal use, an axial pull of 30 N is applied for 5 s.*

*During this test, the membranes shall not come out.*

*The test is then repeated with membranes which have not been subjected to any treatment.*

**13.15.2** It is recommended that membranes be so designed and made of such material that the introduction of the cables into the switch is permitted when the ambient temperature is low.

NOTE In the following countries, compliance with this requirement is considered as necessary, due to installation practices in cold conditions: SE, FI, DK and NO.

*Compliance is checked by the following test:*

*The switches are fitted with membranes which have not been subjected to any ageing treatment, those without opening being suitably pierced.*

*The switches are then kept, for 2 h, in a freezer at a temperature of  $(-15 \pm 2) ^\circ\text{C}$ .*

*After this period, the switches are removed from the freezer and immediately afterwards, while the switches are still cold, it shall be possible to introduce, without undue force, cables of the heaviest type, as declared by the manufacturer, through the membranes.*

After the tests of 13.15.1 and 13.15.2, the membranes shall show no harmful deformation, cracks or similar damage which would lead to non-compliance with this document.

### 13.16 Pilot light units

Pilot light units shall comply with IEC 60669-2-1:2002, IEC 60669-2-1:2002/AMD1:2008 and IEC 60669-2-1:2002/AMD2:2015, 101.1.1.1 and Clause 102, as far as applicable.

## 14 Mechanism

### 14.1 Indication of the position

The actuating member of a switch, when released, shall automatically take up the position corresponding to that of the moving contacts, except that for cord-operated switches and for those with a single push-button, the actuating member may take up a single rest position.

### 14.2 Rest and intermediate position

Switches shall be so constructed that the moving contacts can come to rest only in the "on" and "off" positions, an intermediate position being, however, permissible if it corresponds to the intermediate position of the actuating member, and if the insulation between the fixed and the moving contacts is then adequate.

If necessary, the insulation between the fixed and the moving contact, when in an intermediate position, is checked by an electric strength test as specified in 16.3, the test voltage being applied between the relevant terminals without removing the cover or cover plate of the switch.

*Compliance with the requirements of 14.1 and 14.2 is checked by inspection and by manual test.*

### 14.3 Undue arcing

Switches shall be so constructed that undue arcing cannot occur when the switch is operated slowly.

*Compliance is checked at the end of the test of 19.1, breaking the circuit a further ten times, the actuating member being, however, moved steadily by hand over a period of 2 s and moving contacts being stopped, if possible, in an intermediate position, the actuating member being then released.*

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

### 14.4 Making and breaking

Switches of pattern numbers 2, 3, 03 and 6/2 shall make and break all poles substantially simultaneously except that for switches of pattern number 03, the neutral shall not make after or break before the other poles.

*Compliance is checked by inspection and by manual test when the switch is mounted with the cover, cover plates and actuating members installed as for normal use.*

#### 14.5 Action of the mechanism without cover or cover plate

The action of the mechanism if the covers or cover plates are removable for installation purposes shall be independent of the presence of the cover or cover plate.

NOTE The actuating member, in some constructions, ~~may~~ can constitute the cover.

*Compliance is checked by connecting the switch, without cover or cover plate fitted, in series with a lamp and by pressing the actuating member without undue force as in normal use.*

*During the test, the lamp shall not flicker.*

#### 14.6 Pull force for cord-operated switches

Cord-operated switches shall be capable of effecting a change from the "off" to the "on" position, and from the "on" to the "off" position by application and removal of a steady pull not exceeding 45 N applied vertically and 65 N applied at  $45^\circ \pm 5^\circ$  to the vertical and in a plane perpendicular to the mounting surface when the switches are mounted as in normal use as specified by the manufacturer.

*Compliance is checked by manual test.*

NOTE — ~~The wording "as in normal use" implies that the switch is mounted as specified by the manufacturer.~~

### 15 Resistance to ageing, ~~to harmful ingress of water~~ protection provided by enclosures of switches and resistance to humidity

#### 15.1 Resistance to ageing

Switches shall be resistant to ageing.

Parts intended for decorative purposes only, such as certain lids, shall be removed if possible and these parts are not subjected to the test.

*Compliance is checked by the following test:*

*Switches and boxes, mounted as for normal use, are subjected to a test in a heating cabinet with an atmosphere having the composition and pressure of the ambient air and ventilated by natural circulation.*

*Switches ~~other than ordinary~~ having an IP code higher than IPX0 are tested after having been mounted and assembled as ~~prescribed~~ specified in 15.2.2.*

*The temperature in the cabinet is maintained at  $(70 \pm 2)^\circ\text{C}$ .*

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

*The use of an electrically heated cabinet is recommended.*

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

*After the treatment, the specimens are removed from the cabinet and kept at room temperature and at a relative humidity between 45 % and 55 % for at least 4 days (96 h).*

*The specimens shall show no crack visible with normal or corrected vision without additional magnification, nor shall the material have become sticky or greasy, this being judged as follows:*

*With the forefinger wrapped in a dry piece of rough cloth the specimen is pressed with a force of 5 N.*

*No traces of the cloth shall remain on the specimen and the material of the specimen shall not stick to the cloth.*

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

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

The specimen is placed on one of the pans of a balance and the other pan is loaded with a mass equal to the mass of the specimen plus 500 g.

Equilibrium is then restored by pressing the specimen with the forefinger wrapped in a dry piece of rough cloth.

## **~~15.2 Resistance to harmful ingress of water~~**

~~The enclosure of switches other than ordinary shall provide a degree of protection against harmful ingress of water in accordance with the classification of the switches.~~

~~Compliance is checked by the following tests.~~

~~15.2.1 The surface-type switches are mounted on a vertical surface with the open drain hole in the lowest position.~~

~~Flush-type and semi-flush-type switches are fixed vertically in an appropriate box which is placed in a recess in a block of hardwood.~~

~~Unenclosed switches are tested under simulated conditions of normal use, taking into account the manufacturer's instructions.~~

~~Switches with screwed glands or membranes are fitted and connected with cables within the connecting range specified in table 2.~~

~~Fixing screws for enclosures are tightened with a torque equal to two-thirds of the appropriate value given in table 3.~~

~~Glands are tightened with a torque equal to two-thirds of that applied during the test of 20.3.~~

~~Parts which can be removed without the aid of a tool are removed.~~

NOTE — Glands are not filled with sealing compound or the like.

~~15.2.2 Splash-proof switches are subjected to the test specified for the degree of protection IPX4, according to the requirements of IEC 60529.~~

~~15.2.3 Jet-proof switches are subjected to the test specified for the degree of protection IPX5, according to the requirements of IEC 60529.~~

~~If the enclosure is designed with drain holes, one drain hole, as in normal use, shall be opened.~~

~~Immediately after the tests specified in 15.2.2 and 15.2.3, the specimens shall withstand an electric strength test as specified in 16.2 and inspection shall show that water has not entered the specimens to any appreciable extent and has not reached any live part.~~

## **15.2 Protection provided by enclosures of switches**

### **15.2.1 General**

The enclosure of the switch shall provide protection against access to hazardous parts, against harmful effect due to ingress of solid foreign objects and against effects due to ingress of water in accordance with the IP classification of the switch.

*Compliance is checked by the tests of 15.2.2 and 15.2.3.*

### **15.2.2 Protection against access to hazardous parts and against harmful effects due to ingress of solid foreign objects**

#### **15.2.2.1 General**

Enclosures of switches shall provide a degree of protection against access to hazardous parts and against harmful effects due to ingress of solid foreign objects in accordance with the IP classification of the switch.

*Compliance is checked by the appropriate tests of IEC 60529 under the conditions specified below.*

*The switches are mounted as in normal use.*

*Flush-type and semi-flush-type switches are mounted in an appropriate box according to the manufacturer's instructions.*

*Switches with screwed glands or membranes are fitted and connected with cables within the connecting range specified in Table 4. Glands are tightened with a torque equal to two-thirds of that applied during the test of 20.4.*

*Screws of the enclosure are tightened with a torque equal to two-thirds of the values given in Table 5.*

*Parts which can be removed without the aid of a tool are removed.*

*If a switch passes the test successfully, then this test is deemed to be passed for a combination of such single switches.*

*Glands are not filled with sealing compound or the like.*

#### **15.2.2.2 Protection against access to hazardous parts**

*The appropriate test specified in IEC 60529 is performed (see also Clause 10).*

#### **15.2.2.3 Protection against harmful effects due to ingress of solid foreign bodies**

*The appropriate test according to IEC 60529 is performed.*

*Test probes are not applied to drain holes.*

*For the test of the first characteristic numeral 5, enclosures of switches are considered to be of category 2 (see IEC 60529:1989 and IEC 60529:1989/AMD1:1999, 13.4); dust shall not penetrate in a quantity to interfere with satisfactory operation or impair safety.*

*For the test of the first characteristic numeral 6, enclosures of switches are considered to be of category 1 (see IEC 60529:1989, 13.6); no dust shall penetrate.*



### 15.2.3 Protection against harmful effects due to ingress of water

*Enclosures of switches shall provide a degree of protection against harmful effects due to ingress of water in accordance with their IP classification.*

*Compliance is checked by the appropriate tests of IEC 60529 under the conditions specified below.*

*Flush-type and semi-flush-type switches are fixed in a test wall representing the intended use of the switch using an appropriate box in accordance with the manufacturer's instructions.*

*Where the manufacturer's instructions specify particular types of walls, these walls as well as any special installation requirements for the switch, shall be described in sufficient detail (see 8.7).*

*Where the manufacturer's instructions do not specify a type of wall, the test wall according to Figure 21 is used. It is made with bricks having flat smooth surfaces. When the box is mounted in the test wall, it shall fit tight against the wall so that water cannot enter between the box and the wall.*

*If sealing material is used in order to seal the box into the wall, it shall not influence the sealing properties of the specimen to be tested.*

NOTE Figure 21 shows an example where the edge of the box is positioned in the reference plane. Other positions are possible according to the manufacturer's instructions.

*The test wall is placed in a vertical position.*

*Surface-type switches are mounted as in normal use on a vertical surface and fitted with cables with conductors whose largest and smallest cross-sectional area is given in Table 4, as appropriate for their rating.*

*Screws of the enclosure operated when mounting the switch are tightened with a torque equal to two-thirds of the appropriate value given in Table 5.*

*Glands are tightened with a torque equal to two-thirds of the appropriate value given in Table 22.*

*Glands are not filled with sealing compound or the like.*

*Parts which can be removed without the aid of a tool are removed.*

*If the enclosure of a switch that has an IP code less than IPX5 is designed with drain holes, one drain hole is opened and in the lowest position. If an enclosure of a switch that has an IP code equal to or greater than IPX5 is designed with drain holes, they shall not be opened.*

*Care should be taken not to disturb, for example knock or shake, the assembly to such an extent as to affect test results.*

*If the switch has drain holes which have been opened, it shall be proved by inspection that any water which enters does not accumulate and that it drains away without doing any harm to the complete assembly.*

*The specimens shall withstand an electric strength test as specified in 16.3, which shall be started within 5 min of completion of the tests according to 15.2.*



### 15.3 Resistance to humidity

*Switches shall be proof against humidity which may occur in normal use.*

*Compliance is checked by the humidity treatment described in 15.3, followed immediately by the measurement of the insulation resistance and by the electric strength test specified in Clause 16.*

*Inlet openings, if any, are left open; if knock-outs are provided, one of them is opened.*

*Parts which can be removed without the aid of a tool are removed and subjected to the humidity treatment with the main part; spring lids are open during this treatment.*

*The humidity treatment is carried out in a humidity cabinet containing air with relative humidity maintained between 91 % and 95 %.*

*The temperature of the air in which the specimens are placed is maintained within  $\pm 1$  K of any convenient value  $t$  between 20 °C and 30 °C.*

*Before being placed in the humidity cabinet, the specimens are brought to a temperature between  $t$  and  $t + 4$  °C.*

*The specimens are kept in the cabinet for*

- two days (48 h) for ~~ordinary~~ switches that have an IP code IPX0;*
- seven days (168 h) for switches ~~other than ordinary~~ that have an IP code higher than IPX0.*

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

**NOTE 2** A relative humidity between 91 % and 95 % can be obtained by placing in the humidity cabinet a saturated solution of sodium sulphate ( $\text{Na}_2\text{SO}_4$ ) or potassium nitrate ( $\text{KNO}_3$ ) in water having a sufficiently large contact surface with the air.

**NOTE 3** ~~In order to achieve the specified conditions within the cabinet, it is necessary to ensure constant circulation of the air within and, in general, to use a cabinet which is thermally insulated.~~

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

## 16 Insulation resistance and electric strength

### 16.1 General

The insulation resistance and electric strength of switches shall be adequate.

*One pole of any pilot light is disconnected for the test of Clause 16.*

*Compliance is checked by the following tests, which are made immediately after the tests of 15.3, in the humidity cabinet or in the room in which the specimens were brought to the prescribed temperature, after reassembly of those parts which can be removed without the aid of a tool and were removed for the test.*

### 16.2 Test for measuring the insulation resistance

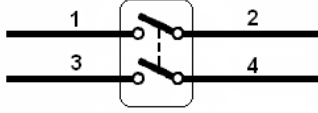
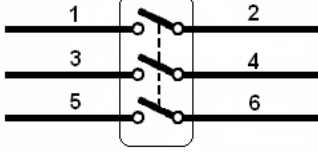
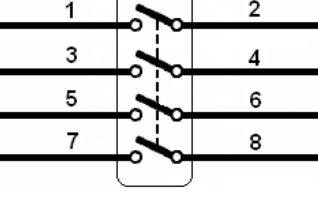
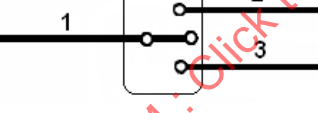
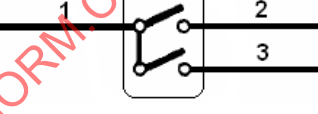
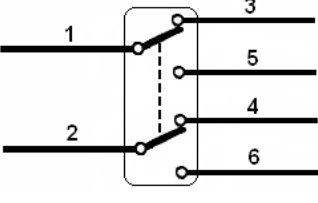
*The insulation resistance is measured with a DC voltage of approximately 500 V, the measurement being made **not more than** 1 min after application of the voltage.*

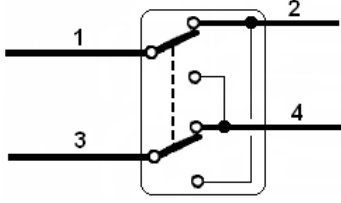
*The measurements are made consecutively for items 1, 2 and 3 of Table 15 with the switch position and the necessary connections as shown in Table 14.*

*In addition, if electrically independent pattern numbers are combined in a common base the measurements are made between all terminals of one pattern number connected together and to the body and to all terminals of the other pattern numbers connected together. This is repeated for each contact position and for each pattern number of the combination. The minimum insulation resistance shall be 5 M $\Omega$ .*

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**Table 14 – Points of application of the test voltage  
for the verification of insulation resistance and electric strength**

| Pattern number | Diagrams of connections                                                                                                                   | Position | Number of poles | Application of the voltage <sup>a</sup> |                                                             |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------|-----------------------------------------|-------------------------------------------------------------|
|                |                                                                                                                                           |          |                 | Between Terminal No.                    | Between body (B) together with terminal No.                 |
| 1              |  <p>Single-pole switch</p>                               | Off      | 1               | 1<br>2                                  | B + 2<br>B + 1                                              |
|                |                                                                                                                                           | On       |                 | 1 – 2                                   | B                                                           |
| 2              |  <p>Two-pole switch</p>                                  | Off      | 2               | 1 + 3<br>2 + 4                          | B + 2 + 4<br>B + 1 + 3                                      |
|                |                                                                                                                                           | On       |                 | 1 – 2<br>1 – 2 + 3 – 4                  | B + 3 – 4<br>B                                              |
| 3              |  <p>Three-pole switch</p>                                | Off      | 3               | 1 + 3 + 5<br>2 + 4 + 6                  | B + 2 + 4 + 6<br>B + 1 + 3 + 5                              |
|                |                                                                                                                                           | On       |                 | 1 – 2<br>3 – 4<br>5 – 6                 | B + 3 – 4 + 5 – 6<br>B + 1 – 2 + 5 – 6<br>B + 1 – 2 + 3 – 4 |
| 03             |  <p>Three-pole plus switched neutral</p>               | Off      | 4               | 1 + 3 + 5 + 7<br>2 + 4 + 6 + 8          | B + 2 + 4 + 6 + 8<br>B + 1 + 3 + 5 + 7                      |
|                |                                                                                                                                           | On       |                 | 1 – 2 + 5 – 6<br>1 – 2 + 7 – 8          | B + 3 – 4 + 7 – 8<br>B + 3 – 4 + 5 – 6                      |
| 4              |  <p>Two-way switch with one off position</p>           | Off      | 1               | 1                                       | B + 2 + 3                                                   |
|                |                                                                                                                                           | On       |                 | 1 – 2<br>1 – 3                          | B + 3<br>B + 2                                              |
| 5              |  <p>Two-circuit switch with a common incoming line</p> | Off      | 1               | 2 + 3<br>1                              | B + 1<br>B + 2 + 3                                          |
|                |                                                                                                                                           | On       |                 | 1 – 3<br>1 – 2 – 3                      | B + 2<br>B                                                  |
| 6              |  <p>Two-way switch</p>                                 | –        | 1               | 1 – 3<br>1 – 2                          | B + 2<br>B + 3                                              |
| 6/2            |  <p>Two-way double-pole switch</p>                     | –        | 2               | 1 – 3 + 2 – 4<br>1 – 5 + 2 – 6          | B + 5 + 6<br>B + 3 + 4                                      |

| Pattern number                                                                                                     | Diagrams of connections                                                                                                                    | Position | Number of poles | Application of the voltage <sup>a</sup> |                                                  |
|--------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------|-----------------------------------------|--------------------------------------------------|
|                                                                                                                    |                                                                                                                                            |          |                 | Between Terminal No.                    | Between body (B) together with terminal No.      |
| 7                                                                                                                  |  <p>Two-way reversing switch (or intermediate switch)</p> | –        | 1               | 1 – 2<br>3 – 4<br>1 – 4<br>2 – 3        | B + 3 – 4<br>B + 1 – 2<br>B + 2 – 3<br>B + 1 – 4 |
| <sup>a</sup> – denotes an existing electrical connection.<br>+ denotes an electrical connection made for the test. |                                                                                                                                            |          |                 |                                         |                                                  |

The term "body" includes accessible metal parts, metal frames supporting the base of flush-type switches, operating keys, metal foil in contact with the outer surface of accessible external parts and operating keys of insulating material, the point of anchorage of the cord, chain or rod for switches operated by such means, fixing screws of ~~bases~~ main parts or covers and cover plates, external assembly screws, earthing terminals and any metal part of the mechanism if required to be insulated from live parts (see 10.4).

For the measurements according to items 1 and 2, the metal foil is applied in such a way that sealing compound is effectively tested.

The test according to item 5 is only made if any insulating lining is necessary to provide insulation.

The insulation resistance shall be not less than the values shown in Table 15.

**NOTE** While wrapping the metal foil round the outer surface or placing it in contact with the inner surface of parts of insulating material, it is pressed against holes or grooves without any appreciable force, by means of ~~a straight unjointed test finger having the same dimensions as the standard test finger shown in figure 9~~ test probe 11 of IEC 61032.

### 16.3 Electric strength test

The insulation is subjected for 1 min to a voltage of substantially sine wave form, having a frequency of 50 Hz or 60 Hz.

~~The value of the test voltage and the points of application are shown in Table 14.~~

The tests are made consecutively as indicated in Table 14 at points of application as described in Table 15, the switch position and the necessary connections for items 1, 2 and 3 of Table 15 being as shown in Table 14.

In addition, if electrically independent pattern numbers are combined in a common base the test is made between all terminals of the one pattern number connected together and to the body and to all terminals of the other pattern numbers connected together. This is repeated for each contact position and for each pattern number of the combination. The test voltage applied shall be 1 250 V for ratings not exceeding 130 V or 2 000 V for ratings greater than 130 V.

Initially, not more than half the prescribed voltage is applied; then it is raised rapidly to the full value. No flashover or breakdown shall occur during the test.

**NOTE 1** The high-voltage transformer used for the test ~~should~~ *shall* be so designed that, when the output terminals are short-circuited after the output voltage has been adjusted to the appropriate test voltage, the output current is at least 200 mA.

**NOTE 2** The overcurrent relay shall not trip when the output current is less than 100 mA.

**NOTE 3** ~~Care should be taken that~~ The rms value of the test voltage applied ~~is~~ *shall be* measured with ~~in~~ *an accuracy of*  $\pm 3$  %.

**NOTE 4** Glow discharges without drop in voltage ~~are~~ *shall be* neglected.

**NOTE** In the following country the test of item 8 in Table 15 is conducted between live parts and metal knobs, push-buttons and metal foil in contact with the outer surface of accessible external parts and operating keys of insulating material: AU.

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**Table 15 – Test voltage, points of application and minimum values of insulating resistance for the verification of dielectric strength**

| Insulation to be tested                                                                                                                                                                                                                                                                                                            | Minimum value<br>of insulation<br>resistance<br><br>MΩ | Test voltage<br>V                                            |                                                          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|--------------------------------------------------------------|----------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                    |                                                        | Switches having<br>a rated voltage<br>not exceeding<br>130 V | Switches having<br>a rated voltage<br>exceeding<br>130 V |
| 1 Between all poles connected together and the body, with the switch in the "on" position.                                                                                                                                                                                                                                         | 5                                                      | 1 250                                                        | 2 000                                                    |
| 2 Between each pole in turn and all other poles connected to the body, with the switch in the "on" position.                                                                                                                                                                                                                       | 2                                                      | 1 250                                                        | 2 000                                                    |
| 3 Between the terminals which are electrically connected together when the switch is in the "on" position, the switch being in the "off" position:                                                                                                                                                                                 |                                                        |                                                              |                                                          |
| – normal/mini-gap construction;                                                                                                                                                                                                                                                                                                    | 2                                                      | 1 250                                                        | 2 000                                                    |
| – micro-gap construction;                                                                                                                                                                                                                                                                                                          | 2                                                      | 500 (note 1)                                                 | 1 250 (note 2)                                           |
| – semiconductor switching devices.                                                                                                                                                                                                                                                                                                 | (note 3)                                               | (note 3)                                                     | (note 3)                                                 |
| 4 Between metal parts of the mechanism, when insulated from live parts, and                                                                                                                                                                                                                                                        |                                                        |                                                              |                                                          |
| – live parts;                                                                                                                                                                                                                                                                                                                      | 5                                                      | 1 250                                                        | 2 000                                                    |
| – metal foil in contact with the surface of the knob or a similar actuating member;                                                                                                                                                                                                                                                | 5                                                      | 1 250                                                        | 2 000                                                    |
| – the key of key-operated switches, if insulation is required (see 10.6);                                                                                                                                                                                                                                                          | 5                                                      | 1 250                                                        | 2 000                                                    |
| – the point of anchorage of the cord, chain or rod of switches operated by such means, if insulation is required (see 10.6);                                                                                                                                                                                                       | 5                                                      | 1 250                                                        | 2 000                                                    |
| – accessible metal parts, including fixing screws, of the <del>base</del> main part, if insulation is required (see 10.5).                                                                                                                                                                                                         | 5                                                      | 1 250                                                        | 2 000                                                    |
| 5 Between any metal enclosure and metal foil in contact with the inner surface of its insulating linings, if any (note 4).                                                                                                                                                                                                         | 5                                                      | 1 250                                                        | 2 000                                                    |
| 6 Between live parts and accessible metal parts, if the metal parts of the mechanism are not insulated from live parts.                                                                                                                                                                                                            | –                                                      | <del>1 250</del> 2 000                                       | 3 000                                                    |
| 7 Between live parts and parts of the mechanism                                                                                                                                                                                                                                                                                    |                                                        |                                                              |                                                          |
| – if the latter parts are not insulated from accessible metal parts (see 10.5);                                                                                                                                                                                                                                                    | –                                                      | 2 000                                                        | 3 000                                                    |
| – if the latter parts are not insulated from the point of contact with a removable key or operating cord, chain or rod (see 10.6).                                                                                                                                                                                                 | –                                                      | 2 000                                                        | 3 000                                                    |
| 8 Between live parts and metal knobs, push-buttons and the like (see 10.2).                                                                                                                                                                                                                                                        | –                                                      | 2 500                                                        | 4 000                                                    |
| NOTE 1 This value also applies for the electric strength test after normal operation.                                                                                                                                                                                                                                              |                                                        |                                                              |                                                          |
| NOTE 2 For switches having a rated voltage up to and including 250 V, this value is reduced to                                                                                                                                                                                                                                     |                                                        |                                                              |                                                          |
| – 750 V for the electric strength test after resistance to humidity;                                                                                                                                                                                                                                                               |                                                        |                                                              |                                                          |
| – 500 V for the electric strength test after normal operation.                                                                                                                                                                                                                                                                     |                                                        |                                                              |                                                          |
| NOTE 3 Tests for the verification to the "off" position of semiconductor switching devices according to item 3 are under consideration.                                                                                                                                                                                            |                                                        |                                                              |                                                          |
| NOTE 4 This test is only made if any insulation is necessary.                                                                                                                                                                                                                                                                      |                                                        |                                                              |                                                          |
| NOTE 5 In the following country the test of item 8 is conducted between live parts and metal knobs, push-buttons and metal foil in contact with the outer surface of accessible external parts and operating keys of insulating material. The test voltage for switches with a rating voltage exceeding 130 V is to be 3 000 V: AU |                                                        |                                                              |                                                          |

## 17 Temperature rise

### 17.1 General

Switches shall be so constructed that the temperature rise in normal use is not excessive.

The metal and the design of the contacts shall be such that the operation of the switch is not adversely affected by oxidation or any other deterioration.

*Compliance is checked by the following test:*

*The switches are mounted vertically as in normal use fitted with PVC insulated rigid solid or stranded copper conductors as specified in Table 16, the terminal screws or nuts being tightened with a torque equal to two-thirds of that specified in Table 5.*

To ensure normal cooling of the terminal, the conductors connected to them shall have a length of at least 1 m.

~~NOTE 1 – The rigid conductor may be solid or stranded, as applicable.~~

*The switches are loaded for 1 h with alternating current having the value shown in Table 16.*

**Table 16 – Temperature-rise test currents and cross-sectional areas of copper conductors**

| Rated current<br>A | Test current<br>A | Nominal cross-sectional<br>area of conductors<br>mm <sup>2</sup> |
|--------------------|-------------------|------------------------------------------------------------------|
| 1                  | 1,5               | 0,5                                                              |
| 2                  | 3                 | 0,75                                                             |
| 4                  | 5                 | 1                                                                |
| 6                  | 8                 | 1,5                                                              |
| 10                 | 13,5              | 2,5                                                              |
| 13                 | 17                | 2,5                                                              |
| 16                 | 20                | 4 <sup>a</sup>                                                   |
| 20                 | 25                | 4                                                                |
| 25                 | 32                | 6                                                                |
| 32                 | 38                | 10                                                               |
| 40                 | 46                | 16                                                               |
| 45                 | 51                | 16                                                               |
| 50                 | 57,5              | 16                                                               |
| 63                 | 75                | 25                                                               |

<sup>a</sup> For switches having a rated voltage not exceeding 250 V, other than those of pattern numbers 3 and 03, ~~and when terminals for rated current 10 A are used~~ provided with screwless terminals, the test shall be carried out with conductors having a cross-sectional area of 2,5 mm<sup>2</sup>.

NOTE 1 The test currents for switches having other rated currents are determined by interpolation between the next lower and higher ratings.

*For switches of pattern numbers 4, 5, 6, 6/2 and 7, only one circuit is loaded.*

*Flush-mounted switches are mounted in flush-mounted boxes. The box is placed in a block of pinewood filled around the box with plaster so that the front edge of the box does not protrude and is not more than 5 mm below the front surface of the pinewood block.*

**NOTE 3** *The test assembly should be allowed to dry for at least 7 days when first made.*

*The size of the pinewood block, which may be fabricated from more than one piece, shall be such that there is at least 25 mm of wood surrounding the plaster, the plaster having a thickness between 10 mm and 15 mm around the maximum dimensions of the sides and rear of the box.*

**NOTE 2** *The sides of the cavity in the pinewood block ~~may~~ can have a cylindrical shape.*

*The cables connected to the switch shall enter through the top of the box, the point(s) of entry being sealed to prevent the circulation of air. The length of each conductor within the box shall be  $(80 \pm 10)$  mm.*

*Surface-type switches shall be mounted centrally on the surface of a wooden block, which shall be at least 20 mm thick, 500 mm wide and 500 mm high.*

*Other types of switches shall be mounted according to the manufacturer's instructions or, in the absence of such instructions, in the position of normal use considered to give the most onerous conditions.*

*The test assembly shall be placed in a draught-free environment for the test.*

*The temperature is determined by means of melting particles, colour changing indicators or thermocouples, so chosen and positioned that they have negligible effect on the temperature being determined.*

*The temperature rise of the terminals shall not exceed 45 K.*

*During the test, the temperature rise necessary to perform the test of 21.4 shall be determined.*

**NOTE 3** *~~Undue oxidation of the contacts may be prevented by~~ Sliding action or ~~by~~ the use of silver or silver-faced contacts prevents undue oxidation of the contacts.*

**NOTE 6** *~~Pellets of beeswax (melting point 65 °C) with a diameter of 3 mm may be used as melting particles.~~*

**NOTE 7** *In the case of combination of switches, the test is carried out separately on each switch.*

## 17.2 Switches incorporating pilot lights

Switches incorporating pilot lights or intended to incorporate pilot lights shall be so designed that in normal use the temperature of accessible surfaces is not excessive.

*Compliance is checked by the following test:*

*The switch is mounted and connected as in 17.1 with the pilot light supplied at rated voltage so that it is constantly illuminated for 1 h. The switch is loaded at its rated current.*

*The temperature rise of the external surface of the switch shall not exceed:*

- 45 K for knobs, handles, sensing surfaces, etc., of non-metallic material;
- 55 K for other external parts of non-metallic material;
- 35 K for knobs, handles, sensing surfaces, etc., of metallic material;
- 45 K for other external parts of metallic material.

*Pilot lights using neon lamps or LEDs consuming no more than 3 mA are not tested.*



## 18 Making and breaking capacity

### 18.1 General

Switches shall have adequate making and breaking capacity.

*For the purpose of this test, pilot lights are disconnected.*

*Compliance is checked by the test of 18.2. In addition, for switches having a rated current not exceeding 16 A with a rated voltage up to and including 250 V and for switches of pattern numbers 3 or 03 having a rated voltage over 250 V, by the tests of 18.3.*

*Cord-operated switches shall be tested mounted as in normal use and with a pull of a value adequate to operate the cord-operated switch, but not exceeding 50 N, on the cord throughout the test, at  $30^\circ \pm 5^\circ$  to the vertical and in a plane perpendicular to the mounting surface.*

*The tests are made by means of an apparatus ~~the principle of which is as shown in figure 12.~~*

*The connections are shown in Figure 11.*

*For switches of pattern number 7, one side is tested as pattern number 6. The test is repeated on the other side of a new set of specimens if the other side is not identical.*

*For switches of pattern numbers 6, 6/2 and 7, the selector switch S shown in Figure 11 is moved after the fraction of the total number of operations indicated in Table 17.*

*Switches are fitted with conductors as for the test of Clause 17.*

**NOTE** In the following country, switches intended to control the inrush current of motors are tested according to 13.13 (Motor Control Test) of AS/NZ 3133:2013: AU.

### 18.2 Overload

Switches are tested at 1,1 times the rated voltage and 1,25 times the rated current.

*The tolerance for the test voltage and test current is  $\begin{smallmatrix} +5 \\ 0 \end{smallmatrix}$  %.*

*They are subjected to 200 operations at a uniform rate of*

- *30 operations per minute if the rated current does not exceed ~~10~~ 13 A;*
- *15 operations per minute if the rated current exceeds ~~10~~ 13 A but is less than 25 A;*
- *7,5 operations per minute if the rated current is 25 A or more.*

*The on period shall be  $(25 \begin{smallmatrix} +5 \\ 0 \end{smallmatrix})$  % of the total cycle and the off period  $(75 \begin{smallmatrix} 0 \\ -5 \end{smallmatrix})$  %.*

*For rotary switches intended to be operated in either direction, the actuating member is turned in one direction for half the total number of operations and in the reverse direction for the remainder.*

*Switches are tested using an alternating current having a  $\cos \varphi$  of  $0,3 \pm 0,05$ . Resistors and inductors are not connected in parallel, except that, if an air core inductor is used, a resistor taking approximately 1 % of the current through the inductor is connected in parallel with it.*

*Iron core inductors may be used, provided the current is of substantially sine wave form.*

For three phase tests, three core inductors are used.

The metal support of the switch, if any, on which the switch is mounted, and the accessible metal parts of the switch, if any, shall be earthed through a wire fuse which shall not blow during the test. The fuse element shall consist of a copper wire of 0,1 mm in diameter and not less than 50 mm in length.

~~For switches of pattern Nos 6, 6/2 and 7, the selector switch S shown in figure 13 is moved after the fraction of the total number of operations indicated in table 16.~~

**Table 17 – Fractions of total number of operations**

| Pattern number | Type of switch          | Fraction for switch S |
|----------------|-------------------------|-----------------------|
| 1, 2, 4 or 5   | Rotary, both directions | –                     |
|                | Other types             | –                     |
| 3 or 03        | Rotary, both directions | –                     |
|                | Other types             | –                     |
| 6, 6/2 or 7    | Rotary, both directions | 1/4 and 3/4           |
|                | Other types             | 1/2                   |

Switches of pattern number 5 with a single ~~mechanism~~ actuating member are operated 200 times with one circuit loaded with rated current ( $I_n$ ) and the other with 0,25  $I_n$  and 200 times with each circuit loaded with 0,625  $I_n$ .

Switches of pattern number 5 with two independent ~~mechanisms~~ actuating members are tested as two switches of pattern number 1, the tests being made consecutively. If both circuits are identical, only one circuit need be tested.

While testing one part, the other part is in the "off" position.

Switches of pattern number 4 shall be tested for half the number of operations on one way and half the number of operations on the other way.

During the test, no sustained arcing nor welding of the contacts shall occur.

Sticking of the contacts which does not prevent further operation of the switch is not regarded as welding.

Sticking of contacts is permitted if the contacts can be separated with a force applied to the actuator of a value which does not damage the switch mechanically.

For the purpose of this test, blows which are intended to separate welded contacts are not permitted.

After the test, the specimens shall show no damage which may impair their use.

Breakage of the replaceable pull cord not involving the part entering the cord-operated switch shall not be considered a failure to pass the test.

**NOTE 1** Care ~~should be~~ is taken that the test apparatus makes the actuating member of the switch operate smoothly and does not interfere with the normal action of the switch mechanism and the free movement of the actuating member.

**NOTE 2** During the test, the specimens are not lubricated.

### 18.3 Overload test with filament lamps

Switches are normally tested at the rated voltage and at 1,2 times the rated current.

The test is carried out by using *either* a number of 200 W tungsten filament lamps or a number of halogen filament lamps.

*As the characteristics of halogen filament lamps of different power are equivalent, lamps of any power can be used to reach the rated load.*

*If filament lamps with rated voltage equal to the rated voltage of the switch are not available, filament lamps with the nearest lower voltage shall be used.*

**NOTE 1** It is recommended that the rated voltage of the filament lamps be no lower than 95 % of the rated voltage of the switch.

The test voltage shall be the rated voltage of the lamps. The number of lamps shall be the smallest number giving a test current not less than 1,2 times the rated current of the switch.

Available short-circuit current shall be at least 1 500 A. The other conditions shall be as specified in 18.2.

During the test, no sustained arcing nor welding of the contacts shall occur.

**NOTE 2** Sticking of the contacts which does not prevent ~~the next~~ further operation of the switch is not ~~considered~~ regarded as welding.

*Sticking of contacts is permitted if the contacts can be separated with a force applied to the actuator of a value which does not damage the switch mechanically.*

*For the purpose of this test, blows which are intended to separate welded contacts are not permitted.*

After the test, the specimens shall show no damage which may impair their further use.

EXAMPLE 10 A 250 V switches have to be tested.

The largest available rated voltage of 200 W tungsten filament lamps is 240 V.

The test voltage is then 240 V and the number of lamps is

$$\frac{240 \times 1,2 \times 10}{200} = 14,4 \rightarrow 15$$

## 19 Normal operation

### 19.1 Test for switches intended for inductive loads

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

*For the purpose of this test, pilot lights are disconnected.*

Compliance is checked by the following test.

The switches are tested at rated voltage and rated current in the apparatus and with the connections specified in Clause 18.

The tolerance for the test voltage and test current is  $^{+5}_0$  %.

The circuit details and the manner of operation of the selector switch S are described in 18.2, unless otherwise specified.

The number of operations is shown in Table 18.

**Table 18 – Number of operations for normal operation test**

| Rated current                                                                                                                           | Number of operations |
|-----------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| Up to and including 16 A, for switches having a rated voltage not exceeding 250 V <del>a.c.</del> , except for pattern numbers 3 and 03 | 40 000               |
| Up to and including 16 A, for switches having a rated voltage exceeding 250 V <del>a.c.</del> , and for pattern numbers 3 and 03        | 20 000               |
| Over 16 A up to and including <del>40</del> 50 A                                                                                        | 10 000               |
| Over <del>40</del> 50 A                                                                                                                 | 5 000                |

The rate of operation is as specified in 18.2.

The on period shall be  $(25^{+5}_0)$  % of the total cycle and the off period  $(75^{0}_{-5})$  %.

For rotary switches of pattern number 5 intended to be operated in either direction, the actuating member is turned in one direction for half the total number of operations and in the reverse direction for the remainder.

For other rotary switches intended to be operated in either direction, three quarters of the total number of operations are effected in the clockwise direction and the remainder in the reverse direction.

Cord-operated switches shall be tested mounted as in normal use and with a pull of a value adequate to operate the cord-operated switch, but not exceeding 50 N, on the cord throughout the test at  $30^\circ \pm 5^\circ$  to the vertical and in a plane perpendicular to the mounting surface.

Switches are tested using an alternating current having a  $\cos \varphi$  of  $0,6 \pm 0,05$ .

Switches of pattern number 2 are tested ~~for the first set of three specimens~~ with the poles connected in series as shown in Figure 11.

~~For the second set of three specimens only one pole is tested at full load at half the number of operations. If the two poles are not identical, the test has to be repeated for the other pole.~~

The two circuits of switches of pattern number ~~4 and~~ 5 are tested as two switches of pattern number 1. If both circuits are identical, only one circuit need be tested.

For switches of pattern number 5 with a single ~~mechanism~~ actuating member, each circuit is loaded with 0,5 times the rated current.

Switches of pattern numbers 4 and 6 shall be tested for half the number of operations on one ~~pole~~ way and half the number of operations on the other ~~pole~~ way.

Switches of pattern number 6/2 are tested as one switch of pattern number 6 if the two pairs of poles are identical. Otherwise, they are tested as two switches of pattern number 6.

*For switches of pattern number 7 ~~are tested as a double switch of~~ one side is tested as pattern number 6. ~~While testing one part, the other part is in the "off" position.~~*

*The second set of specimens used for the test of Clause 18 is submitted to this test on the side already tested.*

*The test specimens shall be connected to the test circuit with cables of length ~~0,3 m ± 0,015~~ (1 ± 0,1) m ~~so that the temperature rise measurement can be made without disturbing the terminals.~~*

*During the test, the specimens shall function correctly.*

*After the test, the specimens shall withstand an electric strength test as specified in Clause 16, ~~the test voltage of a nominal 4 000 V being, reduced by a nominal 1 000 V, and the other test voltages by a nominal 500 V,~~ and a terminal temperature rise test as specified in Clause 17, ~~the test current being reduced to the value of the rated current.~~*

*For the electric strength test, the test voltage of 4 000 V shall be reduced by 1 000 V and the other test voltages by 500 V. For the terminal temperature rise test, the test current shall be reduced to the value of the rated current and the only measurement made shall be at the terminals.*

*The specimens shall then not show*

- wear impairing their further use;*
- discrepancy between the position of the actuating member and that of the moving contacts, if the position of the actuating member is indicated;*
- deterioration of enclosures, insulating linings or barriers to such an extent that the switch cannot be further operated or that it no longer complies with the requirements of Clause 10;*
- seepage of sealing compound;*
- loosening of electrical or mechanical connections;*
- relative displacement of the moving contacts of switches of pattern numbers 2, 3, 03 or 6/2.*

NOTE The humidity treatment of 15.3 is not repeated before the electric strength test of 19.1.

**NOTE 2** *During the test, the specimens are not lubricated.*

*The test is followed by the test of 14.3.*

*Sticking of the contacts which does not prevent further operation of the switch is not regarded as welding.*

*Sticking of contacts is permitted if the contacts can be separated with a force applied to the actuator of a value which does not damage the switch mechanically.*

*During the test, no sustained arcing nor welding of the contacts shall occur.*

*For the purpose of this test, blows which are intended to separate welded contacts are not permitted.*

*Breakage of the replaceable pull cord not involving the part entering the cord-operated switch shall not be considered a failure to pass the test.*

## 19.2 Test for switches intended for externally ballasted lamp loads

Switches intended for ~~fluorescent~~ externally ballasted lamp loads shall withstand, without excessive wear or other harmful effect, the electrical and thermal stresses occurring when controlling ~~fluorescent~~ externally ballasted lamp circuits ~~with power factor correction, with load inserted between the test circuit terminals as indicated in figure 14, with the following test conditions.~~

*Compliance is checked by the test circuit indicated in Figure 12a with the following test conditions.*

The prospective short-circuit current of the supply shall be between 3 kA and 4 kA at  $\cos \varphi = 0,9 \pm 0,05$  (lagging).

*F* is a copper-wire fuse of 0,1 mm nominal diameter having a length not less than 50 mm.

*R*<sub>1</sub> is a resistor limiting the current to about 100 A.

The twin-core cable shall have a suitable length to give a resistance *R*<sub>3</sub> equal to 0,25 Ω in the test circuit to the load. It shall have a cross-sectional area of 1,5 mm<sup>2</sup> when switches with rated current up to and including ~~10~~ 13 A are being tested and 2,5 mm<sup>2</sup> when switches with rated current over ~~10~~ 13 A up to and including 20 A are being tested.

Load A shall consist of

- *C*<sub>1</sub>, a capacitor bank having a capacitance of 70 μF ± 10 % for 6 A switches and 140 μF ± 10 % for other switches. The capacitors shall be connected with 2,5 mm<sup>2</sup> conductors having the shortest possible length;
- *L*<sub>1</sub> and *R*<sub>2</sub>, an inductor and a resistor adjusted to give the power factor of 0,9 ± 0,05 (lagging) and the test current  $I_n^{+5}_0$  % through the specimen.

~~Load B shall consist of:~~

- ~~— a capacitor, *C*<sub>2</sub>, of 7,3 μF ± 10 %;~~
- ~~— an inductor, *L*<sub>2</sub>, of 0,5 H ± 0,1 H having a resistance of not more than 15 Ω measured using d.c.~~

NOTE The circuit parameters have been chosen to represent the ~~fluorescent~~ externally ballasted lamp loads used in most practical applications.

~~Compliance is checked by the following test.~~

For the test, new specimens are used.

The switches, ~~except those of pattern Nos 3 and 03,~~ are tested at rated voltage and at the rated current assigned by the manufacturer for the externally ballasted lamp loads in the test apparatus and with the connections specified in 18.2.

The tolerance of the test voltage is ± 5 % and that for the test current is  $I_n^{+5}_0$  %. The circuit details and the manner of operation of the selector switch *S* are as described in 18.2.

The number of operations is as follows:

For switches with a rated ~~fluorescent~~ externally ballasted lamp current of 6 A up to and including ~~10~~ 13 A: 10 000 operations with 30 operations per minute.

For switches with rated current above ~~10~~ 13 A up to and including 20 A: 5 000 operations with 15 operations per minute.

For rotary switches of pattern number 5 intended to be operated in either direction, the actuating member is turned in one direction for half the total number of operations and in the reverse direction for the remainder.

For other rotary switches intended to be operated in either direction, three quarters of the total number of operations are effected in the clockwise direction, and the remainder in the reverse direction.

Cord-operated switches shall be tested mounted as in normal use and with a pull of a value adequate to operate the cord-operated switch, but not exceeding 50 N, on the cord throughout the test at  $30^\circ \pm 5^\circ$  to the vertical and in a plane perpendicular to the mounting surface.

Switches of pattern number 2 are tested ~~for the first set of three specimens~~ with the poles connected in series.

~~For the second set of three specimens only one pole is tested for the full load at half the number of operations.~~

~~If the two poles are not identical, the test has to be repeated for the other pole.~~

The two ~~poles~~ circuits of switches of pattern number ~~4~~ and 5 are tested as two switches of pattern number 1. If the ~~poles~~ circuits are identical, only one ~~pole~~ circuit need be tested.

Switches of pattern numbers 4 and 6 shall be tested for half the number of operations on one ~~pole~~ way and half of the number of operations on the other ~~pole~~ way.

Switches of pattern number 6/2 are tested as one switch of pattern number 6, if the two pairs of poles are identical. Otherwise, they are tested as two switches of pattern number 6.

For switches of pattern number 7 ~~are tested as a double switch of~~, one side is tested as pattern number 6. The test is repeated on the other side of a new set of specimens if the other side is not identical.

The test specimens shall be connected to the test circuit with cables of length ~~0,3 m  $\pm$  0,015~~ (1  $\pm$  0,1) m ~~so that the temperature rise measurement can be made without disturbing the terminals.~~ The load shall be as specified in Figure 12a, load A.

~~The load shall, after the specified number of operations, be substituted by load B in figure 14 and the switches shall be tested with 100 operations in that circuit at the rated voltage.~~

The metal support of the switch, if any, on which the switch is mounted, and the accessible metal parts of the switch, if any, shall be earthed through a wire fuse which shall not blow during the test. The fuse element shall consist of a copper wire of 0,1 mm in diameter not less than 50 mm in length.

During this test, the switch shall be operated so that the test apparatus does not interfere with the normal action of the switch mechanism and the free movement of the actuating member.



There shall be no forced actuation. The "on" period shall be  $25 \left( \begin{smallmatrix} +5 \\ 0 \end{smallmatrix} \right) \%$  of the total cycle and the "off" period  $75 \left( \begin{smallmatrix} 0 \\ -5 \end{smallmatrix} \right) \%$ .

During the test, no sustained arcing nor welding of the contacts shall occur.

Sticking of the contacts which does not prevent further operation of the switch is not regarded as welding.

Sticking of contacts is permitted if the contacts can be separated with a force applied to the actuator of a value which does not damage the switch mechanically.

For the purpose of this test, blows which are intended to separate welded contacts are not permitted.

During the test, the specimens shall function correctly.

After the test, the specimens shall withstand an electric strength test as specified in Clause 16 and a terminal temperature rise test as specified in Clause 17.

For the electric strength test, the test voltage of 4 000 V shall be reduced by 1 000 V and the other test voltages by 500 V. For the terminal temperature rise test, the test current shall be reduced to the value of the rated current and the only measurement made shall be at the terminals.

After these tests, it shall also be possible to make and break the switch by hand in the test circuit and the specimen shall not show

- wear impairing further use;
- discrepancy between the position of the actuating member and that of the moving contacts, if the position of the actuating member is indicated;
- deterioration of the enclosures, insulating lining or barriers to such an extent that the switch cannot be further operated or that it no longer complies with the requirements of Clause 10;
- loosening of electrical or mechanical connections;
- seepage of sealing compound;
- relative displacement of the moving contacts of switches of pattern numbers 2, 3 or 6/2.

Breakage of the replaceable pull cord not involving the part entering the cord-operated switch shall not be considered a failure to pass the test.

### 19.3 Test for switches intended for self ballasted lamp loads

Switches intended for self ballasted lamp (SBL) loads shall withstand, without excessive wear or other harmful effect, the electrical and thermal stresses occurring when controlling self ballasted lamp circuits.

Compliance is checked by connecting the load as given in Figure 12b via the switch under test to a power supply.

The calculations are based on the following parameters in order to have the required values for inrush current and  $I^2t$ :

- a prospective short-circuit current (rms) of the supply of 3 kA at  $\cos \varphi = 0,9$  (lagging);



- a resistance  $R_3$  equal to  $0,25 \Omega$  in the test circuit to the load. This value is obtained with a wire having a cross-sectional area of  $1,5 \text{ mm}^2$  when switches with rated current up to and including 13 A are being tested and  $2,5 \text{ mm}^2$  when switches with rated current over 13 A up to and including 20 A are being tested.

The load shall be in accordance with Figure 12b. The values for the maximum peak value and the maximum  $I^2t$  of the inrush current are given in Table 19.

NOTE 1  $R_2$  is the total series resistance in the lamp circuit including the ESR (equivalent series resistance) value of the capacitor.

The values of  $R_2$  and  $C$  in load B shall be chosen in order to reach the values ( $\pm 5 \%$ ) for  $I_{\text{peak}}$  and  $I^2t$  as given in Table 19 when the switching contact closes at  $90^\circ \pm 5^\circ$  phase-angle.

The value of  $R_4$  shall be chosen to reach the current in amperes to reach the corresponding SBL power as given in Table 19.

**Table 19 – Values for  $I_{\text{peak}}$  and  $I^2t$  depending on the type of distribution system**

|                                 | Distribution system [V]: | Distribution system [V]: | Distribution system [V]: | Distribution system [V]: | Distribution system [V]:       | Distribution system [V]:       |
|---------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------------|--------------------------------|
|                                 | 220/380                  | 220/380                  | 120/208                  | 120/208                  | 220/380                        | 120/208                        |
|                                 | 230/400                  | 230/400                  | 120/240                  | 120/240                  | 230/400                        | 120/240                        |
|                                 | 240/415                  | 240/415                  | 127/220                  | 127/220                  | 240/415                        | 127/220                        |
| Rated current                   | $I_{\text{peak}}$        | $I^2t$                   | $I_{\text{peak}}$        | $I^2t$                   | Rated power of the SBL circuit | Rated power of the SBL circuit |
| (A)                             | [A]                      | [A <sup>2</sup> s]       | [A]                      | [A <sup>2</sup> s]       | [W]                            | [W]                            |
| Up to and including 10          | 108                      | 2,8                      | 162                      | 5,9                      | 100                            | 60                             |
| Above 10 up to and including 13 | 142                      | 5,5                      | 162                      | 5,9                      | 150                            | 60                             |
| Above 13 up to and including 16 | 170                      | 9                        | 200                      | 11,5                     | 200                            | 100                            |
| Above 16 up to and including 20 | 192                      | 13                       | 231                      | 18,5                     | 250                            | 150                            |

Switches with a rated voltage of 250 V shall be considered as switches for a distribution system 230/400 V.

Switches with a rated voltage of 130 V shall be considered as switches for a distribution system 120/208 V.

**Table 20 – Calculated circuit parameters**

| Rated current (A)               | 230 V              |              | 120 V              |              |
|---------------------------------|--------------------|--------------|--------------------|--------------|
|                                 | $R_2$ [ $\Omega$ ] | C [ $\mu$ F] | $R_2$ [ $\Omega$ ] | C [ $\mu$ F] |
| Up to and including 10          | 1,9                | 125          | 0,28               | 280          |
| Above 10 up to and including 13 | 1,25               | 180          | 0,28               | 280          |
| Above 13 up to and including 16 | 0,95               | 240          | 0,17               | 445          |
| Above 16 up to and including 20 | 0,8                | 310          | 0,11               | 640          |

For other rated voltages and currents the values need to be recalculated

The values in Table 20 are given for information only. The circuit shall be adjusted to reach the  $I_{peak}$  and  $I^2t$  values of Table 19.

Compliance is checked by the following test:

For the test, new specimens are used.

The switches are tested at rated voltage in the apparatus and with the connections specified in 18.2.

The tolerance of the test voltage is  $\pm 5$  %.

The circuit details and the manner of operation of the selector switch S are as described in 18.2.

The number of operations is shown in Table 18.

The rate of operation is as specified in 18.2.

The on period shall be  $(25^{+5}_0)$  % of the total cycle and the off period  $(75^0_{-5})$  %.

For rotary switches of pattern number 5 intended to be operated in either direction, the actuating member is turned in one direction for half the total number of operations and in the reverse direction for the remainder.

For other rotary switches intended to be operated in either direction, three quarters of the total number of operations are effected in the clockwise direction, and the remainder in the reverse direction.

Cord-operated switches shall be tested mounted as in normal use and with a pull of a value adequate to operate the cord-operated switch, but not exceeding 50 N, on the cord throughout the test at  $30^\circ \pm 5^\circ$  to the vertical and in a plane perpendicular to the mounting surface.

Switches of pattern number 2 are tested with the poles connected in series.

The two circuits of switches of pattern number 5 are tested as two switches of pattern number 1. If the circuits are identical, only one circuit need be tested.

Switches of pattern numbers 4 and 6 shall be tested for half the number of operations on one way and half the number of operations on the other way.

Switches of pattern number 6/2 are tested as one switch of pattern number 6, if the two pairs of poles are identical. Otherwise, they are tested as two switches of pattern number 6.

For switches of pattern number 7, one side is tested as pattern number 6. The test is repeated on the other side of a new set of specimens if the other side is not identical.

The test specimens shall be connected to the test circuit with cables of length  $(1 \pm 0,1)$  m.

The metal support of the switch, if any, on which the switch is mounted, and the accessible metal parts of the switch, if any, shall be earthed through a wire fuse (F) which shall not blow during the test. The fuse element shall consist of a copper wire of 0,1 mm diameter and not less than 50 mm in length.  $R_1$  is a resistor limiting the current to about 100 A.

During this test, the switch shall be operated so that the test apparatus does not interfere with the normal action of the switch mechanism and the free movement of the actuating member.

There shall be no forced actuation. ~~The on-period shall be 25 (%) % of the total cycle and the off-period 75 (%) %.~~

~~During the test the specimens shall function correctly.~~ No sustained arcing or welding of the contacts shall occur.

Sticking of the contacts which does not prevent the next operation of the switch is not regarded as welding.

Sticking of contacts is permitted if the contacts can be separated with a force applied to the actuator of a value which does not damage the switch mechanically.

For the purpose of this test, it is not permitted to apply blows to open welded contacts.

~~After the test, without disturbing the connections of the specimen under test, a temperature rise measurement is performed as specified in clause 17, using a test current with a value equal to the value of the rated current. The temperature rise of the terminals shall not exceed 45 K.~~

After the test, the specimens shall withstand an electric strength test as specified in Clause 16 and a terminal temperature rise test as specified in Clause 17.

For the electric strength test, the test voltage of 4 000 V shall be reduced by 1 000 V and the other test voltages by 500 V. For the terminal temperature rise test, the test current shall be reduced to the value of the rated current and the only measurement made shall be at the terminals.

After these tests, it shall also be possible to make and break the switch by hand in the test circuit and the specimen shall not show:

- wear impairing further use;
- discrepancy between the position of the actuating member and that of the moving contacts, if the position of the actuating member is indicated;
- deterioration of the enclosures, insulating lining or barriers to such an extent that the switch cannot be further operated or that it no longer complies with the requirements of Clause 10;
- loosening of electrical or mechanical connections;
- seepage of sealing compound;
- relative displacement of the moving contacts of switches of pattern numbers 2, 3 or 6/2.

*Breakage of the replaceable pull cord not involving the part entering the cord-operated switch shall not be considered a failure to pass the test.*

## 20 Mechanical strength

### 20.1 General

The test of the relevant subclauses 20.5 to 20.9 shall be applied according to the type of construction as specified in 13.3.

~~Switches, boxes and screwed glands of switches other than ordinary~~ Accessories, surface mounting boxes, screwed glands and shrouds shall have adequate mechanical strength so as to withstand the stresses imposed during installation and use.

Compliance is checked by the following tests:

- ~~— for switches other than ordinary~~ ~~20.1 and 20.2;~~
- all types of switches ..... 20.2
- for switches with a base intended to be mounted directly on a surface ..... 20.3
- for boxes ..... 20.2
- for screwed glands of switches ~~other than ordinary~~ that have an IP code higher than IP20 ..... 20.4
- for operating members of cord-operated switches ..... 20.10

**NOTE** Combinations of switches or of switches and socket-outlets are tested in the following way:

- in the case of one common cover, as a single product;
- in the case of separate covers, as separate products.

### 20.2 Pendulum hammer test

The specimens are ~~subjected to~~ checked by applying blows by means of ~~an impact~~ the pendulum hammer test apparatus as described in IEC 60068-2-75 (test Eha), with an equivalent mass of 250 g.

~~The striking element has a hemispherical face of 10 mm radius, made of polyamide having a Rockwell hardness of HR 100, and a mass of 150 g ± 1 g.~~

~~It is rigidly fixed to the lower end of a steel tube with an external diameter of 9 mm and a wall thickness of 0,5 mm, which is pivoted at its upper end in such a way that it swings only in a vertical plane.~~

~~The axis of the pivot is 1 000 mm ± 1 mm above the axis of the striking element.~~

~~The Rockwell hardness of the polyamide striking element is determined by using a ball having a diameter of 12,700 mm ± 0,0025 mm, the initial load being 100 N ± 2 N and the extra load 500 N ± 2,5 N.~~

**NOTE 1** ~~Additional information concerning the determination of the Rockwell hardness of plastics is given in ISO 2039-2.~~

~~The design of the apparatus is such that a force between 1,9 N and 2,0 N has to be applied to the face of the striking element to maintain the tube in a horizontal position.~~

The specimens are mounted on a sheet of plywood, 8 mm nominal thickness and approximately 175 mm square, secured at its top and bottom edges to a rigid bracket which is part of the mounting support.

The mounting support shall have a mass of  $(10 \pm 1)$  kg and shall be mounted on a rigid frame by means of pivots. The frame is fixed to a solid wall.

The design of the mounting is such that

- the specimen can be so placed that the point of impact lies in the vertical plane through the axis of the pivot;
- the specimen can be removed horizontally and turned about an axis perpendicular to the surface of the plywood;
- the plywood can be turned  $60^\circ$ , in both directions, about a vertical axis.

The switches and boxes are mounted on the plywood as in normal use.

Inlet openings which are not provided with knock-outs, are left open; if they are provided with knock-outs, one of them is opened.

For flush-type switches the specimen is mounted in a recess provided in a block of hornbeam or similar material, which is fixed to a sheet of plywood, and not in its relevant mounting box. If wood is used for the block, the direction of the wood fibres shall be perpendicular to the direction of the impact.

Flush-type screw fixing switches shall be fixed by means of the screws to lugs recessed in the hornbeam block. Flush-type claw fixing switches shall be fixed to the block by means of the claws.

Before applying the blows, fixing screws of ~~bases~~ **main parts** and covers are tightened with a torque equal to two-thirds of the relevant value specified in column 3 or 5 as applicable, of Table 5.

The specimens are mounted so that the point of impact lies in a vertical plane through the axis of the pivot.

The striking element is allowed to fall from a height which is specified in Table 21.

**Table 21 – Height of fall for impact test**

| Height of fall<br>mm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Parts of enclosures to be subjected to the impact <sup>a</sup>   |                                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|---------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <del>Ordinary accessory</del><br>Switches having an IP code IPX0 | <del>Other accessory</del><br>Switches having an IP code higher than IPX0 |
| <del>100</del> 80<br><del>150</del> 120<br><del>200</del> 160<br><del>250</del> 200                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | A and B<br>C<br>D<br>–                                           | –<br>A and B<br>C<br>D                                                    |
| <sup>a</sup> Parts of enclosures are defined as follows:<br>A parts on the front surface, including the parts which are recessed;<br>B parts which do not project more than 15 mm from the mounting surface (distance from the wall) after mounting as in normal use, with the exception of the above parts A;<br>C parts which project more than 15 mm and not more than 25 mm from the mounting surface (distance from the wall) after mounting as in normal use, with the exception of the above parts A;<br>D parts which project more than 25 mm from the mounting surface (distance from the wall) after mounting as in normal use, with the exception of the above parts A. |                                                                  |                                                                           |

**NOTE 2** The impact energy determined by the part of the specimen which projects most from the mounting surface is applied on all parts of the specimen, with the exception of its parts A.

Parts of accessories exclusively intended for mounting in panel-boards are submitted to impacts which are obtained by allowing the striking element to fall from the height of 100 mm; impacts shall only be applied on parts which are accessible after mounting the accessory in the panel board.

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

**NOTE 3** — Theoretically the centre of gravity of the striking element should be the checking point. As the centre of gravity in practice is difficult to determine, the checking point is chosen as described above.

The specimens are subjected to nine blows, which are evenly distributed over the specimens. The blows are not applied to knock-out areas. The following blows are applied:

- for parts A, five blows:
  - one blow in the centre, after the specimen has been moved horizontally;
  - one each on the unfavourable points between the centre and the edges; and then
  - one each on similar points after the specimen has been turned 90° about its axis perpendicular to the plywood;
- for parts B (as far as applicable), C and D, four blows:
  - two blows on each of the two sides of the specimen on which blows can be applied after the plywood sheet has been turned 60° in each of the opposite directions;
  - two blows on each of the other two sides of the specimen on which blows can be applied after the specimen has been turned 90° about its axis perpendicular to the plywood sheet and the plywood sheet has been turned 60° in each of the opposite directions.

If inlet openings are provided, the specimen is so mounted that the two lines of blows are as nearly as possible equidistant from these openings.

Cover plates and other covers of multiple switches are treated as cover plates or covers of single switches.

For switches ~~other than ordinary~~ that have an IP code higher than IPX0 the test is ~~made~~ carried out with any lids closed and, ~~in addition~~, the appropriate number of blows is then applied to those parts which are exposed when the lids are open.

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

After the test on a lens (window for pilot lights), the lens may be cracked and/or dislodged, but it shall not be possible to touch live parts with

- the ~~standard jointed~~ test ~~finger~~ probe B of IEC 61032 under the conditions stated in 10.1;
- the ~~standard unjointed~~ test ~~finger~~ probe 11 of IEC 61032 under the conditions stated in 10.1, but with a force of 10 N.

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

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

**NOTE 4** Damage to the finish, small dents which do not reduce creepage distances or clearances below the value specified in 23.1 and small chips which do not adversely affect the protection against electric shock are neglected.

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

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

### 20.3 Test on the main parts of surface-type switches

The ~~bases~~ main parts of ~~ordinary~~ surface-type switches are first fixed to a cylinder of rigid steel sheet, which has a radius equal to 4,5 times the distance between fixing holes but in any case ~~not lower~~ no less than 200 mm. The axes of the holes are in a plane perpendicular to the axis of the cylinder and parallel to the radius through the centre of the distance between the holes.

The fixing screws of the main part are gradually tightened, the maximum torque applied being 0,5 Nm for screws with a thread diameter up to and including 3 mm and 1,2 Nm for screws with a larger thread diameter.

The ~~bases~~ main parts are then fixed in a similar manner to a flat steel sheet.

During and after the tests the ~~bases~~ main parts of the switch shall show no damage ~~impairing~~ likely to impair their ~~further~~ future use.

### 20.4 Screwed glands

Screwed glands are fitted with a cylindrical metal rod having a diameter, in millimetres, equal to the nearest whole number below the internal diameter, in millimetres, of the packing.

The glands are then tightened by means of a suitable spanner, the torque shown in Table 22 being applied to the spanner for 1 min.

**Table 22 – Torque for the verification of the mechanical strength of glands**

| Diameter of test rod<br>mm          | Torque<br>Nm |                            |
|-------------------------------------|--------------|----------------------------|
|                                     | Metal glands | Glands of moulded material |
| Up to and including 14              | 6,25         | 3,75                       |
| Above 14 and up to and including 20 | 7,5          | 5,0                        |
| Above 20                            | 10,0         | 7,5                        |

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



## 20.5 Covers, cover plates or actuating members – accessibility to live parts

### 20.5.1 General

*When testing the force necessary for covers, cover plates or actuating members to come off or not come off, the switches are mounted as for normal use. Flush-type switches are fixed in appropriate mounting boxes, which are installed as for normal use so that the rims of the boxes are flush with the walls, and the covers, cover plates or actuating members are fitted. If they are provided with locking means which can be operated without the aid of a tool, these means are unlocked.*

*Compliance is then checked by the tests of 20.5.2 and 20.5.3.*

### 20.5.2 Verification of the non-removal of covers, cover plates or actuating members

*Forces are gradually applied in directions perpendicular to the mounting surfaces, in such a way that the resulting force acting on the centre of the covers, cover plates, actuating members or parts of them is ~~respectively~~:*

- 40 N, for covers, cover plates, actuating members or parts of them complying with the tests of 20.8 and 20.9; or*
- 80 N, for other covers, cover plates, actuating members or parts of them.*

*The force is applied for 1 min. The covers, cover plates, or actuating members shall not come off.*

*The test is then repeated on new specimens, the cover or cover plate being fitted on the wall after a sheet of hard material, 1 mm  $\pm$  0,1 mm thick, has been fitted around the supporting frame, as shown in Figure 13.*

NOTE The sheet of hard material is used to simulate wallpaper and ~~may~~ can consist of a number of pieces.

*After the test the specimens shall show no damage within the meaning of this document.*

### 20.5.3 Verification of the removal of covers, cover plates or actuating members

*A force not exceeding 120 N is gradually applied, in directions perpendicular to the mounting/supporting surfaces, to covers, cover plates, actuating members or parts of them by means of a hook placed in turn in each of the grooves, holes, spaces or the like provided for removing them.*

*The covers, cover plates or actuating members shall come off.*

*The test is made 10 times on each separable part the fixing of which is not dependent on screws (the application points being equally distributed as far as practicable). The removal force is applied each time to the different grooves, holes or the like provided for removing the separable part.*

*The test is then repeated on new specimens, the cover, cover plate, or actuating member being fitted on the wall after a sheet of hard material, (1  $\pm$  0,1) mm thick has been fitted around the supporting frame, as shown in Figure 13.*

*After the test, the specimens shall show no damage within the meaning of this document.*

## 20.6 Covers, cover plates or actuating members – accessibility to non-earthed metal parts separated from live parts

*The test is made as described in 20.5, but applying, for 20.5.2, the following forces:*



- 10 N, for covers or cover plates or actuating members complying with the tests of 20.8 and 20.9;
- 20 N, for other covers or cover plates or actuating members.

## **20.7 Covers, cover plates or actuating members – accessibility to insulating parts, earthed metal parts, the live parts of SELV $\leq 25$ V AC and 60 V DC or metal parts separated from live parts**

The test is made as described in 20.5, but applying, for 20.5.2, the force of 10 N for all covers, cover plates, or actuating members.

## **20.8 Covers, cover plates or actuating members – application of gauges**

The gauge shown in Figure 14 is pushed toward each side of each cover, cover plate or actuating member which is fixed without screws on a mounting or supporting surface, as shown in Figure 15. With face B resting on the mounting/supporting surface, and face A perpendicular to it, the gauge is applied at right angles to each side under test.

In the case of a cover or cover plate fixed without screws to another cover or cover plate or to a mounting box, having the same outline dimensions, face B of the gauge shall be placed at the same level as the junction; the outline at the cover or cover plate shall not exceed the outline of the supporting surface.

The distances between face C of the gauge and the outline of the side under test, measured parallel to face B, shall not decrease (with the exception of grooves, holes, reverse tapers or the like, placed ~~at a distance~~ less than 7 mm from a plane including face B and complying with the test of 20.9) when measurements are repeated starting from point x in the direction of the arrow y (see Figure 16).

## **20.9 Grooves, holes and reverse tapers**

A gauge according to Figure 17, applied with a force of 1 N, shall not enter more than 1,0 mm from the upper part of any groove, hole or reverse taper or the like when the gauge is applied parallel to the mounting/supporting surface and at right angles to the part under test, as shown in Figure 18.

NOTE The verification whether the gauge according to Figure 17 has entered more than 1,0 mm is made with reference to a surface perpendicular to face B and including the upper part of the outline of the grooves, holes, reverse tapers or the like.

## **20.10 Additional test for cord-operated switch**

The operating member of a cord-operated switch shall have adequate strength.

Compliance is checked on a new specimen by the following test:

The switch is mounted on a support as in normal use.

A pull of 100 N is applied for 1 min on the operating member as in normal use, after which a pull of 50 N is applied for 1 min in the most unfavourable direction within a conical surface with the centre being the operating cord and the angle not exceeding 80° to the vertical.

After the test the switch shall show no damage within the meaning of this document. The operating member shall not have broken and the cord-operated switch shall still operate.

## 21 Resistance to heat

### 21.1 General

Switches and boxes shall be sufficiently resistant to heat.

Parts intended for decorative purposes only, such as certain lids, shall be removed if possible and these parts are not subjected to the test.

*Compliance is checked*

- a) for surface mounting boxes, separable covers, separable cover plates and separable frames by the test of 21.4;
- b) for switches, with the exception of the parts, if any, covered by a), by the tests of 21.2, 21.3 and, with the exception of the switches made from natural or synthetic rubber or a mixture of both, by the test of 21.4.

### 21.2 Basic heating test

The specimens are kept for 1 h in a heating cabinet at a temperature of  $(+100 \pm 2) ^\circ\text{C}$ .

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

After the test and after the specimens have been allowed to cool down to approximately room temperature, there shall be no access to live parts which are normally not accessible when the specimens are mounted as in normal use, even if the test ~~finger~~ probe B of IEC 61032 is applied with a force not exceeding 5 N.

After the test, markings shall still be legible.

Discoloration, blisters or slight displacement of the sealing compound is disregarded provided that safety is not impaired within the meaning of this document.

### 21.3 Ball-pressure test on parts of insulating material necessary to retain current-carrying parts and parts of the earthing circuit in position

Parts of insulating material necessary to retain current-carrying parts and parts of the earthing circuit in position are subjected to a ball-pressure test by means of the apparatus shown in Figure 19, except for the insulating parts necessary to retain the earthing terminals in a box which shall be tested as specified in 21.4.

**NOTE** When it is not possible to carry out the test on the specimens, the test ~~should~~ shall be carried out on a piece at least 2 mm thick which is cut out of a new set of aged specimens. If this is not possible, up to and including four layers, each cut out of the same specimen, ~~may~~ should be used, in which case the total thickness of the layers ~~should~~ shall be not less than 2,5 mm.

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

The test ~~lead~~ load and the supporting means shall be placed within the heating cabinet for a sufficient time to ensure that they have attained the stabilized testing temperature before the test commences.

The test is made in a heating cabinet at a temperature of  $(+125 \pm 2) ^\circ\text{C}$ .

After 1 h, the ball is removed from the specimen which is then cooled down within 10 s to approximately room temperature by immersion in cold water.

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

#### **21.4 Ball-pressure test on parts of insulating material not necessary to retain current-carrying parts and parts of the earthing circuit in position**

*Parts of insulating material not necessary to retain current-carrying parts and parts of the earthing circuit in position, even though they are in contact with them, are subjected to a ball pressure test in accordance with 21.3, but the test is made at a temperature of  $(+70 \pm 2) ^\circ\text{C}$  or  $(+40 \pm 2) ^\circ\text{C}$  plus the highest temperature rise determined for the relevant part during the test of Clause 17, whichever is the higher.*

## **22 Screws, current-carrying parts and connections**

### **22.1 General**

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

Mechanical connections to be used during installation of accessories may be made using thread-forming screws or thread-cutting screws only when the screws are supplied together with the piece in which they are intended to be inserted. In addition, thread-cutting screws intended to be used during installation shall be captive with the relevant part of the accessory.

Screws or nuts which transmit contact pressure shall be of metal and shall be in engagement with a metal thread.

*Compliance is checked by inspection and, for screws and nuts which are operated when connecting the external conductors and mounting the switch during the installation, by the following test.*

NOTE 1 The requirements for the verification of terminals are given in Clause 12.

*The screws or nuts are tightened and loosened*

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

*The screws or nuts in engagement with a thread of insulating material are completely removed and reinserted each time.*

*The test is made by means of a suitable test screwdriver or a suitable tool, applying the relevant torque as specified in 12.2.5.*

*The conductor is moved each time the screw or nut is loosened.*

*During the test, no damage impairing the further use of the screwed connections shall occur, such as breakage of screws or damage to the head slots (rendering the use of an appropriate screwdriver impossible), threads, washers or stirrups.*

NOTE 2 Screws or nuts which are operated when assembling the switch include screws for fixing covers or cover plates, etc., but not connecting means for screwed conduits and screws for fixing the base main part of a switch.

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

*The screws and nuts shall be tightened in one smooth and continuous motion.*

NOTE 3 Screwed connections are considered as partially checked by the tests of Clauses 19 and 20.

## 22.2 Correct insertion of screws

For screws in engagement with a thread of insulating material which are operated when mounting the switch during installation, their correct introduction into the screw hole or nut shall be ensured.

*Compliance is checked by inspection.*

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 parts to be fixed, by a recess in the female thread or by the use of a screw with the leading thread removed.

## 22.3 Contact pressure of electrical connections

Electrical connections shall be so designed that 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 possible shrinkage or yielding of the insulating material.

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

NOTE The suitability of the material is considered in respect of the stability of the dimensions.

## 22.4 Screws and rivets, used both as electrical and mechanical connections

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

*Compliance is checked by inspection.*

NOTE 1 Spring washers ~~may~~ can provide satisfactory locking.

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

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

## 22.5 Material of current-carrying parts

Current-carrying parts, including those of terminals (also earthing terminals), shall be of a metal having, under the conditions occurring in the ~~equipment~~ accessory, mechanical strength, electrical conductivity and resistance to corrosion adequate for their intended use.

The requirement of 22.5 does not apply to screws, nuts, washers, clamping plates and similar parts of terminals.

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

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

- copper;
- an alloy containing at least 58 % copper for parts made from cold-rolled sheet or at least 50 % copper for other parts;
- stainless steel containing at least 13 % chromium and not more than ~~0,12~~ 0,09 % carbon;
- steel provided with an electroplated coating of zinc according to ISO 2081, the coating having a thickness of at least
  - 5 µm, service condition ISO No. 1, for ~~ordinary equipment~~ switches that have an IP code IPX0;

- 12 µm, service condition ISO No. 2, for ~~drip-proof and splash-proof equipment switches~~ that have an IP code IPX4;
- 25 µm, service condition ISO No. 3, for ~~jet-proof and watertight equipment switches~~ that have an IP code IPX5 or IPX6.
- steel provided with an electroplated coating of nickel and chromium according to ISO 1456, the coating having a thickness of at least
  - 20 µm, service condition ISO No. 2, for ~~ordinary equipment switches~~ that have an IP code IPX0;
  - 30 µm, service condition ISO No. 3, for ~~drip-proof and splash-proof equipment switches~~ that have an IP code IPX4;
  - 40 µm, service condition ISO No. 4, for ~~jet-proof and watertight equipment switches~~ that have an IP code IPX5 or IPX6.
- steel provided with an electroplated coating of tin according to ISO 2093, the coating having a thickness of at least
  - 12 µm, service condition ISO No. 2, for ~~ordinary equipment switches~~ that have an IP code IPX0;
  - 20 µm, service condition ISO No. 3, for ~~drip-proof and splash-proof equipment switches~~ that have an IP code IPX4;
  - 30 µm, service condition ISO No. 4, for ~~jet-proof and watertight equipment switches~~ that have an IP code IPX5 or IPX6.

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

*Compliance is checked by a test which is under consideration.*

~~NOTE — The requirement of this subclause does not apply to screws, nuts, washers, clamping plates and similar parts of terminals.~~

## 22.6 Contacts subjected to sliding actions

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

*Compliance with the requirements of 22.5 and 22.6 is checked by inspection and, in case of doubt, by chemical analysis.*

## 22.7 Thread-forming and thread-cutting screws

Thread-forming screws and thread-cutting screws shall not be used for the connection of current-carrying parts. Thread-forming screws and thread-cutting screws may be used to provide earthing continuity, provided that it is not necessary to disturb the connection in normal use and at least two screws are used for each connection.

*Compliance is checked by inspection.*

~~NOTE — The use of thread-cutting screws which are operated when mounting the switch during installation is under consideration.~~

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

### **23.1 General**

Creepage distances, clearances and distances through sealing compound shall be not less than the values shown in Table 23.

Subclause 23.1 does not apply to pilot light units. Requirements for pilot light units are given in 13.16.

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**Table 23 – Creepage distances, clearances and distances through insulating sealing compound**

| Description                                          |                                                                                                                                       | mm                |                   |                    |
|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------|--------------------|
|                                                      |                                                                                                                                       | normal gap        | mini-gap          | micro-gap          |
| <b>Creepage distances</b>                            |                                                                                                                                       |                   |                   |                    |
| 1                                                    | Between internal live parts which are separated when the contacts are open.                                                           | 3                 | 3 <sup>a</sup>    | 3 <sup>a</sup>     |
| 2                                                    | Between live parts of different polarity including all terminals for external wiring.                                                 | 4 <sup>c, e</sup> | 4 <sup>c, e</sup> | 4 <sup>c, e</sup>  |
| 3                                                    | Between live parts and                                                                                                                |                   |                   |                    |
|                                                      | – accessible surfaces of parts of insulating material;                                                                                | 3                 | 3                 | 3                  |
|                                                      | – earthed metal parts, including the earthing circuit;                                                                                | 3                 | 3                 | 3                  |
|                                                      | – metal frames supporting the base of flush-type switches;                                                                            | 3                 | 3                 | 3                  |
|                                                      | – screws or devices for fixing main parts, covers or cover-plates;                                                                    | 3                 | 3                 | 3                  |
|                                                      | – metal parts of the mechanism, if required to be insulated from live parts (see 10.4).                                               | 3                 | 3                 | 3                  |
| 4                                                    | Between metal parts of the mechanism, if required to be insulated from accessible metal parts (see 10.5), and                         |                   |                   |                    |
|                                                      | – screws or devices for fixing main parts, covers or cover-plates;                                                                    | 3                 | 3                 | 3                  |
|                                                      | – metal frames supporting the base of flush-type switches;                                                                            | 3                 | 3                 | 3                  |
|                                                      | – accessible metal parts.                                                                                                             | 3                 | 3                 | 3                  |
| 5                                                    | Between live parts and accessible unearthed metal parts, with the exception of screws and the like.                                   | 6 <sup>d</sup>    | 6 <sup>d</sup>    | 6 <sup>d</sup>     |
| <b>Clearances</b>                                    |                                                                                                                                       |                   |                   |                    |
| 6                                                    | Between internal live parts which are separated when the contacts are open.                                                           | 3                 | 1,2 <sup>b</sup>  | < 1,2 <sup>b</sup> |
| 7                                                    | Between live parts of different polarity including all terminals for external wiring.                                                 | 3 <sup>e</sup>    | 3 <sup>e</sup>    | 3 <sup>e</sup>     |
| 8                                                    | Between live parts and                                                                                                                |                   |                   |                    |
|                                                      | – accessible surfaces of insulating material;                                                                                         | 3                 | 3                 | 3                  |
|                                                      | – earthed metal parts, including the earthing circuit, not mentioned under items 9 and 11;                                            | 3                 | 3                 | 3                  |
|                                                      | – metal frames supporting the base of flush-type switches;                                                                            | 3                 | 3                 | 3                  |
|                                                      | – screws or devices for fixing main parts, covers, or cover-plates;                                                                   | 3                 | 3                 | 3                  |
|                                                      | – metal parts of the mechanism, if required to be insulated from live parts (see 10.4).                                               | 3                 | 3                 | 3                  |
| 9                                                    | Between live parts and                                                                                                                |                   |                   |                    |
|                                                      | – exclusively earthed metal boxes (see NOTE) with the switch mounted in the most unfavourable position;                               | 3                 | 3                 | 3                  |
|                                                      | – unearthed metal boxes, without insulating lining, with the switch mounted in the most unfavourable position.                        | 4,5               | 4,5               | 4,5                |
| 10                                                   | Between metal parts of the mechanism, if required to be insulated from accessible metal parts (see 10.5), and                         |                   |                   |                    |
|                                                      | – screws or devices for fixing main parts, covers or cover-plates;                                                                    | 3                 | 3                 | 3                  |
|                                                      | – metal frames supporting the base of flush-type switches;                                                                            | 3                 | 3                 | 3                  |
|                                                      | – accessible metal parts when the base is fixed directly on the wall.                                                                 | 3                 | 3                 | 3                  |
| 11                                                   | Between live parts and the surface on which the base of a surface-type switch is mounted when the base is fixed directly on the wall. | 6                 | 6                 | 6                  |
| 12                                                   | Between live parts and the bottom of the space, if any, for external conductors, for surface-type switches.                           | 3                 | 3                 | 3                  |
| 13                                                   | Between live parts and accessible unearthed metal parts with the exception of screws and the like.                                    | 6 <sup>d</sup>    | 6 <sup>d</sup>    | 6 <sup>d</sup>     |
| <b>Distances through insulating sealing compound</b> |                                                                                                                                       |                   |                   |                    |



| Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | mm             |                |                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------|----------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | normal gap     | mini-gap       | micro-gap      |
| 14 Between live parts covered with at least 2 mm of sealing compound and the surface on which the base of a surface-type switch is mounted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 4 <sup>c</sup> | 4 <sup>c</sup> | 4 <sup>c</sup> |
| 15 Between live parts covered with at least 2 mm of sealing compound and the bottom of the space, if any, for external conductors, for surface-type switches.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 2,5            | 2,5            | 2,5            |
| NOTE Exclusively earthed metal boxes are those suitable only for use in installations where earthing of metal boxes is required.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |                |                |
| <p><sup>a</sup> For switches with rated voltage up to and including 250 V the creepage distances may be reduced to 1,2 mm if the insulating material has at least a comparative tracking index (CTI) value of 600 according to IEC 60112 or to 1,8 mm if the insulating material has at least a CTI value of 400 according to IEC 60112.</p> <p><sup>b</sup> The clearances between internal live parts shall be greater than the switch contact gap.</p> <p><sup>c</sup> The 4 mm value is reduced to 3 mm for switches having a rated voltage up to and including 250 V.</p> <p><sup>d</sup> The 6 mm value is reduced to 4,5 mm for accessories having a rated voltage up to and including 250 V.</p> <p><sup>e</sup> Clearances and creepage distances between live parts of different polarity are reduced to 1 mm between the lead wires in the pinch of a neon lamp or an LED with external resistor.</p> <p><del><sup>3</sup> This value is reduced to 1,2 mm, when the contacts are open, for live parts of switches of mini-gap construction, which are moved during the separation of the contacts.</del></p> <p><del><sup>4</sup> This value is not specified, when the contacts are open, for live parts of switches of micro-gap construction, which are moved during the separation of the contacts.</del></p> |                |                |                |

Compliance is checked by measurement.

The measurements are made on the switch fitted with conductors of the largest cross-sectional area specified in Clause 12, and also without conductors.

Distances through slots or openings in external parts of insulating material are measured to metal foil in contact with the accessible surface; the foil is pushed into corners and the like by means of the ~~straight unjointed test finger having the same dimension as the standard test finger of figure 9~~ test probe B of IEC 61032, but is not pressed into openings.

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

For ~~ordinary~~ surface-type switches that have an IP code IP 20, the most unfavourable conduit or cable is introduced for a distance of 1 mm into the switch, in accordance with 13.12.

If the metal frame supporting the ~~base~~ main part of flush-type switches is movable, this frame is placed in the most unfavourable position.

**NOTE 1** Any metal part in contact with a metal part of the mechanism is considered to be a metal part of the mechanism.

**NOTE 2** In double-break switches, the creepage distance mentioned under item 1 in Table 23 or the clearance mentioned under item 6 in Table 23 is the sum of the creepage distance or clearance between one fixed contact and the moving part, and that between the moving part and the other fixed contact.

**NOTE 3** The contribution to the creepage distance of any groove less than 1 mm wide is limited to its width.

**NOTE 4** Any air-gap less than 1 mm is ignored in computing the total clearance.

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

## 23.2 Insulating compound

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

*Compliance is checked by inspection.*

## 24 Resistance of insulating material to abnormal heat, to fire and to tracking

### 24.1 Resistance to abnormal heat and to fire

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

#### 24.1.1 Glow-wire test

*Compliance is checked by performing the glow-wire test according to IEC 60695-2-10 and IEC 60695-2-11 under the following conditions:*

- a) *for parts made of insulating material necessary to retain current-carrying parts and parts of the earthing circuit in position, by the test made at a temperature of 850 °C, with the exception of parts of insulating material needed to retain the earth terminal in position in a box, which shall be tested at a temperature of 650 °C;*
- b) *for parts of insulating material not necessary to retain current-carrying parts and parts of the earthing circuit in position, even though they are in contact with them, by the test made at a temperature of 650 °C.*

*A current-carrying part or a part of the earthing circuit retained by mechanical means is considered to be retained in position. The use of grease or the like is not considered to be mechanical means.*

*External conductors cannot be considered as retaining the current-carrying parts.*

*In case of doubt, to determine whether an insulating material is necessary to retain current-carrying parts and parts of the earthing circuit in position, the device 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.*

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

*Small parts, where each surface lies completely within a circle of 15 mm in diameter, or where any part of the surface lies outside a 15 mm diameter circle and it is not possible to fit a circle of 8 mm in diameter on any of the surfaces, are not subjected to the test of 24.1 (see Figure 20 for diagrammatic representation).*

NOTE 1 When checking a surface, projections on the surfaces and holes which are not greater than 2 mm on the largest dimension are disregarded.

*The tests are not made on parts of ceramic material.*

NOTE 2 The glow-wire test is applied to ensure that an electrically heated test wire under defined test conditions does not cause ignition of insulating parts or to ensure that a part of insulating material which might be ignited by the heated test wire under defined conditions has a limited time to burn without spreading fire by flame or burning parts or droplets from the tested part falling down onto the pinewood board covered with tissue paper.

*If possible, the specimen should be a complete switch.*

NOTE 3 If the test cannot be made on a complete switch, a suitable part ~~may~~ can be cut from it for the purpose of the test.

*The test is made on one specimen. In case of doubt, the test shall be repeated on two further specimens.*

*The specimen shall be stored for 24 h at standard ambient atmospheric conditions before the test, in accordance with IEC 60212.*

*The test is made applying the glow-wire once.*

*The specimen shall be positioned during the test in the most unfavourable position of its intended use (with the surface tested in a vertical position). The tip of the glow-wire shall be applied to the specified surface of the specimen taking into account the conditions of the intended use under which a heated or glowing element may come into contact with the switch.*

*During the application time of the glow-wire and during a period of 30 s from the end of the application time, the specimen and the surrounding parts, including the layer under the specimen, shall be observed.*

*The time when the ignition of the specimen occurs and/or the time when the flames extinguish during or after the application time shall be measured and recorded.*

*The switch is regarded as having passed the glow-wire test if one of the following conditions is met:*

- *there is no visible flame and sustained glowing;*
- *flames and glowing at the switch extinguish within 30 s after the removal of the glow-wire.*

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

## **24.2 Resistance to tracking**

For switches ~~other than ordinary~~ that have an IP code higher than IPX0, parts of insulating material retaining live parts in position shall be of material resistant to tracking.

*Compliance is checked according to IEC 60112.*

*Ceramic parts are not tested.*

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

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

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

## **25 Resistance to rusting**

Ferrous parts, including covers and boxes, shall be adequately protected against rusting.

*Compliance is checked by the following test:*

*All grease is removed from the parts to be tested, ~~by immersion in carbontetrachloride, trichloroethane or an equivalent~~ using a suitable degreasing agent, ~~for 10 min.~~*

*The parts are then immersed for 10 min in a 10 % solution of ammonium chloride in water at a temperature of  $(+20 \pm 5)$  °C.*

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

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

NOTE 1 Traces of rust on sharp edges and any yellowish film removable by rubbing is ignored.

NOTE 2 For small springs and the like, and for inaccessible parts exposed to abrasion, a layer of grease ~~may~~ can 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.

## 26 EMC requirements

### 26.1 Immunity

Switches within the scope of this document are tolerant of electromagnetic disturbances and therefore no immunity tests are necessary.

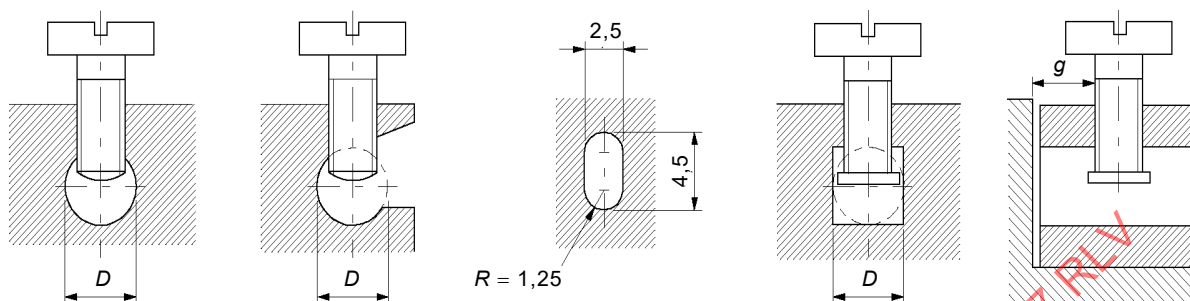
### 26.2 Emission

Electromagnetic disturbances may only be generated during switching operations. Since this is not continuous, no emission tests are necessary.

Dimensions in millimetres

Screw not requiring washer, clamping plate or anti-spread device

Screw requiring washer, clamping plate or anti-spread device



Terminals without pressure plate

Elongated hole terminal

Terminals with pressure plate

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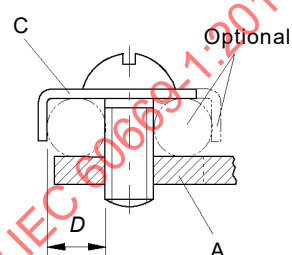
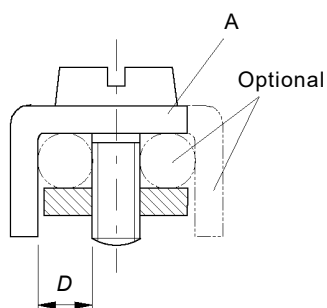
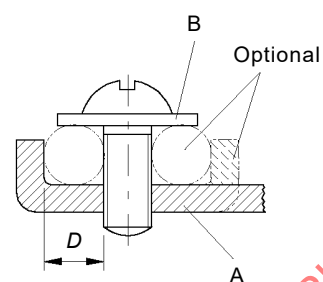
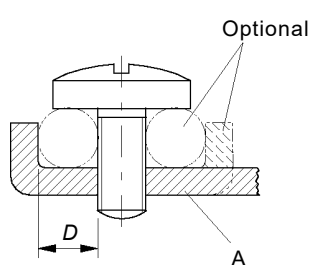
| Cross-section of conductor accepted by the terminal<br>mm <sup>2</sup> | Minimum diameter <i>D</i> (or minimum dimensions) of conductor space<br>mm | Minimum distance <i>g</i> between clamping screw and end of conductor when fully inserted<br>mm |     | Torque<br>Nm   |            |                |            |                |            |
|------------------------------------------------------------------------|----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-----|----------------|------------|----------------|------------|----------------|------------|
|                                                                        |                                                                            |                                                                                                 |     | 1 <sup>a</sup> |            | 3 <sup>a</sup> |            | 4 <sup>a</sup> |            |
|                                                                        |                                                                            |                                                                                                 |     | One screw      | Two screws | One screw      | Two screws | One screw      | Two screws |
| Up to 1,5                                                              | 2,5                                                                        | 1,5                                                                                             | 1,5 | 0,2            | 0,2        | 0,2            | 0,4        | 0,4            | 0,4        |
| 2,5<br>(circular hole)                                                 | 3,0                                                                        | 1,5                                                                                             | 1,5 | 0,25           | 0,2        | 0,5            | 0,4        | 0,5            | 0,4        |
| 2,5<br>(elongated hole)                                                | 2,5 × 4,5                                                                  | 1,5                                                                                             | 1,5 | 0,25           | 0,2        | 0,5            | 0,4        | 0,5            | 0,4        |
| 4                                                                      | 3,6                                                                        | 1,8                                                                                             | 1,5 | 0,4            | 0,2        | 0,8            | 0,4        | 0,7            | 0,4        |
| 6                                                                      | 4,0                                                                        | 1,8                                                                                             | 1,5 | 0,4            | 0,25       | 0,8            | 0,5        | 0,8            | 0,5        |
| 10                                                                     | 4,5                                                                        | 2,0                                                                                             | 1,5 | 0,7            | 0,25       | 1,2            | 0,5        | 1,2            | 0,5        |
| 16                                                                     | 5,5                                                                        | 2,5                                                                                             | 2,0 | 0,8            | 0,7        | 2,0            | 1,2        | 2,0            | 1,2        |
| 25                                                                     | 7,0                                                                        | 3,0                                                                                             | 2,0 | 1,2            | 0,7        | 2,5            | 1,2        | 3,0            | 1,2        |

<sup>a</sup> The values specified apply to the screws covered by the corresponding columns in Table 5.

The part of the terminal containing the threaded hole and the part of the terminal against which the conductor is clamped by the screw may be two separate parts, as in the case of terminals provided with a stirrup.

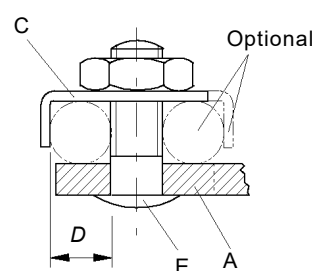
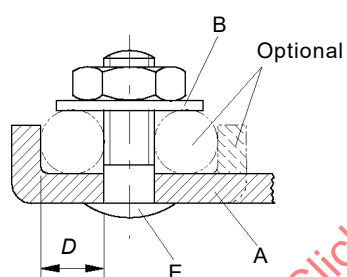
The shape of the conductor space may differ from those shown provided that a circle with a diameter equal to the minimum specified for *D* or the minimum outline specified for the elongated hole accepting cross-sections of conductors up to 2,5 mm<sup>2</sup> can be inscribed.

Figure 1 – Pillar terminals



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## Screw head terminals



IEC

## Stud terminals

- A fixed part
- B washer or clamping plate
- C anti-spread device
- D conductor space
- E stud

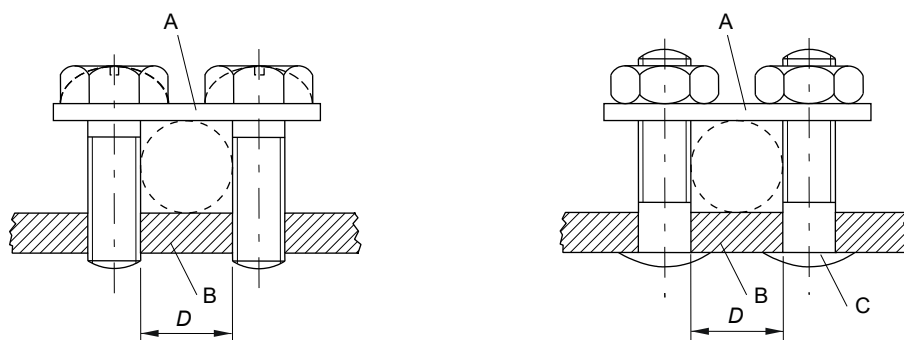
| Cross-section of conductor accepted by the terminal<br><br>mm <sup>2</sup>                             | Minimum diameter <i>D</i> of conductor space<br><br>mm | Torque<br>Nm   |            |                   |                     |
|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------|----------------|------------|-------------------|---------------------|
|                                                                                                        |                                                        | 3 <sup>a</sup> |            | 4 <sup>a</sup>    |                     |
|                                                                                                        |                                                        | One screw      | Two screws | One screw or stud | Two screws or studs |
| Up to 1,5                                                                                              | 1,7                                                    | 0,5            | –          | 0,5               | –                   |
| Up to 2,5                                                                                              | 2,0                                                    | 0,8            | –          | 0,8               | –                   |
| Up to 4                                                                                                | 2,7                                                    | 1,2            | 0,5        | 1,2               | 0,5                 |
| Up to 6                                                                                                | 3,6                                                    | 2,0            | 1,2        | 2,0               | 1,2                 |
| Up to 10                                                                                               | 4,3                                                    | 2,0            | 1,2        | 2,0               | 1,2                 |
| Up to 16                                                                                               | 5,5                                                    | 2,0            | 1,2        | 2,0               | 1,2                 |
| Up to 25                                                                                               | 7,0                                                    | 2,5            | 2,0        | 3,0               | 2,0                 |
| <sup>a</sup> The values specified apply to the screws covered by the corresponding columns in Table 5. |                                                        |                |            |                   |                     |

The part which retains the conductor in position may be of insulating material provided the pressure necessary to clamp the conductor is not transmitted through the insulating material.

The second optional space for the terminal accepting cross-sections of conductors up to 2,5 mm<sup>2</sup> may be used for the connection of the second conductor, when it is required to connect two 2,5 mm<sup>2</sup> conductors.

**Figure 2 – Screw head terminals and stud terminals**





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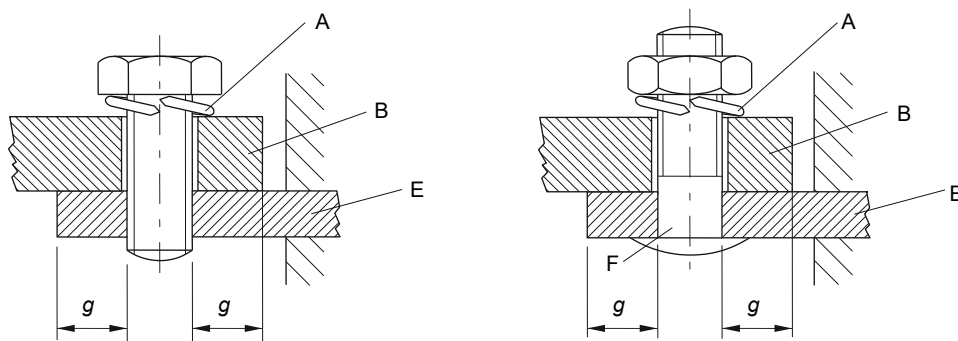
- A saddle  
 B fixed part  
 C stud  
 D conductor space

| Cross-section of conductor<br>accepted by the terminal | Minimum diameter $D$<br>of conductor space | Torque |
|--------------------------------------------------------|--------------------------------------------|--------|
| mm <sup>2</sup>                                        | mm                                         | Nm     |
| Up to 4                                                | 3,0                                        | 0,5    |
| Up to 6                                                | 4,0                                        | 0,8    |
| Up to 10                                               | 4,5                                        | 1,2    |
| Up to 16                                               | 5,5                                        | 1,2    |
| Up to 25                                               | 7,0                                        | 2,0    |

The shape of the conductor space may differ from that shown in the figure, provided that a circle with a diameter equal to the minimum value specified for  $D$  can be inscribed.

The shape of the upper and lower faces of the saddle may be different to accommodate conductors of either small or large cross-sectional areas by inverting the saddle.

**Figure 3 – Saddle terminals**



- A locking means
- B cable lug or bar
- E fixed part
- F stud

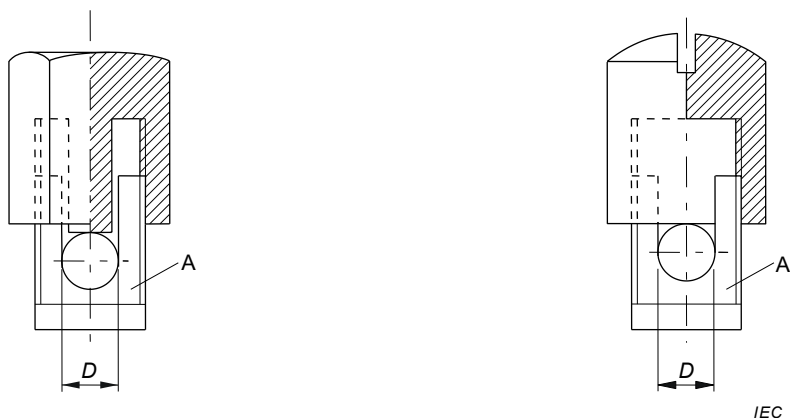
| Cross-section of conductor<br>accepted by the terminal | Minimum distance <i>g</i> between<br>edge of hole and side of clamping<br>area | Torque         |                |
|--------------------------------------------------------|--------------------------------------------------------------------------------|----------------|----------------|
|                                                        |                                                                                | Nm             |                |
| mm <sup>2</sup>                                        | mm                                                                             | 3 <sup>a</sup> | 4 <sup>a</sup> |
| Up to 16                                               | 7,5                                                                            | 2,0            | 2,0            |
| Up to 25                                               | 9,0                                                                            | 2,5            | 3,0            |

<sup>a</sup> The values specified apply to the screws covered by the corresponding columns in Table 5.

For this type of terminal, a spring washer or equally effective locking means shall be provided and the surface within the clamping area shall be smooth.

For certain types of switches, the use of lug terminals of sizes smaller than that specified is allowed.

**Figure 4 – Lug terminals**



A fixed part

D conductor space<sup>a</sup>

| Cross-section of conductor accepted by the terminal<br>mm <sup>2</sup> | Minimum diameter <i>D</i> of conductor space <sup>a</sup><br>mm | Minimum distance between fixed part and end of conductor when fully inserted<br>mm |
|------------------------------------------------------------------------|-----------------------------------------------------------------|------------------------------------------------------------------------------------|
| Up to 1,5                                                              | 1,7                                                             | 1,5                                                                                |
| Up to 2,5                                                              | 2,0                                                             | 1,5                                                                                |
| Up to 4                                                                | 2,7                                                             | 1,8                                                                                |
| Up to 6                                                                | 3,6                                                             | 1,8                                                                                |
| Up to 10                                                               | 4,3                                                             | 2,0                                                                                |
| Up to 16                                                               | 5,5                                                             | 2,5                                                                                |
| Up to 25                                                               | 7,0                                                             | 3,0                                                                                |

<sup>a</sup> The bottom of the conductor space shall be slightly rounded in order to obtain a reliable connection.

The value of the torque to be applied is that specified in column 2 or 4 of Table 5, as appropriate.

**Figure 5 – Mantle terminals**

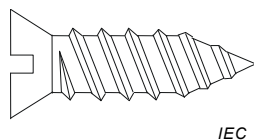


**Figure 6 – Thread-forming screw**

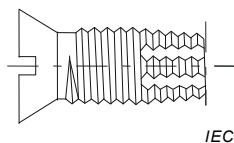
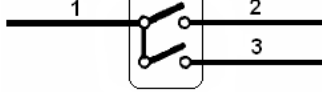
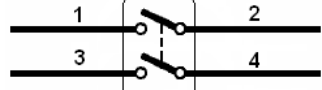
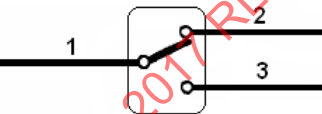
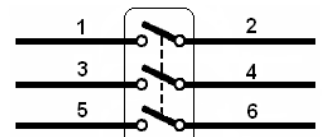
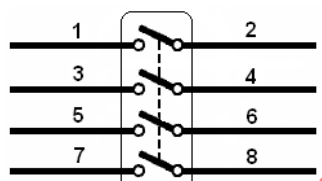
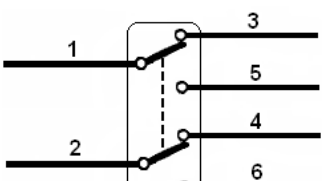
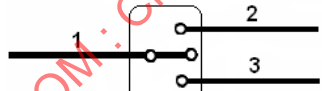
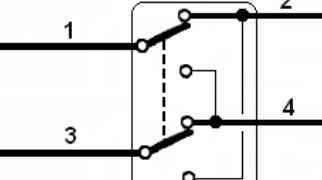


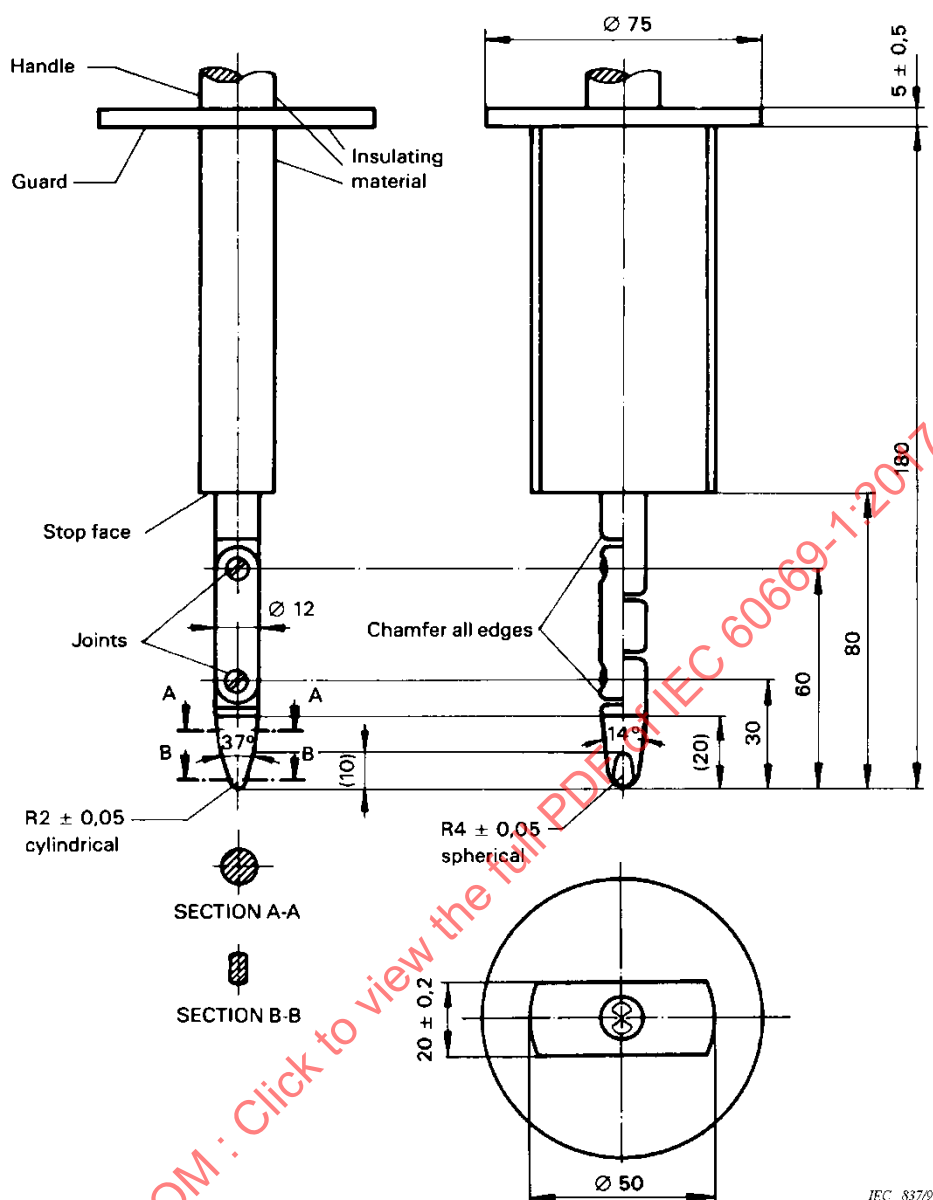
**Figure 7 – Thread-cutting screw**

| Pattern number | Number of poles | Possible connections                                                                | Pattern number | Number of poles | Possible connections                                                                  |
|----------------|-----------------|-------------------------------------------------------------------------------------|----------------|-----------------|---------------------------------------------------------------------------------------|
| 1              | 1               |    | 5              | 1               |    |
| 2              | 2               |    | 6              | 1               |    |
| 3              | 3               |    |                |                 |                                                                                       |
| 03             | 4               |   | 6/2            | 2               |   |
| 4              | 1               |  | 7              | 1               |  |

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The figures indicating the terminals are given for test purposes only and are not those required to be marked.

**Figure 8 – Classification according to connections**



IEC 837/96

Dimensions in millimetres

Tolerances on dimensions without specific tolerance

on angles:  $\frac{0}{-10^\circ}$

on linear dimensions: up to 25 mm:  $\frac{0}{-0,05}$

over 25 mm:  $\pm 0,2$

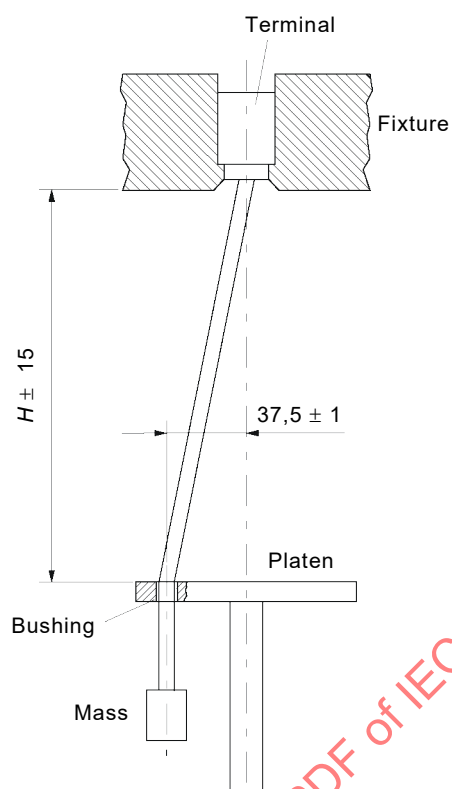
Material of finger: for example heat-treated steel.

Both joints of this finger may be bent through an angle of  $90^\circ \frac{+10^\circ}{0}$  but in one and the same direction only.

Using the pin and groove solution is only one of the possible approaches in order to limit the bending angle to  $90^\circ$ . For this reason dimensions and tolerances of these details are not given in the drawing. The actual design must ensure a  $90^\circ$  bending angle with a  $0^\circ$  to  $+10^\circ$  tolerance.

**Figure 9 — Standard test finger**

*Dimensions in millimetres*

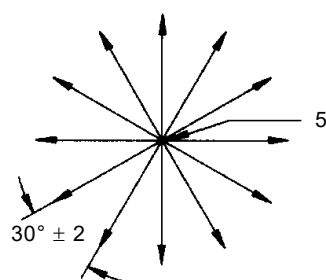


IEC

NOTE ~~Care should be taken that~~ The bushing hole is made in a way which ensures that the force extended to the cable is a pure pulling force and that the transmission of any torque to the connection in the clamping means is avoided.

**Figure 9 – Test apparatus for checking damage to conductors**

Dimensions in millimetres



Directions of application of the forces

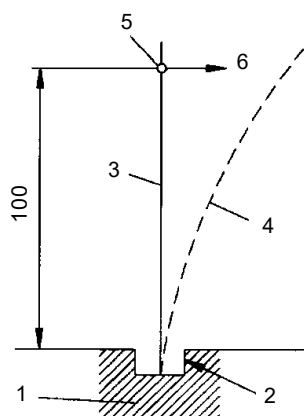


**Figure 10a – Principle of the test apparatus for deflecting test on screwless terminal**

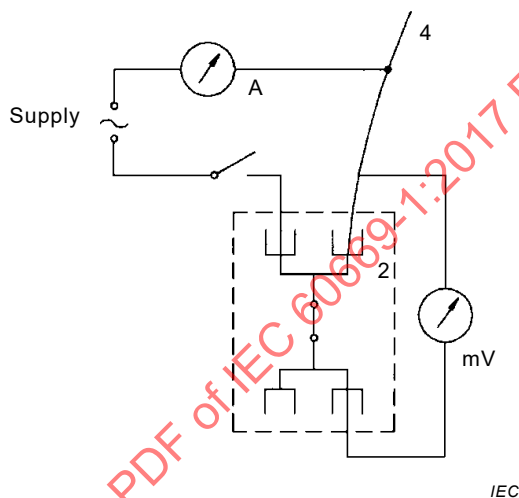
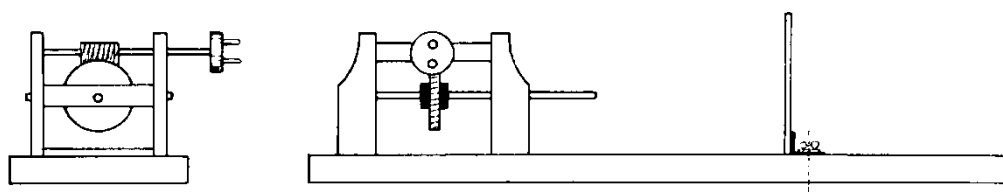


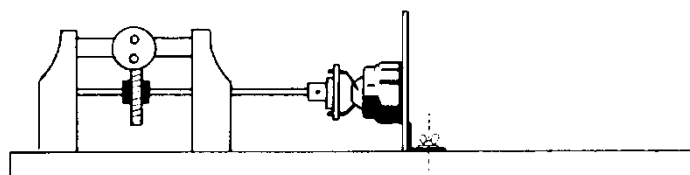
**Figure 10b – Example of test arrangement to measure the voltage drop during deflecting test on screwless terminal**

|    |                                                                |
|----|----------------------------------------------------------------|
| A  | ammeter                                                        |
| S  | switch                                                         |
| mV | millivoltmeter                                                 |
| 1  | specimen                                                       |
| 2  | clamping unit under test                                       |
| 3  | conductor                                                      |
| 4  | conductor deflected                                            |
| 5  | point of application of the force for deflecting the conductor |
| 6  | deflecting force (perpendicular to the straight conductor)     |

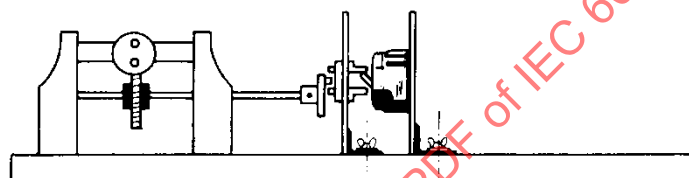
**Figure 10 – Information for deflection test**



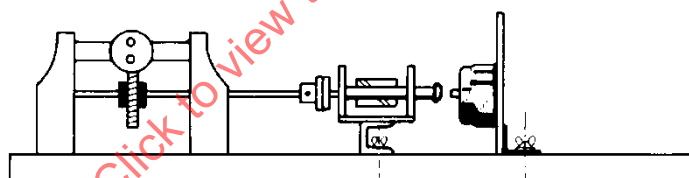
Driving mechanism



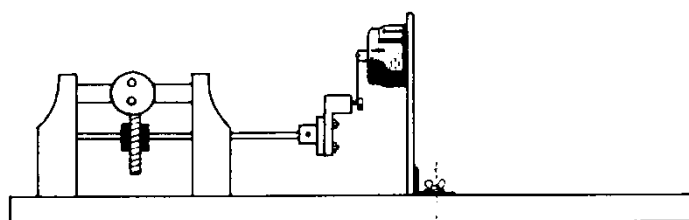
Arrangement for rotary switches



Arrangement for tumbler switches



Arrangement for rocker switches and push-button switches

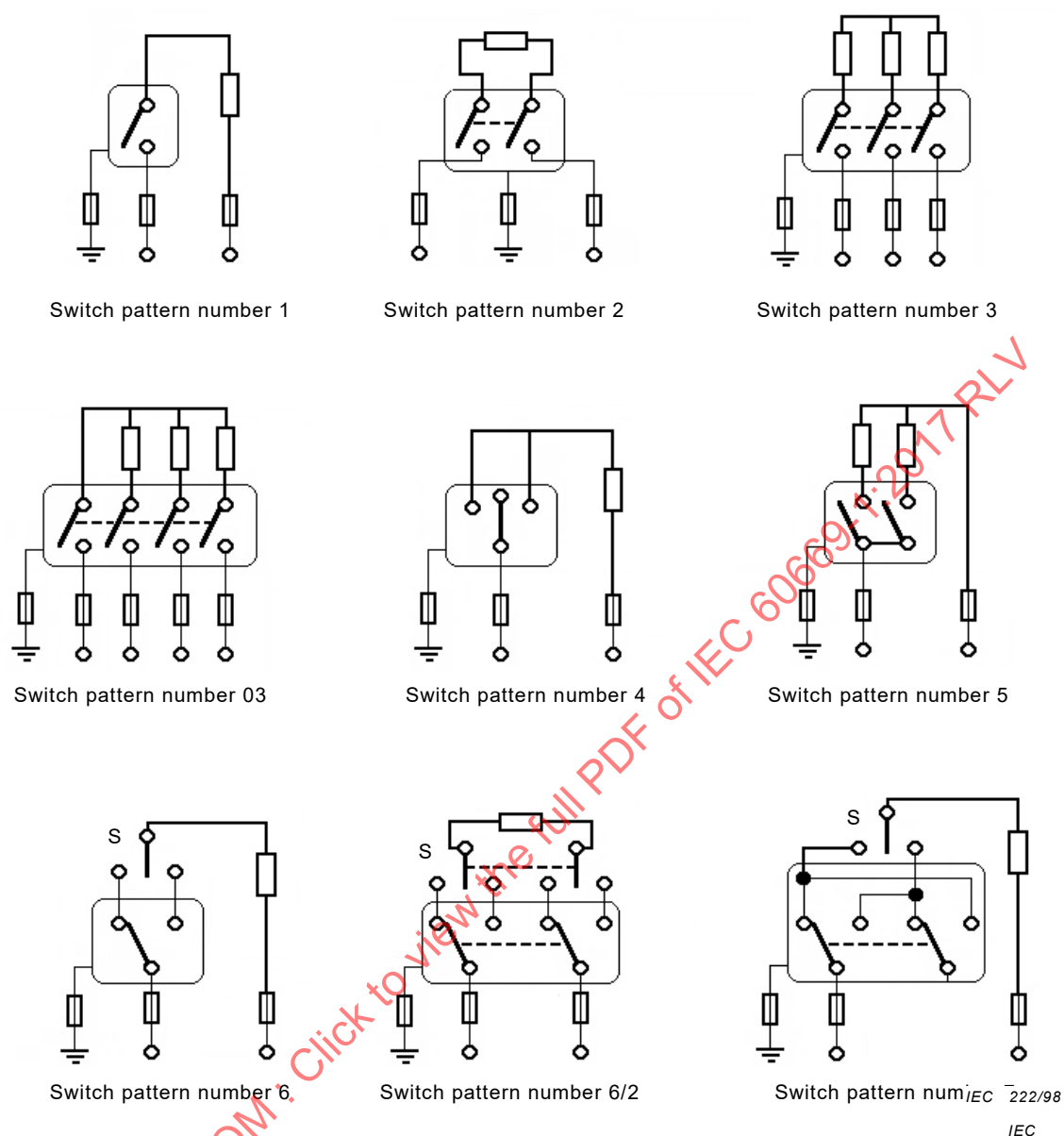


Arrangement for cord-operated switches

IEC 221/98

**Figure 12 – Apparatus for making and breaking capacity and normal operation tests**





The arrows indicating the connection of the phase conductors are shown as an example only.

**Figure 11 – Circuit diagrams for making and breaking capacity and normal operation**

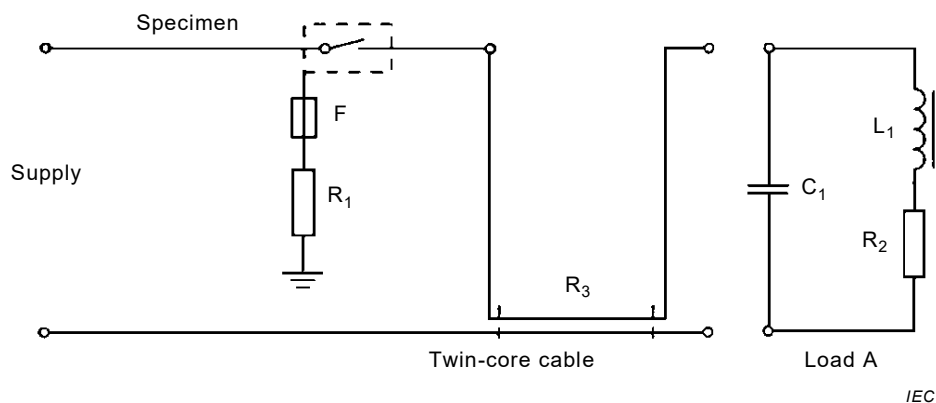


Figure 12a – Circuit diagrams for testing switches for use on **fluorescent** externally ballasted lamp loads

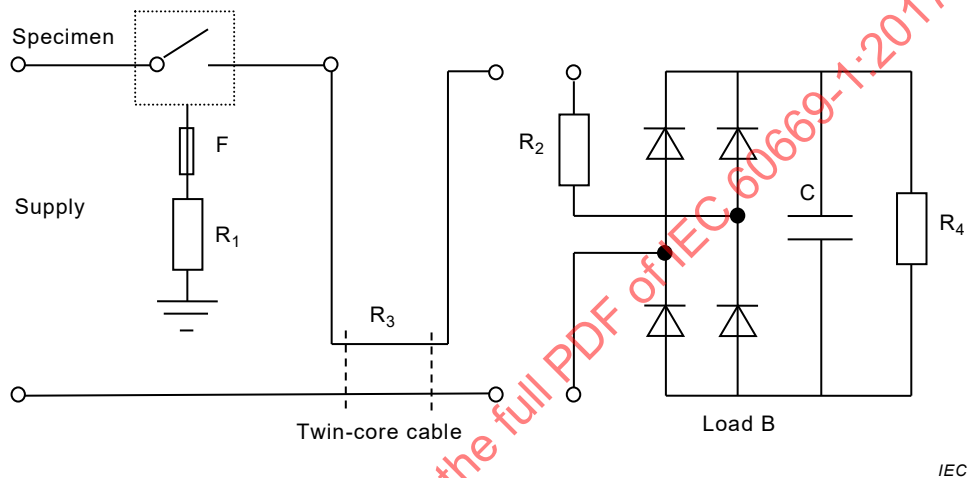


Figure 12b – Circuit diagrams for testing switches according to 19.3

Figure 12 – Circuit diagrams for testing switches

Dimensions in millimetres

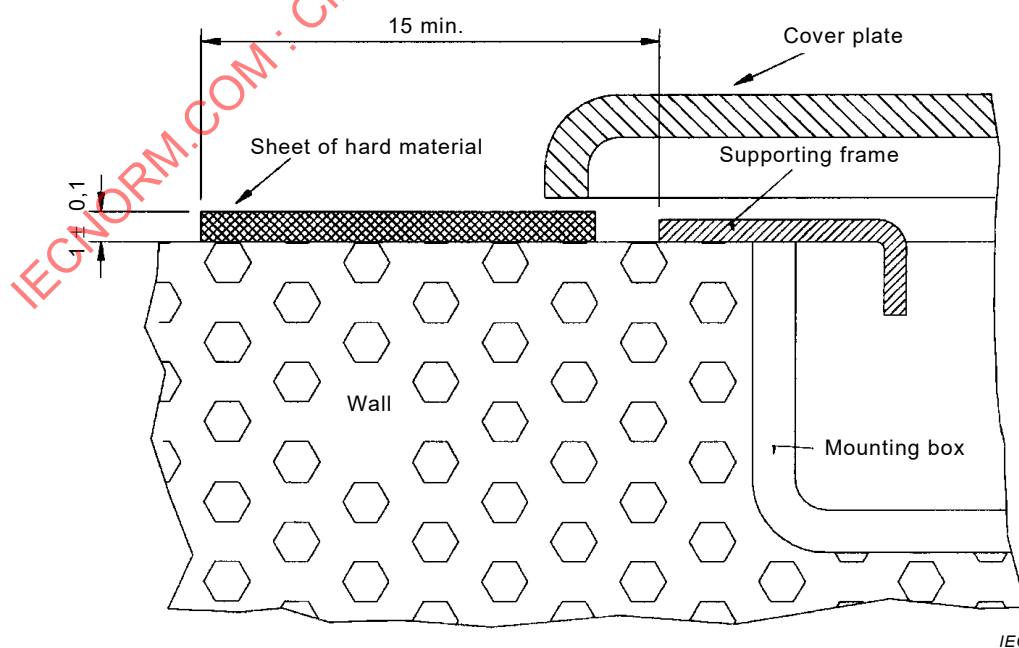


Figure 13 – Arrangement for test on cover-plates

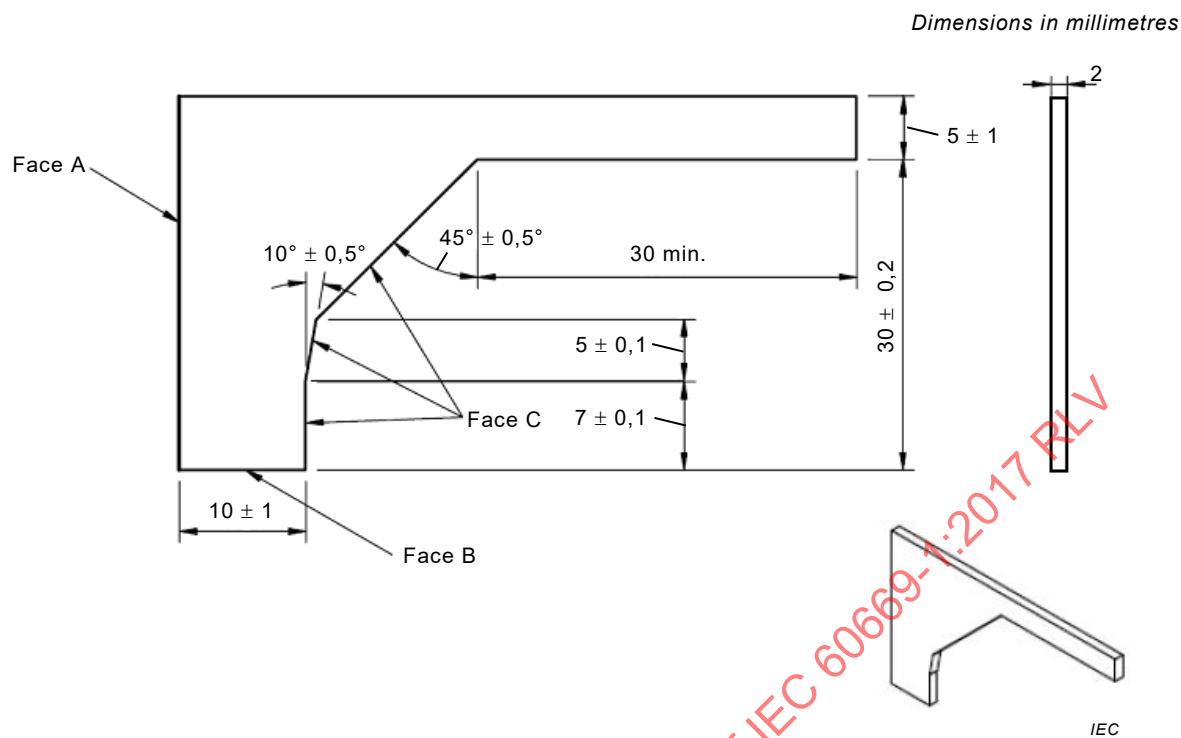
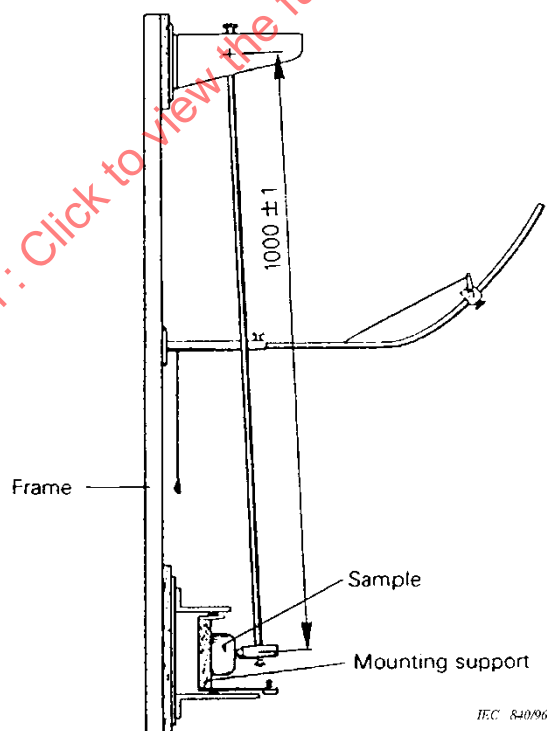
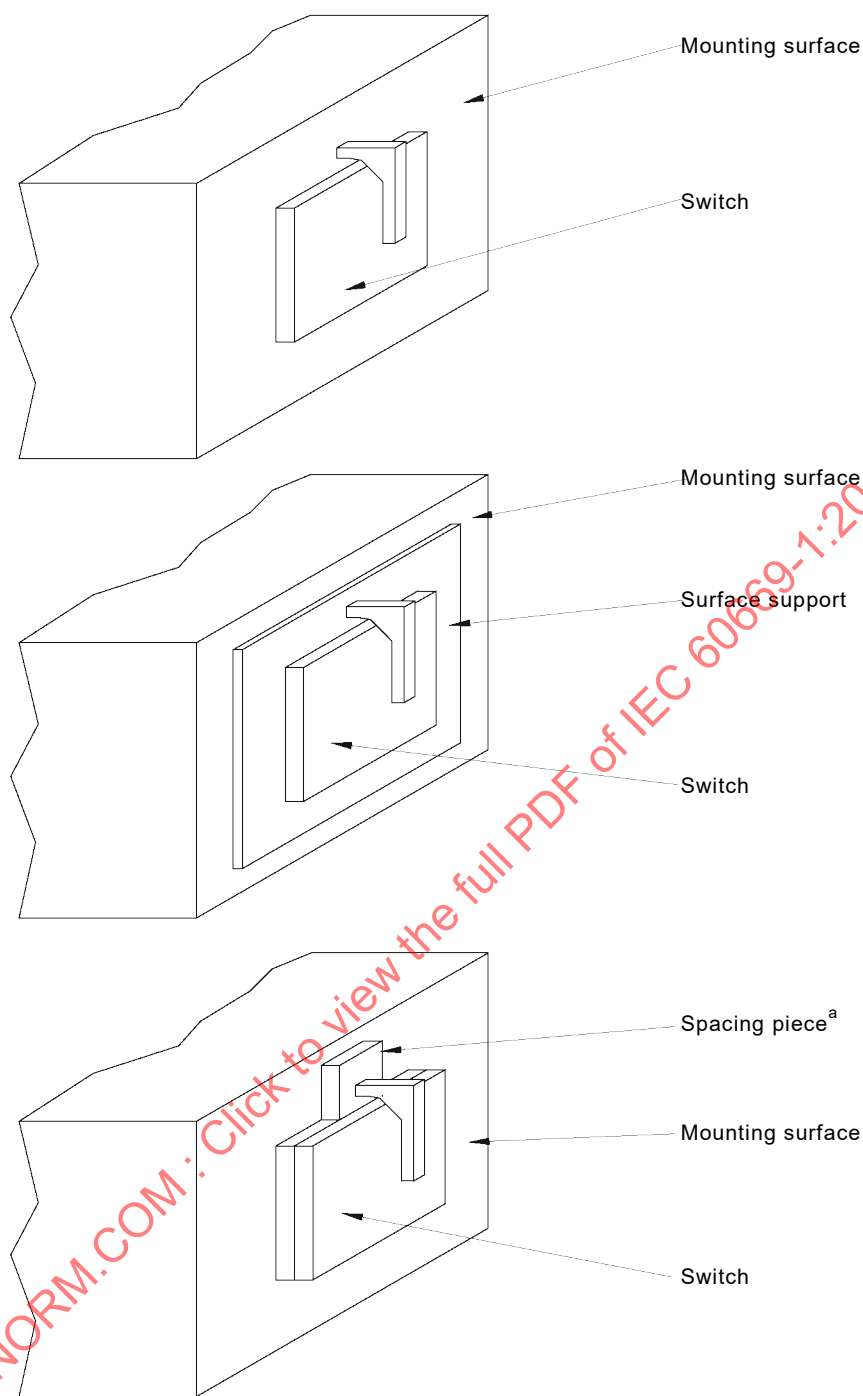


**Figure 14 – Gauge (thickness: about 2 mm) for the verification of the outline of covers, cover-plates or actuating members**



*Dimensions in millimetres*

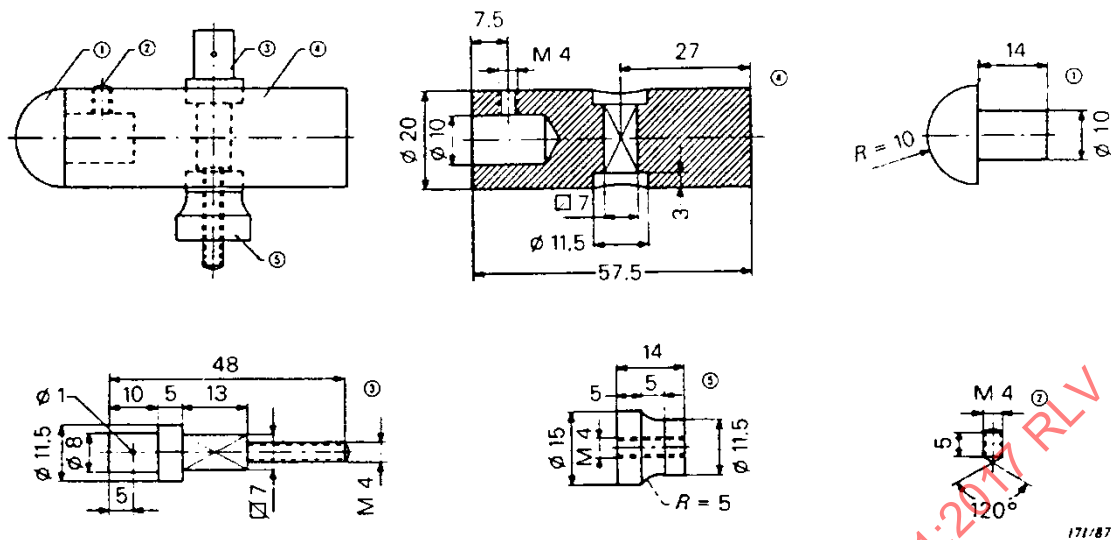
**Figure 15 – Impact test apparatus**



IEC

<sup>a</sup> The spacing piece has the same thickness as the supporting part.

**Figure 15 – Example of application of the gauge of Figure 14 on covers fixed without screws on a mounting surface or supporting surface**



Dimensions in millimetres

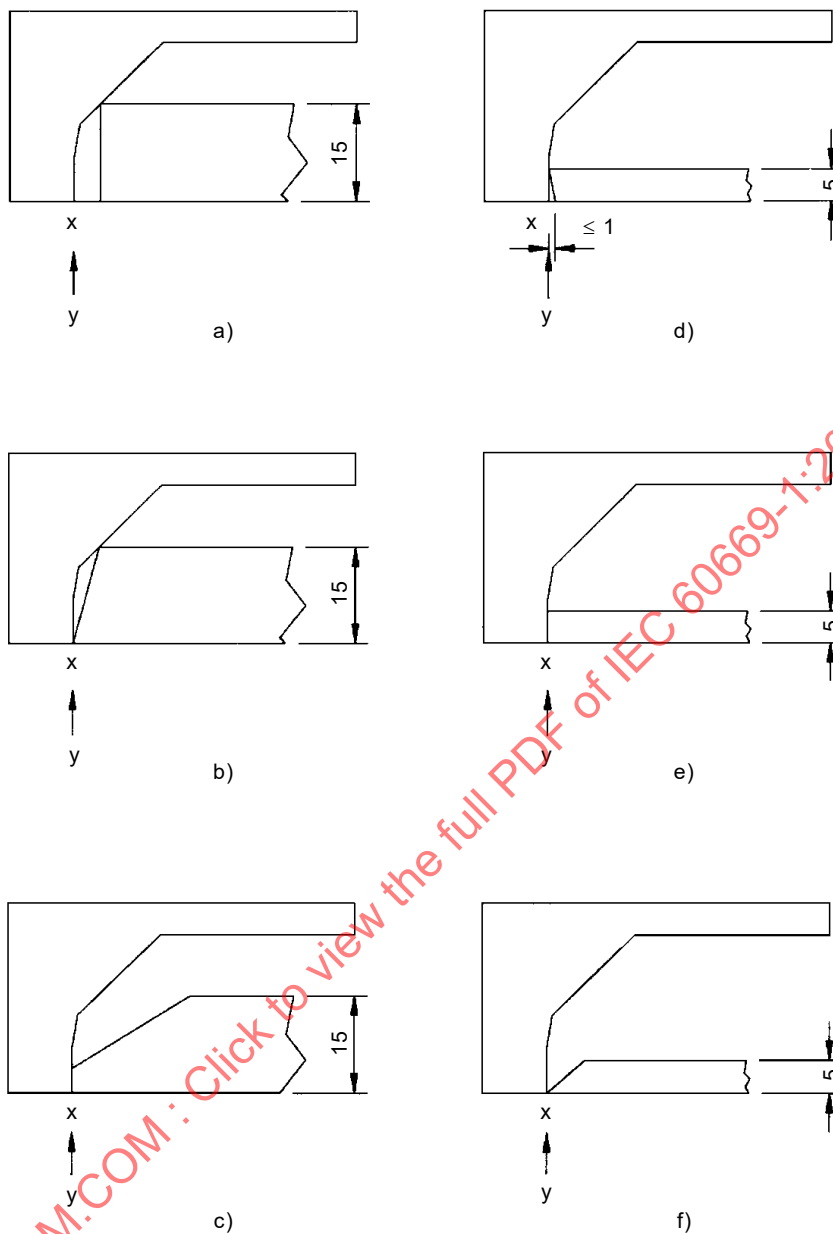
Material of the parts:

⊕: Polyamide

⊕, ⊖, ⊕, ⊖, ⊕, ⊖: Steel Fe 360

**Figure 16—Pendulum impact test apparatus (striking element)**

*Dimensions in millimetres*



IEC

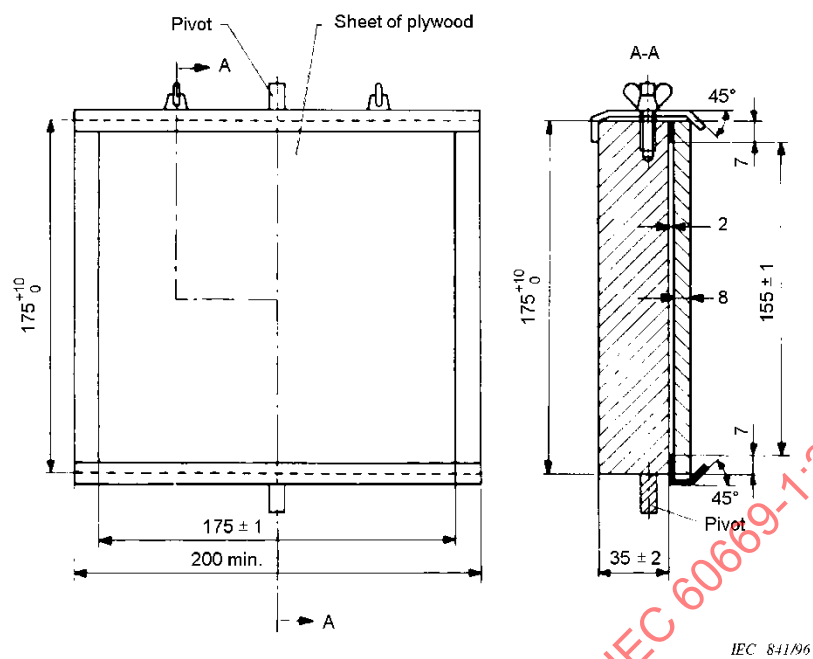
Cases a) and b):

do not comply.

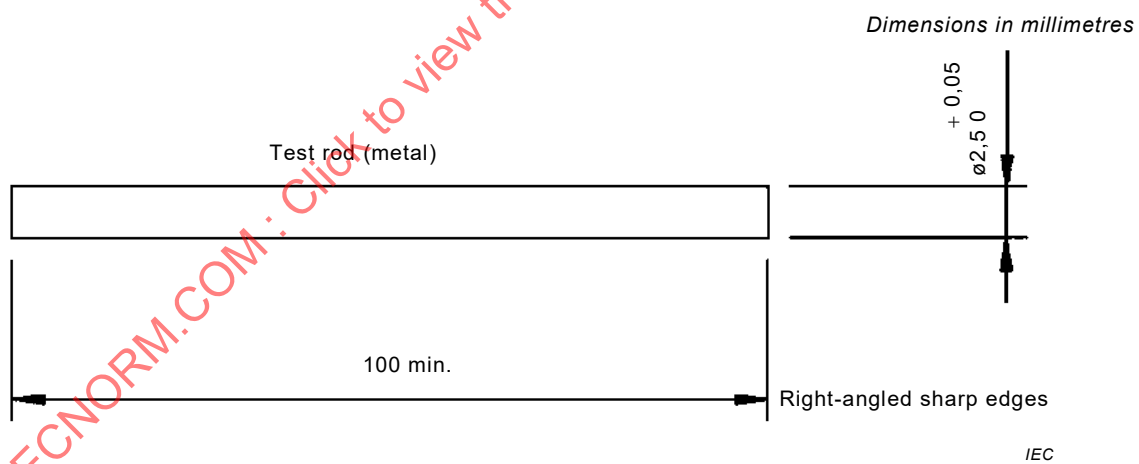
Cases c), d), e) and f):

comply (compliance shall however be checked also with the requirements of 20.8 using the gauge shown in Figure 17).

**Figure 16 – Examples of applications of the gauge of Figure 14 in accordance with the requirements of 20.8**

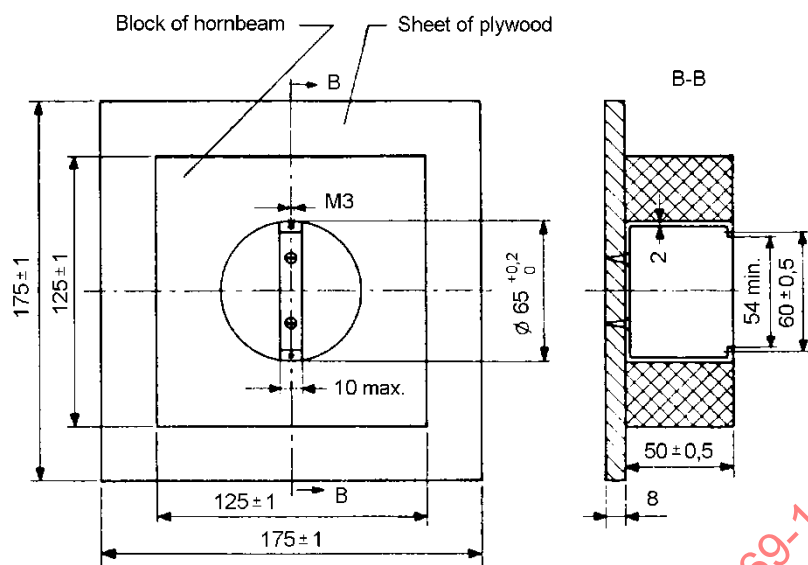


IEC 841/96

*Dimensions in millimetres***Figure 17 – Mounting support for sample**

IEC

**Figure 17 – Gauge for verification of grooves, holes and reverse tapers**



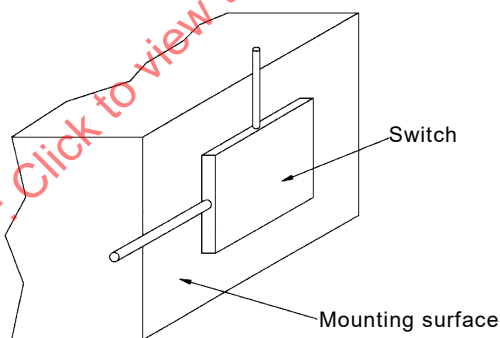
IEC 224/98

*Dimensions in millimetres*

The dimensions of the recess in the block of hornbeam, or similar material, are given as an example.

**Figure 18 – Mounting block for flush-type switches**

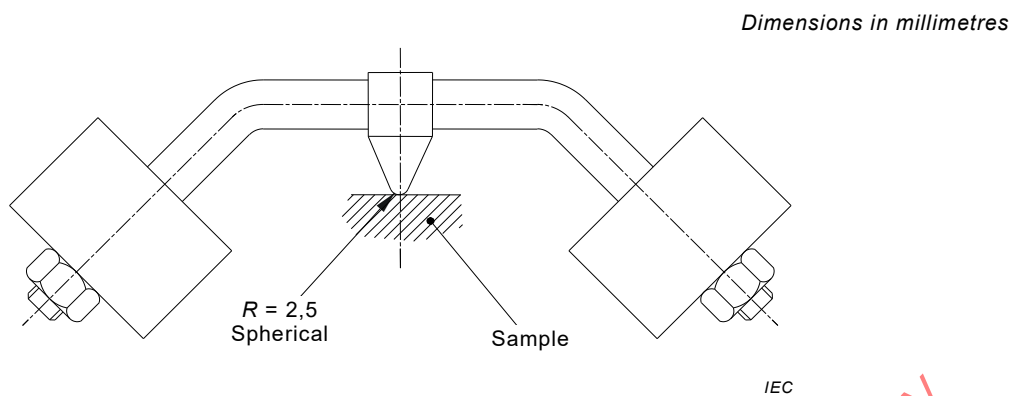
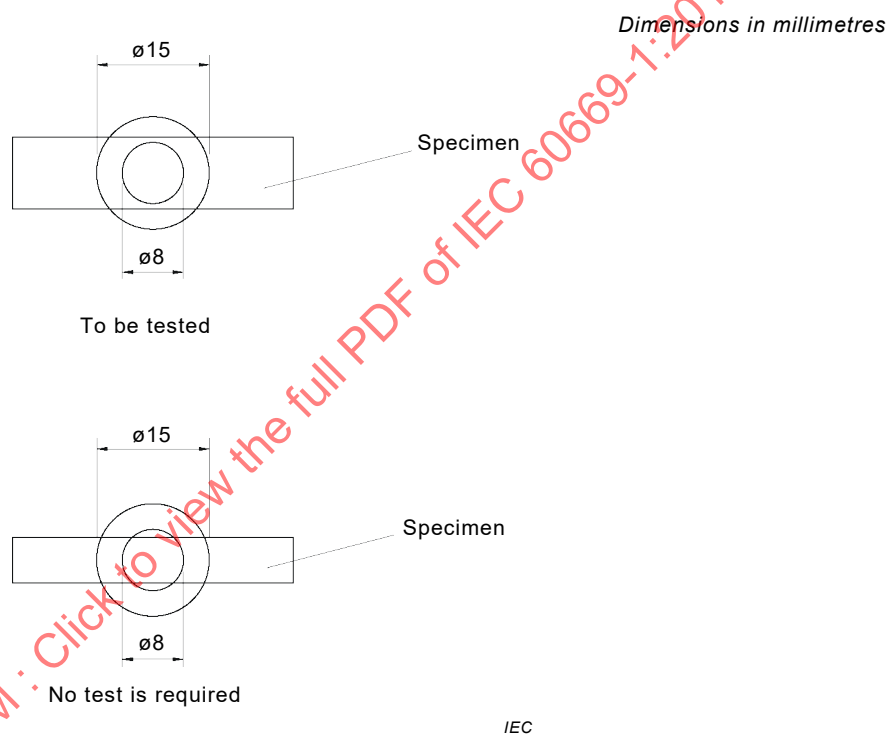
*Dimensions in millimetres*



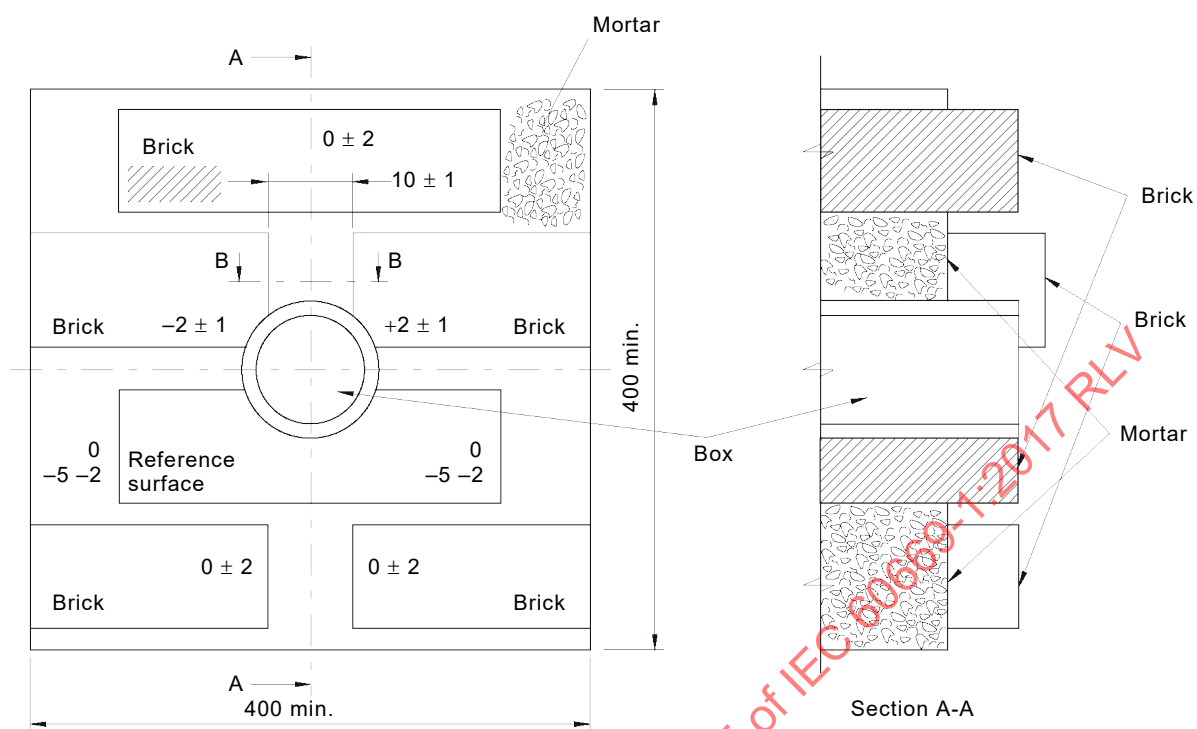
IEC

**Figure 18 – Sketch showing the direction of application of the gauge of Figure 17**

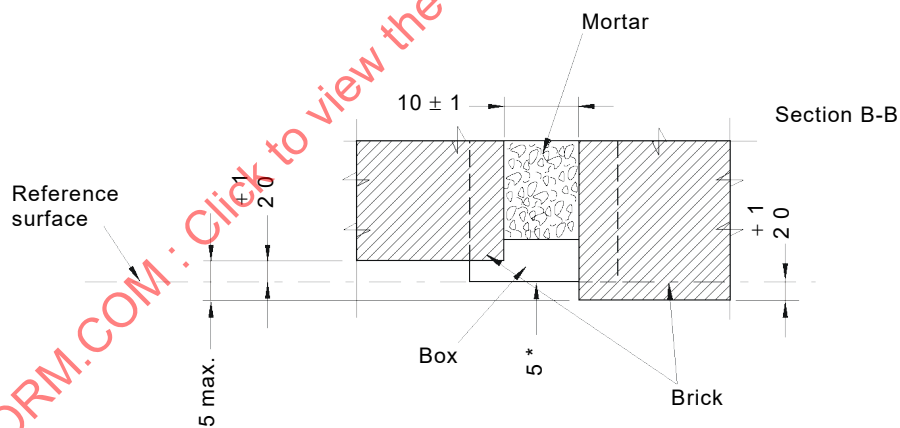


**Figure 19 – Ball-pressure apparatus****Figure 20 – Determining parts of insulating material to be tested – Diagrammatic representation (see 24.1)**

Dimensions in millimetres



All mortar joints  $10 \pm 5$  mm thick unless otherwise specified



\*or in accordance with the manufacturer's instructions

IEC

Figure 21 – Test wall in accordance with the requirements of 15.2.3

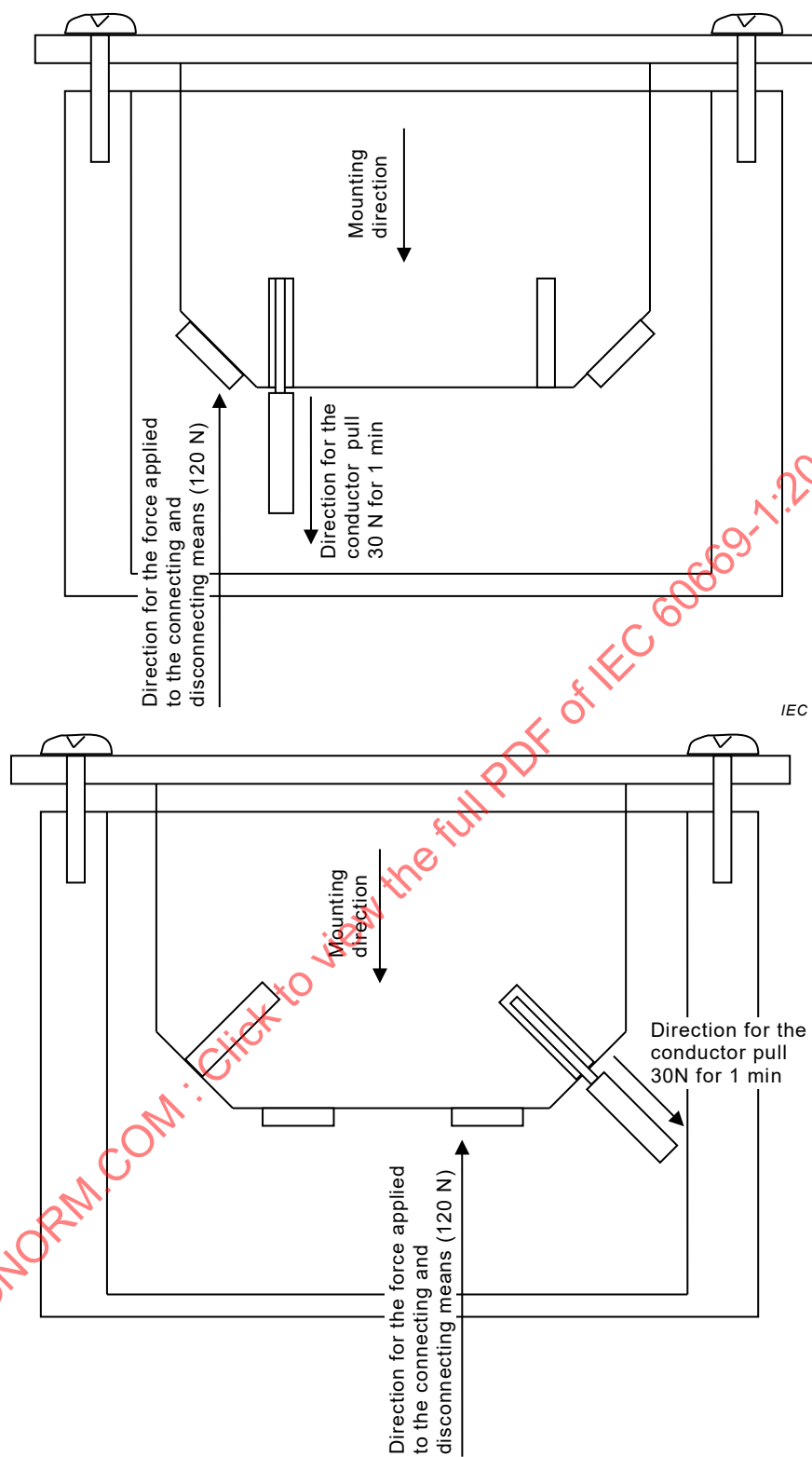


Figure 22a – Determination of the direction of the forces to be applied

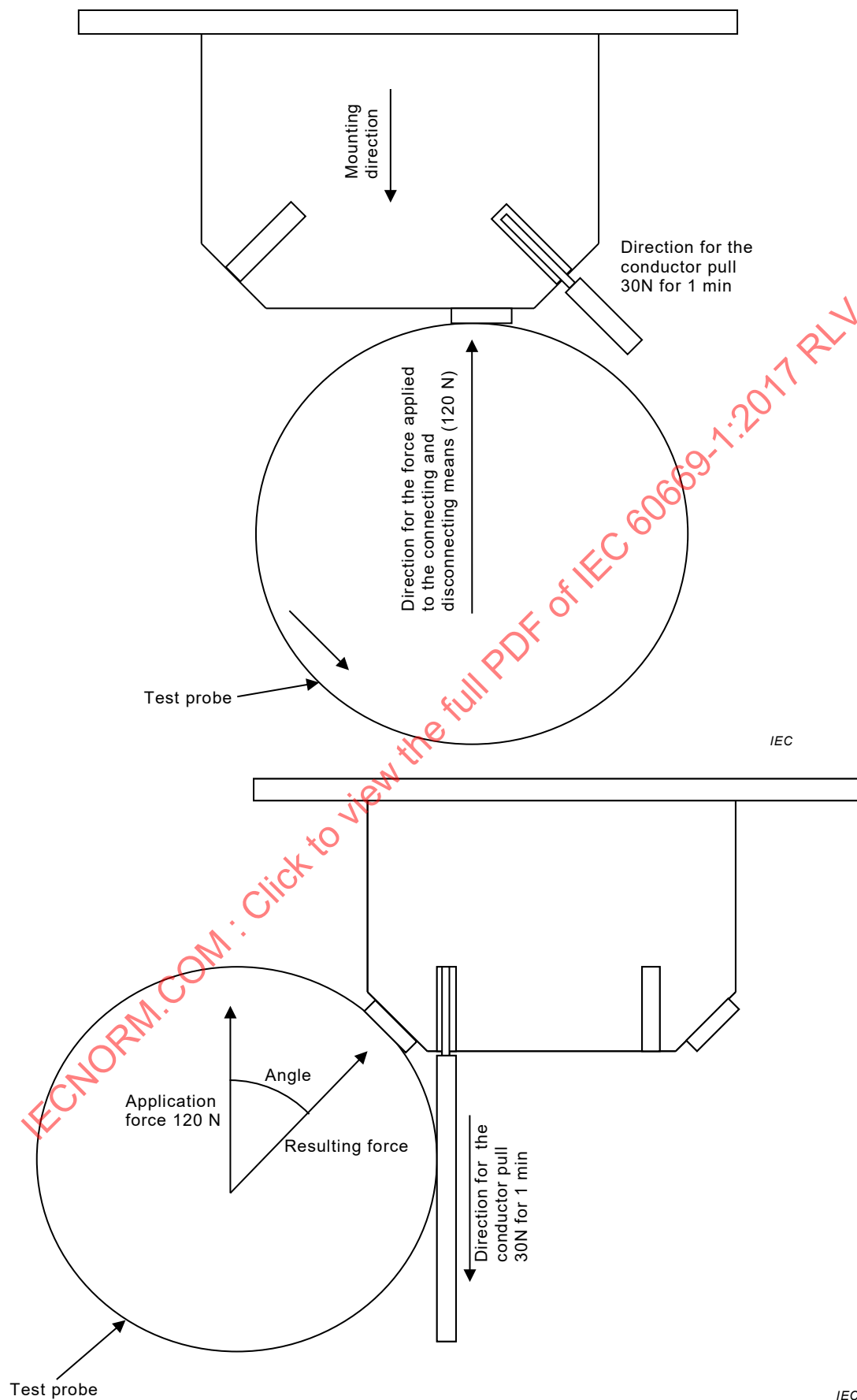
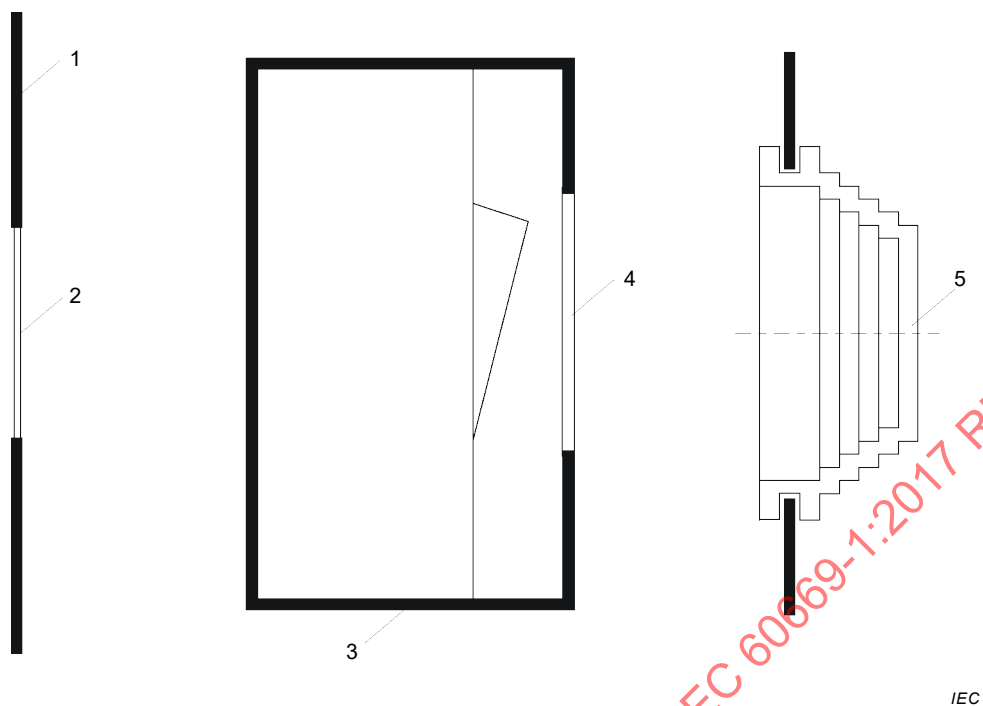


Figure 22b – Test set up

Figure 22 – Direction for the conductor pull of 30 N for 1 min

**Key**

- 1 Box
- 2 Entry membrane
- 3 Envelope
- 4 Protective membrane
- 5 Grommet

**Figure 23 – Examples of membranes and grommets**

**Annex A**  
(normative)

**Survey of specimens needed for tests**

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## Annex A (normative)

### Additional requirements for switches having facilities for the outlet and retention of flexible cables

The purpose of Annex A is to bring additional explanations and requirements to the normative text of this document. Therefore the numbering of clauses, subclauses, figures and tables follows that of the main body of the text. Only the relevant clauses, subclauses, tables and figures are cited. Any additional tables and figures are numbered starting from A.

### 3 Terms and definitions

Add the following definition:

#### ~~3.21~~ 3.23

##### **flexible cable outlet switch**

switch having provision for a flexible cable outlet

### 7 Classification

Add the following subclause:

~~7.1.9~~ 7.10 according to the presence of a flexible cable outlet:

- without flexible cable outlet;
- with flexible cable outlet.

### 10 Protection against electric shock

#### 10.1 Prevention of access to live parts

Add the following text at the end of the ~~3rd~~ fourth paragraph:

For flexible cable outlet switches the test is carried out without the flexible cable fitted.

### 12 Terminals

12.2.5 Add the following text after the ~~3rd~~ fifth paragraph:

For flexible cable outlet switches, the test is repeated with flexible cables of the appropriate size (see 13.15) following the same procedure.

### 13 Constructional requirements

Add the following subclause:

~~13.16~~ 13.17 Flexible cable outlet switches shall be so designed that an appropriate flexible cable, complying with IEC 60245-4, code designation 60245 IEC 66 or IEC 60227-5, code designation 60227 IEC 53, or as specified by the manufacturer, may enter the switch through a suitable hole, groove or gland. The entry shall accept the maximum dimensions (outer sheath) of the appropriate flexible cable, having conductors of the cross-sectional area

specified in Table A.1, according to the current rating of the switch, but with a minimum of 1,5 mm<sup>2</sup> and the entry shall be so shaped as to prevent damage to the flexible cable.

A cable anchorage for the flexible cable shall be provided such that the conductors are relieved from strain, including twisting, where they are connected to the terminals or terminations.

The cable anchorage shall contain the sheath and shall be either of insulating material or, if of metal, shall be provided with an insulating lining fixed to the metal parts.

Cable anchorages shall anchor the flexible cable securely to the switch.

The design shall ensure that

- the cable anchorage cannot be released from the outside;
- clamping the cable does not require the use of a special purpose tool.

**Table A.1 – Limits of external dimensions of flexible cables**

| Rated current<br>A | Cross-sectional area of conductors<br>mm <sup>2</sup> | Number of conductors | Limits of external dimensions of flexible cables |               |
|--------------------|-------------------------------------------------------|----------------------|--------------------------------------------------|---------------|
|                    |                                                       |                      | Minimum<br>mm                                    | Maximum<br>mm |
| 6                  | 0,75 up to and including 1,5                          | 2                    | 3,8 × 6                                          | 5,2 × 7,6     |
|                    |                                                       | 3                    | 5,7<br>or<br>3,7 × 6,0                           | 11,5 11,0     |
|                    |                                                       | 4                    |                                                  | 12,5 11,9     |
|                    |                                                       | 5                    |                                                  | 13,5 13,1     |
| 10 and 13          | 1 up to and including 2,5                             | 2                    | 7,6<br>5,9<br>or<br>3,9 × 6,2                    | 15 14,4       |
|                    |                                                       | 3                    |                                                  | 13,5 13,1     |
|                    |                                                       | 4                    |                                                  | 14,5 14,0     |
|                    |                                                       | 5                    |                                                  | 15,5          |
| 16                 | 1,5 up to and including 4                             | 2                    | 7,6 6,8                                          | 17            |
|                    |                                                       | 3                    |                                                  | 15 15,1       |
|                    |                                                       | 4                    |                                                  | 16 16,2       |
|                    |                                                       | 5                    |                                                  | 17,9          |
| 20 to 25           | 2,5 up to and including 6                             | 2                    | 8,6 8,4                                          | 18 17,9       |
|                    |                                                       | 3                    |                                                  | 19,5 19,9     |
|                    |                                                       | 4                    |                                                  | 20 18,0       |
|                    |                                                       | 5                    |                                                  | 22 20,0       |
|                    |                                                       |                      |                                                  | 24,5 22,2     |

NOTE The limits of the external diameter of cables specified in this table are based on type 60227 IEC 53 according to IEC 60227-5 and type 60245 IEC 66 according to IEC 60245-4 and are given for information.

Screws which are used when clamping the flexible cable shall not serve to fix any other component unless the switch is rendered manifestly incomplete if the component is omitted or is replaced in an incorrect position, or the component intended to be fixed cannot be removed without further use of a tool.

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



*Switches are fitted with a flexible cable complying with IEC 60227-5, code designation 60227 IEC 53, having a nominal conductor cross-sectional area of 1,5 mm<sup>2</sup> and the number of cores corresponding to the number of poles of the switch.*

NOTE For the purposes of this test, earth is considered as a pole.

*The conductors are introduced into the terminals and the terminal screws tightened just sufficiently to prevent the conductors easily changing their position. The cable anchorage is used in the normal way, the clamping screws, if any, being tightened to a torque of two-thirds of that given in Table 5.*

*After this preparation, it shall not be possible to push the flexible cable into the switch to such an extent as to impair safety or so that the cable anchorage is loosened.*

*The flexible cable is then subjected 25 times to a pull of 30 N. The pulls are applied without jerks in the most unfavourable direction, each time for 1 s. Immediately afterwards, the flexible cable is subjected for 1 min to a torque of 0,15 Nm as near as practicable to the cable entry.*

*The above test is then repeated, the switch being fitted with the appropriate largest diameter flexible cable complying with IEC 60245-4, code designation 60245 IEC 66. The pull is increased to 60 N and the torque is increased to 0,35 Nm.*

*After the test the flexible cable shall not have been displaced by more than 2 mm.*

*For the measurement of longitudinal displacement a mark is made on the flexible cable whilst it is subjected to a pull, at a distance of approximately 20 mm from the cable anchorage, before starting the test. After the test the displacement of the mark on the flexible cable in relation to the cable anchorage is measured whilst the flexible cable is again subjected to a pull.*

*An AC voltage of 2 000 V is applied for 1 min between the conductors and the cord anchorage.*

*During the test, the insulation of the flexible cable shall not be damaged. Breakdown or flashover is considered to indicate damage to the flexible cable.*

## **Annex B**

(informative)

### **Changes planned for the future in order to align IEC 60669-1 with the requirements of IEC 60998 (all parts), IEC 60999 (all parts) and IEC 60228**

Annex B is provided for information to show the large number of changes planned for the future to align IEC 60669-1 with the requirements of IEC 60998 (all parts), IEC 60999 (all parts) and IEC 60228.

There is no intention that Annex B be used for any conformity testing or certification.

The purpose of Annex B is to bring additional explanations and requirements to the normative text of this document. Therefore the numbering of clauses, subclauses, figures and tables follows that of the main body of the text. Only the relevant clauses, subclauses, tables and figures are cited. Any additional tables and figures are numbered starting from B.

## **12 Terminals**

*Replace Clause 12 by the following:*

### **12.1 General**

Switches shall be provided with terminals having screw clamping or with screwless terminals.

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

The test of 12.2.8 and 12.3.9 including 12.3.10 shall be carried out after the test of 15.1. Rigid solid conductors shall be of Class 1, rigid stranded conductors shall be of Class 2 and flexible conductor shall be of Class 5 according to IEC 60228.

*Compliance is checked by inspection and by the tests of 12.2 or 12.3, as applicable.*

*Terminals having screw clamping complying with IEC 60998-2-1 are considered to be in compliance with the requirements and tests of 12.2 provided they are chosen according to Table 4, except for the requirements according to 12.2.7 and 12.2.8. The tests of 12.2.7 and 12.2.8 shall be carried out in addition.*

The connecting capability of terminals for circuits other than those of the main circuit (for example terminals for pilot lights) need not be in relation with the rated current of the switch. This means that these terminals need not necessarily have the same connecting capability as the mains terminals of the switch. Terminals for circuits other than those of the main circuit shall fulfil the requirements of IEC 60998 (all parts) or IEC 60999 (all parts).

Terminals having screwless clamping complying with IEC 60998-2-2 are considered to be in compliance with the requirements and tests of 12.3 provided they are chosen according to Table 8, except for the requirements of 12.3.7 and 12.3.9. The tests of 12.3.7 and 12.3.9 shall be carried out in addition.

### **12.2 Terminals with screw clamping for external copper conductors**

**12.2.1** Terminals with screw clamping shall be of the type suitable for rigid copper conductors only or of the type suitable for both rigid and flexible copper conductors having cross-sectional areas as shown in Table 4.

**Table 4 – Relationship between rated currents and connectable cross-sectional areas of copper conductors**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Conductors                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| Ranges of rated currents<br>A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Nominal cross-sectional areas<br>mm <sup>2</sup> |
| up to and including 6 <sup>a</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | From 0,75 up to 1,5 inclusive                    |
| above 6 up to and including 13 <sup>b</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | From 1 up to 2,5 inclusive                       |
| above 13 up to and including 16 <sup>b</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | From 1,5 up to 4 inclusive                       |
| above 16 up to and including 25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | From 2,5 up to 6 inclusive                       |
| above 25 up to and including 32                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | From 4 up to 10 inclusive                        |
| above 32 up to and including 50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | From 6 up to 16 inclusive                        |
| above 50 up to and including 63                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | From 10 up to 25 inclusive                       |
| <p><sup>a</sup> For rated current up to 4 A when used for special purposes such as ELV applications, where flexible conductors are used (from 0,5 mm<sup>2</sup> up to and including 1 mm<sup>2</sup>).</p> <p><sup>b</sup> Each supply terminal of switches, other than those of pattern numbers 3, 03 and 7, shall allow the connection of two 2,5 mm<sup>2</sup> conductors. For switches having a rated voltage not exceeding 250 V, one hole is sufficient for the connection of two 2,5 mm<sup>2</sup> conductors.</p> |                                                  |

The conductor space shall be at least that specified in Figures 1, 2, 3, 4 and 5 or shall accept the conductor(s) of the largest nominal cross-sectional area as specified in Table 4 and with dimensions as specified in IEC 60999-1:1999, Annex B.

*Compliance is checked by inspection, by measurement according to the Figures 1 to 5 or by fitting conductors with the largest theoretical diameter as specified in IEC 60999-1:1999, Annex B for the largest nominal cross-sectional area as specified in Table 4 or by using the relevant gauges as specified in IEC 60999-1:1999, Annex B.*

**12.2.2** Terminals with screw clamping shall allow the conductor to be connected without special preparation.

*Compliance is checked by inspection.*

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

**12.2.3** Terminals with screw clamping shall have adequate mechanical strength.

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

Screws and nuts of terminals shall be of metal and in engagement with a metal thread.

Screws shall not be of metal which is soft or liable to creep, such as zinc or aluminium.

NOTE 1 The use of aluminium alloy screws in aluminium alloy terminals requires additional tests, according to IEC 61545.

*Compliance is checked by inspection and by the tests of 12.2.6 and 12.2.8.*

NOTE 2 Provisionally SI, BA, and UN threads are considered to be comparable in pitch and mechanical strength to metric ISO thread.

**12.2.4** Terminals with screw clamping shall be resistant to corrosion.

Terminals, the body of which is made of copper or copper alloy as specified in 22.5 are considered as complying with this requirement.

*Compliance is checked by inspection or by chemical analysis if necessary.*

**12.2.5** Terminals with screw clamping shall be so designed and constructed that they clamp the conductor(s) without undue damage to the conductor(s).

*Compliance is checked by the following tests which are performed on three new specimens of each type of terminal:*

*Terminals suitable for rigid conductors only are checked with rigid solid conductors and on a new set of specimens with rigid stranded conductors, if existing.*

NOTE "if existing" means that the conductor is available in the market where the product is sold and installed.

*Terminals suitable for rigid and flexible conductors are checked with rigid solid conductors as above and on a new set of specimens with flexible conductors.*

*The terminal is placed in the test apparatus according to Figure 9.*

The following tests shall be carried out using new specimens for each of the following:

*The terminal is fitted with*

- a) *the minimum number of conductors of the smallest nominal cross-sectional area;*
  - b) *the minimum number of conductors of the largest nominal cross-sectional area;*
- and, if applicable,*
- c) *the maximum number of conductors of the smallest nominal cross-sectional area of the same type;*
  - d) *the maximum number of conductors of the largest nominal cross-sectional area of the same type, according to Table 4.*

*The clamping screw(s) or nut(s) is(are) tightened with the torque according to Table 5.*

*Where a screw has a hexagonal head with a slot for tightening with a screwdriver and the values of columns 3 and 5 are different, the test is made twice, first applying to the hexagonal head the torque specified in column 5 and then applying the torque specified in column 3 by means of a screwdriver. If the values of columns 3 and 5 are the same, only the test with the screwdriver is made.*

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

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

*The screws and nuts shall be tightened in one smooth and continuous motion.*

*If the terminal is fitted with more than one conductor, the test is done on each of the conductors consecutively.*

*The length of the test conductor shall be at least 75 mm longer than the height (H) specified in Table 6.*

*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 6. The bushing shall be*

*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 distance between the mouth of the clamping unit and the upper surface of the bushing shall be as specified in Table 6 with a tolerance of  $\pm 15$  mm. The bushing may be lubricated to prevent binding, twisting, or rotation of the insulated conductor.*

*A mass as specified in Table 6 is to be suspended from the end of the conductor.*

*Then the platen is rotated 150 turns at a speed of  $(10 \pm 2)$  r/min.*

*During the test, the rigid conductor, or any wire of rigid stranded, or flexible conductor, shall neither slip out of the clamping unit nor break near the clamping unit, nor shall the conductor be damaged in such a way as to render it unfit for further use.*

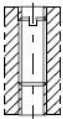
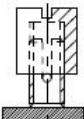
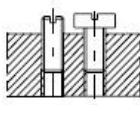
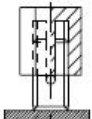
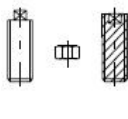
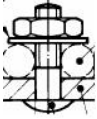
*In the case of the flexible conductor, the break of a few wires shall not be taken into account provided it does not exceed 15 % of the original number of wires.*

*Immediately after each rotation test, the test of 12.2.6 is performed.*

*The terminals shall not be tightened or untightened.*

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**Table 5 – Tightening torque for the verification of the mechanical strength of screw-type terminals**

| Nominal diameter of thread<br>mm | Torque<br>Nm                                                                      |                                                                                   |                                                                                   |                                                                                     |                                                                                     |                                                                                     |
|----------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|                                  | 1                                                                                 | 2                                                                                 | 3                                                                                 | 4                                                                                   | 5                                                                                   | 6                                                                                   |
|                                  |  |  |  |  |  |  |
| Up to and including 2,8          | 0,2                                                                               | –                                                                                 | 0,4                                                                               | –                                                                                   | 0,4                                                                                 | –                                                                                   |
| Over 2,8 up to and including 3,0 | 0,25                                                                              | –                                                                                 | 0,5                                                                               | –                                                                                   | 0,5                                                                                 | –                                                                                   |
| Over 3,0 up to and including 3,2 | 0,3                                                                               | –                                                                                 | 0,6                                                                               | –                                                                                   | 0,6                                                                                 | –                                                                                   |
| Over 3,2 up to and including 3,6 | 0,4                                                                               | –                                                                                 | 0,8                                                                               | –                                                                                   | 0,8                                                                                 | –                                                                                   |
| Over 3,6 up to and including 4,1 | 0,7                                                                               | 1,2                                                                               | 1,2                                                                               | 1,2                                                                                 | 1,2                                                                                 | –                                                                                   |
| Over 4,1 up to and including 4,7 | 0,8                                                                               | 1,2                                                                               | 1,8                                                                               | 1,8                                                                                 | 1,8                                                                                 | –                                                                                   |
| Over 4,7 up to and including 5,3 | 0,8                                                                               | 1,4                                                                               | 2,0                                                                               | 2,0                                                                                 | 2,0                                                                                 | –                                                                                   |
| Over 5,3 up to and including 6,0 | –                                                                                 | 1,8                                                                               | 2,5                                                                               | 3,0                                                                                 | 3,0                                                                                 | –                                                                                   |
| Over 6                           | –                                                                                 | –                                                                                 | –                                                                                 | –                                                                                   | –                                                                                   | 0,8                                                                                 |

Column 1 applies to screws without heads if the screw, when tightened, does not protrude from the hole, and to other screws which cannot be tightened by means of a screwdriver with a blade wider than the diameter of the screw.

Column 2 applies to nuts of mantle terminals which are tightened by means of a screwdriver.

Column 3 applies to other screws which are tightened by means of a screwdriver.

Column 4 applies to nuts of mantle terminals in which the nut is tightened by means other than a screwdriver.

Column 5 applies to screws or nuts, other than nuts of mantle terminals, which are tightened by means other than a screwdriver.

Column 6 applies to nuts of switches with central hole fixing.

**Table 6 – Test values for flexion and pull out of copper conductors**

| Conductor cross-sectional area<br>mm <sup>2</sup> | Diameter of bushing hole <sup>a</sup><br>mm | Height $H$ <sup>b</sup><br>mm | Mass for conductor<br>kg |
|---------------------------------------------------|---------------------------------------------|-------------------------------|--------------------------|
| 0,5                                               | 6,5                                         | 260                           | 0,3                      |
| 0,75                                              | 6,5                                         | 260                           | 0,4                      |
| 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                      |
| 25,0                                              | 13,0                                        | 300                           | 4,5                      |

NOTE AWG sizes corresponding to mm<sup>2</sup> can be found in IEC 60999-1.

<sup>a</sup> If the bushing hole diameter is not large enough to accommodate the conductor without binding, a bushing having the next larger hole size may be used.

<sup>b</sup> Tolerance for height  $H = \pm 15$  mm.

**12.2.6** Terminals with screw clamping shall be so designed that they clamp the conductor reliably between metal surfaces.

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

*After each rotation test of 12.2.5, the pulling force given in Table 7 shall be applied to the conductor under test in accordance with 12.2.5. Clamping screws or nuts, if any, shall not be retightened for this test. The force shall be applied in one smooth and continuous application, for 1 min, in the direction of the axis of the conductor. During the test the conductor shall not come out of the terminal.*

**Table 7 – Relationship between pull force and cross-sectional area**

| Cross-sectional area | Pull force |
|----------------------|------------|
| mm <sup>2</sup>      | N          |
| 0,5                  | 20         |
| 0,75                 | 30         |
| 1,0                  | 35         |
| 1,5                  | 40         |
| 2,5                  | 50         |
| 4                    | 60         |
| 6                    | 80         |
| 10                   | 90         |
| 16                   | 100        |
| 25                   | 135        |

*After these tests, neither the terminals nor the clamping means shall have worked loose and the conductors shall show no deterioration impairing their further use.*

NOTE In the following countries, terminals allowing connection of two conductors are additionally tested with one rigid solid conductor and one rigid stranded conductor with the same cross-sectional area connected at the same time: DK, FI, NO, SE, ZA.

**12.2.7** Terminals with screw clamping shall be so designed or placed that neither a rigid solid conductor nor a wire of a stranded conductor can slip out while the clamping screws or nuts are tightened.

This requirement does not apply to lug terminals.

*Compliance is checked by the following test:*

*Terminals suitable for rigid conductors only are checked with rigid solid conductors and on a new set of specimens with rigid stranded conductors, if existing.*

NOTE “if existing” means that the conductor is available in the market where the product is sold and installed.

*Terminals suitable for rigid and flexible conductors are checked with rigid conductors as above and on a new set of specimens with flexible conductors.*

*The terminals are fitted with conductors having the largest cross-sectional area specified in Table 4.*

*Terminals intended for the looping-in of two or more conductors are checked fitted with the permissible number of conductors.*



*The terminals are fitted with conductors having the composition given in IEC 60228.*

*Before insertion into the clamping means of the terminal, wires of rigid (solid or stranded) conductors are straightened; rigid stranded conductors may, in addition, be twisted to restore them approximately to their original shape and flexible conductors are twisted in one direction so that there is a uniform twist of one complete turn in a length of approximately 20 mm.*

*The conductor is inserted into the clamping means of the terminal for the minimum distance prescribed or, where no distance is prescribed, until it just projects from the far side of the terminal and in the position most likely to allow the wire to escape.*

*The clamping screw(s) or nut(s) is (are) then tightened with a torque equal to two-thirds of the torque shown in the appropriate column of Table 5.*

*After the test, no wire of the conductors shall have escaped outside the clamping unit thus reducing creepage distances and clearance distances to values lower than those indicated in Table 23.*

**12.2.8** Terminals with screw clamping shall be so fixed or located within the switch that, when the clamping screws or nuts are tightened or loosened, the terminals shall not work loose from their fixing to the switch.

Movement of the terminal is allowed as long as it is sufficiently limited so as to prevent non-compliance with this document.

The use of sealing compound or resin is considered to be sufficient for preventing a terminal from working loose, provided that:

- the sealing compound or resin is not subject to stress during normal use, and
- the effectiveness of the sealing compound or resin is not impaired by temperatures attained by the terminal under the most unfavourable conditions specified in this document.

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

*A solid rigid copper conductor of the largest cross-sectional area specified in Table 4 is placed in the terminal*

*Where rigid solid conductors do not exist, the test may be made with rigid stranded conductors.*

*Before insertion into the clamping means of the terminal, wires of rigid (solid or stranded) are straightened; rigid stranded conductors may, in addition, be twisted to restore them approximately to their original shape.*

*The conductor is inserted into the clamping means of the terminal for the minimum distance prescribed or, where no distance is prescribed, until it just projects from the far side of the terminal and in the position most likely to allow the wire to escape.*

*Screws and nuts are tightened and loosened five times by means of a suitable test screwdriver or spanner, the torque applied when tightening being equal to the torque shown in the appropriate column of Table 5 or in the table of the appropriate Figures 1 to 4, whichever is the highest.*

*A new conductor end is used each time the screw or nut is loosened.*



*Where a screw has a hexagonal head with a slot and the values in columns 3 and 5 of Table 5 are different, the test is made twice, first on a set of three specimens applying to the hexagonal head the torque specified in column 5 and then on another set of three specimens, applying the torque specified in column 3 by means of a screwdriver. If the values in columns 3 and 5 are the same, only the test with the screwdriver is made.*

*During the test, terminals shall not work loose and there shall be no damage, such as breakage of screws or damage to the heads, slots (rendering the use of the appropriate screwdriver impossible), threads, washers or stirrups that will impair the further use of the terminals.*

*For mantle terminals the specified nominal diameter is that of the slotted stud.*

*The shape of the blade of the test screwdriver shall suit the head of the screw to be tested. The screws and nuts shall be tightened in one smooth and continuous application of the torque.*

**12.2.9** Clamping screws or nuts of earthing terminals with screw clamping 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 manual test.*

*In general, the designs of terminals shown in Figures 1, 2, 3, 4 and 5 provide sufficient resiliency to comply with this requirement; for other designs, special provisions, such as the use of an adequately resilient part which is not likely to be removed inadvertently, may be necessary.*

**12.2.10** Earthing terminals with screw clamping 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 terminals 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 other metal no less resistant to corrosion.

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

*Compliance is checked by inspection.*

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

**12.2.11** In case where the figures are used to verify the requirements of 12.2.1, the following applies.

For pillar terminals, the distance between the clamping screw and the end of the conductor, when fully inserted, shall be at least that specified in Figure 1.

NOTE The minimum distance between the clamping screw and the end of the conductor applies only to pillar terminals in which the conductor cannot pass right through.

For mantle terminals, the distance between the fixed part and the end of the conductor, when fully inserted, shall be at least that specified in Figure 5.

*Compliance is checked by measurement, after a solid conductor of the largest nominal cross-sectional area specified, for the appropriate rated current in Table 4, has been fully inserted and fully clamped.*

**12.2.12** Lug terminals shall be used only for switches having a rated current of 40 A or greater; if such terminals are provided, they shall be fitted with spring washers or equally effective locking means.

*Compliance is checked by inspection.*

### 12.3 Screwless terminals for external copper conductors

**12.3.1** Screwless terminals may be of the type suitable for rigid copper conductors only or of the type suitable for both rigid and flexible copper conductors.

*Terminals suitable for rigid conductors only are checked with rigid solid conductors and on a new set of specimens with rigid stranded conductors, if existing.*

NOTE “if existing” means that the conductor is available in the market where the product is sold and installed.

*For screwless terminals suitable for both rigid and flexible copper conductors, the tests are carried out with rigid conductors first and then repeated with flexible conductors.*

12.3 is not applicable to switches provided with:

- screwless terminals requiring the fixing of special devices to the conductors before clamping in the screwless terminal, for example flat push-on connectors;
- screwless terminals requiring twisting of the conductors, for example those with twisted joints;
- screwless terminals providing direct contact to the conductors by means of edges or points penetrating the insulation.

**12.3.2** Screwless terminals shall be provided with clamping units which allow the proper connection of rigid or of rigid and flexible copper conductors having nominal cross-sectional areas as shown in Table 8.

**Table 8 – Relationship between rated currents and connectable cross-sectional areas of copper conductors for screwless terminals**

| Rated current<br>A                                                                                                                                                                                                                                                  | Conductors                                       |                                           |                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|-------------------------------------------|----------------------------------------------|
|                                                                                                                                                                                                                                                                     | Nominal cross-sectional areas<br>mm <sup>2</sup> | Diameter of largest rigid conductor<br>mm | Diameter of largest flexible conductor<br>mm |
| Up to and including 4 <sup>a</sup>                                                                                                                                                                                                                                  | 0,75 to 1,5                                      | 1,5                                       | 1,8                                          |
| Above 4 and including 6                                                                                                                                                                                                                                             | 1 to 1,5                                         | 1,5                                       | 1,8                                          |
| Above 6 and including 16 <sup>b</sup>                                                                                                                                                                                                                               | 1,5 to 2,5                                       | 2,2                                       | 2,4                                          |
| NOTE In the following country, the largest diameter of flexible conductors above 6 A and including 16 A is 2,21 mm: CH.                                                                                                                                             |                                                  |                                           |                                              |
| <sup>a</sup> For special purposes such as ELV applications, conductors from 0,5 mm <sup>2</sup> up to 1 mm <sup>2</sup> inclusive can be used.                                                                                                                      |                                                  |                                           |                                              |
| <sup>b</sup> Each supply terminal of switches other than those of pattern numbers 3, 03 and 7 shall allow the connection of two 2,5 mm <sup>2</sup> conductors. In such cases a terminal with separate independent clamping means for each conductor shall be used. |                                                  |                                           |                                              |

*Compliance is checked by inspection and by fitting conductors of the smallest and largest cross-sectional areas specified.*

**12.3.3** Screwless terminals shall allow the conductor to be connected without special preparation.

*Compliance is checked by inspection.*

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.

**12.3.4** Parts of screwless terminals mainly intended for carrying current shall be of materials as specified in 22.5.

*Compliance is checked by inspection or by chemical analysis.*

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

**12.3.5** Screwless terminals shall be so designed that they clamp the specified conductors with sufficient contact pressure and without undue damage to the conductor.

The conductor shall be clamped reliably and between metal surfaces.

*Compliance is checked by inspection and by the test of 12.3.10.*

**12.3.6** It shall be clear how the connection and disconnection of the conductors is to be made.

The intended disconnection of a conductor shall require an operation, other than a pull on the conductor, so that it can be made manually with or without the help of a general purpose tool.

It shall not be possible to confuse the opening intended for the use of a tool to assist the connection or disconnection with the opening intended for the conductor.

In case the screwless terminal is intended for flexible conductors, the system shall allow release of the opening of the contact in order to allow the introduction and the disconnection of all the wires of the flexible conductor.

*Compliance is checked by inspection and by the following tests which are performed on new specimens:*

*Screwless-type clamping units are tested with the relevant conductors as given in 12.3.2 having the largest diameter.*

*Five insertions and disconnections are made with each type of conductor for which the clamping unit is intended to be used.*

*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 clamping units shall not be damaged in such a way as to impair their further use.*

**12.3.7** Screwless terminals which are intended to be used for the interconnection of two or more conductors shall be so designed that:

- each conductor is clamped individually;

NOTE The clamping of one of the conductors is independent of the clamping of the other conductor(s).

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

It shall be possible to clamp securely any number of conductors up to the maximum as designed.

*Compliance is checked by inspection and by manual tests with the appropriate conductors (in number and size).*

**12.3.8** Screwless terminals shall be so designed that adequate insertion of the conductor is obvious and over-insertion is prevented if further insertion is liable to reduce the creepage distances and/or clearances required in Table 23, or to influence the operation of the switch.

*Compliance is checked by inspection and by the test of 12.3.10.*

**12.3.9** Screwless terminals shall be properly fixed to the switch.

They shall not work loose when the conductors are connected or disconnected during installation.

*Compliance is checked by inspection and by the test of 12.3.10.*

Covering with sealing compound without other means of locking is not sufficient. However, self-hardening resins may be used to fix terminals which are not subject to mechanical stress in normal use.

**12.3.10** Screwless terminals shall withstand the mechanical stresses occurring in normal use.

*Compliance is checked by the following tests which are performed on three specimens of each type of terminal which has been used for 12.3.2.*

*Terminals suitable for rigid conductors only are checked with rigid solid conductors and on a new set of specimens with rigid stranded conductors, if existing.*

NOTE “if existing” means that the conductor is available in the market where the product is sold and installed.

*Terminals suitable for rigid and flexible conductors are checked with rigid conductors as above and on a new set of specimens with flexible conductors.*

*The terminal is placed in the test apparatus according to Figure 9.*

*The terminal is fitted first with*

- a) *the maximum number of conductors of the largest nominal cross-sectional area of the same type;*

*Then the test is repeated with*

- b) *the maximum number of conductors of the smallest nominal cross-sectional area of the same type,*

*according to Table 8.*

*If the terminal is fitted with more than one conductor, the test is done on each of the conductors consecutively.*

*The length of the test conductor shall be at least 75 mm longer than the height H specified in Table 6.*

*The test conductor is then connected in the clamping unit in the intended manner.*

*The end of the conductor shall be passed through an appropriate sized bushing in a platen positioned at a height H below the equipment as given in Table 6. The bushing shall be positioned, in a horizontal plane, such that its centre line describes a circle of 75 mm diameter, concentric with the centre of the clamping unit, in the horizontal plane; the platen is then rotated at a rate of  $(10 \pm 2)$  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 6. The bushing may be lubricated to prevent binding, twisting or rotation of the insulated conductor.*

*Each conductor introduced in the screwless terminal is subjected for 15 min to a circular motion with  $(10 \pm 2)$  r/min using an apparatus, an example of which is shown in Figure 9. The conductor is subjected to a pull having a value shown in Table 6.*

*During the test the conductors shall not move noticeably in the clamping unit.*

*After each rotation test, the pulling force given in Table 7 shall be applied to the conductor under test. The force shall be applied in one smooth and continuous application, for 1 min, in the direction of the axis of the conductor.*

*During the test, the rigid conductor, or any wire of rigid stranded or flexible conductor, shall neither slip out of the clamping unit nor break near the clamping unit, nor shall the conductor be damaged in such a way as to render it unfit for further use.*

*In the case of the flexible conductor, the break of a few wires shall not be taken into account provided it does not exceed 15 % of the original number of wires.*

*After these tests, neither the terminals nor the clamping means shall have worked loose and the conductors shall show no deterioration impairing their further use.*

**12.3.11** Screwless terminals shall withstand the electrical and thermal stresses occurring in normal use.

*Compliance is checked by the following tests a) and b), which are carried out on five screwless terminals of accessories which have not been used for any other test.*

*Both tests are carried out with new copper conductors.*

- a) *For screwless terminals accepting rigid solid conductors, the test is carried out by loading the screwless terminals for 1 h with an alternating current (DC current and extra low voltage may be used) as specified in Table 9 and connecting rigid solid conductors 1 m long having the nominal cross-sectional area as specified in the same table.*

*The test is carried out on each clamping unit.*

**Table 9 – Test current for the verification of electrical and thermal stresses in normal use for screwless terminals**

| Rated current             | Test current | Nominal cross-sectional area of the conductor |
|---------------------------|--------------|-----------------------------------------------|
| A                         | A            | mm <sup>2</sup>                               |
| Up to and including 4     | 9            | 0,75                                          |
| Above 4 and including 6   | 13,5         | 1                                             |
| Above 6 and including 13  | 17,5         | 1,5                                           |
| Above 13 and including 16 | 22           | 2,5                                           |

*During the test, the current is not passed through the accessories but only through the terminals.*

*Immediately after this period, the voltage drop across each screwless terminal is measured with rated current flowing.*

*In no case shall the voltage drop exceed 15 mV.*

*The measurements are made across each screwless terminal and as near as possible to the place of contact.*

*If the back connection of the terminal is not accessible, the second connecting point in the case of two-way switches may be used for the returning wire; in the case of one-way switches the specimens may be adequately prepared by the manufacturer; care should be taken not to affect the behaviour of the terminal.*

*Care should be taken to ensure that, during the period of the test, including the measurements, the conductors and the measurement devices are not moved noticeably.*

*b) The screwless terminals already subjected to the determination of the voltage drop specified in the previous test a) are tested as follows.*

*During the test, a current equal to the test current value given in Table 9 is passed.*

*The whole test arrangement, including the conductors, shall not be moved until the measurements of the voltage drop have been completed.*

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

- the current flows for approximately 30 min;*
- for a further period of approximately 30 min no current flows.*

*The voltage drop in each screwless terminal is determined as prescribed for the test of a) and is done at the following moments:*

- after the first 24 temperature cycles and after the 192 temperature cycles;*
- additional measurements to be done after any three of the following temperature cycles: after the 48th, 72nd, 96th, 120th, 144th or 168th temperature cycles.*

*In no case shall the voltage drop exceed 22,5 mV or twice the value measured after the 24th cycle, whichever is the smaller.*



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

**12.3.12** Screwless terminals shall be so designed that the connected rigid conductor remains clamped, even when it has been deflected during normal installation, for example during mounting in a box, and the deflecting stress is transferred to the clamping unit.

This test need not be carried out with flexible conductors.

*Compliance is checked by the following test which is made on three specimens of switches which have not been used for any other test.*

*Terminals are checked with rigid solid and rigid stranded conductors, if existing.*

NOTE 1 “if existing” means that the conductor is available in the market where the product is sold and installed.

*The test apparatus, the principle of which is shown in Figure 10a, shall be so constructed that:*

- a specified conductor properly inserted into a terminal is allowed to be deflected in any of the 12 directions differing from each other by 30°, with a tolerance referred to each direction of  $\pm 5^\circ$ , and*
- the starting point can be varied by 10° and 20° from the original point.*

*A reference point need not be specified.*

*The deflection of the conductor from its straight position to the testing positions shall be effected by means of a suitable device applying a specified force to the conductor at a certain distance from the terminal.*

*The deflecting device shall be so designed that:*

- the force is applied in the direction perpendicular to the undeflected conductor;*
- the deflection is attained without rotation or displacement of the conductor within the clamping unit, and*
- the force remains applied while the prescribed voltage drop measurement is made.*

*Provision shall be made so that the voltage drop across the clamping unit under test can be measured when the conductor is connected, as shown for example in Figure 10b.*

*The specimen is mounted on the fixed part of the test apparatus in such a way that the specified conductor inserted into the clamping unit under test can be freely deflected.*

*To avoid oxidation, the insulation of the wire shall be removed immediately before starting the test.*

NOTE 2 If necessary, the inserted conductor can be permanently bent around obstacles, so that these do not influence the results of the test.

NOTE 3 In some cases, with the exception of the case of guidance for the conductor, it may be advisable to remove those parts of the specimens which do not allow the deflection of the conductor corresponding to the force to be applied.

*A clamping unit is fitted as for normal use with a rigid solid copper conductor having the smallest cross-sectional area specified in Table 10 and is submitted to a first test sequence. The same clamping unit is submitted to a second test sequence using the conductor having the largest cross-sectional area, unless the first test sequence has failed.*

The force for deflecting the conductor is specified in Table 11, the distance of 100 mm being measured from the extremity of the terminal, including the guidance, if any, for the conductor, to the point of application of the force to the conductor.

**Table 10 – Cross-sectional areas of rigid copper conductors for deflection test of screwless terminals**

| Rated current of the switch    | Cross-sectional area of the test conductor |                               |
|--------------------------------|--------------------------------------------|-------------------------------|
| A                              | mm <sup>2</sup>                            |                               |
|                                | 1 <sup>st</sup> test sequence              | 2 <sup>nd</sup> test sequence |
| ≤ 6                            | 1,0 <sup>a</sup>                           | 1,5                           |
| Above 6 up to and including 16 | 1,5                                        | 2,5                           |

<sup>a</sup> Only for countries allowing the use of 1,0 mm<sup>2</sup> conductors in fixed installations.

**Table 11 – Deflection test forces**

| Cross-sectional area of the test conductor | Force for deflecting the test conductor <sup>a</sup> |
|--------------------------------------------|------------------------------------------------------|
| mm <sup>2</sup>                            | N                                                    |
| 1,0                                        | 0,25                                                 |
| 1,5                                        | 0,5                                                  |
| 2,5                                        | 1,0                                                  |

<sup>a</sup> The forces are chosen so that they stress the conductors close to the limit of elasticity.

The test is made with continuous current (i.e. the current is not switched on and off during the test). A suitable power supply should be used and an appropriate resistance should be inserted in the circuit so that the current variations are kept within ±5 % during the test.

A test current equal to the rated current of the switch is passed through the clamping unit under test. A force according to Table 11 is applied to the test conductor inserted in the clamping unit under test in one of the 12 directions shown in Figure 10a and the voltage drop across this clamping unit is measured. The force is then removed.

The force is then applied successively in each one of the remaining 11 directions shown in Figure 10a following the same test procedure.

If for any of the 12 test directions the voltage drop is greater than 25 mV, the force is maintained in this direction until the voltage drop is reduced to a value below 25 mV, but for not more than 1 min. After the voltage drop has reached a value below 25 mV, the force is 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 specimens of switches of the set are tested following the same test procedure, but moving the 12 directions of the force so that they differ by approximately 10° for each specimen. If one specimen has failed at one of the directions of application of the test force, the tests are repeated on another set of specimens, all of which shall comply with the repeated tests.

## 22 Screws, current-carrying parts and connections

### 22.1 General

Add the following requirement after the third paragraph:



The requirements of Clause 22 are not applicable to terminals unless otherwise mentioned. The requirements for the verification of terminals are given in Clause 12.

Replace the fourth paragraph by the following:

Compliance is checked by inspection and, for screws and nuts transmitting contact pressure or which are operated when connecting up the accessory, by the following test.

Delete NOTE 1.

Replace the seventh paragraph by the following:

The test is made by means of a suitable test screwdriver or a suitable tool, applying the relevant torque as specified in Table 5.

Delete the eighth paragraph:

The conductor is moved each time the screw or nut is loosened.

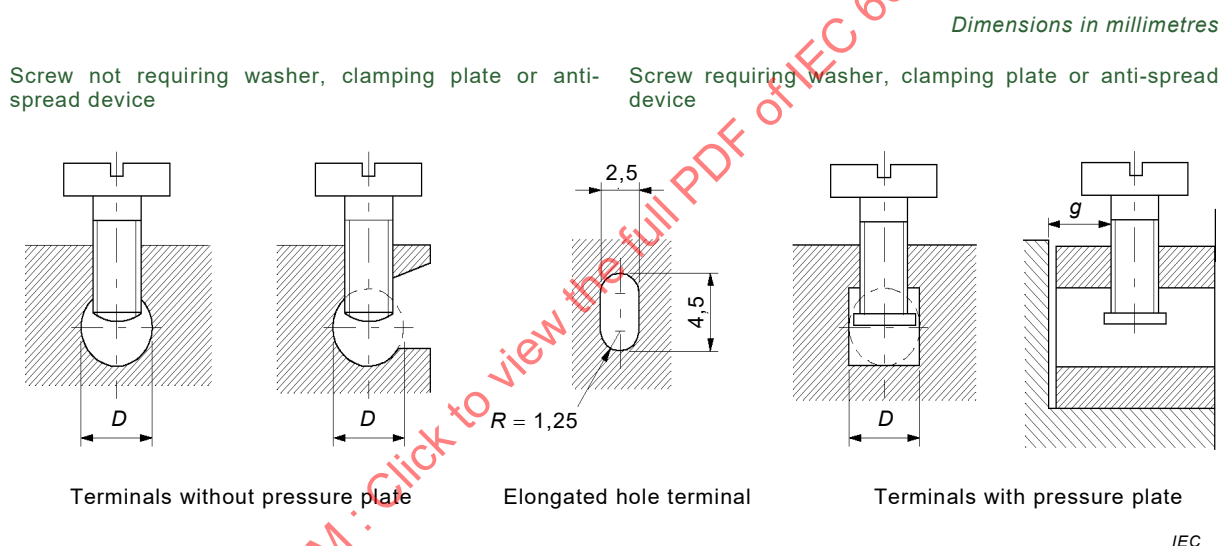


**Figure 1 – Pillar terminals**

Replace Figure 1 with the following new Figure 1, which includes modified minimum diameter values for 10 mm<sup>2</sup>, 16 mm<sup>2</sup> and 25 mm<sup>2</sup> cross-sections:

| Cross-section of conductor accepted by the terminal<br>mm <sup>2</sup> | Minimum diameter <i>D</i> (or minimum dimensions) of conductor space<br>mm | Minimum distance <i>g</i> between clamping screw and end of conductor when fully inserted<br>mm |     | Torque<br>Nm   |            |                |            |                |            |
|------------------------------------------------------------------------|----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-----|----------------|------------|----------------|------------|----------------|------------|
|                                                                        |                                                                            |                                                                                                 |     | 1 <sup>a</sup> |            | 3 <sup>a</sup> |            | 4 <sup>a</sup> |            |
|                                                                        |                                                                            |                                                                                                 |     | One screw      | Two screws | One screw      | Two screws | One screw      | Two screws |
| Up to 1,5                                                              | 2,5                                                                        | 1,5                                                                                             | 1,5 | 0,2            | 0,2        | 0,2            | 0,4        | 0,4            | 0,4        |
| 2,5<br>(circular hole)                                                 | 3,0                                                                        | 1,5                                                                                             | 1,5 | 0,25           | 0,2        | 0,5            | 0,4        | 0,5            | 0,4        |
| 2,5<br>(elongated hole)                                                | 2,5 × 4,5                                                                  | 1,5                                                                                             | 1,5 | 0,25           | 0,2        | 0,5            | 0,4        | 0,5            | 0,4        |
| 4                                                                      | 3,6                                                                        | 1,8                                                                                             | 1,5 | 0,4            | 0,2        | 0,8            | 0,4        | 0,7            | 0,4        |
| 6                                                                      | 4,0                                                                        | 1,8                                                                                             | 1,5 | 0,4            | 0,25       | 0,8            | 0,5        | 0,8            | 0,5        |
| 10                                                                     | 5,2                                                                        | 2,0                                                                                             | 1,5 | 0,7            | 0,25       | 1,2            | 0,5        | 1,2            | 0,5        |
| 16                                                                     | 6,4                                                                        | 2,5                                                                                             | 2,0 | 0,8            | 0,7        | 2,0            | 1,2        | 2,0            | 1,2        |
| 25                                                                     | 7,9                                                                        | 3,0                                                                                             | 2,0 | 1,2            | 0,7        | 2,5            | 1,2        | 3,0            | 1,2        |

<sup>a</sup> The values specified apply to the screws covered by the corresponding columns in Table 5.

## Annex C (informative)

### Circuit development (19.3)

#### C.1 Rationale

Due to the phasing out of incandescent lamps and the replacement of these lamps by self ballasted lamps, a joint forum between IEC technical committees 23B, 34A, 77A and 17B was formed to discuss the technical consequences of this change.

One of the main impacts for switches is the change in inrush currents when switching these energy efficient lamps in comparison to incandescent lamps.

The joint forum fixed the maximum values for one lamp. The source impedance  $Z_{\text{mains}}$  as shown in Table C.1 was added to be able to test the lamp. This will be covered by the lamp standards (for example IEC 60969).

Table C.1 – Lamp

| $P$ [W]          | $V_{\text{mains}}$ [Vrms] | $I_{\text{peak}}$ [A] | $I^2t$ [A <sup>2</sup> s] | $Z_{\text{mains}}$                     |
|------------------|---------------------------|-----------------------|---------------------------|----------------------------------------|
| $P \leq 15$      | 120                       | 60                    | 0,5                       | $0,450 \, \Omega + 100 \, \mu\text{H}$ |
| $P \leq 15$      | 230                       | 20                    | 0,08                      | $0,2 \, \Omega + 400 \, \mu\text{H}$   |
| $15 < P \leq 25$ | 120                       | 60                    | 0,5                       | $0,450 \, \Omega + 100 \, \mu\text{H}$ |
| $15 < P \leq 25$ | 230                       | 35                    | 0,15                      | $0,2 \, \Omega + 400 \, \mu\text{H}$   |

The value of  $I_{\text{peak}}$  and  $I^2t$  shown in Table C.1 represent the highest value that can occur at the moment the contact mechanism closes.

#### C.2 $I_{\text{peak}}$ and $I^2t$ for normal operation tests

##### C.2.1 General

Where 19.2 in IEC 60669-1:1998 and IEC 60669-1:1998/AMD2:2006 is based on the principle to define an equivalent circuit which results in an  $I_{\text{peak}}$  and  $I^2t$  value, 19.3 in this document uses the values of  $I_{\text{peak}}$  and  $I^2t$  as the reference. This approach has been preferred, as within testing environments it is not always possible to reach the ideal parameters of  $Z_{\text{mains}}$ . In this approach equivalent circuits can be adjusted to reach the required values within the tolerances given in this document.

##### C.2.2 Switching a single lamp

For the purpose of this test the lamp with a  $P = 15 \text{ W}$  has been used. This load results in the higher  $I_{\text{peak}}/W$  ratio compared to the 25 W lamp and is used for C.2.3 when added to get higher loads.

For the calculation a prospective short circuit current of 3 000 A was used which was considered adequate.

The  $R$  and  $C$  values of the equivalent circuit of the lamps in Figure C.1 and Figure C.2 are calculated from Table C.1.

The  $Z_{\text{mains}}$  of these networks are:

- (120 V; 60 Hz;  $I_{pSCC} = 3\,000\text{ A}$ ;  $\cos \varphi = 0,9$ ):  
 $0,036\ \Omega + 46,25\ \mu\text{H} + \text{cables } 0,25\ \Omega + 20\ \mu\text{H} = 0,286\ \Omega + 66,25\ \mu\text{H}$
- (230 V; 50 Hz;  $I_{pSCC} = 3\,000\text{ A}$ ;  $\cos \varphi = 0,9$ ):  
 $0,069\ \Omega + 106\ \mu\text{H} + \text{cables } 0,25\ \Omega + 20\ \mu\text{H} = 0,319\ \Omega + 126\ \mu\text{H}$

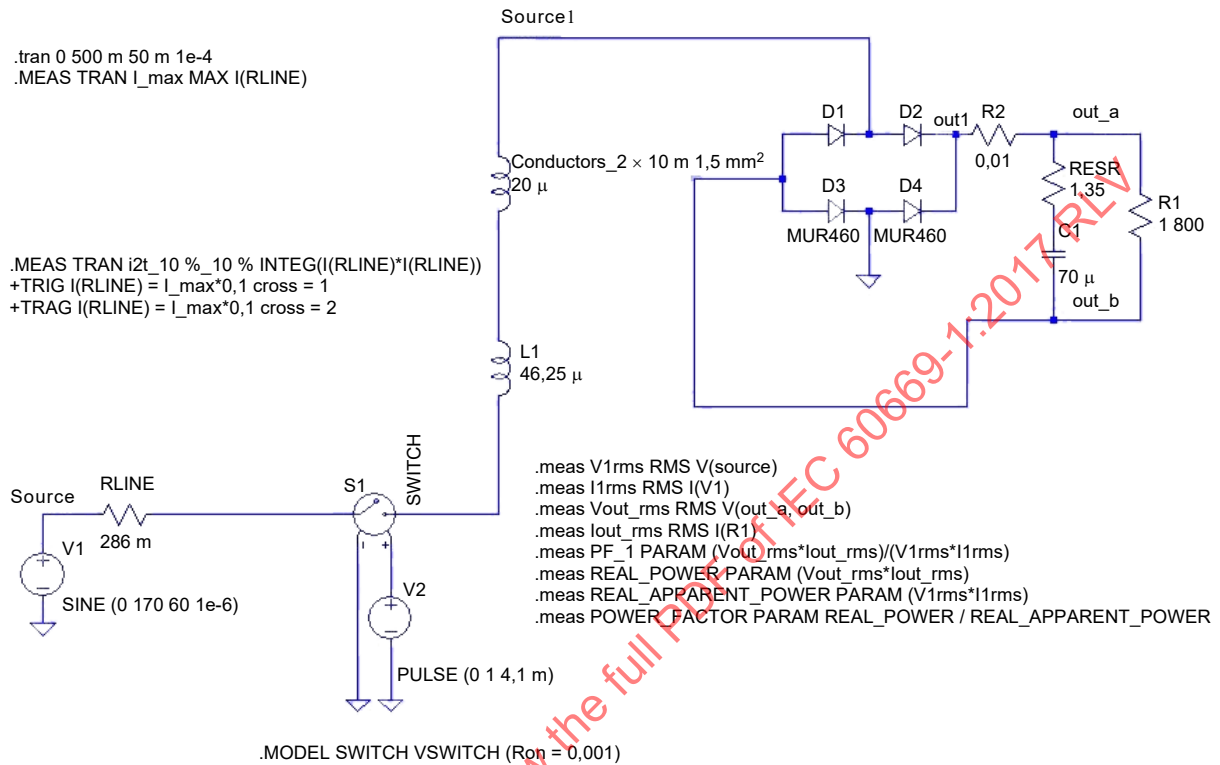


Figure C.1 – 120 V 15 W (LT spice model)

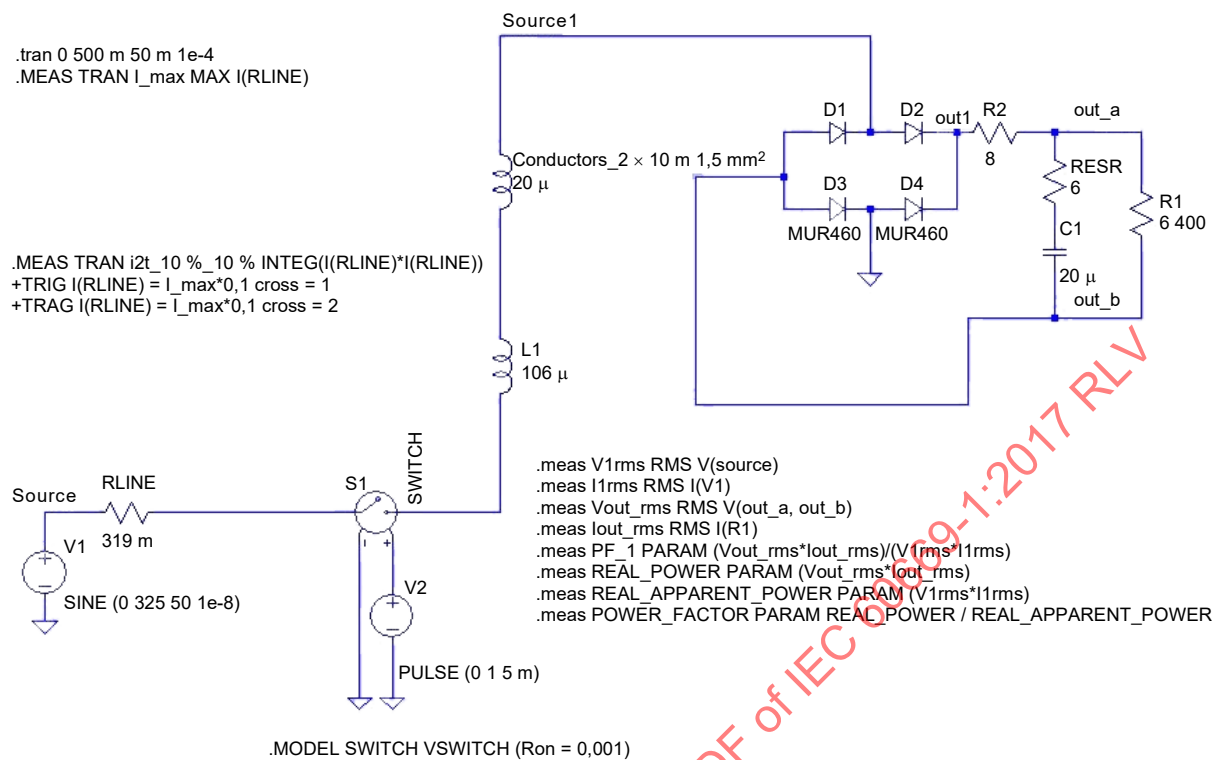


**Figure C.2 – 230 V 15 W (LT spice model)**

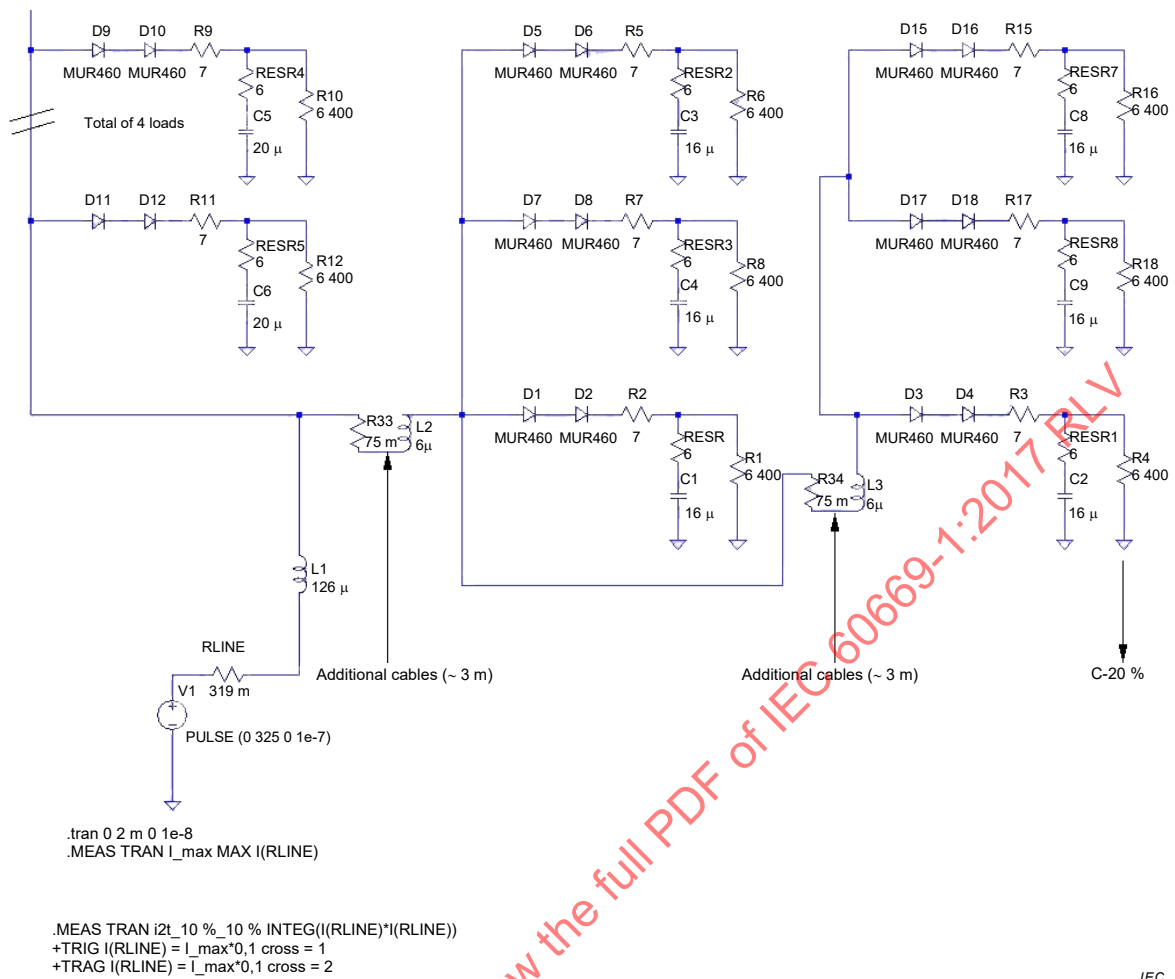
Attention: R1 in Figures C.1 and C.2 is not the  $R_1$  of Figure 12.

### C.2.3 Switching multiple lamps

Multiple lamp loads, an example of which is shown in Figure C.3, are obtained by combining single lamps with a power of 15 W.

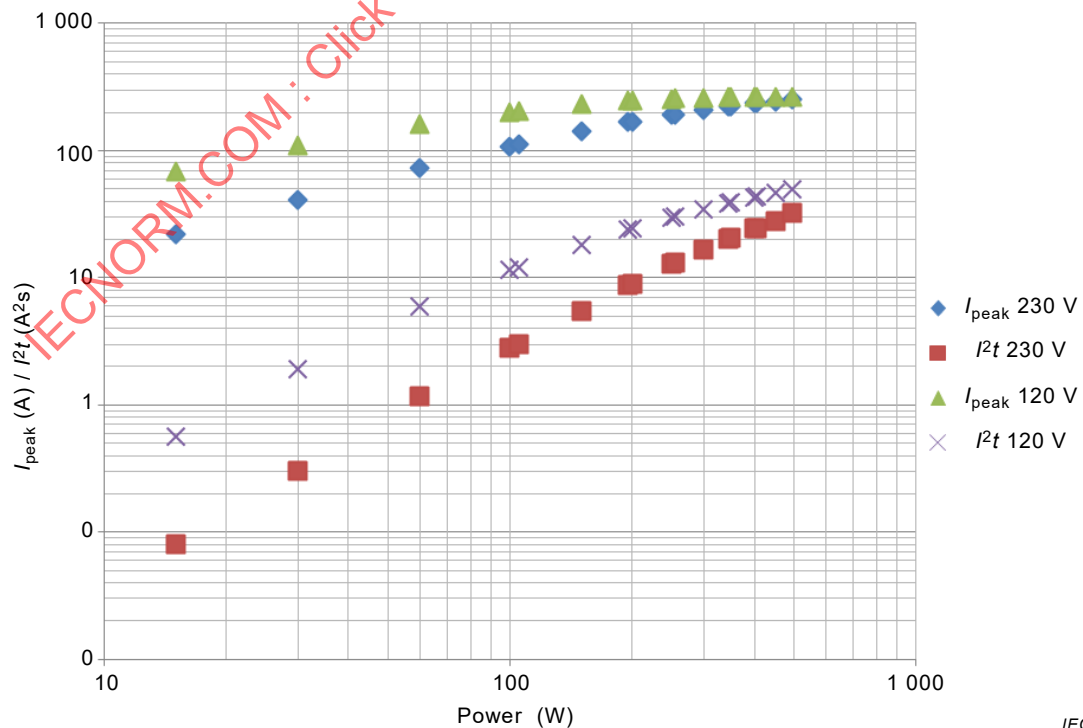
The  $I_{peak}$  and  $I^2t$  values (see Figure C.4) for multiple lamps are based on the following principles:

- Up to 60 W (four lamps) the worst conditions apply:
  - 15 W lamps which give the highest  $I_{peak}$  and  $I^2t$  value as given in Table C.1;
  - the network impedance as given in C.2.2.
- For higher power lamp loads:
  - for every three additional lamps 3 m of cables have been added (75 mΩ + 6 μH);
  - the bulk capacitor within each additional lamp uses the nominal value and not the worst case as given in Table C.1;
  - the values have been interpolated to fit the nominal values of Table 19.



IEC

Figure C.3 – Model for multiple lamp loads



IEC

Figure C.4 –  $I_{peak}$  and  $I^2t$  for multiple lamp loads

## **Annex D** (informative)

### **Additional requirements for insulation-piercing terminals**

Annex D is provided for information to show the changes planned for the future to introduce requirements for insulation-piercing terminals into IEC 60669-1.

The purpose of Annex D is to bring additional explanations and requirements to the normative text of this document. Therefore the numbering of clauses, subclauses, figures and tables follows that of the main body of the text. Only the relevant clauses, subclauses, tables and figures are cited. Any additional tables and figures are numbered starting from D.

Annex D is written in such a way that it will amend the main text, when the requirements for IPT are incorporated.

#### **1 Scope**

*Replace the second paragraph by:*

For switches provided with screwless terminals or insulation-piercing terminals, the rated current is limited to 16 A.

#### **3 Terms and definitions**

*Add the following new definitions:*

##### **3.24**

##### **insulation-piercing terminal IPT**

connecting device for the connection and possible disconnection of one conductor or two or more conductors, the connection being made by piercing, boring through, cutting through, removing, 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 sheath of the cable, if necessary, is not considered as a previous stripping.

Note 2 to entry: Examples of insulation-piercing terminals are given in Figure D.1.

##### **3.24.1**

##### **reusable insulation-piercing terminal**

insulation-piercing terminal that can be used more than once

##### **3.24.2**

##### **non-reusable insulation-piercing terminal**

insulation-piercing terminal that can be used only once

Note 1 to entry: The accessory can only be removed from the circuit by cutting the conductors or when removing the accessory, it is damaged in such a way that it can not be reused.

##### **3.25**

##### **clamping unit**

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

## 5 General remarks on tests

Add the following Table D.1 at the end of Clause 5:

**Table D.1 – Specimens needed for Clause 12 for insulation-piercing terminals (IPTs)**

| Subclause                                                                                                                                                                                                                                                                                                                                                              | Reusable                                                                                           | Non-reusable                                                                                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| 12.4.2                                                                                                                                                                                                                                                                                                                                                                 | 2 new terminals of each type of construction                                                       | 2 new terminals of each type of construction                                                |
| 12.4.3                                                                                                                                                                                                                                                                                                                                                                 | 4 new terminals of each type of construction                                                       | NA                                                                                          |
| 12.4.10                                                                                                                                                                                                                                                                                                                                                                | 6 new terminals <sup>a</sup> of each type of construction previously submitted to the test of 15.1 | 6 or 12 new terminals of each type of construction previously submitted to the test of 15.1 |
| 12.4.11                                                                                                                                                                                                                                                                                                                                                                | 12 new terminals of each type of construction                                                      | 12 new terminals of each type of construction                                               |
| <sup>a</sup> The terminals of specimens “ABC” shall be used. If more terminals are necessary, new specimens which have been previously submitted to the test of 15.1 may be used.<br><br>NOTE If the IPT is declared as suitable for stripped and unstripped conductors, the specimens needed are twice the number of specimens shown in the table, except for 12.4.3. |                                                                                                    |                                                                                             |

## 7 Classification

**7.8** according to the type of terminal:

Add the following new list items at the end:

- switches with IPTs for rigid conductors only;
- switches with IPTs for rigid and flexible conductors.

Add the following new numbered paragraphs:

**7.10** IPT classification according to the method of making the connection

- with a general purpose tool;
- with a special tool; only allowed for non-reusable IPT;
- by hand.

**7.11** IPT classification according to reusability:

- reusable IPTs;
- non-reusable IPTs.

Switches provided with non-reusable IPTs can only be used in trunking systems according to IEC 61084 (all parts).

## 8 Marking

### 8.1 General

Add the following new list item after m):

- n) length of the conductor to be inserted into the IPT, if applicable.

Add the following new subclause:



## 8.9 Manufacturer information

The following shall be indicated on the manufacturer's documentation for IPTs:

- the connection and disconnection procedure, if necessary;
- the method of connection according to 7.1.10, if necessary;
- for non-reusable IPTs, information that the product shall only be used in cable trunking systems and how the product shall be installed in order to have the possibility to replace it without impairing the safety of the installation;
- an indication that the switch is equipped with non-reusable IPTs, if applicable;
- a clear information that the conductor shall not be stripped before connecting it to the terminal, unless the manufacturer has designed the product for this purpose.

## 12 Terminals

### 12.1 General

*Replace the first paragraph by the following:*

Switches shall be provided with either terminals having screw clamping, screwless terminals, or insulation-piercing terminals (IPTs).

*Replace the third paragraph by the following:*

The tests of 12.2.8, 12.3.9 (including the test of 12.3.10), and 12.4.9 (including the test of 12.4.10) shall be carried out after the test of 15.4.

*Replace the fourth paragraph by the following:*

*Compliance is checked by inspection and by the tests of 12.2 or 12.3 or 12.4, as applicable.*

*Add the following new subclause:*

### 12.4 IPTs for external copper conductors

**12.4.1** IPTs shall be of the type suitable for rigid copper conductors only or shall be of the type suitable for both rigid and flexible conductors.

**12.4.2** IPTs shall be provided with clamping units which allow the proper connection of rigid or of rigid and flexible copper conductors having nominal cross-sectional areas as shown in Table D.2. IPTs shall accept insulated conductors having the maximum outer diameter specified in Table D.2 or as specified by the manufacturer for other insulation types.

It shall be possible to connect an unprepared conductor into the IPTs.

The construction of IPTs shall be such that the contact pressure is transmitted by metallic parts. An IPT where the contact pressure is transmitted only through insulating material is not allowed.

**Table D.2 – Relationship between rated currents and connectable cross-sectional areas of copper conductors for insulation-piercing terminals**

| Rated current<br>A                                                                                                                                                                                                                   | Nominal cross-sectional areas<br>mm <sup>2</sup> | Conductors                              |                                            | Isolated conductor                                                     |                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|-----------------------------------------|--------------------------------------------|------------------------------------------------------------------------|------------------------------------------------------------------|
|                                                                                                                                                                                                                                      |                                                  | Diameter of the largest rigid conductor | Diameter of the largest flexible conductor | Outer diameter of the largest rigid stranded conductor<br>60227 IEC 01 | Outer diameter of the largest flexible conductor<br>60227 IEC 08 |
|                                                                                                                                                                                                                                      |                                                  | mm                                      | mm                                         | mm                                                                     | mm                                                               |
| Up to and including 4 <sup>a</sup>                                                                                                                                                                                                   | 0,75 to 1,5                                      | 1,7                                     | 1,8                                        | 3,3                                                                    | 3,4                                                              |
| Above 4 and including 6                                                                                                                                                                                                              | 1 to 1,5                                         | 1,7                                     | 1,8                                        | 3,3                                                                    | 3,4                                                              |
| Above 6 and including 16 <sup>b</sup>                                                                                                                                                                                                | 1,5 to 2,5                                       | 2,2                                     | 2,4                                        | 4,0                                                                    | 4,1                                                              |
| NOTE These values are based on PVC isolated conductors according to IEC 60227 (all parts); for rubber isolated conductors according to IEC 60245 (all parts) other values can apply.                                                 |                                                  |                                         |                                            |                                                                        |                                                                  |
| <sup>a</sup> For special purposes such as ELV applications, conductors from 0,5 mm <sup>2</sup> up to 1 mm <sup>2</sup> inclusive can be used.                                                                                       |                                                  |                                         |                                            |                                                                        |                                                                  |
| <sup>b</sup> Each switch other than those of pattern numbers 3 and 03 shall be designed to permit the continuity of the supply line. This can be achieved by a terminal with separate independent clamping units for each conductor. |                                                  |                                         |                                            |                                                                        |                                                                  |

*Compliance is checked for each type of terminal construction by inspection made by measurement and/or by fitting conductors of the smallest and largest cross-sectional areas of all kinds of conductor accepted by the terminal, and when applicable, with unstripped and stripped conductors.*

**12.4.3** Reusable IPTs shall be designed in such a way that no insulating material of the conductor remains inside the terminal impairing their further use if a new conductor is connected and disconnected.

*Compliance is checked by connecting and disconnecting five times the same conductor with the largest and smallest cross-sectional area of all kinds of conductor accepted by the terminal as given in Table D.2, rotating the conductor for each application in such a way that it is not connected twice at the same place.*

*If the insulating material of the conductor remains inside the switch, it shall be possible to withdraw it, and the terminal shall not be damaged in such a way as to impair its further use.*

**12.4.4** Parts of IPTs mainly intended for carrying current shall be of materials as specified in 22.5.

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

NOTE Additional springs and the like are not considered as parts mainly intended to carry current.

**12.4.5** IPTs shall be so designed that they clamp the specified conductors with sufficient contact pressure and without undue damage to the conductor.

The conductor shall be clamped reliably and between metal surfaces.

*Compliance is checked by inspection and by the test of 12.4.10.*

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

It shall not be possible to confuse the opening for the use of a tool to assist the connection or disconnection with the opening intended for the connection of the conductor.

*Compliance is checked by inspection and by the test of 12.4.10.*

**12.4.7** IPTs which are intended to be used for the interconnection of two or more conductors shall be so designed that:

- each conductor is clamped individually;  
NOTE The clamping of one of the conductors is independent of the clamping of the other conductor(s).
- during the connection or for reusable IPT disconnection, the conductors can be connected or disconnected either at the same time or separately;
- each conductor is introduced in a separate clamping unit (not necessarily in separate holes).

It shall be possible to clamp securely any number of conductors up to the maximum as designed.

*Compliance is checked by inspection.*

**12.4.8** IPTs shall be designed so that adequate insertion of the conductor is obvious and over-insertion is prevented if further insertion is liable to reduce the creepage distances and/or clearances required in Table 23, or to influence the operation of the accessory.

*Compliance is checked by inspection.*

**12.4.9** IPTs shall be properly fixed to the switch.

They shall not work loose when the conductors are connected or disconnected during installation.

*Compliance is checked by inspection and by the test of 12.4.10.*

Covering with sealing compound without other means of locking is not sufficient. However, self-hardening resins may be used to fix terminals which are not subject to mechanical stress in normal use.

**12.4.10** IPTs shall withstand the mechanical stresses occurring in normal use.

*For reusable IPT, compliance is checked by the following tests which are performed on one terminal of each type of terminal construction of the three specimens.*

*Terminals suitable for rigid conductors only are checked with rigid solid and rigid stranded conductors in a new set of specimens, if existing.*

NOTE "if existing" means that the conductor is available in the market where the product is intended to be sold and installed.

*Terminals suitable for rigid and flexible conductors are checked with rigid solid conductors and on a new set of specimens with flexible conductors.*

*For non-reusable IPTs for rigid conductors, compliance is checked by the following test which is performed on six specimens of each type of terminal: three with the smallest conductor*

cross-sectional area and three with the largest conductor cross-sectional area. The same number of specimens is also needed if the IPT is also suitable for flexible conductors.

If the terminals are also designed to connect stripped conductors, then all tests need to be repeated on a new set of specimens with stripped conductors.

The terminal is placed in the test apparatus according to Figure 10.

The terminal is fitted first with

- a) the maximum number of conductors of the largest nominal cross-sectional area of the same type;

then the test is repeated with

- b) the maximum number of conductors of the smallest nominal cross-sectional area of the same type,

according to Table D.2.

If the terminal is fitted with more than one conductor, the test is done on each of the conductors consecutively.

The length of the test conductor shall be at least 75 mm longer than the height  $H$  specified in Table 6.

The test conductor is then connected in the clamping unit in the intended manner.

The end of the conductor shall be passed through an appropriate sized bushing in a platen positioned at a height  $H$  below the equipment as given in Table 6. The bushing shall be positioned, in a horizontal plane, such that its centre line describes a circle of 75 mm diameter, concentric with the centre of the clamping unit, in the horizontal plane; the platen is then rotated at a rate of  $(10 \pm 2)$  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 6. The bushing may be lubricated to prevent binding, twisting or rotation of the insulated conductor.

Each conductor introduced in the IPT is subjected for 15 min to a circular motion with  $(10 \pm 2)$  r/min using an apparatus, an example of which is shown in Figure 10. The conductor is subjected to a pull having a value shown in Table 6.

After each rotation test, the pulling force given in Table 7 shall be applied to the conductor under test. The force shall be applied in one smooth and continuous application, for 1 min, in the direction of the axis of the conductor.

During the test, the rigid solid conductor, or any wire of rigid stranded, or flexible conductor, shall neither slip out of the clamping unit nor break near the clamping unit.

After these tests, neither the terminals nor the clamping means shall have worked loose and the conductors shall show no deterioration impairing their further use.

In the case of the flexible conductor, the break of individual wires of the conductor shall not be taken into account.

In addition, no lack of the insulating material of the conductor shall be observed, in order to be sure that no piece of insulating material has remained inside the terminal.

**12.4.11** IPTs shall withstand the electrical and thermal stresses occurring in normal use.

*Compliance is checked by the following test, which is carried out on 12 new IPTs which have not been used for any other test.*

*Terminals suitable for rigid conductors only are checked with rigid solid and rigid stranded conductors, if existing.*

NOTE “if existing” means that the conductor is available in the market where the product is intended to be sold and installed.

*Terminals suitable for rigid and flexible conductors are checked with rigid solid conductors and with flexible conductors.*

If the terminals are also designed to connect stripped conductors, then all tests need to be repeated on a new set of specimens with stripped conductors.

*The test is made with new copper conductors having the minimum and maximum cross-sectional areas according to Table D.2.*

*Before the test on the reusable IPTs, a rigid solid conductor having the largest cross-sectional area is connected and disconnected once.*

*Conductors having the smallest cross-sectional area are connected, as in normal use, to each of three IPTs and conductors having the largest cross-sectional area are connected, as in normal use, to each of the other three IPTs.*

*To ensure normal cooling of terminals, the conductors connected to them shall have a length of at least 1 m.*

*The use of alternating current is preferable but direct current and extra low voltage are 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  $(20 \pm 2) ^\circ\text{C}$ .*

*Except during the cooling period the test current as defined in Table 8 is applied. The test current shall be applied for the initial 30 min of each cycle.*

*The IPTs 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  $40 ^\circ\text{C}$ .*

*It is maintained within  $\pm 5 ^\circ\text{C}$  of this value for approximately 10 min. The IPTs are then allowed to cool down in approximately 20 min to a temperature of approximately  $30 ^\circ\text{C}$ , forced cooling being allowed. They are kept at this temperature for approximately 10 min and, if necessary, for measuring the voltage drop, allowed to cool down further to a temperature of  $(20 \pm 2) ^\circ\text{C}$  (see Figure D.3).*

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

*The voltage drop in the IPTs is measured after the completion of the 24th and 192nd cycles and recorded.*

*The maximum allowable voltage drop of each clamping unit, measured with the current as specified in Table D.3, shall not exceed the smaller of the two following values:*

- either 22,5 mV, or
- 1,5 times the value measured after the 24<sup>th</sup> cycle.

*The measuring points shall be as close as possible to the clamping unit of the IPT. 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. An example of test-points is shown in Figure D.2.*

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

**Table D.3 – Test current for the verification of electrical and thermal stresses in normal use of insulation-piercing terminals**

| Rated current            | Test current | Minimum cross-sectional area of the conductor | Test current | Maximum cross-sectional area of the conductor |
|--------------------------|--------------|-----------------------------------------------|--------------|-----------------------------------------------|
| A                        | A            | mm <sup>2</sup>                               | A            | mm <sup>2</sup>                               |
| Up to and including 4    | 9            | 0,75                                          | 17,5         | 1,5                                           |
| Above 4 and including 6  | 13,5         | 1                                             | 17,5         | 1,5                                           |
| Above 6 and including 16 | 17,5         | 1,5                                           | 24           | 2,5                                           |

NOTE For switches having rated currents other than the preferred ones, the test current is determined by interpolation between the next lower and higher preferred rated currents, and the cross-sectional area of the conductor is chosen equal to the one specified for the next higher preferred rated current.

**12.4.12** A non-reusable IPT shall be so designed and constructed that it is not possible to disconnect the product without destroying it or cutting the conductors. The damage shall be obvious.

*Compliance is checked by inspection.*

NOTE An IPT is considered to be permanently destroyed when, for its re-installation, new parts or materials other than the original ones have to be used.

**12.4.13** If an IPT uses screws for wire connection, the following test shall be performed before each test of 12.4:

*Screws of IPTs are tightened and loosened 5 times by means of an appropriate tool applying the torque as stated in the corresponding column of Table 3. A new conductor end is used each time the screw is loosened and subsequently re-tightened.*

*Higher values of torque may be used if so stated by the manufacturer of the IPT, when the relevant information is provided.*

*During the test an IPT shall not be damaged so as to impair its further use, for example, the breakage of screws or damage to the head slots, threads, washers, or stirrups.*

*The shape of the blade of the test screwdriver shall suit the head of the screw to be tested. The screws shall be tightened in one smooth and continuous application of the torque.*

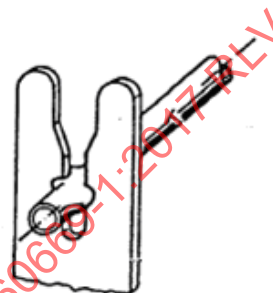
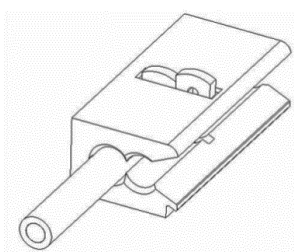
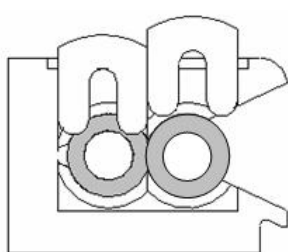
**12.4.14** Screws for making contact-pressure shall not serve to fix any other component, although they may hold the IPT in place or prevent it from turning.

Screws shall not be of metal which is soft or liable to creep.

NOTE The use of aluminium alloy screws in aluminium alloy bodied IPTs requires additional tests, according to IEC 61545.

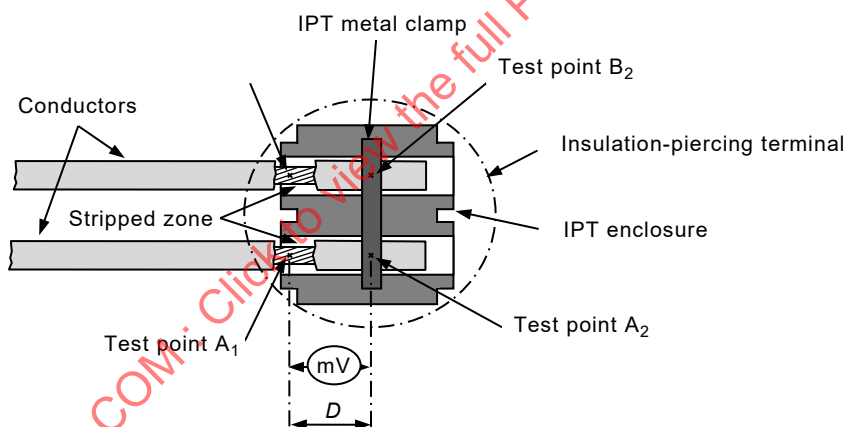
*Compliance is checked by inspection.*

IPT transmitting contact pressure via metal parts



IEC

**Figure D.1 – Example of insulation-piercing terminals**



IEC

Distance  $D$  between two test points shall be as short as possible to avoid including the voltage drop of the conductor when measuring the IPT's voltage drop.

**Figure D.2 – Example of test-points**

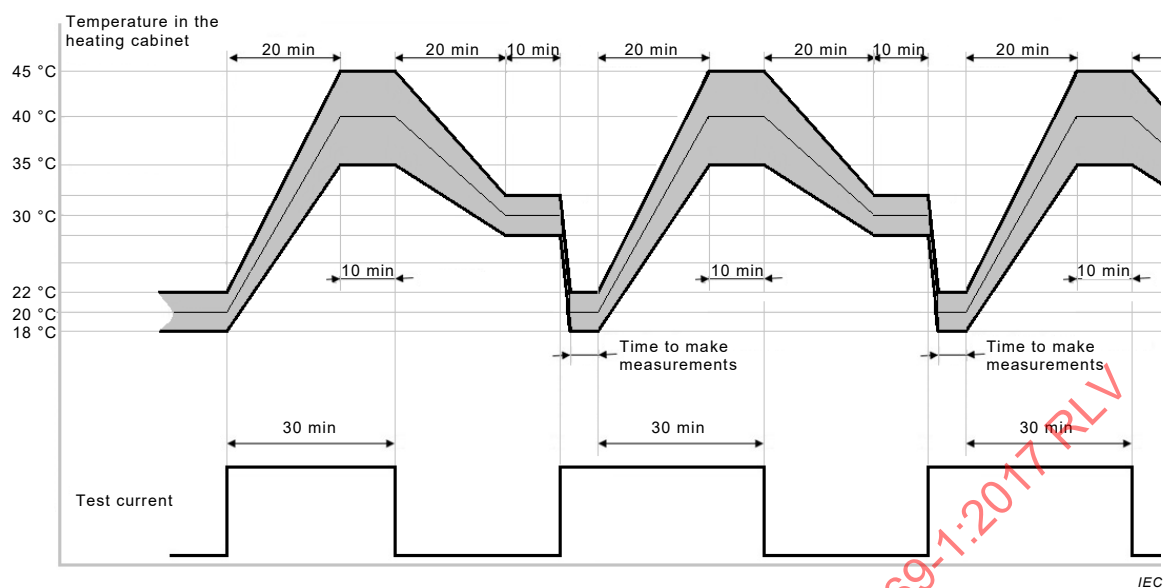


Figure D.3 – Temperature cycle for the voltage drop test of 12.4.11

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## Annex E (informative)

### Additional requirements and tests for switches intended to be used at a temperature lower than $-5\text{ °C}$

The purpose of Annex E is to bring additional explanations and requirements to the normative text of this document. Therefore the numbering of clauses, subclauses, figures and tables follows that of the main body of the text. Only the relevant clauses, subclauses, tables and figures are cited.

#### 1 Scope

Replace NOTE 4 by:

For switches intended to be used in temperatures below normal range, additional requirements and tests are given in informative Annex E.

NOTE 4 In the following countries, Annex E is normative: FI, NO, SE.

#### 5 General remarks on tests

Add at the end of Clause 5:

All tests in Annex E are related to a temperature of  $-25\text{ °C}$ . If a lower value is declared by the manufacturer, the declared value shall be a multiple of  $5\text{ °C}$ . All tests in Annex E shall be carried out at the declared temperature.

#### 8 Marking

##### 8.1 General

Add the following new list item after m):

n) Symbol for products declared as suitable for use at a temperature below the normal range.

##### 8.2 Symbols

Add the following marking:

– Intended for use in cold environment down to  $-25\text{ °C}$ , symbol IEC 60417-6292:2015-11



If a lower value of temperature is declared by the manufacturer, the declared value shall be a multiple of  $5\text{ °C}$ ; the symbol shall indicate this value.

##### 13.15.2

The test of 13.15.2 shall be performed at a temperature of  $(-25 \pm 2)\text{ °C}$ .

#### 19 Normal operation

Add the following new subclause at the end of Clause 19:

#### 19.4 Test for switches intended to be used in ambient temperature below $-5^{\circ}\text{C}$

The following additional test shall be carried out on switches intended to be used below the normal temperature ranges if marking for low temperature is used:

- *Wire the switch with a signal circuit including an indicator to easily evaluate that the switch is working as intended during the test.*
- *The switches are then kept for 16 h in a freezer at a temperature of  $(-25 \pm 2)^{\circ}\text{C}$ .*
- *For each of the last 4 h, the switches shall be mechanically operated by hand for 20 operations. The rate of operation shall be approximately 30 operations per minute, i.e. each test sequence shall be 40 s in duration. For these operations, the switch shall be taken out of the freezer, and immediately afterwards (within 3 min) while the switches are still cold, the specimens are subjected to the operations. Immediately after the operations, the switch shall be put again into the freezer.*
- *During and after this test the switch shall operate properly and show no visible harmful deformation, cracks or similar damage which would lead to non-compliance with this document.*
- *Verification of operation is checked by the test described in 19.4, immediately followed by the measurement of the insulation resistance and by the electric strength test specified in Clause 16.*

### 20 Mechanical strength

Add the following new subclause at the end of Clause 20:

#### 20.11 Impact test at low temperatures

The following additional test shall be carried out on switches intended to be used below the normal temperature ranges if marking for low temperature is used:

- *The switch is mounted as given in 20.2 and kept for 16 h in a freezer at a temperature of  $(-25 \pm 2)^{\circ}\text{C}$ .*
- *Then the switch assemblies shall be taken out of the freezer and immediately afterwards (within 3 min) while the switches are still cold, the specimens are subjected to the impact test and compliance according to 20.2.*

## Bibliography

IEC 60050-151, *International Electrotechnical Vocabulary – Part 151: Electrical and magnetic devices* (available at <http://www.electropedia.org>)

IEC 60050-442, *International Electrotechnical Vocabulary – Part 442: Electrical accessories* (available at <http://www.electropedia.org>)

IEC TR 60083, *Plugs and socket-outlets for domestic and similar general use standardized in member countries of IEC*

IEC 60227-1, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 1: General requirements*

IEC 60227-3, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 3: Non-sheathed cables for fixed wiring*

IEC 60227-4, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 4: Sheathed cables for fixed wiring*

IEC 60245-1, *Rubber insulated cables – Rated voltages up to and including 450/750 V – Part 1: General requirements*

IEC 60364-4-41, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*

IEC 60364-5-53, *Electrical installations of buildings – Part 5-53: Selection and erection of electrical equipment – Isolation, switching and control*

IEC 60669-2-2, *Switches for household and similar fixed electrical installations – Part 2-2: Particular requirements – Electromagnetic remote-control switches (RCS)*

IEC 60669-2-3, *Switches for household and similar fixed electrical installations – Part 2-3: Particular requirements – Time-delay switches (TDS)*

IEC 60669-2-4, *Switches for household and similar fixed electrical installations – Part 2-4: Particular requirements – Isolating switches*

IEC 60669-2-5, *Switches for household and similar fixed electrical installations – Part 2-5: Particular requirements – Switches and related accessories for use in home and building electronic systems (HBES)*

IEC 60669-2-6, *Switches for household and similar fixed electrical installations – Part 2-6: Particular requirements – Fireman's switches for exterior and interior signs and luminaires*

IEC 60670-1, *Boxes and enclosures for electrical accessories for household and similar fixed electrical installations – Part 1: General requirements*

IEC 60969, *Self-ballasted lamps for general lighting services – Performance requirements*

IEC 60998 (all parts), *Connecting devices for low-voltage circuits for household and similar purposes*

IEC 60998-2-1, *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-1: Particular requirements for connecting devices as separate entities with screw-type clamping units*

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 60998-2-3, *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-3: Particular requirements for connecting devices as separate entities with insulation-piercing clamping units.*

IEC 60999 (all parts), *Connecting devices – Electrical copper conductors – Safety requirements for screw type and screwless-type clamping units*

IEC 60999-1:1999, *Connecting devices – Electrical copper conductors – Safety requirements for screw type and screwless-type clamping units – Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm<sup>2</sup> up to 35 mm<sup>2</sup> (included)*

IEC 61084 (all parts), *Cable trunking and ducting systems for electrical installations*

IEC 61347-1, *Lamp controlgear – Part 1: General and safety requirements*

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

ISO 2039-2, *Plastics – Determination of hardness – Part 2: Rockwell hardness*

ISO/IEC Guide 51:2014, *Aspects liés à la sécurité – Principes directeurs pour les inclure dans les normes*

AS/NZ 3133:2013, *Approval and test specification – Air-break switches*  
 AS/NZ 3133:2013/AMD1:2014  
 AS/NZ 3133:2013/AMD2:2016

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# INTERNATIONAL STANDARD

## NORME INTERNATIONALE



**Switches for household and similar fixed electrical installations –  
Part 1: General requirements**

**Interrupteurs pour installations électriques fixes domestiques et analogues –  
Partie 1: Exigences générales**

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SWITCHES FOR HOUSEHOLD AND SIMILAR  
FIXED ELECTRICAL INSTALLATIONS –****Part 1: General requirements****FOREWORD**

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60669-1 has been prepared by subcommittee 23B: Plugs, socket-outlets and switches, of IEC technical committee 23:

This fourth edition cancels and replaces the third edition published in 1998, Amendment 1:1999 and Amendment 2:2006. This edition constitutes a technical revision.

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

- a) change of the scope for motor load switches;
- b) deletion of some dated normative references;
- c) changes to the definitions;
- d) in Clause 5 the number of specimens to be used for the tests are clearly given in Table 1 (Corresponding Annex A of IEC 60669-1:1998 was therefore deleted);
- e) in Clause 5 it was clarified on which switches the tests of Clause 19 shall be carried out;

- f) requirements concerning 13 A switches have been included;
- g) mandatory indication that a terminal is suitable for rigid conductor only;
- h) requirements and test conditions for flexible conductors have been included in Clause 12;
- i) requirements for pilot light units have been included;
- j) new test for self-ballasted lamp loads in 19.3;
- k) Table 20 has been completely redrawn to cover normal, mini and micro-gap switches and renumbered Table 23;
- l) new informative Annex B including changes planned for the future in order to align IEC 60669-1 with the requirements of IEC 60998 (all parts), IEC 60999 (all parts) and IEC 60228;
- m) new informative Annex C about the circuit development for 19.3;
- n) new informative Annex D including additional requirements for insulation-piercing terminals;
- o) new informative Annex E including additional requirements and tests for switches intended to be used at a temperature lower than –5 °C.

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

|               |                  |
|---------------|------------------|
| FDIS          | Report on voting |
| 23B/1235/FDIS | 23B/1241/RVD     |

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

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

In this standard, the following print types are used:

- *compliance statements: in italic type*

A list of all parts in the IEC 60669 series, published under the general title *Switches for household and similar fixed electrical installations*, can be found on the IEC website.

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

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

The contents of the corrigendum of January 2020 have been included in this copy.

**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.**

# SWITCHES FOR HOUSEHOLD AND SIMILAR FIXED ELECTRICAL INSTALLATIONS –

## Part 1: General requirements

### 1 Scope

This part of IEC 60669 applies to manually operated general purpose functional switches, for alternating current (AC) only with a rated voltage not exceeding 440 V with a rated current not exceeding 63 A, intended for household and similar fixed electrical installations, either indoors or outdoors.

For switches provided with screwless terminals, the rated current is limited to 16 A.

NOTE 1 The rated current is limited to 16 A for switches provided with insulation piercing terminals (IPT's) according to Annex D.

Switches covered by this document are, where applicable, intended for the control in normal use of all of the following loads:

- a circuit for a tungsten filament lamp load;
- a circuit for an externally ballasted lamp load (for example LED, CFL, fluorescent lamp load);
- a circuit for a self ballasted lamp load (for example LEDi or CFLi);
- a circuit for a substantially resistive load with a power factor not less than 0,95;
- a single phase circuit for motor load with a rated current not exceeding 3 A at 250 V (750 VA) and 4,5 A at 120 V (540 VA) and a power factor not less than 0,6. This applies to both switches rated not less than 10 A that have not undergone additional tests and to momentary switches rated not less than 6 A that have not undergone additional tests.

NOTE 2 In the following country the suitability of a switch intended to control the inrush current of a motor shall be tested: AU.

This document also applies to boxes for switches, with the exception of mounting boxes for flush-type switches.

NOTE 3 General requirements for boxes for flush-type switches are given in IEC 60670-1.

It also applies to switches such as

- switches incorporating pilot lights;
- electromagnetic remote control switches (particular requirements are given in IEC 60669-2-2);
- switches incorporating a time-delay device (particular requirements are given in IEC 60669-2-3);
- combinations of switches and other functions (with the exception of switches combined with fuses);
- electronic switches (particular requirements are given in IEC 60669-2-1);
- switches having facilities for the outlet and retention of flexible cables (see Annex A);
- isolating switches (particular requirements are given in IEC 60669-2-4);
- switches and related accessories for use in home and building electronic systems (particular requirements are given in IEC 60669-2-5);
- firemen's switches (particular requirements are given in IEC 60669-2-6).

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

NOTE 4 For lower temperatures see Annex E.

Switches complying with this document are suitable only for incorporation in equipment in such a way and in such a place that it is unlikely that the surrounding ambient temperature exceeds +35 °C.

In locations where special conditions prevail, such as in ships, vehicles and the like and in hazardous locations, for example where explosions are liable to occur, special construction and/or additional requirements may be required.

## 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 60038:2009, *IEC standard voltages*

IEC 60068-2-75:2014, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

IEC 60112:2009, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60212:2010, *Standard conditions for use prior to and during the testing of solid electrical insulation materials*

IEC 60227-5:2011, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 5: Flexible cables (cords)*

IEC 60228:2004, *Conductors of insulated cables*

IEC 60245-4:2011, *Rubber insulated cables – Rated voltages up to and including 450/750 V – Part 4: Cords and flexible cables*

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

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*  
IEC 60529:1989/AMD1:1999  
IEC 60529:1989/AMD2:2013

IEC 60669-2-1:2002, *Switches for household and similar fixed electrical installations – Part 2-1: Particular requirements – Electronic switches*  
IEC 60669-2-1:2002/AMD1:2008  
IEC 60669-2-1:2002/AMD2:2015

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

IEC 60695-2-11:2014, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products (GWEPT)*

IEC 60998-1:2002, *Connecting devices for low-voltage circuits for household and similar purposes – Part 1: General requirements*

IEC 60998-2-1, *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-1: Particular requirements for connecting devices as separate entities with screw-type clamping units*

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 60998-2-3, *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-3: Particular requirements for connecting devices as separate entities with insulation-piercing clamping units*

IEC 60998-2-4, *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-4: Particular requirements for twist-on connecting devices*

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

ISO 1456:2009, *Metallic and other inorganic coatings – Electrodeposited coatings of nickel, nickel plus chromium, copper plus nickel and of copper plus nickel plus chromium*

ISO 2081:2008, *Metallic and other inorganic coatings – Electroplated coatings of zinc with supplementary treatments on iron or steel*

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

### 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 are rms values unless otherwise specified.

#### 3.1

##### **switch**

device designed to make or break the current in one or more electric circuits

##### 3.1.1

##### **on/off switch**

switch for alternatively closing and opening one or more electric circuits.

[SOURCE: IEC 60050-151:2001, 151-12-23]

##### 3.1.2

##### **momentary contact switch**

switch which returns its contacts automatically to the initial state after operation.

Note 1 to entry: Momentary contact switches are intended to operate, for example, bells, electromagnetic remote control switches, time-delay switches and electronic switches.

### 3.1.3

#### **push-button switch**

switch having a single actuator which moves with a single motion when operated by an external, manual force usually applied by the finger or palm of the hand and having stored energy return

### 3.1.4

#### **cord-operated switch**

switch the operating means of which is a cord which has to be pulled in order to change its contact state

### 3.1.5

#### **switch of normal-gap construction**

switch construction having a clearance between the contacts in the open position of not less than 3 mm

### 3.1.6

#### **switch of mini-gap construction**

switch construction having a clearance between the contacts which is less than 3 mm but is not less than 1,2 mm

### 3.1.7

#### **switch of micro-gap construction**

switch construction having a clearance between the contacts in the open position of less than 1,2 mm

## 3.2

### **one operation**

transfer of the moving contacts from one operating position to another

## 3.3

### **terminal**

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

## 3.4

### **clamping unit**

part or parts of a terminal necessary for the mechanical clamping and the electrical connection of the conductor(s)

## 3.5

### **screw-type terminal**

terminal intended for the connection, by clamping only, of (an) external rigid or flexible conductor(s)

### 3.5.1

#### **pillar terminal**

screw-type terminal in which the conductor(s) is (are) 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 can be applied directly by the shank of the screw or through an intermediate clamping part to which pressure is applied by the shank of the screw.

Note 2 to entry: Examples of pillar terminals are shown in Figure 1.

[SOURCE: IEC 60050-442:1998, 442-06-22, modified — “or screws” has been added because in some constructions there is more than one screw.]



### 3.5.2

#### **screw head terminal**

screw-type terminal in which the conductor is clamped under the head of the screw

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

Note 2 to entry: Examples of screw head terminals are shown in Figure 2.

### 3.5.3

#### **stud terminal**

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

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

Note 2 to entry: Examples of stud terminals are shown in Figure 2.

[SOURCE: IEC 60050-442:1998, 442-06-23]

### 3.5.4

#### **saddle terminal**

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

Note 1 to entry: Examples of saddle terminals are shown in Figure 3.

[SOURCE: IEC 60050-442:1998, 442-06-09, modified — "screw-type" has been added.]

### 3.5.5

#### **lug terminal**

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

Note 1 to entry: Examples of lug terminals are shown in Figure 4.

[SOURCE: IEC 60050-442:1998, 442-06-16, modified — "screw-type terminal" is replaced with "screw head terminal or stud terminal" and "directly and indirectly" has been deleted.]

### 3.5.6

#### **mantle terminal**

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

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.

Note 2 to entry: Examples of mantle terminals are shown in Figure 5.

[SOURCE: IEC 60050-442:1998, 442-06-14, modified — "screw-type" has been added and the last part of the definition is included in a note.]

### 3.6

#### **screwless-type terminal**

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

[SOURCE: IEC 60050-442:1998, 442-06-11, modified]

### 3.7

#### **thread-forming screw**

screw having an uninterrupted thread which, by screwing in, forms a thread by displacing material in the cavity

Note 1 to entry: An example of a thread-forming screw is shown in Figure 6.

[SOURCE: IEC 60050-442:1998, 442-06-04]

### 3.8

#### **thread-cutting screw**

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

Note 1 to entry: An example of a thread-cutting screw is shown in Figure 7.

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

### 3.9

#### **mechanical time-delay device**

device which, through a mechanical auxiliary, operates some time after the instant at which the conditions which cause it to operate are established

### 3.10

#### **base**

part of the switch retaining current-carrying parts and which normally retains the mechanism in position

### 3.11

#### **rated voltage**

voltage assigned by the manufacturer for a specific operating condition of the switch

[SOURCE: IEC 60050-442:1998, 442-01-03, modified — "accessory" has been replaced with "switch".]

### 3.12

#### **rated current**

current assigned by the manufacturer for a specific operating condition of the switch

[SOURCE: IEC 60050-442:1998, 442-01-02, modified — "accessory" has been replaced with "switch".]

### 3.13

#### **operating member**

part of a cord-operated switch which connects the internal mechanism with a pull cord and is usually attached to the actuating member of the switch

### 3.14

#### **pole of a switching device**

portion of a switching device associated exclusively with one electrically separated conducting path of its main circuit and excluding those portions which provide a means for mounting and operating all poles together

Note 1 to entry: A switching device is called single-pole if it has only one pole. If it has more than one pole, it may be called multipole (two-pole, three-pole, etc.) provided the poles are or can be coupled in such a manner as to operate together.

[SOURCE: IEC 60050-441:2000, 441-15-01]

**3.15****actuating member**

part which is pulled, pushed, turned or otherwise moved to cause an operation of the switch

[SOURCE: IEC 60050-442:1998, 442-04-14]

**3.16****pilot light**

device incorporating a light source either integral or designed to be installed with the switch and intended to give for example an indication of the switch state or to indicate the switch location

**3.17****main part**

assembly consisting of the base and other parts which is not intended to be dismantled at any time after manufacture

**3.18****grommet**

component used to support and protect the wires or cable or conduit at the point of entry

Note 1 to entry: A grommet may also prevent the ingress of moisture or contaminants.

Note 2 to entry: Examples are shown in Figure 23.

[SOURCE: IEC 60050-581:2008, 581-27-19, modified — "part of a component or an accessory" has been replaced with "component", "or conduit" has been added and part of the definition is included in a note.]

**3.19****entry membrane**

component or integral part of the switch used to protect the wires or cable which may be used to support the cable or conduit at the point of entry

Note 1 to entry: An entry membrane may also prevent the ingress of moisture or contaminants and may be part of a grommet.

Note 2 to entry: Examples are shown in Figure 23.

**3.20****protecting membrane**

component or integral part of the switch that is not intended to be penetrated in normal use and is intended to provide protection against ingress of water or solid objects and/or to allow the operation of an accessory

Note 1 to entry: Examples are shown in Figure 23

**3.21****self ballasted lamp****SBL**

unit which cannot be dismantled without being permanently damaged, which is provided with a lamp cap or caps and which incorporates a light source and any additional elements necessary for starting and stable operation of the light source

Note 1 to entry: In the text, a self ballasted lamp is also called CFLi or LEDi, where:

- CFL stands for Compact Fluorescent Lamp;
- LED stands for Light Emitting Diode;
- "i" means that the control gear is incorporated in the lamp.

Note 2 to entry: This note applies to the French language only.

### 3.22

#### **externally ballasted lamp**

lamp other than an incandescent lamp which cannot be dismantled without being permanently damaged, which is provided with a lamp cap and which incorporates a light source to be controlled by a separate lamp control gear

Note 1 to entry: For lamp control gear, see definitions in IEC 61347-1.

## **4 General requirements**

Switches and boxes of surface mounting accessories 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 51:2014.

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

## **5 General remarks on tests**

*Tests according to this document are type tests.*

*Unless otherwise specified, the specimens are tested as delivered and under normal conditions of use.*

*Switches having provision for pilot lights shall be tested with pilot lights fitted, unless otherwise stated. The results of the tests shall be considered to apply to switches of the same type which do not have provision for pilot lights.*

*Flush and semi-flush type switches shall be tested when installed in a box complying with the applicable standard sheet(s), if any. In case the switch is manufactured for a specific box, the tests shall be conducted when the switch is installed in the corresponding box as specified by the manufacturer.*

*Unless otherwise specified, the tests are carried out in the order of the clauses, at an ambient temperature between +15 °C and +35 °C.*

*In case of doubt, the tests are made at an ambient temperature of (+20 ± 5) °C.*

*For each of the two combinations of rated voltages and rated currents marked on the switch, three specimens are subjected to all the relevant tests except the test of 19.2 and 19.3, where two further sets of three specimens are used.*

*For switches with a rated current up to and including 16 A the tests of 19.1, 19.2 and 19.3 shall be carried out.*

*For switches with a rated current above 16 A and up to and including 20 A the tests of 19.1 and 19.3 shall be carried out.*

*For switches with a rated current above 16 A and up to 20 A inclusive the test of 19.2 shall be carried out only if the manufacturer has assigned the switch with an externally ballasted lamp current rating.*

*For switches with a rated current above 20 A, only the tests of 19.1 shall be carried out.*

*A switch marked 250 V/400 V is tested as a 400 V switch.*

*Momentary contact switches are not to be submitted to the tests of 18.3, 19.2 and 19.3.*

*Switches of pattern 3 and 03 are submitted to the tests of 18.3 if they have a rated voltage over 250 V, but are not to be submitted to the tests of 19.2 and 19.3.*

*The number of specimens required for the tests shall be as specified in Table 1.*

**Table 1 – Number of specimens needed for the tests**

| Clauses and subclauses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                 | Number of specimens | Number of additional specimens for dual current rating |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---------------------|--------------------------------------------------------|
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Ratings                                                                                         | A                   | JKL                                                    |
| 7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Classification                                                                                  | A                   |                                                        |
| 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Marking                                                                                         | A                   |                                                        |
| 9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Checking of dimensions                                                                          | ABC                 |                                                        |
| 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Protection against electric shock                                                               | ABC                 |                                                        |
| 11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Provision for earthing                                                                          | ABC                 |                                                        |
| 12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Terminals <sup>a, f, l</sup>                                                                    | ABC                 |                                                        |
| 13                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Constructional requirements <sup>b, m</sup>                                                     | ABC                 |                                                        |
| 14                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Mechanism                                                                                       | ABC                 |                                                        |
| 15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Resistance to ageing, protection provided by enclosures of switches, and resistance to humidity | ABC                 |                                                        |
| 16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Insulation resistance and electric strength <sup>c</sup>                                        | ABC                 |                                                        |
| 17                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Temperature rise                                                                                | ABC                 |                                                        |
| 18                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Making and breaking capacity                                                                    | ABC <sup>i</sup>    |                                                        |
| 19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Normal operation                                                                                | ABC <sup>i</sup>    |                                                        |
| 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Mechanical strength <sup>d, g</sup>                                                             | ABC                 |                                                        |
| 21                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Resistance to heat <sup>h</sup>                                                                 | ABC                 |                                                        |
| 22                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Screws, current-carrying parts and connections                                                  | ABC                 |                                                        |
| 23                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Creepage distances, clearances and distances through sealing compound                           | ABC                 |                                                        |
| 19.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Test for switches intended for externally ballasted lamp loads                                  | DEF <sup>j</sup>    | MNO                                                    |
| 19.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Test for switches intended for self ballasted lamp loads                                        | UVW <sup>k</sup>    | XYZ                                                    |
| 24.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Resistance to abnormal heat and to fire                                                         | GHI                 |                                                        |
| 24.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Resistance to tracking <sup>e</sup>                                                             | GHI                 |                                                        |
| 25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Resistance to rusting                                                                           | GHI                 |                                                        |
| TOTAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                 | 12                  | 9                                                      |
| <sup>a</sup> Five extra screwless terminals are used for the test of 12.3.11 and one extra set of specimens is used for the test of 12.3.12.<br><sup>b</sup> An extra set of membranes are needed for each of the tests of 13.15.1 and 13.15.2.<br><sup>c</sup> One extra set of specimens of switches fitted with pilot light may be used for the tests of Clause 16.<br><sup>d</sup> One extra set of specimens of cord-operated switches is needed for the test of 20.10.<br><sup>e</sup> One extra set of specimens may be used.<br><sup>f</sup> Two extra set of specimens of terminals suitable for rigid and flexible conductors are required for 12.2.5, 12.2.6 and 12.2.7.<br><sup>g</sup> One extra set of specimens is needed for the tests of 20.5.1 and 20.5.2.<br><sup>h</sup> One extra set of specimens may be used for the tests of 21.2 and 21.3. In this case the specimens shall be subjected first to the tests of 15.1.<br><sup>i</sup> One extra set of specimens of switches of pattern number 7 are necessary for 18 and 19.1.<br><sup>j</sup> One extra set of specimens of switches of pattern number 7 are necessary for 19.2.<br><sup>k</sup> One extra set of specimens of switches of pattern number 7 are necessary for 19.3.<br><sup>l</sup> Number of specimens required for insulation-piercing terminals (IPTs) are shown in Table D.1<br><sup>m</sup> For switches with pilot light units if the electronic circuitry is so enclosed that the short-circuiting or disconnecting of components is impossible or difficult, the manufacturer shall provide additional prepared test specimens. |                                                                                                 |                     |                                                        |

*The specimens are submitted to all the relevant tests and comply with this document if all the requirements of all the relevant tests are met.*

If one specimen does not satisfy a test due to an assembly or a manufacturing fault, that test and any preceding one which may have influenced the results of the test shall be repeated and also the tests which follow shall be made in the required sequence on another full set of specimens, all of which shall comply with the requirements.

The applicant may submit, together with a number of specimens specified in Table 1, the additional set of specimens which may be required, should one specimen fail. The test laboratory should then, without further request, test additional specimens and will reject them only if a further failure occurs. If the additional set of specimens is not submitted at the same time, the failure of one specimen will result in non compliance.

## **6 Ratings**

### **6.1 Rated voltage**

Preferred values of rated voltage are 130 V, 220 V, 230 V, 240 V, 250 V, 277 V, 380 V, 400 V, 415 V or 440 V.

If any other voltage rating is used, it shall not be less than that specified in IEC 60038:2009, Table 1.

### **6.2 Rated current**

Preferred values of rated current are 6 A, 10 A, 13 A, 16 A, 20 A, 25 A, 32 A, 40 A, 45 A, 50 A or 63 A.

The rated current of switches shall not be less than 6 A, except for momentary contact switches where a rated current of 1 A, 2 A or 4 A is allowed.

Switches with a rated current not exceeding 16 A shall have an externally ballasted lamp current rating equal to the rated current. This requirement does not apply to switches of pattern numbers 3 and 03 or to momentary contact switches.

Switches with a rated current not exceeding 20 A shall be tested with self ballasted lamp (SBL) circuits as given in 19.3.

Switches which are tested according to 19.3 are capable of switching the rated power of SBL circuits according to Table 2.

NOTE Higher values of rated power of SBL circuits can be declared by the manufacturer according to Table 19.

**Table 2 – Relationship between rated current of the switch and rated power of the SBL circuit**

| Rated current of the switch [A] | Distribution system [V]:<br>220/380<br>230/400<br>240/415 | Distribution system [V]:<br>120/208<br>120/240<br>127/220 |
|---------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|
|                                 | Rated power of the SBL circuit [W]                        | Rated power of the SBL circuit [W]                        |
| Up to and including 10          | 100                                                       | 60                                                        |
| Above 10 up to and including 13 | 150                                                       | 60                                                        |
| Above 13 up to and including 16 | 200                                                       | 100                                                       |
| Above 16 up to and including 20 | 250                                                       | 150                                                       |

Compliance with the requirements of 6.1 and 6.2 is checked by inspection of the marking.

### 6.3 Preferred combinations of number of poles and ratings

Preferred combinations of number of poles and ratings are shown in Table 3.

**Table 3 – Preferred combinations of numbers of poles and ratings**

| Rated current<br>A                   | Number of poles                                |                             |
|--------------------------------------|------------------------------------------------|-----------------------------|
|                                      | Rated voltage from<br>120 V to 250 V inclusive | Rated voltage<br>over 250 V |
| 1, 2 and 4                           | 1                                              | –                           |
| 6                                    | 1                                              | 1                           |
|                                      | 2                                              | 2                           |
| 10 and 13                            | 1                                              | 1                           |
|                                      | 2                                              | 2                           |
|                                      |                                                | 3                           |
|                                      |                                                | 4                           |
| 16, 20, 25, 32, 40, 45, 50<br>and 63 | 1                                              | 1                           |
|                                      | 2                                              | 2                           |
|                                      | 3                                              | 3                           |
|                                      | 4                                              | 4                           |

## 7 Classification

Switches are classified

**7.1** according to the possible connections (see Figure 8):

|                                                               | Pattern number |
|---------------------------------------------------------------|----------------|
| – single-pole switches .....                                  | 1              |
| – double-pole switches .....                                  | 2              |
| – three-pole switches .....                                   | 3              |
| – three-pole plus switched neutral switches .....             | 03             |
| – two-way switches .....                                      | 6              |
| – two-circuit switches with a common incoming line .....      | 5              |
| – two-way switches with one off-position .....                | 4              |
| – two-way double-pole switches .....                          | 6/2            |
| – two-way reversing switches (or intermediate switches) ..... | 7              |

NOTE 1 Two or more switches having the same or different pattern numbers can be mounted on a common base.

NOTE 2 For the pattern number for which an off-position is considered, the above classification refers also to push-button switches and momentary contact switches.

**7.2** according to the contact opening:

- switches of normal-gap construction;
- switches of mini-gap construction;
- switches of micro-gap construction;
- switches without contact gap (semiconductor switching devices).

**7.3** according to the degree of protection against access to hazardous parts and against harmful effects due to the ingress of solid foreign objects as described in IEC 60529.

**7.4** according to the degree of protection against harmful effects due to the ingress of water as described in IEC 60529.

**7.5** according to the method of actuating the switch:

- rotary;
- tumbler;
- rocker;
- push-button;
- cord-operated.

**7.6** according to the method of mounting the switch:

- surface-type;
- flush-type;
- semi flush-type;
- panel-type;
- architrave-type.



**7.7** according to the method of installation, as a consequence of the design of the switch:

- switches where the cover or cover plate can be removed without displacement of the conductors (design A);
- switches where the cover or cover plate cannot be removed without displacement of the conductors (design B).

NOTE If a switch has a base which cannot be separated from the cover or cover plate, and requires a supplementary plate to meet the standard, which can be removed for redecorating the wall without displacement of the conductors, it is considered to be of design A, provided the supplementary plate meets the requirements specified for covers and cover plates.

**7.8** according to the type of terminal:

- switches with screw-type terminals;
- switches with screwless-type terminals.

**7.9** according to the suitability to accept conductors:

- switches with terminals for rigid conductors only;
- switches with terminals for rigid and flexible conductors.

NOTE 1 In the following country, switches with terminals for rigid conductors only are not allowed: ES, IN and IT.

NOTE 2 In the following countries, switches with screw terminals for rigid conductors only are not allowed: DE, DK, IN and ZA.

## **8 Marking**

### **8.1 General**

Switches shall be marked with

- a) rated current(s)
  - in amperes (A) if the switch is tested according to 19.1 only
  - in amperes (A) if the switch is tested according to 19.1 and 19.3 only or
  - in amperes (AX) if the switch is tested according to 19.1, 19.2 and 19.3 when the rated currents in amperes (A) and (AX) are equal or
  - in amperes (A and AX) if the switch is tested according to 19.1, 19.2 and 19.3 when the rated currents in amperes (A) and (AX) are not equal;
- b) rated voltage(s) in volts;
- c) symbol for nature of supply;
- d) manufacturer's or responsible vendor's name, trade mark or identification mark;
- e) type reference, which may be a catalogue number;
- f) symbol for switches of mini-gap construction, if applicable;
- g) symbol for switches of micro-gap construction, if applicable;
- h) symbol for switches without contact gap (semiconductor switching device), if applicable;
- i) first characteristic numeral for the degree of protection against access to hazardous parts and against harmful effects due to ingress of solid foreign objects, if declared to be higher than 4 in which case the second characteristic numeral shall also be marked;
- j) second characteristic numeral for the degree of protection against harmful effects due to ingress of water, if declared to be higher than 2 in which case the first characteristic numeral shall also be marked;
- k) length of insulation to be removed before the insertion of the conductor into the screwless-type terminal;
- l) symbol for the suitability to accept rigid conductors only.

In addition the following information shall be given in the manufacturer's documentation:

m) for SBL loads: the rated power in watts and the type of load if the switch is tested according to 19.3.

NOTE 1 Marking of the pattern number given in 7.1 can be made if the connections are not clear from an inspection of the switch; this pattern number may be part of the type reference.

NOTE 2 If a base carries two or more switches with separate operating devices, marking with the pattern numbers can be made, for example 1+6 or 1+1+1.

NOTE 3 If there is no marking on the terminals, they are suitable to accept both rigid and flexible conductors.

NOTE 4 In the following country, the marking of the type reference is not used: UK.

NOTE 5 In the following countries, the symbol that electrotechnical expertise is required (see IEC 60417-6182:2013-09) is to be placed on the packaging: DE.

## 8.2 Symbols

When symbols are used, they shall be as follows:

|                                                                              |                                                                                               |
|------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| Amperes (Rated current for externally ballasted loads).....                  | AX                                                                                            |
| (other currents).....                                                        | A                                                                                             |
| Volts .....                                                                  | V                                                                                             |
| Alternating current .....                                                    | ~                                                                                             |
| Watt .....                                                                   | W                                                                                             |
| Neutral .....                                                                | N                                                                                             |
| Line .....                                                                   | L                                                                                             |
| Protective earth (IEC 60417-5019:2006-08) .....                              |          |
| "open" position (off) .....                                                  | O                                                                                             |
| "closed" position (on) .....                                                 | I                                                                                             |
| Mini-gap construction.....                                                   | m                                                                                             |
| Micro-gap construction.....                                                  | μ                                                                                             |
| Without contact gap (semiconductor switching device).....                    | ε                                                                                             |
| Degree of protection, when relevant.....                                     | IPXX                                                                                          |
| Degree of protection for fixed accessories to be installed on rough surfaces |                                                                                               |
| (test wall of Figure 21) .....                                               | IPXX<br> |
| Suitability to accept rigid conductors only.....                             | r                                                                                             |

NOTE 1 Details of construction of certain symbols are given in IEC 60417.

NOTE 2 In the IP code the letter "X" is replaced by the relevant number.

NOTE 3 Lines formed by the construction of the tool are not considered as part of the marking.

The symbol "AX" may be replaced by the symbol "X". For the marking with rated current and rated voltage the figures may be used alone.

The marking for the nature of supply shall be placed next to the marking for rated current and rated voltage.

NOTE 4 The marking for current, voltage and nature of supply can be, for example, as follows:

|                      |    |                |    |                              |
|----------------------|----|----------------|----|------------------------------|
| 10 AX 250 V ~        | or | 10 X/250 ~     | or | $\frac{10 X}{250} \sim$      |
| 20 A – 16 AX 250 V ~ | or | 20 -16 X/250 ~ | or | $\frac{20 - 16 X}{250} \sim$ |
| 10 AX 400 V ~        | or | 10 X/400 ~     | or | $\frac{10 X}{400} \sim$      |
| 25 AX 400 V ~        | or | 25 X/400 ~     | or | $\frac{25 X}{400} \sim$      |
| 25 A 250 V ~         | or | 25/250 ~       | or | $\frac{25}{250} \sim$        |
| 25 AX 440 V ~        | or | 25 X/440 ~     | or | $\frac{25 X}{440} \sim$      |

### 8.3 Visibility of markings

Markings shall be clearly visible with normal or corrected vision, without additional magnification.

Markings as given in 8.1 a), b), c), d), e) and, if applicable, f), g), h), k), and l) shall be placed on the main part of the switch.

NOTE 1 Marking e) can be the series reference only.

NOTE 2 In the following country, the marking of the type reference is not used: UK.

Parts such as cover plates, which are necessary for safety purposes and are intended to be sold separately, shall be marked with the manufacturer's or responsible vendor's name, trade mark or identification mark and type reference.

Markings i) and j), when applicable, shall be marked so as to be easily discernible when the switch is mounted and wired as in normal use. These markings shall be placed on parts which cannot be removed without the use of a tool.

NOTE 3 Additional type references can be marked on the main part, or on the outside or the inside of the associated enclosure.

### 8.4 Marking on terminals for phase conductors

Terminals intended for the connection of phase conductors (supply conductors) shall be identified unless the method of connection is of no importance, is self-evident or is indicated on a wiring diagram. Such identification may take the form of a letter L or, in the case of more than one of such terminals, the letters L1, L2, L3, etc. The letters L1, L2, L3 may be accompanied by an arrow or arrows pointing to the relevant terminal or terminals.

These indications shall not be placed on screws or any other easily removable part.

Alternatively, the surface of such terminals shall be bare brass or copper, other terminals being covered with a metallic layer of another colour.

For switches of pattern numbers 2, 3, 03 and 6/2, terminals associated with any one pole shall have similar identification, if applicable, differing from that of the terminals associated with the other poles, unless the relationship is self-evident.

NOTE 1 The wiring diagram can be an instruction sheet which accompanies the switch.

NOTE 2 "Easily removable parts" are those parts which can be removed during the normal installation of the switch.

### 8.5 Marking on terminals for neutral and earth conductors

Terminals intended exclusively for the neutral conductor shall be indicated by the letter N.

Earthing terminal for the connection of the protective conductor shall be indicated by the symbol  (IEC 60417-5019:2006-08).

These markings shall not be placed on screws or any other easily removable part.

NOTE "Easily removable parts" are those parts which can be removed during the normal installation of the switch.

Terminals provided for the connection of conductors not forming part of the main function of the switch shall be clearly identified unless their purpose is self-evident, or indicated in a wiring diagram which shall be fixed to the accessory.

The identification of switch terminals may be achieved by

- their marking with graphical symbols according to IEC 60417 or colours and/or alpha-numeric system;
- their physical dimension or relative location.

Leads of pilot lights are not considered to be conductors for the purpose of 8.5.

### 8.6 Marking of the switch position

If switches are marked to indicate the switch position, they shall be so marked that the direction of movement of the actuating member to its different positions or the actual position is clearly indicated. For switches having more than one actuating member, this marking shall indicate, for each of the actuating members, the effect achieved by its operation.

The marking shall be clearly visible on the front of the switch when fitted with its cover or cover plate.

If this marking is placed on the cover, cover plate, or removable actuating members, it shall not be possible to fix them in a position such that the marking is incorrect.

The symbols for "on" and "off" shall not be used for the indication of the switch positions unless, at the same time, they clearly indicate the direction of the movement of the actuating members.

NOTE 1 Other suitable means for the indication of the switch position can be used, for example pilot lights.

The short straight line indicating the "on" position shall be radial for rotary switches, perpendicular to the axis of rotation of the dolly for tumbler switches and rocker switches and vertical for push-button switches when mounted vertically.

These requirements do not apply to cord-operated switches and to switches of pattern numbers 6, 6/2 and 7.

NOTE 2 This indication can be avoided for push-button switches.

*Compliance with the requirements of 8.1 to 8.6 is checked by inspection.*

## 8.7 Additional requirements for marking

If it is necessary to take special precautions when installing the switch, details of these shall be given in an instruction sheet which accompanies the switch.

Instruction sheets shall be written in the official language(s) of the country in which the switch is to be sold.

*Compliance is checked by inspection.*

NOTE 1 Special precautions can, for example, be necessary for unenclosed switches and for switches for panel mounting.

NOTE 2 After installation, the conditions necessary to meet the requirements of this document are achieved when the instruction sheet includes clear information with regard to the following:

- dimensions of the space to be provided for each switch;
- dimensions and position of the means for supporting and fixing the switch within this space;
- minimum clearance between the various parts of the switch and the surrounding parts where fitted;
- minimum dimensions of ventilating openings, if needed, and their correct arrangement.

NOTE 3 If necessary, information concerning the connection between the earthing terminal and accessible metal parts can be given.

## 8.8 Durability

Marking shall be durable and easily legible.

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

*The marking is rubbed by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with 95 % n-hexane.*

NOTE 1 Marking made by impression, moulding, pressing, laser marking or engraving is not subjected to this test.

NOTE 2 95 % n-hexane (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.

## 9 Checking of dimensions

Switches and boxes shall comply with the appropriate standard sheets, if any.

*Compliance is checked by measurement.*

## 10 Protection against electric shock

### 10.1 Prevention of access to live parts

Switches shall be so designed that when they are mounted and wired as in normal use, live parts are not accessible even after removal of parts which can be removed without the use of a tool.

Switches which are designed to be fitted with pilot lights supplied at voltages other than ELV shall have means to prevent direct contact with the lamp.

*Compliance is checked by inspection and, if necessary, by the following test:*

*The specimen is mounted as in normal use and fitted with conductors of the smallest cross-sectional area specified in Clause 12; the test is repeated using conductors of the largest cross-sectional area specified in Clause 12.*

*Test probe B of IEC 61032 is applied in every possible position, an electrical indicator with a voltage between 40 V and 50 V being used to show contact with the relevant part.*

*Switches having enclosures or covers in thermoplastic or elastomeric material are subjected to the following additional test, which is carried out at an ambient temperature of  $(35 \pm 2) ^\circ\text{C}$ , the switches being at this temperature.*

*During the additional test, the switches are subjected for 1 min to a force of 75 N, applied through the tip of test probe 11 of IEC 61032.*

*This finger, with an electrical indicator as described above, is applied to all places where yielding of insulating material could impair the safety of the switch, but is not applied to membranes or the like and is applied to thin-walled knock-outs with a force of only 10 N.*

*During this test, switches with their associated mounting means shall not deform to such an extent that live parts can be touched with the test probe 11 of IEC 61032.*

NOTE Membranes or the like are tested according to 13.15.1 only.

## **10.2 Requirements for operating parts**

Knobs, operating levers, push-buttons, rockers and the like shall be of insulating material, unless their accessible metal parts are separated from the metal parts of the mechanism by double insulation or reinforced insulation, or, as an alternative, they are reliably connected to earth.

*Compliance is checked by inspection and by the tests of Clauses 16 and 23.*

This requirement does not apply to removable keys or intermediate parts, such as chains or rods.

## **10.3 Requirements for accessible metal parts**

**10.3.1** Accessible parts of switches when in normal use shall be made of insulating material with the exception of the following:

- small screws and the like which are isolated from live parts and which are used for the fixing of the base and of covers, cover plates and other parts of the enclosure;
- actuating members complying with 10.2;
- the covers, cover plates and other parts of the enclosure made of metal which comply with the requirements of 10.3.2 or 10.3.3.

**10.3.2** Covers or cover plates of metal shall be protected by additional insulation made by insulating linings or insulating barriers. The insulating linings or insulating barriers shall either

- be fixed to covers or cover plates or the body of the switches in such a way that they cannot be removed without being permanently damaged, or
- be so designed that
  - they cannot be replaced in an incorrect position;
  - if they are omitted, the accessories are rendered inoperable or manifestly incomplete;
  - there is no risk of accidental contact between live parts and metal covers or cover plates, for example through their fixing screws, even if a conductor should come away from its terminal;

- precautions are taken in order to prevent creepage distances or clearances becoming less than the values specified in Clause 23.

*Compliance is checked by inspection.*

The above linings or barrier shall comply with the tests of Clauses 16 and 23.

NOTE Insulating coating sprayed on the inside or on the outside of the metal cover or cover plate is not deemed to be an insulating lining or barrier for the purpose of 10.3.2.

**10.3.3** The earthing of metal covers or cover plates can be made with fixing screws or other integral means, the resulting connection shall be of low resistance.

*Compliance is checked by inspection and by the tests of 11.4.*

#### **10.4 Requirements for insulation of the mechanism**

Metal parts of the mechanism, such as the spindle or the pivot of the dolly or rocker, that are not insulated from live parts, shall not protrude from the enclosure.

However, for switches operated by means of a removable key or similar device, such metal parts of the mechanism shall be insulated from live parts.

*Compliance is checked by inspection and, if necessary, after the actuating member has been removed or broken.*

*If the actuating member has to be broken, compliance is checked by the test of Clause 23.*

#### **10.5 Requirements for insulation of the mechanism with respect to the surrounding environment**

Metal parts of the mechanism shall not be accessible and shall be insulated from accessible metal parts when the switch is fixed as in normal use.

These requirements do not apply if the metal parts of the mechanism are separated from live parts in such a way that the creepage distances and clearances have at least twice the values specified in Clause 23, or, as an alternative, if they are reliably connected to earth.

*Compliance is checked by inspection and, if necessary, by measurement and by the tests of Clauses 10 and 16.*

NOTE When checking the inaccessibility of metal parts of the mechanism of unenclosed switches or architrave-type switches, the protection provided by the normal way of mounting the switch is taken into account.

For unenclosed stack-type switches having a metal spindle pivoting in a metal base plate, the additional requirement means that the creepage distances and clearances between live parts and the spindle, and between metal parts of the mechanism and base plate, shall have at least twice the values specified in Clause 23.

#### **10.6 Requirements for switches operated indirectly**

Switches operated by means of a removable key or by means of an intermediate part, such as a cord, a chain or a rod, shall be so designed that the key or intermediate part can only touch parts which are insulated from live parts.

The key or intermediate part shall be insulated from metal parts of the mechanism, unless the creepage distances and clearances between live parts and metal parts of the mechanism have at least twice the values specified in Clause 23.

*Compliance is checked by inspection, by the test of 16.3 and, if necessary, by measurement.*

NOTE Lacquer or enamel is not considered to be insulating material for the purposes of 10.1 to 10.6.

## **10.7 Requirements for switches with replaceable pull cord**

Where cord-operated switches are provided with a pull cord which can be fitted or replaced by the user, they shall be so designed that it is impossible to touch live parts when fitting or replacing the pull cord in the normal way.

*Compliance is checked by inspection.*

## **11 Provision for earthing**

### **11.1 General**

Accessible metal parts, which can become live in the event of an insulation fault, shall be provided with, or permanently and reliably connected to, an earthing terminal.

This requirement does not apply to the metal cover plates mentioned in 10.3.2.

For the purpose of this requirement, small screws and the like, isolated from live parts, are not considered as accessible parts which can become live in the event of an insulation fault.

### **11.2 Earthing terminals**

Earthing terminals shall be terminals with screw clamping or screwless terminals and shall comply with the appropriate requirements of Clause 12.

### **11.3 Requirements for surface-type switches**

Surface-type switches with an enclosure of insulating material, having an IP code higher than IPX0 and more than one cable inlet, shall be provided with either an internal fixed earthing terminal or adequate space for a floating terminal allowing the connection of an incoming and outgoing conductor for the continuity of the earthing circuit.

Clause 12 does not apply to floating terminals which shall comply with IEC 60998-1 and the relevant sub-part of IEC 60998-2.

*Compliance with 11.1 to 11.3 is checked by inspection and by the tests of Clause 12.*

*Compliance for adequate space for floating terminals is checked by performing a test connection using the type of terminal specified by the manufacturer.*

### **11.4 Test for earthing connection**

The connection between the earthing terminal and accessible metal parts to be connected thereto shall be of low resistance.

*Compliance is checked by the following test:*

*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 or 25 A, whichever is the greater, 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  $\Omega$ .*

NOTE Care is taken that the contact resistance between the tip of the measuring probe and the metal part under test does not influence the test results.

## 12 Terminals

### 12.1 General

Switches shall be provided with terminals having screw clamping or with screwless terminals.

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

All the tests on terminals, with the exception of 12.3.11, shall be carried out after the test of 15.1. Rigid solid conductors shall be of Class 1, rigid stranded conductors shall be of Class 2 and flexible conductors shall be of Class 5 according to IEC 60228.

*Compliance is checked by inspection and by the tests of 12.2 or 12.3, as applicable.*

### 12.2 Terminals with screw clamping for external copper conductors

**12.2.1** Terminals with screw clamping may be of the type suitable for rigid copper conductors only or of the type suitable for both rigid and flexible copper conductors having cross-sectional areas as shown in Table 4.

**Table 4 – Relationship between rated currents and connectable cross-sectional areas of copper conductors**

| Ranges of rated currents<br><br>A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Rigid conductors (solid or stranded) <sup>c</sup> |                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|-------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Nominal cross-sectional areas<br>mm <sup>2</sup>  | Diameter of largest conductor<br>mm |
| up to and including 4 <sup>a</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | –                                                 | –                                   |
| above 4 up to and including 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | From 0,75 up to 1,5 inclusive                     | 1,45                                |
| above 6 up to and including 13 <sup>b</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | From 1 up to 2,5 inclusive                        | 2,13                                |
| above 13 up to and including 16 <sup>b</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | From 1,5 up to 4 inclusive                        | 2,72                                |
| above 16 up to and including 25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | From 2,5 up to 6 inclusive                        | 3,34                                |
| above 25 up to and including 32                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | From 4 up to 10 inclusive                         | 4,34                                |
| above 32 up to and including 50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | From 6 up to 16 inclusive                         | 5,46                                |
| above 50 up to and including 63                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | From 10 up to 25 inclusive                        | 6,85                                |
| <sup>a</sup> For special purposes such as ELV applications, where flexible conductors are used (from 0,5 mm <sup>2</sup> up to 1 mm <sup>2</sup> inclusive).<br><sup>b</sup> Each supply terminal of switches, other than those of pattern numbers 3, 03 and 7, shall allow the connection of two 2,5 mm <sup>2</sup> conductors. For switches having a rated voltage not exceeding 250 V a round hole is sufficient for the connection of two 2,5 mm <sup>2</sup> conductors.<br><sup>c</sup> The use of flexible conductors is permitted. |                                                   |                                     |

The conductor space shall be at least that specified in Figures 1, 2, 3, 4 and 5.

*Compliance is checked by inspection and by fitting conductors of the smallest and largest cross-sectional areas specified.*

**12.2.2** Terminals with screw clamping shall allow the conductor to be connected without special preparation.

*Compliance is checked by inspection.*

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

**12.2.3** Terminals with screw clamping shall have adequate mechanical strength.

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

Screws shall not be of metal which is soft or liable to creep, such as zinc or aluminium.

*Compliance is checked by inspection and by the tests of 12.2.6 and 12.2.8.*

NOTE Provisionally SI, BA, and UN threads are considered to be comparable in pitch and mechanical strength to metric ISO thread.

**12.2.4** Terminals with screw clamping shall be resistant to corrosion.

Terminals, the body of which is made of copper or copper alloy as specified in 22.5 are considered as complying with this requirement.

**12.2.5** Terminals with screw clamping shall be so designed and constructed that they clamp the conductor(s) without undue damage to the conductor(s).

*Compliance is checked by the following test.*

*Terminals suitable for rigid conductors only are checked with rigid solid conductors and on a new set of specimens with rigid stranded conductors, if existing.*

NOTE "if existing" means that the conductor is available in the market where the product is sold and installed.

*Terminals suitable for rigid and flexible conductors are checked with rigid conductors as above and on a new set of specimens with flexible conductors.*

*The terminal is placed in the test apparatus according to Figure 9. The terminal is fitted first with a conductor of the smallest and then with a conductor of the largest cross-sectional area according to Table 4, the clamping screw(s) or nut(s) being tightened with the torque according to Table 5.*

*Where a screw has a hexagonal head with a slot for tightening with a screwdriver and the values of columns 3 and 5 are different, the test is made twice, first applying to the hexagonal head the torque specified in column 5 and then applying the torque specified in column 3 by means of a screwdriver. If the values of columns 3 and 5 are the same, only the test with the screwdriver is made.*

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

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

*The screws and nuts shall be tightened in one smooth and continuous motion.*

**Table 5 – Tightening torque for the verification  
of the mechanical strength of screw-type terminals**

| Nominal diameter of thread<br>mm | Torque<br>Nm |     |     |     |     |     |
|----------------------------------|--------------|-----|-----|-----|-----|-----|
|                                  | 1            | 2   | 3   | 4   | 5   | 6   |
| Up to and including 2,8          | 0,2          | –   | 0,4 | –   | 0,4 | –   |
| Over 2,8 up to and including 3,0 | 0,25         | –   | 0,5 | –   | 0,5 | –   |
| Over 3,0 up to and including 3,2 | 0,3          | –   | 0,6 | –   | 0,6 | –   |
| Over 3,2 up to and including 3,6 | 0,4          | –   | 0,8 | –   | 0,8 | –   |
| Over 3,6 up to and including 4,1 | 0,7          | 1,2 | 1,2 | 1,2 | 1,2 | –   |
| Over 4,1 up to and including 4,7 | 0,8          | 1,2 | 1,8 | 1,8 | 1,8 | –   |
| Over 4,7 up to and including 5,3 | 0,8          | 1,4 | 2,0 | 2,0 | 2,0 | –   |
| Over 5,3 up to and including 6,0 | –            | 1,8 | 2,5 | 3,0 | 3,0 | –   |
| Over 6                           | –            | –   | –   | –   | –   | 0,8 |

Column 1 applies to screws without heads if the screw when tightened does not protrude from the hole, and to other screws which cannot be tightened by means of a screwdriver with a blade wider than the diameter of the screw.

Column 2 applies to nuts of mantle terminals which are tightened by means of a screwdriver.

Column 3 applies to other screws which are tightened by means of a screwdriver.

Column 4 applies to nuts of mantle terminals in which the nut is tightened by means other than a screwdriver.

Column 5 applies to screws or nuts, other than nuts of mantle terminals, which are tightened by means other than a screwdriver.

Column 6 applies to nuts of switches with central hole fixing.

*The length of the test conductor shall be 75 mm longer than the height (H) specified in Table 6.*

*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 6. The bushing shall be positioned in a horizontal plane such that its centre line describes a circle of 75 mm diameter, concentric with the centre of the clamping unit in the horizontal plane. The platen is then rotated at a rate of  $(10 \pm 2)$  r/min.*

*The distance between the mouth of the clamping unit and the upper surface of the bushing shall be within  $\pm 15$  mm of the height of Table 6. The bushing may be lubricated to prevent binding, twisting, or rotation of the insulated conductor.*

*A mass as specified in Table 6 is to be suspended from the end of the conductor. The duration of the test shall be 15 min.*

*During the test, the rigid conductor, or any wire of rigid stranded or flexible conductor, shall neither slip out of the clamping unit nor break near the clamping unit, nor shall the conductor be damaged in such a way as to render it unfit for further use.*

*In the case of the flexible conductor, the breakage of a few wires shall not be taken into account provided it does not exceed 15 % of the original number of wires.*

**Table 6 – Test values for flexion and pull out for copper conductors**

| Conductor cross-sectional area <sup>a</sup><br>mm <sup>2</sup> | Diameter of bushing hole <sup>b</sup><br>mm | Height $H$ <sup>c</sup><br>mm | Mass for conductor<br>kg |
|----------------------------------------------------------------|---------------------------------------------|-------------------------------|--------------------------|
| 0,5                                                            | 6,5                                         | 260                           | 0,3                      |
| 0,75                                                           | 6,5                                         | 260                           | 0,4                      |
| 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                      |
| 25,0                                                           | 13,0                                        | 300                           | 4,5                      |

<sup>a</sup> AWG sizes corresponding to mm<sup>2</sup> can be found in IEC 60999-1.

<sup>b</sup> If the bushing hole diameter is not large enough to accommodate the conductor without binding, a bushing having the next larger hole size may be used.

<sup>c</sup> Tolerance for height  $H = \pm 15$  mm.

**12.2.6** Terminals with screw clamping shall be so designed that they clamp the conductor reliably between metal surfaces.

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

*Terminals suitable for rigid conductors only are checked with rigid solid conductors and on a new set of specimens with rigid stranded conductors, if existing.*

NOTE 1 “if existing” means that the conductor is available in the market where the product is sold and installed.

*Terminals suitable for rigid and flexible conductors are checked with rigid conductors as above and on a new set of specimens with flexible conductors.*

*The terminals are fitted first with conductors of the smallest and then with conductors of the largest cross-sectional area specified in Table 4, the terminal screws being tightened with a torque equal to two-thirds of the torque shown in the appropriate column of Table 5.*

*If the screw has a hexagonal head with a slot, the torque applied is equal to two-thirds of the torque shown in column 3 of Table 5.*

*The conductor is then subjected to a pull as specified in Table 7, applied without jerks, for 1 min, in the direction of the axis of the conductor space.*

*If the clamp is intended for two conductors, the appropriate pull is applied consecutively to each conductor.*

**Table 7 – Test values for pulling out test**

| Cross-section of conductors connected to the terminal<br>mm <sup>2</sup> | 0,75 | 1  | 1,5 | 2,5 | 4  | 6  | 10 | 16 | 25  |
|--------------------------------------------------------------------------|------|----|-----|-----|----|----|----|----|-----|
| Pull<br>N                                                                | 30   | 35 | 40  | 50  | 50 | 60 | 80 | 90 | 100 |

*During the test, the conductor shall not move noticeably in the terminal.*

*If the clamp is intended for connection of more than two conductors, reference is made for the testing to the requirements given in the appropriate part of IEC 60998.*

NOTE 2 In the following countries, terminals allowing connection of two conductors are additionally tested with one rigid solid conductor and one rigid stranded conductor with the same cross-sectional area connected at the same time: DK, FI, NO, SE and ZA.

**12.2.7** Terminals with screw clamping shall be so designed or placed that neither a rigid solid conductor nor a wire of a stranded conductor can slip out while the clamping screws or nuts are tightened.

This requirement does not apply to lug terminals.

*Compliance is checked by the following test:*

*Terminals suitable for rigid conductors only are checked with rigid solid conductors and on a new set of specimens with rigid stranded conductors, if existing.*

NOTE "if existing" means that the conductor is available in the market where the product is sold and installed.

*Terminals suitable for rigid and flexible conductors are checked with rigid conductors as above and on a new set of specimens with flexible conductors.*

*The terminals are fitted with conductors having the largest cross-sectional area specified in Table 4.*

*Terminals intended for the looping-in of two or three conductors are checked, fitted with the permissible number of conductors.*

*The terminals are fitted with conductors having the composition given in IEC 60228.*

*Before insertion into the clamping means of the terminal, wires of rigid (solid or stranded) conductors are straightened; rigid stranded conductors may, in addition, be twisted to restore them approximately to their original shape and flexible conductors are twisted in one direction so that there is a uniform twist of one complete turn in a length of approximately 20 mm.*

*The conductor is inserted into the clamping means of the terminal for the minimum distance prescribed or, where no distance is prescribed, until it just projects from the far side of the terminal and in the position most likely to allow the wire to escape.*

*The clamping screw(s) or nut(s) is (are) then tightened with a torque equal to two-thirds of the torque shown in the appropriate column of Table 5.*

*After the test, no wire of the conductors shall have escaped outside the clamping unit thus reducing creepage distances and clearances to values lower than those indicated in Table 23.*

**12.2.8** Terminals with screw clamping shall be so fixed or located within the switch that, when the clamping screws or nuts are tightened or loosened, the terminals shall not work loose from their fixing to the switch.

Movement of the terminal is allowed as long as it is sufficiently limited so as to prevent non-compliance with this document.

The use of sealing compound or resin is considered to be sufficient for preventing a terminal from working loose, provided that

- the sealing compound or resin is not subject to stress during normal use, and
- the effectiveness of the sealing compound or resin is not impaired by temperatures attained by the terminal under the most unfavourable conditions specified in this document.

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

*A solid rigid copper conductor of the largest cross-sectional area specified in Table 4 is placed in the terminal.*

*Screws and nuts are tightened and loosened five times by means of a suitable test screwdriver or spanner, the torque applied when tightening being equal to the torque shown in the appropriate column of Table 5 or in the table of the appropriate Figures 1 to 4, whichever is the highest.*

*The conductor is moved each time the screw or nut is loosened.*

During the test, terminals shall not work loose and there shall be no damage, such as breakage of screws or damage to the heads, slots, threads, washers or stirrups that will impair the further use of the terminals.

**12.2.9** Clamping screws or nuts of earthing terminals with screw clamping 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 manual test.*

*In general, the designs of terminals shown in Figures 1, 2, 3, 4 and 5 provide sufficient resiliency to comply with this requirement; for other designs, special provisions, such as the use of an adequately resilient part which is not likely to be removed inadvertently, may be necessary.*

**12.2.10** Earthing terminals with screw clamping 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 terminals 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 other metal no less resistant to corrosion.

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

*Compliance is checked by inspection.*

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

**12.2.11** For pillar terminals, the distance between the clamping screw and the end of the conductor, when fully inserted, shall be at least that specified in Figure 1.

NOTE The minimum distance between the clamping screw and the end of the conductor applies only to pillar terminals in which the conductor cannot pass right through.

For mantle terminals, the distance between the fixed part and the end of the conductor, when fully inserted, shall be at least that specified in Figure 5.

*Compliance is checked by measurement, after a solid conductor of the largest cross-sectional area specified for the appropriate rated current in Table 4 has been fully inserted and fully clamped.*

**12.2.12** Lug terminals shall be used only for switches having a rated current of 40 A or greater; if such terminals are provided, they shall be fitted with spring washers or equally effective locking means.

*Compliance is checked by inspection.*

### 12.3 Screwless terminals for external copper conductors

**12.3.1** Screwless terminals may be of the type suitable for rigid copper conductors only or of the type suitable for both rigid and flexible copper conductors.

*For the latter type, the tests are carried out with rigid conductors first and then repeated with flexible conductors.*

12.3 is not applicable to switches provided with

- screwless terminals requiring the fixing of special devices to the conductors before clamping in the screwless terminal, for example flat push-on connectors;
- screwless terminals requiring twisting of the conductors, for example those with twisted joints;
- screwless terminals providing direct contact to the conductors by means of edges or points penetrating the insulation.

**12.3.2** Screwless terminals shall be provided with clamping units which allow the proper connection of rigid or of rigid and flexible copper conductors having nominal cross-sectional areas as shown in Table 8.

**Table 8 – Relationship between rated currents and connectable cross-sectional areas of copper conductors for screwless terminals**

| Rated current<br>A                                                                                                                                                                                                                                                  | Conductors                                       |                                           |                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|-------------------------------------------|----------------------------------------------|
|                                                                                                                                                                                                                                                                     | Nominal cross-sectional areas<br>mm <sup>2</sup> | Diameter of largest rigid conductor<br>mm | Diameter of largest flexible conductor<br>mm |
| Up to and including 4                                                                                                                                                                                                                                               | 0,75 to 1                                        | 1,19                                      | -                                            |
| Above 4 and including 6                                                                                                                                                                                                                                             | 1 to 1,5                                         | 1,45                                      | 1,73                                         |
| Above 6 and including 16 <sup>a</sup>                                                                                                                                                                                                                               | 1,5 to 2,5                                       | 2,13                                      | 2,21                                         |
| <sup>a</sup> Each supply terminal of switches other than those of pattern numbers 3, 03 and 7 shall allow the connection of two 2,5 mm <sup>2</sup> conductors. In such cases a terminal with separate independent clamping means for each conductor shall be used. |                                                  |                                           |                                              |

*Compliance is checked by inspection and by fitting conductors of the smallest and largest cross-sectional areas specified.*



**12.3.3** Screwless terminals shall allow the conductor to be connected without special preparation.

*Compliance is checked by inspection.*

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.

**12.3.4** Parts of screwless terminals mainly intended for carrying current shall be of materials as specified in 22.5.

*Compliance is checked by inspection and by chemical analysis.*

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

**12.3.5** Screwless terminals shall be so designed that they clamp the specified conductors with sufficient contact pressure and without undue damage to the conductor.

The conductor shall be clamped between metal surfaces.

*Compliance is checked by inspection and by the test of 12.3.10.*

**12.3.6** It shall be clear how the connection and disconnection of the conductors is to be made.

The disconnection of a conductor shall require an operation, other than a pull on the conductor, so that it can be made manually with or without the assistance of a general purpose tool.

It shall not be possible to confuse the opening for the use of a tool to assist the connection or disconnection with the opening intended for the insertion of the conductor.

*Compliance is checked by inspection and by the test of 12.3.10.*

**12.3.7** Screwless terminals which are intended to be used for the interconnection of two or more conductors shall be so designed that

- the clamping of one of the conductors is independent of the clamping of the other conductor(s);
- during the connection or disconnection the conductors can be connected or disconnected either at the same time or separately;
- each conductor shall be introduced in a separate clamping unit (not necessarily in separate holes);
- it shall be possible to clamp securely any number of conductors up to the maximum as designed.

*Compliance is checked by inspection and by the tests with the appropriate conductors.*

**12.3.8** Screwless terminals shall be so designed that over-insertion of the conductor is prevented and adequate insertion is obvious.

Screwless terminals of switches shall be so designed that undue insertion of the conductor is prevented by a stop if further insertion is liable to reduce the creepage distances and/or clearances required in Table 23, or to influence the mechanism of the switch.

*Compliance is checked by inspection and by the test of 12.3.10.*



**12.3.9** Screwless terminals shall be properly fixed to the switch.

They shall not work loose when the conductors are connected or disconnected during installation.

*Compliance is checked by inspection and by the test of 12.3.10.*

Covering with sealing compound without other means of locking is not sufficient. However, self-hardening resins may be used to fix terminals which are not subject to mechanical stress in normal use.

**12.3.10** Screwless terminals shall withstand the mechanical stresses occurring in normal use.

*Compliance is checked by the following tests which are carried out with uninsulated conductors on one screwless terminal of each specimen, using a new specimen for each test.*

*The test is carried out with solid copper conductors, first with conductors having the largest cross-sectional area, and then with conductors having the smallest cross-sectional area specified in 12.3.2.*

*Conductors are connected and disconnected five times, new conductors being used each time, except for the fifth time, when the conductors used for the fourth connection are clamped at the same place. For each connection the conductors are either pushed as far as possible into the terminal or are inserted so that adequate connection is obvious.*

*After each connection, the conductor is subjected to a pull of 30 N; the pull is applied without jerks, for 1 min, in the direction of the longitudinal axis of the conductor space.*

*During the application of the pull, the conductor shall not come out of the screwless terminal.*

*The test is then repeated with rigid stranded copper conductors having the largest and smallest cross-sectional areas specified in 12.3.2; these conductors are, however, connected and disconnected only once.*

*Screwless terminals, intended for both rigid and flexible conductors, shall also be tested with flexible conductors, applying five connections and disconnections.*

*Each conductor of screwless terminals is subjected for 15 min to a circular motion with  $(10 \pm 2)$  r/min using an apparatus, an example of which is shown in Figure 9. The conductor is subjected to a pull having a value shown in Table 6.*

*During the test, the conductors shall not move noticeably in the clamping unit.*

*After these tests, neither the terminals nor the clamping means shall have worked loose and the conductors shall show no deterioration impairing their further use.*

**12.3.11** Screwless terminals shall withstand the electrical and thermal stresses occurring in normal use.

*Compliance is checked by the following tests a) and b), which are carried out on five screwless terminals which have not been used for any other test.*

*Both tests are carried out with new copper conductors.*

- a) *The test is carried out by loading the screwless terminals for 1 h with an alternating current as specified in Table 9 and connecting rigid solid conductors 1 m long having the cross-sectional area as specified in Table 9.*

b) The test is carried out on each clamping unit.

**Table 9 – Test current for the verification of electrical and thermal stresses in normal use of screwless terminals**

| Rated current<br>A        | Test current<br>A | Cross-sectional area<br>of the conductor<br>mm <sup>2</sup> |
|---------------------------|-------------------|-------------------------------------------------------------|
| Up to including 4         | 9                 | 0,75                                                        |
| Above 4 and including 6   | 13,5              | 1                                                           |
| Above 6 and including 13  | 17,5              | 1,5                                                         |
| Above 13 and including 16 | 22                | 2,5                                                         |

During the test, the current is not passed through the switch but only through the terminals.

Immediately after this period, the voltage drop across each screwless terminal is measured with rated current flowing.

In no case shall the voltage drop exceed 15 mV.

The measurements are made across each screwless terminal and as near as possible to the place of contact.

If the back connection of the terminal is not accessible, the second connecting point in the case of two-way switches may be used for the returning wire; in the case of one-way switches the specimens may be adequately prepared by the manufacturer; care should be taken not to affect the behaviour of the terminal.

During the period of the test, including the measurements, the conductors and the measurement means shall not be moved so that the result of the test is affected.

The screwless terminals already subjected to the determination of the voltage drop specified in the previous test a) are tested as follows:

- During the test, a current equal to the test current value given in Table 9 is passed.

The whole test arrangement including the conductors shall not be moved until the measurements of the voltage drop have been completed.

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

- the current is flowing for approximately 30 min;
- for a further approximately 30 min no current is flowing.

The voltage drop in each screwless terminal is determined as prescribed for the test of a) and is done at the following moments:

- after the first 24 temperature cycles and after the 192 temperature cycles;
- additional measurements to be done after any three of the following temperature cycles: after the 48<sup>th</sup>, 72<sup>nd</sup>, 96<sup>th</sup>, 120<sup>th</sup>, 144<sup>th</sup> or 168<sup>th</sup> temperature cycles.

In no case shall the voltage drop exceed 22,5 mV or two times the value measured after the 24<sup>th</sup> cycle, whichever is the smaller.

*After this test, an inspection by normal or corrected vision without additional magnification shall show no changes evidently impairing further use such as cracks, deformation or the like.*

*In addition, the mechanical strength test according to 12.3.10 is repeated and all specimens shall withstand this test.*

**12.3.12** Screwless terminals shall be so designed that the connected rigid solid conductor remains clamped, even when it has been deflected during normal installation, for example during mounting in a box, and the deflecting stress is transferred to the clamping unit.

*Compliance is checked by the following test which is made on three specimens of switches which have not been used for any other test.*

*The test apparatus, the principle of which is shown in Figure 10a, shall be so constructed that*

- a specified conductor properly inserted into a terminal is allowed to be deflected in any of the 12 directions differing from each other by 30°, with a tolerance referred to each direction of  $\pm 5^\circ$ , and*
- the starting point can be varied by 10° and 20° from the original point.*

*A reference point need not be specified.*

*The deflection of the conductor from its straight position to the testing positions shall be effected by means of a suitable device applying a specified force to the conductor at a certain distance from the terminal.*

*The deflecting device shall be so designed that*

- the force is applied in the direction perpendicular to the undeflected conductor;*
- the deflection is attained without rotation or displacement of the conductor within the clamping unit, and*
- the force remains applied while the prescribed voltage drop measurement is made.*

*Provision shall be made so that the voltage drop across the clamping unit under test can be measured when the conductor is connected, as shown for example in Figure 10b.*

*The specimen is mounted on the fixed part of the test apparatus in such a way that the specified conductor inserted into the clamping unit under test can be freely deflected.*

*To avoid oxidation, the insulation of the wire shall be removed immediately before starting the test.*

NOTE 1 If necessary, the inserted conductor can be permanently bent around obstacles, so that these do not influence the results of the test.

NOTE 2 In some cases, with the exception of the case of guidance for the conductor, it may be advisable to remove those parts of the specimens which do not allow the deflection of the conductor corresponding to the force to be applied.

*A clamping unit is fitted as for normal use with a rigid solid copper conductor having the smallest cross-sectional area specified in Table 10 and is submitted to a first test sequence. The same clamping unit is submitted to a second test sequence using the conductor having the largest cross-sectional area, unless the first test sequence has failed.*

*The force for deflecting the conductor is specified in Table 11, the distance of 100 mm being measured from the extremity of the terminal, including the guidance, if any, for the conductor, to the point of application of the force to the conductor.*

The test is made with continuous current (i.e. the current is not switched on and off during the test). A suitable power supply should be used and an appropriate resistance should be inserted in the circuit so that the current variations are kept within  $\pm 5\%$  during the test.

**Table 10 – Cross-sectional areas of rigid copper conductors  
for deflection test of screwless terminals**

| Rated current of the switch<br>A | Cross-sectional area of the test conductor<br>mm <sup>2</sup> |                   |
|----------------------------------|---------------------------------------------------------------|-------------------|
|                                  | 1st test sequence                                             | 2nd test sequence |
| $\leq 6$                         | 1,0 <sup>a</sup>                                              | 1,5               |
| Above 6 up to and including 16   | 1,5                                                           | 2,5               |

<sup>a</sup> Only for countries allowing the use of 1,0 mm<sup>2</sup> conductors in fixed installations.

**Table 11 – Deflection test forces**

| Cross-sectional area of the test conductor<br>mm <sup>2</sup> | Force for deflecting the test conductor <sup>a</sup><br>N |
|---------------------------------------------------------------|-----------------------------------------------------------|
| 1,0                                                           | 0,25                                                      |
| 1,5                                                           | 0,5                                                       |
| 2,5                                                           | 1,0                                                       |

<sup>a</sup> The forces are chosen so that they stress the conductors close to the limit of elasticity.

A test current equal to the rated current of the switch is passed through the clamping unit under test. A force according to Table 11 is applied to the test conductor inserted in the clamping unit under test in one of the 12 directions shown in Figure 10a and the voltage drop across this clamping unit is measured. The force is then removed.

The force is then applied successively in each one of the remaining 11 directions shown in Figure 10a following the same test procedure.

If for any of the 12 test directions the voltage drop is greater than 25 mV, the force is maintained in this direction until the voltage drop is reduced to a value below 25 mV, but for not more than 1 min. After the voltage drop has reached a value below 25 mV, the force is 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 specimens of switches of the set are tested following the same test procedure, but moving the 12 directions of the force so that they differ by approximately 10° for each specimen. If one specimen has failed at one of the directions of application of the test force, the tests are repeated on another set of specimens, all of which shall comply with the repeated tests.

## 13 Constructional requirements

### 13.1 Mechanical requirements for insulating means

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

Compliance is checked by inspection after the tests of Clause 20.

### 13.2 Installation requirements

Switches shall be constructed so as to permit

- easy introduction into the terminal and reliable connection of the conductors in the terminals, except for lead wires of pilot lights;

NOTE 1 Screw terminals shown in Figures 1 to 5 are considered suitable for reliable connection of the conductors.

- correct positioning of the conductors;
- easy fixing of the switch to a wall or in a box;
- adequate space between the underside of the main part and the surface on which the main part is mounted or between the sides of the main part and the enclosure (cover or box) so that, after installation of the switch, the insulation of the conductors is not necessarily pressed against live parts of different polarity or against moving parts of the mechanism, such as the spindle of a rotary switch.

NOTE 2 This requirement does not imply that the metal parts of the terminals are necessarily protected by insulation barriers or insulating shoulders, to avoid contact, due to incorrect installation of the terminal metal parts, with the insulation of the conductor.

Surface-type switches shall be constructed so that the fixing means do not damage the insulation of the cables during the installation.

*Compliance is checked by inspection and by an installation test using conductors of the largest cross-sectional area specified, for the relevant ranges of rated currents, in Table 4.*

NOTE 3 For surface-type switches, mounted on a mounting plate, a wiring channel may be needed to comply with this requirement.

In addition, for switches comprising screwless terminals, the switches shall be so constructed that the connecting and/or disconnecting means of the screwless terminals cannot be activated by the conductors during and after installation of the switch in a box or on a wall.

NOTE 4 This requirement does not imply that the connecting and/or disconnecting means cannot be touched by the conductors.

NOTE 5 This requirement can be met by the placement of the connecting and/or disconnecting means and/or the use of protective barriers or shoulders placed around the connecting and/or disconnecting means.

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

*The test is carried out with a solid copper conductor having the smallest cross-sectional area specified in 12.3.2.*

*The conductor is pushed as far as possible into the terminal under test or is inserted so that adequate connection is obvious.*

*A test probe 1 of IEC 61032 is pushed against the connecting or disconnecting means with a force of 120 N in the direction opposite to the mounting direction as described in Figure 22a.*

*During the application of the force, the conductor, except for lead wires of pilot lights, is subjected to a pull of 30 N; the pull is applied in one smooth and continuous motion, for 1 min, in the direction of the longitudinal axis of the conductor space.*

*During the application of the pull, the conductor shall not come out of the screwless terminal.*

*The force of 120 N has to be applied before the force of 30 N is applied. The force of 30 N is maintained on the conductor during the complete test.*

*Care should be taken that the test probe does not touch the conductor during the application of the forces.*

*Where the axis between the application force and the axis through the force necessary to operate the connecting/disconnecting means deviates by more than 20°, it is allowed to exert the calculated resulting force directly onto the connecting/disconnecting means using the test probe. An example is shown in Figure 22b.*

*If the angle is greater than 60° no test is necessary and the product is deemed to comply with the requirements without further tests.*

*If it is not possible to exert a force onto the connecting/disconnecting device, the product is deemed to comply with the requirements without further tests.*

In addition, switches classified as design A shall permit easy positioning and removal of the cover or cover plate, without displacing the conductors or activating the connecting and/or disconnecting means of screwless terminals.

NOTE 6 This requirement does not imply that the connecting and/or disconnecting means cannot be touched by the cover or cover plate.

### **13.3 Fixing of covers, cover plates and actuating members**

**13.3.1** Covers, cover plates and actuating members or parts of them, which are intended to ensure protection against electric shock, shall be held in place at two or more points by effective fixing.

Covers, cover plates and actuating members or parts of them may be fixed by means of a single fixing, for example by a screw, provided that they are located by another means (for example by a shoulder).

NOTE 1 The most appropriate method for fixings covers, cover plates or actuating members is to ensure that they are captive. The use of tight fitting washers of cardboard or the like is deemed to be an adequate method for securing screws intended to be captive.

NOTE 2 Non-earthed metal parts, separated from live parts in such a way that creepage distances and clearances have values specified in Table 23, are not considered as accessible if the requirements of 13.3 are met.

Where the fixing of covers, cover plates or actuating members of switches of design A serves to fix the main part there shall be means to maintain the main part in position, even after removal of the covers, cover plates or actuating members.

*Compliance is checked according to 13.3.2, 13.3.3 or 13.3.4.*

**13.3.2** *For covers, cover plates or actuating members whose fixing is of the screw-type: by inspection only.*

**13.3.3** *For covers, cover plates or actuating members whose fixing is not dependent on screws and whose removal is obtained by applying a force in a direction approximately perpendicular to the mounting/supporting surface (see Table 12),*

– *when their removal may give access, with the test probe B of IEC 61032, to live parts:*

*by the tests of 20.5;*

– *when their removal may give access, with the test probe B of IEC 61032, to non-earthed metal parts separated from live parts in such a way that creepage distances and clearances have the values at least equal to those shown in Table 23:*

*by the test of 20.6;*

- when their removal may give access, with the test probe B of IEC 61032, only to
- insulating parts, or
  - earthed metal parts, or
  - metal parts separated from live parts in such a way that creepage distances and clearances have at least twice the values shown in Table 23, or
  - live parts of SELV circuits not greater than 25 V AC and 60 V DC:
- by the test of 20.7.

**Table 12 – Forces to be applied to covers, cover-plates or actuating members whose fixing is not dependent on screws**

| Accessibility with the test probe B of IEC 61032 after removal of covers, cover plates or parts of them                                                                                               | Test according to ... | Force to be applied<br>N              |                |                                           |                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------------------------------|----------------|-------------------------------------------|----------------|
|                                                                                                                                                                                                       |                       | Switches complying with 20.8 and 20.9 |                | Switches not complying with 20.8 and 20.9 |                |
|                                                                                                                                                                                                       |                       | Shall not come off                    | Shall come off | Shall not come off                        | Shall come off |
| To live parts                                                                                                                                                                                         | 20.5                  | 40                                    | 120            | 80                                        | 120            |
| To non-earthed metal parts separated from live parts by creepage distances according to 23.1                                                                                                          | 20.6                  | 10                                    | 120            | 20                                        | 120            |
| To insulating parts, earthed metal parts, the live parts of SELV ≤ 25 V AC and 60 V DC or metal parts separated from live parts by creepage distances and by clearances twice those according to 23.1 | 20.7                  | 10                                    | 120            | 10                                        | 120            |

**13.3.4** For covers, cover plates or actuating members whose fixing is not dependent on screws and whose removal is obtained by using a tool, in accordance with the manufacturer's instructions given in an instruction sheet or catalogue:

by the same tests of 13.3.3 except that the covers, cover plates, actuating members or parts of them need not come out when applying a force not exceeding 120 N in directions perpendicular to the mounting/supporting surface.

#### 13.4 Openings in normal use

Switches shall be so constructed that, when they are fixed and wired as in normal use, there are no free openings in their enclosures according to their IP classification.

Compliance is checked by inspection and by an installation test with conductors of the smallest cross-sectional area specified in Table 4.

NOTE Drain holes, small gaps between enclosures and conduits or cables, or between enclosures and operating means can be neglected if they comply with the relevant IP classification.

#### 13.5 Attachment of knobs

Knobs of rotary switches shall be securely attached to the shaft or part operating the mechanism.

Compliance is checked by the following test.



*Where it is possible to apply an axial pull in normal use, an axial pull shall be applied for 1 min to try to pull off the actuating member.*

*If the shape of the actuating member is such that an axial pull is likely to be applied in normal use, the force is 30 N.*

*If the shape of the actuating member is such that an axial pull is unlikely to be applied in normal use, the force is 15 N.*

*After this, knobs of switches having only one direction of operation are turned, if possible, without undue force, 100 times in the reverse direction.*

*During the test, the knob shall not become detached.*

### **13.6 Mounting means**

Screws or other means for mounting the switch on a surface or in a box or enclosure shall be easily accessible from the front. These means shall not serve any other fixing purpose.

NOTE Switch mounting means, if used to lock the rotation of the box, do not constitute a use for "any fixing purpose".

### **13.7 Combination of switches**

Combinations of switches, or of switches and socket-outlets, comprising separate bases shall be so designed that the correct position of each main part is ensured. The fixing of each main part shall be independent of the fixing of the combination to the mounting surface.

*Compliance with the requirements of 13.6 and 13.7 is checked by inspection.*

### **13.8 Accessories combined with switches**

Accessories combined with switches shall comply with their relevant standard, if any, unless a standard exists for the combination.

### **13.9 Surface-type switches having an IP code higher than IP20**

Surface-type switches that have an IP code higher than IP20 shall be according to their IP classification when fitted with conduits or with sheathed cables as for normal use.

Surface-type switches that have degrees of protection IPX4, IPX5 and IPX6 shall have provisions for opening a drain hole.

If a switch is provided with a drain hole, it shall be not less than 5 mm in diameter, or 20 mm<sup>2</sup> in area with a width and a length not less than 3 mm.

If the design of the switch is such that only one mounting position is possible, the drain hole shall be effective in that position. Alternatively, the drain hole shall be effective in at least two positions of the switch when this is mounted on a vertical wall, one of these with the conductors entering at the top and the other with the conductors entering at the bottom.

Lid springs, if any, shall be of corrosion resistant material, such as bronze or stainless steel.

*Compliance is checked by inspection, by measurement and by the relevant tests of 15.2.*

NOTE A drain hole in the back of the enclosure is deemed to be effective only if the design of the enclosure ensures a clearance of at least 5 mm from the wall, or provides a drainage channel of at least the size specified.



### 13.10 Installation in a box

Switches to be installed in a box shall be so designed that the conductor ends can be prepared after the box is mounted in position, but before the switch is fitted in the box.

In addition, the main part shall have adequate stability when mounted in the box.

*Compliance is checked by inspection and by an installation test with conductors of the largest cross-sectional area specified for the relevant current rating in Table 4.*

### 13.11 Connection of a second current-carrying conductor

Surface-type switches that have an IP code higher than IPX0, of pattern numbers 1, 5 and 6 with an enclosure having more than one inlet opening shall be provided for maintaining the continuity of a second current-carrying conductor either with a fixed additional terminal complying with the requirements of Clause 12 or with adequate space for a floating terminal.

*Compliance is checked by inspection and by the relevant tests of Clause 12.*

### 13.12 Inlet openings

Inlet openings shall allow the introduction of the conduit or the sheath of the cable so as to afford complete mechanical protection.

Surface-type switches shall be so constructed that the intended conduit or the sheath of the cable can enter at least 1 mm into the enclosure.

In surface-type switches, the inlet opening for conduit entries, or at least two of them if there are more than one, shall be capable of accepting conduit sizes of 16, 20, 25 or 32 or a combination of at least two of any of these sizes not excluding two of the same size.

*Compliance is checked by inspection during the test of 13.10 and by measurement.*

In surface-type switches, the inlet opening for cable entries shall preferably be capable of accepting cables having the dimensions specified in Table 13 or be as specified by the manufacturer.

NOTE Inlet openings of adequate size can also be obtained by the use of knock-outs or of suitable insertion pieces.

**Table 13 – External cable diameter limits for surface type switches**

| Rated current<br>A | Cross-sectional areas<br>mm <sup>2</sup> | Number of conductors | Limits of external diameter of cables |               |
|--------------------|------------------------------------------|----------------------|---------------------------------------|---------------|
|                    |                                          |                      | Minimum<br>mm                         | Maximum<br>mm |
| 6                  | 1,5                                      | 2                    | 7,6                                   | 11,0          |
|                    |                                          | 3                    |                                       | 11,9          |
|                    |                                          | 4                    |                                       | 13,1          |
|                    |                                          | 5                    |                                       | 14,4          |
| 10 and 13          | 1,5 up to and including 2,5              | 2                    | 7,6                                   | 13,1          |
|                    |                                          | 3                    |                                       | 14,0          |
|                    |                                          | 4                    |                                       | 15,5          |
|                    |                                          | 5                    |                                       | 17            |
| 16                 | 1,5 up to and including 4                | 2                    | 7,6                                   | 15,1          |
|                    |                                          | 3                    |                                       | 16,2          |
|                    |                                          | 4                    |                                       | 17,9          |
|                    |                                          | 5                    |                                       | 19,9          |
| 20<br>25           | 2,5 up to and including 6                | 2                    | 8,6                                   | 16,8          |
|                    |                                          | 3                    |                                       | 18,0          |
|                    |                                          | 4                    |                                       | 20,0          |
|                    |                                          | 5                    |                                       | 22,2          |
| 32                 | 4 up to and including 10                 | 2                    | 9,6                                   | 22,6          |
|                    |                                          | 3                    |                                       | 24,2          |
|                    |                                          | 4                    |                                       | 26,5          |
|                    |                                          | 5                    |                                       | 29,1          |
| 40<br>45<br>50     | 6 up to and including 16                 | 2                    | 10,5                                  | 25,7          |
|                    |                                          | 3                    |                                       | 27,6          |
|                    |                                          | 4                    |                                       | 30,1          |
|                    |                                          | 5                    |                                       | 33,3          |
| 63                 | 10 up to and including 25                | 2                    | 13                                    | 30,7          |
|                    |                                          | 3                    |                                       | 33,0          |
|                    |                                          | 4                    |                                       | 36,6          |
|                    |                                          | 5                    |                                       | 40,4          |

NOTE The limits of external diameter of cables specified in this table are based on type 60227 IEC 10 according to IEC 60227-4 and type 60245 IEC 66 according to IEC 60245-4 and are given for information.

**13.13 Provision for back entry from a conduit**

If surface-type switches are intended for back entry from a conduit, they shall be so designed that they have provision for back entry from a conduit perpendicular to the mounting surface of the switch.

*Compliance is checked by inspection.*

### 13.14 Switch provided with membranes or the like for inlet openings

If the switch is provided with membranes or the like for inlet openings, they shall be replaceable.

*Compliance is checked by inspection.*

### 13.15 Requirements for membranes in inlet openings

**13.15.1** Membranes shall be reliably fixed and shall not be displaced by the mechanical and thermal stresses occurring in normal use.

*Compliance is checked by the following test:*

*Membranes are tested when assembled in the switches.*

*First the switches are fitted with membranes which have been subjected to the treatment specified in 15.1.*

*The switches are then placed for 2 h in a heating cabinet as described in 15.1, the temperature being maintained at  $(40 \pm 2) ^\circ\text{C}$ .*

*Immediately after this period, a force of 30 N is applied for 5 s to various parts of the membranes by means of the tip of test probe 11 of IEC 61032.*

*During these tests, the membranes shall not deform to such an extent that the live parts become accessible.*

*For membranes likely to be subjected to an axial pull in normal use, an axial pull of 30 N is applied for 5 s.*

*During this test, the membranes shall not come out.*

*The test is then repeated with membranes which have not been subjected to any treatment.*

**13.15.2** It is recommended that membranes be so designed and made of such material that the introduction of the cables into the switch is permitted when the ambient temperature is low.

NOTE In the following countries, compliance with this requirement is considered as necessary, due to installation practices in cold conditions: SE, FI, DK and NO.

*Compliance is checked by the following test:*

*The switches are fitted with membranes which have not been subjected to any ageing treatment, those without opening being suitably pierced.*

*The switches are then kept, for 2 h, in a freezer at a temperature of  $(-15 \pm 2) ^\circ\text{C}$ .*

*After this period, the switches are removed from the freezer and immediately afterwards, while the switches are still cold, it shall be possible to introduce, without undue force, cables of the heaviest type, as declared by the manufacturer, through the membranes.*

After the tests of 13.15.1 and 13.15.2, the membranes shall show no harmful deformation, cracks or similar damage which would lead to non-compliance with this document.

### 13.16 Pilot light units

Pilot light units shall comply with IEC 60669-2-1:2002, IEC 60669-2-1:2002/AMD1:2008 and IEC 60669-2-1:2002/AMD2:2015, 101.1.1.1 and Clause 102, as far as applicable.

## 14 Mechanism

### 14.1 Indication of the position

The actuating member of a switch, when released, shall automatically take up the position corresponding to that of the moving contacts, except that for cord-operated switches and for those with a single push-button, the actuating member may take up a single rest position.

### 14.2 Rest and intermediate position

Switches shall be so constructed that the moving contacts can come to rest only in the "on" and "off" positions, an intermediate position being, however, permissible if it corresponds to the intermediate position of the actuating member, and if the insulation between the fixed and the moving contacts is then adequate.

If necessary, the insulation between the fixed and the moving contact, when in an intermediate position, is checked by an electric strength test as specified in 16.3, the test voltage being applied between the relevant terminals without removing the cover or cover plate of the switch.

*Compliance with the requirements of 14.1 and 14.2 is checked by inspection and by manual test.*

### 14.3 Undue arcing

Switches shall be so constructed that undue arcing cannot occur when the switch is operated slowly.

*Compliance is checked at the end of the test of 19.1, breaking the circuit a further ten times, the actuating member being, however, moved steadily by hand over a period of 2 s and moving contacts being stopped, if possible, in an intermediate position, the actuating member being then released.*

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

### 14.4 Making and breaking

Switches of pattern numbers 2, 3, 03 and 6/2 shall make and break all poles substantially simultaneously except that for switches of pattern number 03, the neutral shall not make after or break before the other poles.

*Compliance is checked by inspection and by manual test when the switch is mounted with the cover, cover plates and actuating members installed as for normal use.*

### 14.5 Action of the mechanism without cover or cover plate

The action of the mechanism if the covers or cover plates are removable for installation purposes shall be independent of the presence of the cover or cover plate.

NOTE The actuating member, in some constructions, can constitute the cover.

*Compliance is checked by connecting the switch, without cover or cover plate fitted, in series with a lamp and by pressing the actuating member without undue force as in normal use.*

*During the test, the lamp shall not flicker.*

#### **14.6 Pull force for cord-operated switches**

Cord-operated switches shall be capable of effecting a change from the "off" to the "on" position, and from the "on" to the "off" position by application and removal of a steady pull not exceeding 45 N applied vertically and 65 N applied at  $45^\circ \pm 5^\circ$  to the vertical and in a plane perpendicular to the mounting surface when the switches are mounted as in normal use as specified by the manufacturer.

*Compliance is checked by manual test.*

### **15 Resistance to ageing, protection provided by enclosures of switches and resistance to humidity**

#### **15.1 Resistance to ageing**

Switches shall be resistant to ageing.

Parts intended for decorative purposes only, such as certain lids, shall be removed if possible and these parts are not subjected to the test.

*Compliance is checked by the following test:*

*Switches and boxes, mounted as for normal use, are subjected to a test in a heating cabinet with an atmosphere having the composition and pressure of the ambient air and ventilated by natural circulation.*

*Switches having an IP code higher than IPX0 are tested after having been mounted and assembled as specified in 15.2.2.*

*The temperature in the cabinet is maintained at  $(70 \pm 2)^\circ\text{C}$ .*

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

*The use of an electrically heated cabinet is recommended.*

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

*After the treatment, the specimens are removed from the cabinet and kept at room temperature and at a relative humidity between 45 % and 55 % for at least 4 days (96 h).*

*The specimens shall show no crack visible with normal or corrected vision without additional magnification, nor shall the material have become sticky or greasy, this being judged as follows:*

*With the forefinger wrapped in a dry piece of rough cloth the specimen is pressed with a force of 5 N.*

*No traces of the cloth shall remain on the specimen and the material of the specimen shall not stick to the cloth.*

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

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

The specimen is placed on one of the pans of a balance and the other pan is loaded with a mass equal to the mass of the specimen plus 500 g.

Equilibrium is then restored by pressing the specimen with the forefinger wrapped in a dry piece of rough cloth.

## **15.2 Protection provided by enclosures of switches**

### **15.2.1 General**

The enclosure of the switch shall provide protection against access to hazardous parts, against harmful effect due to ingress of solid foreign objects and against effects due to ingress of water in accordance with the IP classification of the switch.

*Compliance is checked by the tests of 15.2.2 and 15.2.3.*

### **15.2.2 Protection against access to hazardous parts and against harmful effects due to ingress of solid foreign objects**

#### **15.2.2.1 General**

Enclosures of switches shall provide a degree of protection against access to hazardous parts and against harmful effects due to ingress of solid foreign objects in accordance with the IP classification of the switch.

*Compliance is checked by the appropriate tests of IEC 60529 under the conditions specified below.*

*The switches are mounted as in normal use.*

*Flush-type and semi-flush-type switches are mounted in an appropriate box according to the manufacturer's instructions.*

*Switches with screwed glands or membranes are fitted and connected with cables within the connecting range specified in Table 4. Glands are tightened with a torque equal to two-thirds of that applied during the test of 20.4.*

*Screws of the enclosure are tightened with a torque equal to two-thirds of the values given in Table 5.*

*Parts which can be removed without the aid of a tool are removed.*

*If a switch passes the test successfully, then this test is deemed to be passed for a combination of such single switches.*

*Glands are not filled with sealing compound or the like.*

#### **15.2.2.2 Protection against access to hazardous parts**

*The appropriate test specified in IEC 60529 is performed (see also Clause 10).*

#### **15.2.2.3 Protection against harmful effects due to ingress of solid foreign bodies**

*The appropriate test according to IEC 60529 is performed.*

*Test probes are not applied to drain holes.*

*For the test of the first characteristic numeral 5, enclosures of switches are considered to be of category 2 (see IEC 60529:1989 and IEC 60529:1989/AMD1:1999, 13.4); dust shall not penetrate in a quantity to interfere with satisfactory operation or impair safety.*

*For the test of the first characteristic numeral 6, enclosures of switches are considered to be of category 1 (see IEC 60529:1989, 13.6); no dust shall penetrate.*

### **15.2.3 Protection against harmful effects due to ingress of water**

*Enclosures of switches shall provide a degree of protection against harmful effects due to ingress of water in accordance with their IP classification.*

*Compliance is checked by the appropriate tests of IEC 60529 under the conditions specified below.*

*Flush-type and semi-flush-type switches are fixed in a test wall representing the intended use of the switch using an appropriate box in accordance with the manufacturer's instructions.*

*Where the manufacturer's instructions specify particular types of walls, these walls as well as any special installation requirements for the switch, shall be described in sufficient detail (see 8.7).*

*Where the manufacturer's instructions do not specify a type of wall, the test wall according to Figure 21 is used. It is made with bricks having flat smooth surfaces. When the box is mounted in the test wall, it shall fit tight against the wall so that water cannot enter between the box and the wall.*

*If sealing material is used in order to seal the box into the wall, it shall not influence the sealing properties of the specimen to be tested.*

NOTE Figure 21 shows an example where the edge of the box is positioned in the reference plane. Other positions are possible according to the manufacturer's instructions.

*The test wall is placed in a vertical position.*

*Surface-type switches are mounted as in normal use on a vertical surface and fitted with cables with conductors whose largest and smallest cross-sectional area is given in Table 4, as appropriate for their rating.*

*Screws of the enclosure operated when mounting the switch are tightened with a torque equal to two-thirds of the appropriate value given in Table 5.*

*Glands are tightened with a torque equal to two-thirds of the appropriate value given in Table 22.*

*Glands are not filled with sealing compound or the like.*

*Parts which can be removed without the aid of a tool are removed.*

*If the enclosure of a switch that has an IP code less than IPX5 is designed with drain holes, one drain hole is opened and in the lowest position. If an enclosure of a switch that has an IP code equal to or greater than IPX5 is designed with drain holes, they shall not be opened.*

*Care should be taken not to disturb, for example knock or shake, the assembly to such an extent as to affect test results.*

*If the switch has drain holes which have been opened, it shall be proved by inspection that any water which enters does not accumulate and that it drains away without doing any harm to the complete assembly.*

*The specimens shall withstand an electric strength test as specified in 16.3, which shall be started within 5 min of completion of the tests according to 15.2.*

### **15.3 Resistance to humidity**

*Switches shall be proof against humidity which may occur in normal use.*

*Compliance is checked by the humidity treatment described in 15.3, followed immediately by the measurement of the insulation resistance and by the electric strength test specified in Clause 16.*

*Inlet openings, if any, are left open; if knock-outs are provided, one of them is opened.*

*Parts which can be removed without the aid of a tool are removed and subjected to the humidity treatment with the main part; spring lids are open during this treatment.*

*The humidity treatment is carried out in a humidity cabinet containing air with relative humidity maintained between 91 % and 95 %.*

*The temperature of the air in which the specimens are placed is maintained within  $\pm 1$  K of any convenient value  $t$  between 20 °C and 30 °C.*

*Before being placed in the humidity cabinet, the specimens are brought to a temperature between  $t$  and  $t + 4$  °C.*

*The specimens are kept in the cabinet for*

- two days (48 h) for switches that have an IP code IPX0;*
- seven days (168 h) for switches that have an IP code higher than IPX0.*

NOTE In most cases, the specimens can be brought to the specified temperature by keeping them at this temperature for at least 4 h before the humidity treatment. A relative humidity between 91 % and 95 % can be obtained by placing in the humidity cabinet a saturated solution of sodium sulphate ( $\text{Na}_2\text{SO}_4$ ) or potassium nitrate ( $\text{KNO}_3$ ) in water having a sufficiently large contact surface with the air.

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

## **16 Insulation resistance and electric strength**

### **16.1 General**

*The insulation resistance and electric strength of switches shall be adequate.*

*One pole of any pilot light is disconnected for the test of Clause 16.*

*Compliance is checked by the following tests, which are made immediately after the tests of 15.3, in the humidity cabinet or in the room in which the specimens were brought to the prescribed temperature, after reassembly of those parts which can be removed without the aid of a tool and were removed for the test.*

### **16.2 Test for measuring the insulation resistance**

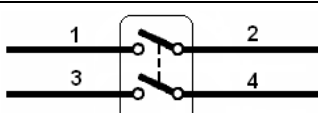
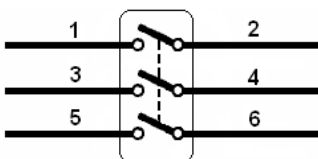
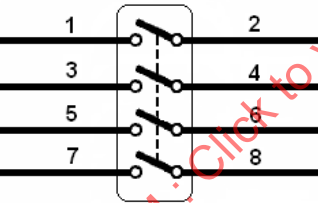
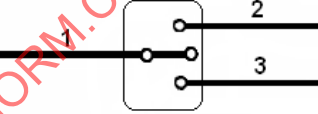
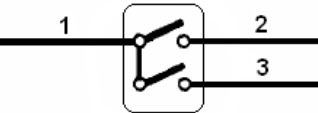
*The insulation resistance is measured with a DC voltage of approximately 500 V, the measurement being made not more than 1 min after application of the voltage.*

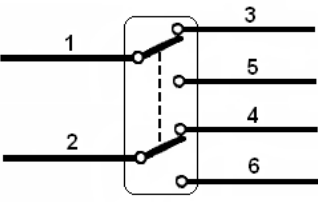
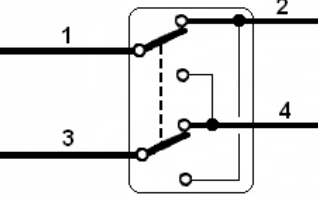
*The measurements are made consecutively for items 1, 2 and 3 of Table 15 with the switch position and the necessary connections as shown in Table 14.*



In addition, if electrically independent pattern numbers are combined in a common base the measurements are made between all terminals of one pattern number connected together and to the body and to all terminals of the other pattern numbers connected together. This is repeated for each contact position and for each pattern number of the combination. The minimum insulation resistance shall be 5 MΩ.

**Table 14 – Points of application of the test voltage  
for the verification of insulation resistance and electric strength**

| Pattern number | Diagrams of connections                                                                                                               | Position | Number of poles | Application of the voltage <sup>a</sup> |                                                             |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------|-----------------------------------------|-------------------------------------------------------------|
|                |                                                                                                                                       |          |                 | Between Terminal No.                    | Between body (B) together with terminal No.                 |
| 1              | <br>Single-pole switch                               | Off      | 1               | 1<br>2                                  | B + 2<br>B + 1                                              |
|                |                                                                                                                                       | On       |                 | 1 – 2                                   | B                                                           |
| 2              | <br>Two-pole switch                                  | Off      | 2               | 1 + 3<br>2 + 4                          | B + 2 + 4<br>B + 1 + 3                                      |
|                |                                                                                                                                       | On       |                 | 1 – 2<br>1 – 2 + 3 – 4                  | B + 3 – 4<br>B                                              |
| 3              | <br>Three-pole switch                               | Off      | 3               | 1 + 3 + 5<br>2 + 4 + 6                  | B + 2 + 4 + 6<br>B + 1 + 3 + 5                              |
|                |                                                                                                                                       | On       |                 | 1 – 2<br>3 – 4<br>5 – 6                 | B + 3 – 4 + 5 – 6<br>B + 1 – 2 + 5 – 6<br>B + 1 – 2 + 3 – 4 |
| 03             | <br>Three-pole plus switched neutral               | Off      | 4               | 1 + 3 + 5 + 7<br>2 + 4 + 6 + 8          | B + 2 + 4 + 6 + 8<br>B + 1 + 3 + 5 + 7                      |
|                |                                                                                                                                       | On       |                 | 1 – 2 + 5 – 6<br>1 – 2 + 7 – 8          | B + 3 – 4 + 7 – 8<br>B + 3 – 4 + 5 – 6                      |
| 4              | <br>Two-way switch with one off position           | Off      | 1               | 1                                       | B + 2 + 3                                                   |
|                |                                                                                                                                       | On       |                 | 1 – 2<br>1 – 3                          | B + 3<br>B + 2                                              |
| 5              | <br>Two-circuit switch with a common incoming line | Off      | 1               | 2 + 3<br>1                              | B + 1<br>B + 2 + 3                                          |
|                |                                                                                                                                       | On       |                 | 1 – 3<br>1 – 2 – 3                      | B + 2<br>B                                                  |
| 6              | <br>Two-way switch                                 | –        | 1               | 1 – 3<br>1 – 2                          | B + 2<br>B + 3                                              |

| Pattern number                                                                                                     | Diagrams of connections                                                                                                                    | Position | Number of poles | Application of the voltage <sup>a</sup>  |                                                          |
|--------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------|------------------------------------------|----------------------------------------------------------|
|                                                                                                                    |                                                                                                                                            |          |                 | Between Terminal No.                     | Between body (B) together with terminal No.              |
| 6/2                                                                                                                |  <p>Two-way double-pole switch</p>                        | –        | 2               | $1 - 3 + 2 - 4$<br>$1 - 5 + 2 - 6$       | $B + 5 + 6$<br>$B + 3 + 4$                               |
| 7                                                                                                                  |  <p>Two-way reversing switch (or intermediate switch)</p> | –        | 1               | $1 - 2$<br>$3 - 4$<br>$1 - 4$<br>$2 - 3$ | $B + 3 - 4$<br>$B + 1 - 2$<br>$B + 2 - 3$<br>$B + 1 - 4$ |
| <sup>a</sup> – denotes an existing electrical connection.<br>+ denotes an electrical connection made for the test. |                                                                                                                                            |          |                 |                                          |                                                          |

The term "body" includes accessible metal parts, metal frames supporting the base of flush-type switches, operating keys, metal foil in contact with the outer surface of accessible external parts and operating keys of insulating material, the point of anchorage of the cord, chain or rod for switches operated by such means, fixing screws of main parts or covers and cover plates, external assembly screws, earthing terminals and any metal part of the mechanism if required to be insulated from live parts (see 10.4).

For the measurements according to items 1 and 2, the metal foil is applied in such a way that sealing compound is effectively tested.

The test according to item 5 is only made if any insulating lining is necessary to provide insulation.

The insulation resistance shall be not less than the values shown in Table 15.

While wrapping the metal foil round the outer surface or placing it in contact with the inner surface of parts of insulating material, it is pressed against holes or grooves without any appreciable force, by means of test probe 11 of IEC 61032.

### 16.3 Electric strength test

The insulation is subjected for 1 min to a voltage of substantially sine wave form, having a frequency of 50 Hz or 60 Hz.

The tests are made consecutively as indicated in Table 14 at points of application as described in Table 15, the switch position and the necessary connections for items 1, 2 and 3 of Table 15 being as shown in Table 14.

In addition, if electrically independent pattern numbers are combined in a common base the test is made between all terminals of the one pattern number connected together and to the body and to all terminals of the other pattern numbers connected together. This is repeated for each contact position and for each pattern number of the combination. The test voltage

*applied shall be 1 250 V for ratings not exceeding 130 V or 2 000 V for ratings greater than 130 V.*

*Initially, not more than half the prescribed voltage is applied; then it is raised rapidly to the full value. No flashover or breakdown shall occur during the test.*

*The high-voltage transformer used for the test shall be so designed that, when the output terminals are short-circuited after the output voltage has been adjusted to the appropriate test voltage, the output current is at least 200 mA. The overcurrent relay shall not trip when the output current is less than 100 mA. The rms value of the test voltage applied shall be measured with an accuracy of  $\pm 3\%$ .*

*Glow discharges without drop in voltage shall be neglected.*

NOTE In the following country the test of item 8 in Table 15 is conducted between live parts and metal knobs, push-buttons and metal foil in contact with the outer surface of accessible external parts and operating keys of insulating material: AU.

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**Table 15 – Test voltage, points of application and minimum values of insulating resistance for the verification of electric strength**

| Insulation to be tested                                                                                                                                                                                                                                                                                                            | Minimum value of insulation resistance<br><br>MΩ | Test voltage<br>V                                   |                                                 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|-----------------------------------------------------|-------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                    |                                                  | Switches having a rated voltage not exceeding 130 V | Switches having a rated voltage exceeding 130 V |
| 1 Between all poles connected together and the body, with the switch in the "on" position.                                                                                                                                                                                                                                         | 5                                                | 1 250                                               | 2 000                                           |
| 2 Between each pole in turn and all other poles connected to the body, with the switch in the "on" position.                                                                                                                                                                                                                       | 2                                                | 1 250                                               | 2 000                                           |
| 3 Between the terminals which are electrically connected together when the switch is in the "on" position, the switch being in the "off" position:                                                                                                                                                                                 |                                                  |                                                     |                                                 |
| – normal/mini-gap construction;                                                                                                                                                                                                                                                                                                    | 2                                                | 1 250                                               | 2 000                                           |
| – micro-gap construction;                                                                                                                                                                                                                                                                                                          | 2                                                | 500 (note 1)                                        | 1 250 (note 2)                                  |
| – semiconductor switching devices.                                                                                                                                                                                                                                                                                                 | (note 3)                                         | (note 3)                                            | (note 3)                                        |
| 4 Between metal parts of the mechanism, when insulated from live parts, and                                                                                                                                                                                                                                                        |                                                  |                                                     |                                                 |
| – live parts;                                                                                                                                                                                                                                                                                                                      | 5                                                | 1 250                                               | 2 000                                           |
| – metal foil in contact with the surface of the knob or a similar actuating member;                                                                                                                                                                                                                                                | 5                                                | 1 250                                               | 2 000                                           |
| – the key of key-operated switches, if insulation is required (see 10.6);                                                                                                                                                                                                                                                          | 5                                                | 1 250                                               | 2 000                                           |
| – the point of anchorage of the cord, chain or rod of switches operated by such means, if insulation is required (see 10.6);                                                                                                                                                                                                       | 5                                                | 1 250                                               | 2 000                                           |
| – accessible metal parts, including fixing screws, of the main part, if insulation is required (see 10.5).                                                                                                                                                                                                                         | 5                                                | 1 250                                               | 2 000                                           |
| 5 Between any metal enclosure and metal foil in contact with the inner surface of its insulating linings, if any (note 4).                                                                                                                                                                                                         | 5                                                | 1 250                                               | 2 000                                           |
| 6 Between live parts and accessible metal parts, if the metal parts of the mechanism are not insulated from live parts.                                                                                                                                                                                                            | –                                                | 2 000                                               | 3 000                                           |
| 7 Between live parts and parts of the mechanism                                                                                                                                                                                                                                                                                    |                                                  |                                                     |                                                 |
| – if the latter parts are not insulated from accessible metal parts (see 10.5);                                                                                                                                                                                                                                                    | –                                                | 2 000                                               | 3 000                                           |
| – if the latter parts are not insulated from the point of contact with a removable key or operating cord, chain or rod (see 10.6).                                                                                                                                                                                                 | –                                                | 2 000                                               | 3 000                                           |
| 8 Between live parts and metal knobs, push-buttons and the like (see 10.2).                                                                                                                                                                                                                                                        | –                                                | 2 500                                               | 4 000                                           |
| NOTE 1 This value also applies for the electric strength test after normal operation.                                                                                                                                                                                                                                              |                                                  |                                                     |                                                 |
| NOTE 2 For switches having a rated voltage up to and including 250 V, this value is reduced to                                                                                                                                                                                                                                     |                                                  |                                                     |                                                 |
| – 750 V for the electric strength test after resistance to humidity;                                                                                                                                                                                                                                                               |                                                  |                                                     |                                                 |
| – 500 V for the electric strength test after normal operation.                                                                                                                                                                                                                                                                     |                                                  |                                                     |                                                 |
| NOTE 3 Tests for the verification to the "off" position of semiconductor switching devices according to item 3 are under consideration.                                                                                                                                                                                            |                                                  |                                                     |                                                 |
| NOTE 4 This test is only made if any insulation is necessary.                                                                                                                                                                                                                                                                      |                                                  |                                                     |                                                 |
| NOTE 5 In the following country the test of item 8 is conducted between live parts and metal knobs, push-buttons and metal foil in contact with the outer surface of accessible external parts and operating keys of insulating material. The test voltage for switches with a rating voltage exceeding 130 V is to be 3 000 V: AU |                                                  |                                                     |                                                 |

## 17 Temperature rise

### 17.1 General

Switches shall be so constructed that the temperature rise in normal use is not excessive.

The metal and the design of the contacts shall be such that the operation of the switch is not adversely affected by oxidation or any other deterioration.

*Compliance is checked by the following test:*

*The switches are mounted vertically as in normal use fitted with PVC insulated rigid solid or stranded copper conductors as specified in Table 16, the terminal screws or nuts being tightened with a torque equal to two-thirds of that specified in Table 5.*

To ensure normal cooling of the terminal, the conductors connected to them shall have a length of at least 1 m.

*The switches are loaded for 1 h with alternating current having the value shown in Table 16.*

**Table 16 – Temperature-rise test currents and cross-sectional areas of copper conductors**

| Rated current<br>A | Test current<br>A | Nominal cross-sectional<br>area of conductors<br>mm <sup>2</sup> |
|--------------------|-------------------|------------------------------------------------------------------|
| 1                  | 1,5               | 0,5                                                              |
| 2                  | 3                 | 0,75                                                             |
| 4                  | 5                 | 1                                                                |
| 6                  | 8                 | 1,5                                                              |
| 10                 | 13,5              | 2,5                                                              |
| 13                 | 17                | 2,5                                                              |
| 16                 | 20                | 4 <sup>a</sup>                                                   |
| 20                 | 25                | 4                                                                |
| 25                 | 32                | 6                                                                |
| 32                 | 38                | 10                                                               |
| 40                 | 46                | 16                                                               |
| 45                 | 51                | 16                                                               |
| 50                 | 57,5              | 16                                                               |
| 63                 | 75                | 25                                                               |

<sup>a</sup> For switches having a rated voltage not exceeding 250 V, other than those of pattern numbers 3 and 03, provided with screwless terminals, the test shall be carried out with conductors having a cross-sectional area of 2,5 mm<sup>2</sup>.

NOTE 1 The test currents for switches having other rated currents are determined by interpolation between the next lower and higher ratings.

*For switches of pattern numbers 4, 5, 6, 6/2 and 7, only one circuit is loaded.*

*Flush-mounted switches are mounted in flush-mounted boxes. The box is placed in a block of pinewood filled around the box with plaster so that the front edge of the box does not protrude and is not more than 5 mm below the front surface of the pinewood block.*

*The test assembly should be allowed to dry for at least 7 days when first made.*

*The size of the pinewood block, which may be fabricated from more than one piece, shall be such that there is at least 25 mm of wood surrounding the plaster, the plaster having a thickness between 10 mm and 15 mm around the maximum dimensions of the sides and rear of the box.*

NOTE 2 The sides of the cavity in the pinewood block can have a cylindrical shape.

*The cables connected to the switch shall enter through the top of the box, the point(s) of entry being sealed to prevent the circulation of air. The length of each conductor within the box shall be  $(80 \pm 10)$  mm.*

*Surface-type switches shall be mounted centrally on the surface of a wooden block, which shall be at least 20 mm thick, 500 mm wide and 500 mm high.*

*Other types of switches shall be mounted according to the manufacturer's instructions or, in the absence of such instructions, in the position of normal use considered to give the most onerous conditions.*

*The test assembly shall be placed in a draught-free environment for the test.*

*The temperature is determined by means of melting particles, colour changing indicators or thermocouples, so chosen and positioned that they have negligible effect on the temperature being determined.*

*The temperature rise of the terminals shall not exceed 45 K.*

*During the test, the temperature rise necessary to perform the test of 21.4 shall be determined.*

NOTE 3 Sliding action or the use of silver or silver-faced contacts prevents undue oxidation of the contacts.

*In the case of combination of switches, the test is carried out separately on each switch.*

## **17.2 Switches incorporating pilot lights**

Switches incorporating pilot lights or intended to incorporate pilot lights shall be so designed that in normal use the temperature of accessible surfaces is not excessive.

*Compliance is checked by the following test:*

*The switch is mounted and connected as in 17.1 with the pilot light supplied at rated voltage so that it is constantly illuminated for 1 h. The switch is loaded at its rated current.*

*The temperature rise of the external surface of the switch shall not exceed:*

- 45 K for knobs, handles, sensing surfaces, etc., of non-metallic material;
- 55 K for other external parts of non-metallic material;
- 35 K for knobs, handles, sensing surfaces, etc., of metallic material;
- 45 K for other external parts of metallic material.

*Pilot lights using neon lamps or LEDs consuming no more than 3 mA are not tested.*

## 18 Making and breaking capacity

### 18.1 General

Switches shall have adequate making and breaking capacity.

*For the purpose of this test, pilot lights are disconnected.*

*Compliance is checked by the test of 18.2. In addition, for switches having a rated current not exceeding 16 A with a rated voltage up to and including 250 V and for switches of pattern numbers 3 or 03 having a rated voltage over 250 V, by the tests of 18.3.*

*Cord-operated switches shall be tested mounted as in normal use and with a pull of a value adequate to operate the cord-operated switch, but not exceeding 50 N, on the cord throughout the test, at  $30^\circ \pm 5^\circ$  to the vertical and in a plane perpendicular to the mounting surface.*

*The tests are made by means of an apparatus.*

*The connections are shown in Figure 11.*

*For switches of pattern number 7, one side is tested as pattern number 6. The test is repeated on the other side of a new set of specimens if the other side is not identical.*

*For switches of pattern numbers 6, 6/2 and 7, the selector switch S shown in Figure 11 is moved after the fraction of the total number of operations indicated in Table 17.*

*Switches are fitted with conductors as for the test of Clause 17.*

NOTE In the following country, switches intended to control the inrush current of motors are tested according to 13.13 (Motor Control Test) of AS/NZ 3133:2013: AU.

### 18.2 Overload

Switches are tested at 1,1 times the rated voltage and 1,25 times the rated current.

The tolerance for the test voltage and test current is  $^{+5}_0$  %.

They are subjected to 200 operations at a uniform rate of

- 30 operations per minute if the rated current does not exceed 13 A;
- 15 operations per minute if the rated current exceeds 13 A but is less than 25 A;
- 7,5 operations per minute if the rated current is 25 A or more.

The on period shall be  $(25^{+5}_0)$  % of the total cycle and the off period  $(75^{0}_{-5})$  %.

*For rotary switches intended to be operated in either direction, the actuating member is turned in one direction for half the total number of operations and in the reverse direction for the remainder.*

*Switches are tested using an alternating current having a  $\cos \varphi$  of  $0,3 \pm 0,05$ . Resistors and inductors are not connected in parallel, except that, if an air core inductor is used, a resistor taking approximately 1 % of the current through the inductor is connected in parallel with it.*

*Iron core inductors may be used, provided the current is of substantially sine wave form.*

*For three phase tests, three core inductors are used.*

*The metal support of the switch, if any, on which the switch is mounted, and the accessible metal parts of the switch, if any, shall be earthed through a wire fuse which shall not blow during the test. The fuse element shall consist of a copper wire of 0,1 mm in diameter and not less than 50 mm in length.*

**Table 17 – Fractions of total number of operations**

| Pattern number | Type of switch          | Fraction for switch S |
|----------------|-------------------------|-----------------------|
| 1, 2, 4 or 5   | Rotary, both directions | –                     |
|                | Other types             | –                     |
| 3 or 03        | Rotary, both directions | –                     |
|                | Other types             | –                     |
| 6, 6/2 or 7    | Rotary, both directions | 1/4 and 3/4           |
|                | Other types             | 1/2                   |

*Switches of pattern number 5 with a single actuating member are operated 200 times with one circuit loaded with rated current ( $I_n$ ) and the other with 0,25  $I_n$  and 200 times with each circuit loaded with 0,625  $I_n$ .*

*Switches of pattern number 5 with two independent actuating members are tested as two switches of pattern number 1, the tests being made consecutively. If both circuits are identical, only one circuit need be tested.*

*While testing one part, the other part is in the "off" position.*

*Switches of pattern number 4 shall be tested for half the number of operations on one way and half the number of operations on the other way.*

*During the test, no sustained arcing nor welding of the contacts shall occur.*

*Sticking of the contacts which does not prevent further operation of the switch is not regarded as welding.*

*Sticking of contacts is permitted if the contacts can be separated with a force applied to the actuator of a value which does not damage the switch mechanically.*

*For the purpose of this test, blows which are intended to separate welded contacts are not permitted.*

*After the test, the specimens shall show no damage which may impair their use.*

*Breakage of the replaceable pull cord not involving the part entering the cord-operated switch shall not be considered a failure to pass the test.*

*Care is taken that the test apparatus makes the actuating member of the switch operate smoothly and does not interfere with the normal action of the switch mechanism and the free movement of the actuating member.*

*During the test, the specimens are not lubricated.*



### 18.3 Overload test with filament lamps

*Switches are normally tested at the rated voltage and at 1,2 times the rated current.*

*The test is carried out by using either a number of 200 W tungsten filament lamps or a number of halogen filament lamps.*

*As the characteristics of halogen filament lamps of different power are equivalent, lamps of any power can be used to reach the rated load.*

*If filament lamps with rated voltage equal to the rated voltage of the switch are not available, filament lamps with the nearest lower voltage shall be used.*

*It is recommended that the rated voltage of the filament lamps be no lower than 95 % of the rated voltage of the switch.*

*The test voltage shall be the rated voltage of the lamps. The number of lamps shall be the smallest number giving a test current not less than 1,2 times the rated current of the switch.*

*Available short-circuit current shall be at least 1 500 A. The other conditions shall be as specified in 18.2.*

*During the test, no sustained arcing nor welding of the contacts shall occur.*

*Sticking of the contacts which does not prevent further operation of the switch is not regarded as welding.*

*Sticking of contacts is permitted if the contacts can be separated with a force applied to the actuator of a value which does not damage the switch mechanically.*

*For the purpose of this test, blows which are intended to separate welded contacts are not permitted.*

*After the test, the specimens shall show no damage which may impair their further use.*

EXAMPLE 10 A 250 V switches have to be tested.

The largest available rated voltage of 200 W tungsten filament lamps is 240 V.

The test voltage is then 240 V and the number of lamps is

$$\frac{240 \times 1,2 \times 10}{200} = 14,4 \rightarrow 15$$

## 19 Normal operation

### 19.1 Test for switches intended for inductive loads

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

*For the purpose of this test, pilot lights are disconnected.*

*Compliance is checked by the following test.*

The switches are tested at rated voltage and rated current in the apparatus and with the connections specified in Clause 18.

The tolerance for the test voltage and test current is  $^{+5}_0$  %.

The circuit details and the manner of operation of the selector switch S are described in 18.2, unless otherwise specified.

The number of operations is shown in Table 18.

**Table 18 – Number of operations for normal operation test**

| Rated current                                                                                                          | Number of operations |
|------------------------------------------------------------------------------------------------------------------------|----------------------|
| Up to and including 16 A, for switches having a rated voltage not exceeding 250 V, except for pattern numbers 3 and 03 | 40 000               |
| Up to and including 16 A, for switches having a rated voltage exceeding 250 V and for pattern numbers 3 and 03         | 20 000               |
| Over 16 A up to and including 50 A                                                                                     | 10 000               |
| Over 50 A                                                                                                              | 5 000                |

The rate of operation is as specified in 18.2.

The on period shall be  $(25^{+5}_0)$  % of the total cycle and the off period  $(75^{0}_{-5})$  %.

For rotary switches of pattern number 5 intended to be operated in either direction, the actuating member is turned in one direction for half the total number of operations and in the reverse direction for the remainder.

For other rotary switches intended to be operated in either direction, three quarters of the total number of operations are effected in the clockwise direction and the remainder in the reverse direction.

Cord-operated switches shall be tested mounted as in normal use and with a pull of a value adequate to operate the cord-operated switch, but not exceeding 50 N, on the cord throughout the test at  $30^\circ \pm 5^\circ$  to the vertical and in a plane perpendicular to the mounting surface.

Switches are tested using an alternating current having a  $\cos \varphi$  of  $0,6 \pm 0,05$ .

Switches of pattern number 2 are tested with the poles connected in series as shown in Figure 11.

The two circuits of switches of pattern number 5 are tested as two switches of pattern number 1. If both circuits are identical, only one circuit need be tested.

For switches of pattern number 5 with a single actuating member, each circuit is loaded with 0,5 times the rated current.

Switches of pattern numbers 4 and 6 shall be tested for half the number of operations on one way and half the number of operations on the other way.

Switches of pattern number 6/2 are tested as one switch of pattern number 6 if the two pairs of poles are identical. Otherwise, they are tested as two switches of pattern number 6.

*For switches of pattern number 7 one side is tested as pattern number 6. The second set of specimens used for the test of Clause 18 is submitted to this test on the side already tested.*

*The test specimens shall be connected to the test circuit with cables of length  $(1 \pm 0,1)$  m.*

*During the test, the specimens shall function correctly.*

*After the test, the specimens shall withstand an electric strength test as specified in Clause 16 and a terminal temperature rise test as specified in Clause 17.*

*For the electric strength test, the test voltage of 4 000 V shall be reduced by 1 000 V and the other test voltages by 500 V. For the terminal temperature rise test, the test current shall be reduced to the value of the rated current and the only measurement made shall be at the terminals.*

*The specimens shall then not show*

- *wear impairing their further use;*
- *discrepancy between the position of the actuating member and that of the moving contacts, if the position of the actuating member is indicated;*
- *deterioration of enclosures, insulating linings or barriers to such an extent that the switch cannot be further operated or that it no longer complies with the requirements of Clause 10;*
- *seepage of sealing compound;*
- *loosening of electrical or mechanical connections;*
- *relative displacement of the moving contacts of switches of pattern numbers 2, 3, 03 or 6/2.*

NOTE The humidity treatment of 15.3 is not repeated before the electric strength test of 19.1.

*During the test, the specimens are not lubricated.*

*The test is followed by the test of 14.3.*

*Sticking of the contacts which does not prevent further operation of the switch is not regarded as welding.*

*Sticking of contacts is permitted if the contacts can be separated with a force applied to the actuator of a value which does not damage the switch mechanically.*

*During the test, no sustained arcing nor welding of the contacts shall occur.*

*For the purpose of this test, blows which are intended to separate welded contacts are not permitted.*

*Breakage of the replaceable pull cord not involving the part entering the cord-operated switch shall not be considered a failure to pass the test.*

## **19.2 Test for switches intended for externally ballasted lamp loads**

Switches intended for externally ballasted lamp loads shall withstand, without excessive wear or other harmful effect, the electrical and thermal stresses occurring when controlling externally ballasted lamp circuits.

Compliance is checked by the test circuit indicated in Figure 12a with the following test conditions.

The prospective short-circuit current of the supply shall be between 3 kA and 4 kA at  $\cos \varphi = 0,9 \pm 0,05$  (lagging).

$F$  is a copper-wire fuse of 0,1 mm nominal diameter having a length not less than 50 mm.

$R_1$  is a resistor limiting the current to about 100 A.

The twin-core cable shall have a suitable length to give a resistance  $R_3$  equal to  $0,25 \Omega$  in the test circuit to the load. It shall have a cross-sectional area of  $1,5 \text{ mm}^2$  when switches with rated current up to and including 13 A are being tested and  $2,5 \text{ mm}^2$  when switches with rated current over 13 A up to and including 20 A are being tested.

Load A shall consist of

- $C_1$ , a capacitor bank having a capacitance of  $70 \mu\text{F} \pm 10 \%$  for 6 A switches and  $140 \mu\text{F} \pm 10 \%$  for other switches. The capacitors shall be connected with  $2,5 \text{ mm}^2$  conductors having the shortest possible length;
- $L_1$  and  $R_2$ , an inductor and a resistor adjusted to give the power factor of  $0,9 \pm 0,05$  (lagging) and the test current  $I_n^{+5}_0 \%$  through the specimen.

NOTE The circuit parameters have been chosen to represent the externally ballasted lamp loads used in most practical applications.

For the test, new specimens are used.

The switches are tested at rated voltage and at the rated current assigned by the manufacturer for the externally ballasted lamp loads in the test apparatus and with the connections specified in 18.2.

The tolerance of the test voltage is  $\pm 5 \%$  and that for the test current is  $^{+5}_0 \%$ . The circuit details and the manner of operation of the selector switch  $S$  are as described in 18.2.

The number of operations is as follows:

For switches with a rated externally ballasted lamp current of 6 A up to and including 13 A: 10 000 operations with 30 operations per minute.

For switches with rated current above 13 A up to and including 20 A: 5 000 operations with 15 operations per minute.

For rotary switches of pattern number 5 intended to be operated in either direction, the actuating member is turned in one direction for half the total number of operations and in the reverse direction for the remainder.

For other rotary switches intended to be operated in either direction, three quarters of the total number of operations are effected in the clockwise direction, and the remainder in the reverse direction.

Cord-operated switches shall be tested mounted as in normal use and with a pull of a value adequate to operate the cord-operated switch, but not exceeding 50 N, on the cord throughout the test at  $30^\circ \pm 5^\circ$  to the vertical and in a plane perpendicular to the mounting surface.

Switches of pattern number 2 are tested with the poles connected in series.

*The two circuits of switches of pattern number 5 are tested as two switches of pattern number 1. If the circuits are identical, only one circuit need be tested.*

*Switches of pattern numbers 4 and 6 shall be tested for half the number of operations on one way and half of the number of operations on the other way.*

*Switches of pattern number 6/2 are tested as one switch of pattern number 6, if the two pairs of poles are identical. Otherwise, they are tested as two switches of pattern number 6.*

*For switches of pattern number 7, one side is tested as pattern number 6. The test is repeated on the other side of a new set of specimens if the other side is not identical.*

*The test specimens shall be connected to the test circuit with cables of length  $(1 \pm 0,1)$  m. The load shall be as specified in Figure 12a, load A.*

*The metal support of the switch, if any, on which the switch is mounted, and the accessible metal parts of the switch, if any, shall be earthed through a wire fuse which shall not blow during the test. The fuse element shall consist of a copper wire of 0,1 mm in diameter not less than 50 mm in length.*

*During this test, the switch shall be operated so that the test apparatus does not interfere with the normal action of the switch mechanism and the free movement of the actuating member.*

*There shall be no forced actuation. The "on" period shall be  $25 \left( \begin{smallmatrix} +5 \\ 0 \end{smallmatrix} \right)$  % of the total cycle and the "off" period  $75 \left( \begin{smallmatrix} 0 \\ -5 \end{smallmatrix} \right)$  %.*

*During the test, no sustained arcing nor welding of the contacts shall occur.*

*Sticking of the contacts which does not prevent further operation of the switch is not regarded as welding.*

*Sticking of contacts is permitted if the contacts can be separated with a force applied to the actuator of a value which does not damage the switch mechanically.*

*For the purpose of this test, blows which are intended to separate welded contacts are not permitted.*

*During the test, the specimens shall function correctly.*

*After the test, the specimens shall withstand an electric strength test as specified in Clause 16 and a terminal temperature rise test as specified in Clause 17.*

*For the electric strength test, the test voltage of 4 000 V shall be reduced by 1 000 V and the other test voltages by 500 V. For the terminal temperature rise test, the test current shall be reduced to the value of the rated current and the only measurement made shall be at the terminals.*

*After these tests, it shall also be possible to make and break the switch by hand in the test circuit and the specimen shall not show*

- wear impairing further use;*
- discrepancy between the position of the actuating member and that of the moving contacts, if the position of the actuating member is indicated;*

- deterioration of the enclosures, insulating lining or barriers to such an extent that the switch cannot be further operated or that it no longer complies with the requirements of Clause 10;
- loosening of electrical or mechanical connections;
- seepage of sealing compound;
- relative displacement of the moving contacts of switches of pattern numbers 2, 3 or 6/2.

*Breakage of the replaceable pull cord not involving the part entering the cord-operated switch shall not be considered a failure to pass the test.*

### 19.3 Test for switches intended for self ballasted lamp loads

Switches intended for self ballasted lamp (SBL) loads shall withstand, without excessive wear or other harmful effect, the electrical and thermal stresses occurring when controlling self ballasted lamp circuits.

*Compliance is checked by connecting the load as given in Figure 12b via the switch under test to a power supply.*

*The calculations are based on the following parameters in order to have the required values for inrush current and  $I^2t$ :*

- a prospective short-circuit current (rms) of the supply of 3 kA at  $\cos \varphi = 0,9$  (lagging);
- a resistance  $R_3$  equal to  $0,25 \Omega$  in the test circuit to the load. This value is obtained with a wire having a cross-sectional area of  $1,5 \text{ mm}^2$  when switches with rated current up to and including 13 A are being tested and  $2,5 \text{ mm}^2$  when switches with rated current over 13 A up to and including 20 A are being tested.

*The load shall be in accordance with Figure 12b. The values for the maximum peak value and the maximum  $I^2t$  of the inrush current are given in Table 19.*

NOTE 1  $R_2$  is the total series resistance in the lamp circuit including the ESR (equivalent series resistance) value of the capacitor.

*The values of  $R_2$  and C in load B shall be chosen in order to reach the values ( $\pm 5 \%$ ) for  $I_{peak}$  and  $I^2t$  as given in Table 19 when the switching contact closes at  $90^\circ \pm 5^\circ$  phase-angle.*

*The value of  $R_4$  shall be chosen to reach the current in amperes to reach the corresponding SBL power as given in Table 19.*

**Table 19 – Values for  $I_{peak}$  and  $I^2t$  depending on the type of distribution system**

|                                 | Distribution system [V]:<br>220/380<br>230/400<br>240/415 | Distribution system [V]:<br>220/380<br>230/400<br>240/415 | Distribution system [V]:<br>120/208<br>120/240<br>127/220 | Distribution system [V]:<br>120/208<br>120/240<br>127/220 | Distribution system [V]:<br>220/380<br>230/400<br>240/415 | Distribution system [V]:<br>120/208<br>120/240<br>127/220 |
|---------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|
| Rated current<br>(A)            | $I_{peak}$<br>[A]                                         | $I^2t$<br>[A <sup>2</sup> s]                              | $I_{peak}$<br>[A]                                         | $I^2t$<br>[A <sup>2</sup> s]                              | Rated power of<br>the SBL circuit<br>[W]                  | Rated power of<br>the SBL circuit<br>[W]                  |
| Up to and including 10          | 108                                                       | 2,8                                                       | 162                                                       | 5,9                                                       | 100                                                       | 60                                                        |
| Above 10 up to and including 13 | 142                                                       | 5,5                                                       | 162                                                       | 5,9                                                       | 150                                                       | 60                                                        |
| Above 13 up to and including 16 | 170                                                       | 9                                                         | 200                                                       | 11,5                                                      | 200                                                       | 100                                                       |
| Above 16 up to and including 20 | 192                                                       | 13                                                        | 231                                                       | 18,5                                                      | 250                                                       | 150                                                       |

Switches with a rated voltage of 250 V shall be considered as switches for a distribution system 230/400 V.

Switches with a rated voltage of 130 V shall be considered as switches for a distribution system 120/208 V.

**Table 20 – Calculated circuit parameters**

| Rated current (A)               | 230 V     |        | 120 V     |        |
|---------------------------------|-----------|--------|-----------|--------|
|                                 | $R_2$ [Ω] | C [μF] | $R_2$ [Ω] | C [μF] |
| Up to and including 10          | 1,9       | 125    | 0,28      | 280    |
| Above 10 up to and including 13 | 1,25      | 180    | 0,28      | 280    |
| Above 13 up to and including 16 | 0,95      | 240    | 0,17      | 445    |
| Above 16 up to and including 20 | 0,8       | 310    | 0,11      | 640    |

For other rated voltages and currents the values need to be recalculated

The values in Table 20 are given for information only. The circuit shall be adjusted to reach the  $I_{peak}$  and  $I^2t$  values of Table 19.

*Compliance is checked by the following test:*

*For the test, new specimens are used.*

*The switches are tested at rated voltage in the apparatus and with the connections specified in 18.2.*

*The tolerance of the test voltage is  $\pm 5$  %.*

*The circuit details and the manner of operation of the selector switch S are as described in 18.2.*

*The number of operations is shown in Table 18.*



*The rate of operation is as specified in 18.2.*

*The on period shall be  $(25^{+5}_0)$  % of the total cycle and the off period  $(75^{0}_{-5})$  %.*

*For rotary switches of pattern number 5 intended to be operated in either direction, the actuating member is turned in one direction for half the total number of operations and in the reverse direction for the remainder.*

*For other rotary switches intended to be operated in either direction, three quarters of the total number of operations are effected in the clockwise direction, and the remainder in the reverse direction.*

*Cord-operated switches shall be tested mounted as in normal use and with a pull of a value adequate to operate the cord-operated switch, but not exceeding 50 N, on the cord throughout the test at  $30^{\circ} \pm 5^{\circ}$  to the vertical and in a plane perpendicular to the mounting surface.*

*Switches of pattern number 2 are tested with the poles connected in series.*

*The two circuits of switches of pattern number 5 are tested as two switches of pattern number 1. If the circuits are identical, only one circuit need be tested.*

*Switches of pattern numbers 4 and 6 shall be tested for half the number of operations on one way and half the number of operations on the other way.*

*Switches of pattern number 6/2 are tested as one switch of pattern number 6, if the two pairs of poles are identical. Otherwise, they are tested as two switches of pattern number 6.*

*For switches of pattern number 7, one side is tested as pattern number 6. The test is repeated on the other side of a new set of specimens if the other side is not identical.*

*The test specimens shall be connected to the test circuit with cables of length  $(1 \pm 0,1)$  m.*

*The metal support of the switch, if any, on which the switch is mounted, and the accessible metal parts of the switch, if any, shall be earthed through a wire fuse (F) which shall not blow during the test. The fuse element shall consist of a copper wire of 0,1 mm diameter and not less than 50 mm in length.  $R_1$  is a resistor limiting the current to about 100 A.*

*During this test, the switch shall be operated so that the test apparatus does not interfere with the normal action of the switch mechanism and the free movement of the actuating member.*

*There shall be no forced actuation.*

*No sustained arcing or welding of the contacts shall occur.*

*Sticking of the contacts which does not prevent the next operation of the switch is not regarded as welding.*

*Sticking of contacts is permitted if the contacts can be separated with a force applied to the actuator of a value which does not damage the switch mechanically.*

*For the purpose of this test, it is not permitted to apply blows to open welded contacts.*

*After the test, the specimens shall withstand an electric strength test as specified in Clause 16 and a terminal temperature rise test as specified in Clause 17.*



*For the electric strength test, the test voltage of 4 000 V shall be reduced by 1 000 V and the other test voltages by 500 V. For the terminal temperature rise test, the test current shall be reduced to the value of the rated current and the only measurement made shall be at the terminals.*

*After these tests, it shall also be possible to make and break the switch by hand in the test circuit and the specimen shall not show:*

- *wear impairing further use;*
- *discrepancy between the position of the actuating member and that of the moving contacts, if the position of the actuating member is indicated;*
- *deterioration of the enclosures, insulating lining or barriers to such an extent that the switch cannot be further operated or that it no longer complies with the requirements of Clause 10;*
- *loosening of electrical or mechanical connections;*
- *seepage of sealing compound;*
- *relative displacement of the moving contacts of switches of pattern numbers 2, 3 or 6/2.*

*Breakage of the replaceable pull cord not involving the part entering the cord-operated switch shall not be considered a failure to pass the test.*

## **20 Mechanical strength**

### **20.1 General**

The test of the relevant subclauses 20.5 to 20.9 shall be applied according to the type of construction as specified in 13.3.

Accessories, surface mounting boxes, screwed glands and shrouds shall have adequate mechanical strength so as to withstand the stresses imposed during installation and use.

*Compliance is checked by the following tests:*

- *all types of switches ..... 20.2*
- *for switches with a base intended to be mounted directly on a surface. .... 20.3*
- *for boxes ..... 20.2*
- *for screwed glands of switches that have an IP code higher than IP20 ..... 20.4*
- *for operating members of cord-operated switches..... 20.10*

*Combinations of switches or of switches and socket-outlets are tested in the following way:*

- *in the case of one common cover, as a single product;*
- *in the case of separate covers, as separate products.*

### **20.2 Pendulum hammer test**

*The specimens are checked by applying blows by means of the pendulum hammer test apparatus as described in IEC 60068-2-75 (test Eha), with an equivalent mass of 250 g.*

*The specimens are mounted on a sheet of plywood, 8 mm nominal thickness and approximately 175 mm square, secured at its top and bottom edges to a rigid bracket which is part of the mounting support.*

*The mounting support shall have a mass of  $(10 \pm 1)$  kg and shall be mounted on a rigid frame by means of pivots. The frame is fixed to a solid wall.*

*The design of the mounting is such that*

- *the specimen can be so placed that the point of impact lies in the vertical plane through the axis of the pivot;*
- *the specimen can be removed horizontally and turned about an axis perpendicular to the surface of the plywood;*
- *the plywood can be turned 60°, in both directions, about a vertical axis.*

*The switches and boxes are mounted on the plywood as in normal use.*

*Inlet openings which are not provided with knock-outs, are left open; if they are provided with knock-outs, one of them is opened.*

*For flush-type switches the specimen is mounted in a recess provided in a block of hornbeam or similar material, which is fixed to a sheet of plywood, and not in its relevant mounting box. If wood is used for the block, the direction of the wood fibres shall be perpendicular to the direction of the impact.*

*Flush-type screw fixing switches shall be fixed by means of the screws to lugs recessed in the hornbeam block. Flush-type claw fixing switches shall be fixed to the block by means of the claws.*

*Before applying the blows, fixing screws of main parts and covers are tightened with a torque equal to two-thirds of the relevant value specified in column 3 or 5 as applicable, of Table 5.*

*The specimens are mounted so that the point of impact lies in a vertical plane through the axis of the pivot.*

*The striking element is allowed to fall from a height which is specified in Table 21.*

**Table 21 – Height of fall for impact test**

| Height of fall<br>mm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Parts of enclosures to be subjected to the impact <sup>a</sup> |                                             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|---------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Switches having an IP code IPX0                                | Switches having an IP code higher than IPX0 |
| 80                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | A and B                                                        | –                                           |
| 120                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | C                                                              | A and B                                     |
| 160                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | D                                                              | C                                           |
| 200                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | –                                                              | D                                           |
| <sup>a</sup> Parts of enclosures are defined as follows:<br>A parts on the front surface, including the parts which are recessed;<br>B parts which do not project more than 15 mm from the mounting surface (distance from the wall) after mounting as in normal use, with the exception of the above parts A;<br>C parts which project more than 15 mm and not more than 25 mm from the mounting surface (distance from the wall) after mounting as in normal use, with the exception of the above parts A;<br>D parts which project more than 25 mm from the mounting surface (distance from the wall) after mounting as in normal use, with the exception of the above parts A. |                                                                |                                             |

*The impact energy determined by the part of the specimen which projects most from the mounting surface is applied on all parts of the specimen, with the exception of its parts A.*

*Parts of accessories exclusively intended for mounting in panel-boards are submitted to impacts which are obtained by allowing the striking element to fall from the height of 100 mm; impacts shall only be applied on parts which are accessible after mounting the accessory in the panel board.*

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

*The specimens are subjected to nine blows, which are evenly distributed over the specimens. The blows are not applied to knock-out areas. The following blows are applied:*

- *for parts A, five blows:*
  - *one blow in the centre, after the specimen has been moved horizontally;*
  - *one each on the unfavourable points between the centre and the edges; and then*
  - *one each on similar points after the specimen has been turned 90° about its axis perpendicular to the plywood;*
- *for parts B (as far as applicable), C and D, four blows:*
  - *two blows on each of the two sides of the specimen on which blows can be applied after the plywood sheet has been turned 60° in each of the opposite directions;*
  - *two blows on each of the other two sides of the specimen on which blows can be applied after the specimen has been turned 90° about its axis perpendicular to the plywood sheet and the plywood sheet has been turned 60° in each of the opposite directions.*

*If inlet openings are provided, the specimen is so mounted that the two lines of blows are as nearly as possible equidistant from these openings.*

*Cover plates and other covers of multiple switches are treated as cover plates or covers of single switches.*

*For switches that have an IP code higher than IPX0 the test is carried out with any lids closed and the appropriate number of blows is then applied to those parts which are exposed when the lids are open.*

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

*After the test on a lens (window for pilot lights), the lens may be cracked and/or dislodged, but it shall not be possible to touch live parts with*

- *the test probe B of IEC 61032 under the conditions stated in 10.1;*
- *the test probe 11 of IEC 61032 under the conditions stated in 10.1, but with a force of 10 N.*

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

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

*Damage to the finish, small dents which do not reduce creepage distances or clearances below the value specified in 23.1 and small chips which do not adversely affect the protection against electric shock are neglected.*

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

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

### 20.3 Test on the main parts of surface-type switches

The main parts of surface-type switches are first fixed to a cylinder of rigid steel sheet, which has a radius equal to 4,5 times the distance between fixing holes but in any case no less than 200 mm. The axes of the holes are in a plane perpendicular to the axis of the cylinder and parallel to the radius through the centre of the distance between the holes.

The fixing screws of the main part are gradually tightened, the maximum torque applied being 0,5 Nm for screws with a thread diameter up to and including 3 mm and 1,2 Nm for screws with a larger thread diameter.

The main parts are then fixed in a similar manner to a flat steel sheet.

During and after the tests the main parts of the switch shall show no damage likely to impair their future use.

### 20.4 Screwed glands

Screwed glands are fitted with a cylindrical metal rod having a diameter, in millimetres, equal to the nearest whole number below the internal diameter, in millimetres, of the packing.

The glands are then tightened by means of a suitable spanner, the torque shown in Table 22 being applied to the spanner for 1 min.

**Table 22 – Torque for the verification of the mechanical strength of glands**

| Diameter of test rod<br>mm          | Torque<br>Nm |                            |
|-------------------------------------|--------------|----------------------------|
|                                     | Metal glands | Glands of moulded material |
| Up to and including 14              | 6,25         | 3,75                       |
| Above 14 and up to and including 20 | 7,5          | 5,0                        |
| Above 20                            | 10,0         | 7,5                        |

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

### 20.5 Covers, cover plates or actuating members – accessibility to live parts

#### 20.5.1 General

When testing the force necessary for covers, cover plates or actuating members to come off or not come off, the switches are mounted as for normal use. Flush-type switches are fixed in appropriate mounting boxes, which are installed as for normal use so that the rims of the boxes are flush with the walls, and the covers, cover plates or actuating members are fitted. If they are provided with locking means which can be operated without the aid of a tool, these means are unlocked.

Compliance is then checked by the tests of 20.5.2 and 20.5.3.

### 20.5.2 Verification of the non-removal of covers, cover plates or actuating members

*Forces are gradually applied in directions perpendicular to the mounting surfaces, in such a way that the resulting force acting on the centre of the covers, cover plates, actuating members or parts of them is*

- 40 N, for covers, cover plates, actuating members or parts of them complying with the tests of 20.8 and 20.9; or
- 80 N, for other covers, cover plates, actuating members or parts of them.

*The force is applied for 1 min. The covers, cover plates, or actuating members shall not come off.*

*The test is then repeated on new specimens, the cover or cover plate being fitted on the wall after a sheet of hard material, 1 mm  $\pm$  0,1 mm thick, has been fitted around the supporting frame, as shown in Figure 13.*

NOTE The sheet of hard material is used to simulate wallpaper and can consist of a number of pieces.

*After the test the specimens shall show no damage within the meaning of this document.*

### 20.5.3 Verification of the removal of covers, cover plates or actuating members

*A force not exceeding 120 N is gradually applied, in directions perpendicular to the mounting/supporting surfaces, to covers, cover plates, actuating members or parts of them by means of a hook placed in turn in each of the grooves, holes, spaces or the like provided for removing them.*

*The covers, cover plates or actuating members shall come off.*

*The test is made 10 times on each separable part the fixing of which is not dependent on screws (the application points being equally distributed as far as practicable). The removal force is applied each time to the different grooves, holes or the like provided for removing the separable part.*

*The test is then repeated on new specimens, the cover, cover plate, or actuating member being fitted on the wall after a sheet of hard material, (1  $\pm$  0,1) mm thick has been fitted around the supporting frame, as shown in Figure 13.*

*After the test, the specimens shall show no damage within the meaning of this document.*

### 20.6 Covers, cover plates or actuating members – accessibility to non-earthed metal parts separated from live parts

*The test is made as described in 20.5, but applying, for 20.5.2, the following forces:*

- 10 N, for covers or cover plates or actuating members complying with the tests of 20.8 and 20.9;
- 20 N, for other covers or cover plates or actuating members.

### 20.7 Covers, cover plates or actuating members – accessibility to insulating parts, earthed metal parts, the live parts of SELV $\leq$ 25 V AC and 60 V DC or metal parts separated from live parts

*The test is made as described in 20.5, but applying, for 20.5.2, the force of 10 N for all covers, cover plates, or actuating members.*

## 20.8 Covers, cover plates or actuating members – application of gauges

*The gauge shown in Figure 14 is pushed toward each side of each cover, cover plate or actuating member which is fixed without screws on a mounting or supporting surface, as shown in Figure 15. With face B resting on the mounting/supporting surface, and face A perpendicular to it, the gauge is applied at right angles to each side under test.*

*In the case of a cover or cover plate fixed without screws to another cover or cover plate or to a mounting box, having the same outline dimensions, face B of the gauge shall be placed at the same level as the junction; the outline at the cover or cover plate shall not exceed the outline of the supporting surface.*

*The distances between face C of the gauge and the outline of the side under test, measured parallel to face B, shall not decrease (with the exception of grooves, holes, reverse tapers or the like, placed less than 7 mm from a plane including face B and complying with the test of 20.9) when measurements are repeated starting from point x in the direction of the arrow y (see Figure 16).*

## 20.9 Grooves, holes and reverse tapers

*A gauge according to Figure 17, applied with a force of 1 N, shall not enter more than 1,0 mm from the upper part of any groove, hole or reverse taper or the like when the gauge is applied parallel to the mounting/supporting surface and at right angles to the part under test, as shown in Figure 18.*

NOTE The verification whether the gauge according to Figure 17 has entered more than 1,0 mm is made with reference to a surface perpendicular to face B and including the upper part of the outline of the grooves, holes, reverse tapers or the like.

## 20.10 Additional test for cord-operated switch

The operating member of a cord-operated switch shall have adequate strength.

*Compliance is checked on a new specimen by the following test:*

*The switch is mounted on a support as in normal use.*

*A pull of 100 N is applied for 1 min on the operating member as in normal use, after which a pull of 50 N is applied for 1 min in the most unfavourable direction within a conical surface with the centre being the operating cord and the angle not exceeding 80° to the vertical.*

*After the test the switch shall show no damage within the meaning of this document. The operating member shall not have broken and the cord-operated switch shall still operate.*

## 21 Resistance to heat

### 21.1 General

Switches and boxes shall be sufficiently resistant to heat.

Parts intended for decorative purposes only, such as certain lids, shall be removed if possible and these parts are not subjected to the test.

*Compliance is checked*

- a) *for surface mounting boxes, separable covers, separable cover plates and separable frames by the test of 21.4;*



- b) for switches, with the exception of the parts, if any, covered by a), by the tests of 21.2, 21.3 and, with the exception of the switches made from natural or synthetic rubber or a mixture of both, by the test of 21.4.

## 21.2 Basic heating test

The specimens are kept for 1 h in a heating cabinet at a temperature of  $(+100 \pm 2) ^\circ\text{C}$ .

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

After the test and after the specimens have been allowed to cool down to approximately room temperature, there shall be no access to live parts which are normally not accessible when the specimens are mounted as in normal use, even if the test probe B of IEC 61032 is applied with a force not exceeding 5 N.

After the test, markings shall still be legible.

Discoloration, blisters or slight displacement of the sealing compound is disregarded provided that safety is not impaired within the meaning of this document.

## 21.3 Ball-pressure test on parts of insulating material necessary to retain current-carrying parts and parts of the earthing circuit in position

Parts of insulating material necessary to retain current-carrying parts and parts of the earthing circuit in position are subjected to a ball-pressure test by means of the apparatus shown in Figure 19, except for the insulating parts necessary to retain the earthing terminals in a box, which shall be tested as specified in 21.4.

When it is not possible to carry out the test on the specimens, the test shall be carried out on a piece at least 2 mm thick which is cut out of a new set of aged specimens. If this is not possible, up to and including four layers, each cut out of the same specimen, should be used, in which case the total thickness of the layers shall be not less than 2,5 mm.

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

The test load and the supporting means shall be placed within the heating cabinet for a sufficient time to ensure that they have attained the stabilized testing temperature before the test commences.

The test is made in a heating cabinet at a temperature of  $(+125 \pm 2) ^\circ\text{C}$ .

After 1 h, the ball is removed from the specimen, which is then cooled down within 10 s to approximately room temperature by immersion in cold water.

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

## 21.4 Ball-pressure test on parts of insulating material not necessary to retain current-carrying parts and parts of the earthing circuit in position

Parts of insulating material not necessary to retain current-carrying parts and parts of the earthing circuit in position, even though they are in contact with them, are subjected to a ball pressure test in accordance with 21.3, but the test is made at a temperature of  $(+70 \pm 2) ^\circ\text{C}$  or  $(+40 \pm 2) ^\circ\text{C}$  plus the highest temperature rise determined for the relevant part during the test of Clause 17, whichever is the higher.

## 22 Screws, current-carrying parts and connections

### 22.1 General

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

Mechanical connections to be used during installation of accessories may be made using thread-forming screws or thread-cutting screws only when the screws are supplied together with the piece in which they are intended to be inserted. In addition, thread-cutting screws intended to be used during installation shall be captive with the relevant part of the accessory.

Screws or nuts which transmit contact pressure shall be of metal and shall be in engagement with a metal thread.

*Compliance is checked by inspection and, for screws and nuts which are operated when connecting the external conductors and mounting the switch during the installation, by the following test.*

NOTE 1 The requirements for the verification of terminals are given in Clause 12.

*The screws or nuts are tightened and loosened*

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

*The screws or nuts in engagement with a thread of insulating material are completely removed and reinserted each time.*

*The test is made by means of a suitable test screwdriver or a suitable tool, applying the relevant torque as specified in 12.2.5.*

*The conductor is moved each time the screw or nut is loosened.*

*During the test, no damage impairing the further use of the screwed connections shall occur, such as breakage of screws or damage to the head slots (rendering the use of an appropriate screwdriver impossible), threads, washers or stirrups.*

NOTE 2 Screws or nuts which are operated when assembling the switch include screws for fixing covers or cover plates, etc., but not connecting means for screwed conduits and screws for fixing the main part of a switch.

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

*The screws and nuts shall be tightened in one smooth and continuous motion.*

NOTE 3 Screwed connections are considered as partially checked by the tests of Clauses 19 and 20.

### 22.2 Correct insertion of screws

For screws in engagement with a thread of insulating material which are operated when mounting the switch during installation, their correct introduction into the screw hole or nut shall be ensured.

*Compliance is checked by inspection.*

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 parts to be fixed, by a recess in the female thread or by the use of a screw with the leading thread removed.



### 22.3 Contact pressure of electrical connections

Electrical connections shall be so designed that 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 possible shrinkage or yielding of the insulating material.

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

NOTE The suitability of the material is considered in respect of the stability of the dimensions.

### 22.4 Screws and rivets used both as electrical and mechanical connections

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

*Compliance is checked by inspection.*

NOTE 1 Spring washers can provide satisfactory locking.

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

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

### 22.5 Material of current-carrying parts

Current-carrying parts, including those of terminals (also earthing terminals), shall be of a metal having, under the conditions occurring in the accessory, mechanical strength, electrical conductivity and resistance to corrosion adequate for their intended use.

The requirement of 22.5 does not apply to screws, nuts, washers, clamping plates and similar parts of terminals.

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

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

- copper;
- an alloy containing at least 58 % copper for parts made from cold-rolled sheet or at least 50 % copper for other parts;
- stainless steel containing at least 13 % chromium and not more than 0,09 % carbon;
- steel provided with an electroplated coating of zinc according to ISO 2081, the coating having a thickness of at least
  - 5 µm, service condition ISO No. 1, for switches that have an IP code IPX0;
  - 12 µm, service condition ISO No. 2, for switches that have an IP code IPX4;
  - 25 µm, service condition ISO No. 3, for switches that have an IP code IPX5 or IPX6.
- steel provided with an electroplated coating of nickel and chromium according to ISO 1456, the coating having a thickness of at least
  - 20 µm, service condition ISO No. 2, for switches that have an IP code IPX0;
  - 30 µm, service condition ISO No. 3, for switches that have an IP code IPX4;
  - 40 µm, service condition ISO No. 4, for switches that have an IP code IPX5 or IPX6.
- steel provided with an electroplated coating of tin according to ISO 2093, the coating having a thickness of at least
  - 12 µm, service condition ISO No. 2, for switches that have an IP code IPX0;

- 20 µm, service condition ISO No. 3, for switches that have an IP code IPX4;
- 30 µm, service condition ISO No. 4, for switches that have an IP code IPX5 or IPX6.

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

*Compliance is checked by a test which is under consideration.*

## **22.6 Contacts subjected to sliding actions**

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

*Compliance with the requirements of 22.5 and 22.6 is checked by inspection and, in case of doubt, by chemical analysis.*

## **22.7 Thread-forming and thread-cutting screws**

Thread-forming screws and thread-cutting screws shall not be used for the connection of current-carrying parts. Thread-forming screws and thread-cutting screws may be used to provide earthing continuity, provided that it is not necessary to disturb the connection in normal use and at least two screws are used for each connection.

*Compliance is checked by inspection.*

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

### **23.1 General**

Creepage distances, clearances and distances through sealing compound shall be not less than the values shown in Table 23.

Subclause 23.1 does not apply to pilot light units. Requirements for pilot light units are given in 13.16.

**Table 23 – Creepage distances, clearances and distances through insulating sealing compound**

| Description                                          |                                                                                                                                       | mm                |                   |                    |
|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------|--------------------|
|                                                      |                                                                                                                                       | normal gap        | mini-gap          | micro-gap          |
| <b>Creepage distances</b>                            |                                                                                                                                       |                   |                   |                    |
| 1                                                    | Between internal live parts which are separated when the contacts are open.                                                           | 3                 | 3 <sup>a</sup>    | 3 <sup>a</sup>     |
| 2                                                    | Between live parts of different polarity including all terminals for external wiring.                                                 | 4 <sup>c, e</sup> | 4 <sup>c, e</sup> | 4 <sup>c, e</sup>  |
| 3                                                    | Between live parts and                                                                                                                |                   |                   |                    |
|                                                      | – accessible surfaces of parts of insulating material;                                                                                | 3                 | 3                 | 3                  |
|                                                      | – earthed metal parts, including the earthing circuit;                                                                                | 3                 | 3                 | 3                  |
|                                                      | – metal frames supporting the base of flush-type switches;                                                                            | 3                 | 3                 | 3                  |
|                                                      | – screws or devices for fixing main parts, covers or cover-plates;                                                                    | 3                 | 3                 | 3                  |
|                                                      | – metal parts of the mechanism, if required to be insulated from live parts (see 10.4).                                               | 3                 | 3                 | 3                  |
| 4                                                    | Between metal parts of the mechanism, if required to be insulated from accessible metal parts (see 10.5), and                         |                   |                   |                    |
|                                                      | – screws or devices for fixing main parts, covers or cover-plates;                                                                    | 3                 | 3                 | 3                  |
|                                                      | – metal frames supporting the base of flush-type switches;                                                                            | 3                 | 3                 | 3                  |
|                                                      | – accessible metal parts.                                                                                                             | 3                 | 3                 | 3                  |
| 5                                                    | Between live parts and accessible unearthed metal parts, with the exception of screws and the like.                                   | 6 <sup>d</sup>    | 6 <sup>d</sup>    | 6 <sup>d</sup>     |
| <b>Clearances</b>                                    |                                                                                                                                       |                   |                   |                    |
| 6                                                    | Between internal live parts which are separated when the contacts are open.                                                           | 3                 | 1,2 <sup>b</sup>  | < 1,2 <sup>b</sup> |
| 7                                                    | Between live parts of different polarity including all terminals for external wiring.                                                 | 3 <sup>e</sup>    | 3 <sup>e</sup>    | 3 <sup>e</sup>     |
| 8                                                    | Between live parts and                                                                                                                |                   |                   |                    |
|                                                      | – accessible surfaces of insulating material;                                                                                         | 3                 | 3                 | 3                  |
|                                                      | – earthed metal parts, including the earthing circuit, not mentioned under items 9 and 11;                                            | 3                 | 3                 | 3                  |
|                                                      | – metal frames supporting the base of flush-type switches;                                                                            | 3                 | 3                 | 3                  |
|                                                      | – screws or devices for fixing main parts, covers, or cover-plates;                                                                   | 3                 | 3                 | 3                  |
|                                                      | – metal parts of the mechanism, if required to be insulated from live parts (see 10.4).                                               | 3                 | 3                 | 3                  |
| 9                                                    | Between live parts and                                                                                                                |                   |                   |                    |
|                                                      | – exclusively earthed metal boxes (see NOTE) with the switch mounted in the most unfavourable position;                               | 3                 | 3                 | 3                  |
|                                                      | – unearthed metal boxes, without insulating lining, with the switch mounted in the most unfavourable position.                        | 4,5               | 4,5               | 4,5                |
| 10                                                   | Between metal parts of the mechanism, if required to be insulated from accessible metal parts (see 10.5), and                         |                   |                   |                    |
|                                                      | – screws or devices for fixing main parts, covers or cover-plates;                                                                    | 3                 | 3                 | 3                  |
|                                                      | – metal frames supporting the base of flush-type switches;                                                                            | 3                 | 3                 | 3                  |
|                                                      | – accessible metal parts when the base is fixed directly on the wall.                                                                 | 3                 | 3                 | 3                  |
| 11                                                   | Between live parts and the surface on which the base of a surface-type switch is mounted when the base is fixed directly on the wall. | 6                 | 6                 | 6                  |
| 12                                                   | Between live parts and the bottom of the space, if any, for external conductors, for surface-type switches.                           | 3                 | 3                 | 3                  |
| 13                                                   | Between live parts and accessible unearthed metal parts with the exception of screws and the like.                                    | 6 <sup>d</sup>    | 6 <sup>d</sup>    | 6 <sup>d</sup>     |
| <b>Distances through insulating sealing compound</b> |                                                                                                                                       |                   |                   |                    |

| Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                            | mm             |                |                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------|----------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                            | normal gap     | mini-gap       | micro-gap      |
| 14                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Between live parts covered with at least 2 mm of sealing compound and the surface on which the base of a surface-type switch is mounted.                   | 4 <sup>c</sup> | 4 <sup>c</sup> | 4 <sup>c</sup> |
| 15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Between live parts covered with at least 2 mm of sealing compound and the bottom of the space, if any, for external conductors, for surface-type switches. | 2,5            | 2,5            | 2,5            |
| NOTE Exclusively earthed metal boxes are those suitable only for use in installations where earthing of metal boxes is required.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                            |                |                |                |
| <p><sup>a</sup> For switches with rated voltage up to and including 250 V the creepage distances may be reduced to 1,2 mm if the insulating material has at least a comparative tracking index (CTI) value of 600 according to IEC 60112 or to 1,8 mm if the insulating material has at least a CTI value of 400 according to IEC 60112.</p> <p><sup>b</sup> The clearances between internal live parts shall be greater than the switch contact gap.</p> <p><sup>c</sup> The 4 mm value is reduced to 3 mm for switches having a rated voltage up to and including 250 V.</p> <p><sup>d</sup> The 6 mm value is reduced to 4,5 mm for accessories having a rated voltage up to and including 250 V.</p> <p><sup>e</sup> Clearances and creepage distances between live parts of different polarity are reduced to 1 mm between the lead wires in the pinch of a neon lamp or an LED with external resistor.</p> |                                                                                                                                                            |                |                |                |

*Compliance is checked by measurement.*

*The measurements are made on the switch fitted with conductors of the largest cross-sectional area specified in Clause 12, and also without conductors.*

*Distances through slots or openings in external parts of insulating material are measured to metal foil in contact with the accessible surface; the foil is pushed into corners and the like by means of the test probe B of IEC 61032, but is not pressed into openings.*

*The conductor shall be inserted into the terminal and so connected that the core insulation touches the metal part of the clamping unit or, if the core insulation is prevented by construction from touching the metal part, the outside of the obstruction.*

*For surface-type switches that have an IP code IP 20, the most unfavourable conduit or cable is introduced for a distance of 1 mm into the switch, in accordance with 13.12.*

*If the metal frame supporting the main part of flush-type switches is movable, this frame is placed in the most unfavourable position.*

Any metal part in contact with a metal part of the mechanism is considered to be a metal part of the mechanism.

In double-break switches, the creepage distance mentioned under item 1 in Table 23 or the clearance mentioned under item 6 in Table 23 is the sum of the creepage distance or clearance between one fixed contact and the moving part, and that between the moving part and the other fixed contact.

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 is ignored in computing the total clearance.

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

## 23.2 Insulating compound

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

*Compliance is checked by inspection.*

## 24 Resistance of insulating material to abnormal heat, to fire and to tracking

### 24.1 Resistance to abnormal heat and to fire

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

*Compliance is checked by performing the glow-wire test according to IEC 60695-2-10 and IEC 60695-2-11 under the following conditions:*

- a) *for parts made of insulating material necessary to retain current-carrying parts and parts of the earthing circuit in position, by the test made at a temperature of 850 °C, with the exception of parts of insulating material needed to retain the earth terminal in position in a box, which shall be tested at a temperature of 650 °C;*
- b) *for parts of insulating material not necessary to retain current-carrying parts and parts of the earthing circuit in position, even though they are in contact with them, by the test made at a temperature of 650 °C.*

A current-carrying part or a part of the earthing circuit retained by mechanical means is considered to be retained in position. The use of grease or the like is not considered to be mechanical means.

External conductors cannot be considered as retaining the current-carrying parts.

In case of doubt, to determine whether an insulating material is necessary to retain current-carrying parts and parts of the earthing circuit in position, the device 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.

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

*Small parts, where each surface lies completely within a circle of 15 mm in diameter, or where any part of the surface lies outside a 15 mm diameter circle and it is not possible to fit a circle of 8 mm in diameter on any of the surfaces, are not subjected to the test of 24.1 (see Figure 20 for diagrammatic representation).*

NOTE 1 When checking a surface, projections on the surfaces and holes which are not greater than 2 mm on the largest dimension are disregarded.

*The tests are not made on parts of ceramic material.*

NOTE 2 The glow-wire test is applied to ensure that an electrically heated test wire under defined test conditions does not cause ignition of insulating parts or to ensure that a part of insulating material which might be ignited by the heated test wire under defined conditions has a limited time to burn without spreading fire by flame or burning parts or droplets from the tested part falling down onto the pinewood board covered with tissue paper.

*If possible, the specimen should be a complete switch.*

NOTE 3 If the test cannot be made on a complete switch, a suitable part can be cut from it for the purpose of the test.

*The test is made on one specimen. In case of doubt, the test shall be repeated on two further specimens.*

*The specimen shall be stored for 24 h at standard ambient atmospheric conditions before the test, in accordance with IEC 60212.*

*The test is made applying the glow-wire once.*

*The specimen shall be positioned during the test in the most unfavourable position of its intended use (with the surface tested in a vertical position). The tip of the glow-wire shall be applied to the specified surface of the specimen taking into account the conditions of the intended use under which a heated or glowing element may come into contact with the switch.*

*During the application time of the glow-wire and during a period of 30 s from the end of the application time, the specimen and the surrounding parts, including the layer under the specimen, shall be observed.*

*The time when the ignition of the specimen occurs and/or the time when the flames extinguish during or after the application time shall be measured and recorded.*

*The switch is regarded as having passed the glow-wire test if one of the following conditions is met:*

- there is no visible flame and sustained glowing;*
- flames and glowing at the switch extinguish within 30 s after the removal of the glow-wire.*

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

## **24.2 Resistance to tracking**

For switches that have an IP code higher than IPX0, parts of insulating material retaining live parts in position shall be of material resistant to tracking.

Compliance is checked according to IEC 60112.

Ceramic parts are not tested.

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

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

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

## **25 Resistance to rusting**

Ferrous parts, including covers and boxes, shall be adequately protected against rusting.

Compliance is checked by the following test:

All grease is removed from the parts to be tested, using a suitable degreasing agent.

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  $(+20 \pm 5) ^\circ\text{C}$ .*

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

NOTE 1 Traces of rust on sharp edges and any yellowish film removable by rubbing is ignored.

NOTE 2 For small springs and the like, and for inaccessible parts exposed to abrasion, a layer of grease can provide sufficient protection against rusting. Such parts are 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.

## **26 EMC requirements**

### **26.1 Immunity**

Switches within the scope of this document are tolerant of electromagnetic disturbances and therefore no immunity tests are necessary.

### **26.2 Emission**

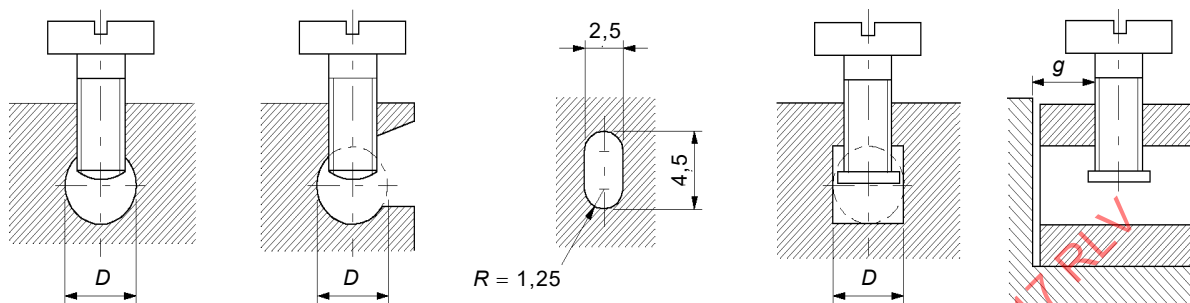
Electromagnetic disturbances may only be generated during switching operations. Since this is not continuous, no emission tests are necessary.

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Dimensions in millimetres

Screw not requiring washer, clamping plate or anti-spread device

Screw requiring washer, clamping plate or anti-spread device



Terminals without pressure plate

Elongated hole terminal

Terminals with pressure plate

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| Cross-section of conductor accepted by the terminal<br>mm <sup>2</sup> | Minimum diameter <i>D</i> (or minimum dimensions) of conductor space<br>mm | Minimum distance <i>g</i> between clamping screw and end of conductor when fully inserted<br>mm |     | Torque<br>Nm   |            |                |            |                |            |
|------------------------------------------------------------------------|----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-----|----------------|------------|----------------|------------|----------------|------------|
|                                                                        |                                                                            |                                                                                                 |     | 1 <sup>a</sup> |            | 3 <sup>a</sup> |            | 4 <sup>a</sup> |            |
|                                                                        |                                                                            |                                                                                                 |     | One screw      | Two screws | One screw      | Two screws | One screw      | Two screws |
| Up to 1,5                                                              | 2,5                                                                        | 1,5                                                                                             | 1,5 | 0,2            | 0,2        | 0,2            | 0,4        | 0,4            | 0,4        |
| 2,5<br>(circular hole)                                                 | 3,0                                                                        | 1,5                                                                                             | 1,5 | 0,25           | 0,2        | 0,5            | 0,4        | 0,5            | 0,4        |
| 2,5<br>(elongated hole)                                                | 2,5 × 4,5                                                                  | 1,5                                                                                             | 1,5 | 0,25           | 0,2        | 0,5            | 0,4        | 0,5            | 0,4        |
| 4                                                                      | 3,6                                                                        | 1,8                                                                                             | 1,5 | 0,4            | 0,2        | 0,8            | 0,4        | 0,7            | 0,4        |
| 6                                                                      | 4,0                                                                        | 1,8                                                                                             | 1,5 | 0,4            | 0,25       | 0,8            | 0,5        | 0,8            | 0,5        |
| 10                                                                     | 4,5                                                                        | 2,0                                                                                             | 1,5 | 0,7            | 0,25       | 1,2            | 0,5        | 1,2            | 0,5        |
| 16                                                                     | 5,5                                                                        | 2,5                                                                                             | 2,0 | 0,8            | 0,7        | 2,0            | 1,2        | 2,0            | 1,2        |
| 25                                                                     | 7,0                                                                        | 3,0                                                                                             | 2,0 | 1,2            | 0,7        | 2,5            | 1,2        | 3,0            | 1,2        |

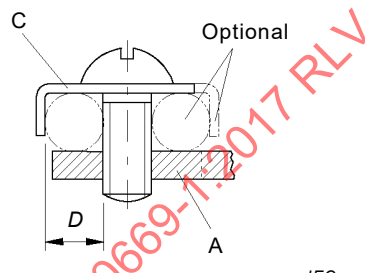
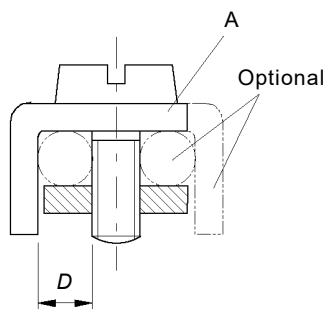
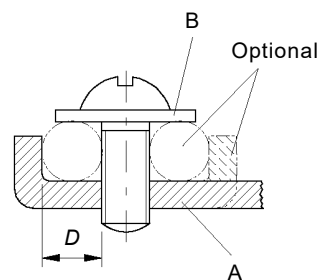
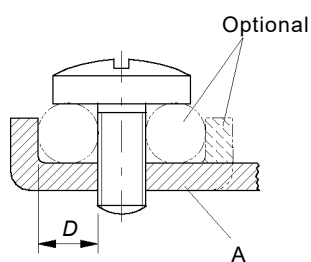
<sup>a</sup> The values specified apply to the screws covered by the corresponding columns in Table 5.

The part of the terminal containing the threaded hole and the part of the terminal against which the conductor is clamped by the screw may be two separate parts, as in the case of terminals provided with a stirrup.

The shape of the conductor space may differ from those shown provided that a circle with a diameter equal to the minimum specified for *D* or the minimum outline specified for the elongated hole accepting cross-sections of conductors up to 2,5 mm<sup>2</sup> can be inscribed.

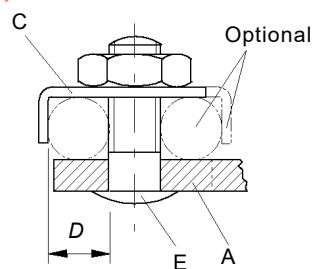
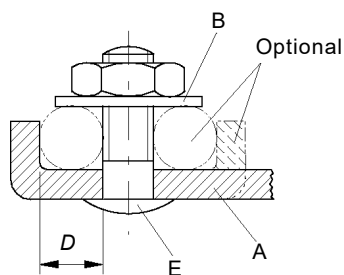
Figure 1 – Pillar terminals





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Screw head terminals



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Stud terminals

- A fixed part  
B washer or clamping plate  
C anti-spread device  
D conductor space  
E stud

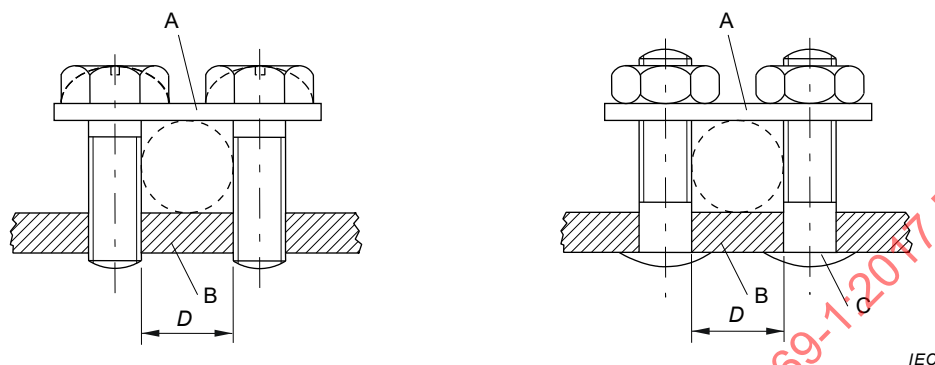
| Cross-section of conductor accepted by the terminal<br>mm <sup>2</sup> | Minimum diameter <i>D</i> of conductor space<br>mm | Torque<br>Nm   |            |                   |                     |
|------------------------------------------------------------------------|----------------------------------------------------|----------------|------------|-------------------|---------------------|
|                                                                        |                                                    | 3 <sup>a</sup> |            | 4 <sup>a</sup>    |                     |
|                                                                        |                                                    | One screw      | Two screws | One screw or stud | Two screws or studs |
| Up to 1,5                                                              | 1,7                                                | 0,5            | –          | 0,5               | –                   |
| Up to 2,5                                                              | 2,0                                                | 0,8            | –          | 0,8               | –                   |
| Up to 4                                                                | 2,7                                                | 1,2            | 0,5        | 1,2               | 0,5                 |
| Up to 6                                                                | 3,6                                                | 2,0            | 1,2        | 2,0               | 1,2                 |
| Up to 10                                                               | 4,3                                                | 2,0            | 1,2        | 2,0               | 1,2                 |
| Up to 16                                                               | 5,5                                                | 2,0            | 1,2        | 2,0               | 1,2                 |
| Up to 25                                                               | 7,0                                                | 2,5            | 2,0        | 3,0               | 2,0                 |

<sup>a</sup> The values specified apply to the screws covered by the corresponding columns in Table 5.

The part which retains the conductor in position may be of insulating material provided the pressure necessary to clamp the conductor is not transmitted through the insulating material.

The second optional space for the terminal accepting cross-sections of conductors up to 2,5 mm<sup>2</sup> may be used for the connection of the second conductor, when it is required to connect two 2,5 mm<sup>2</sup> conductors.

**Figure 2 – Screw head terminals and stud terminals**



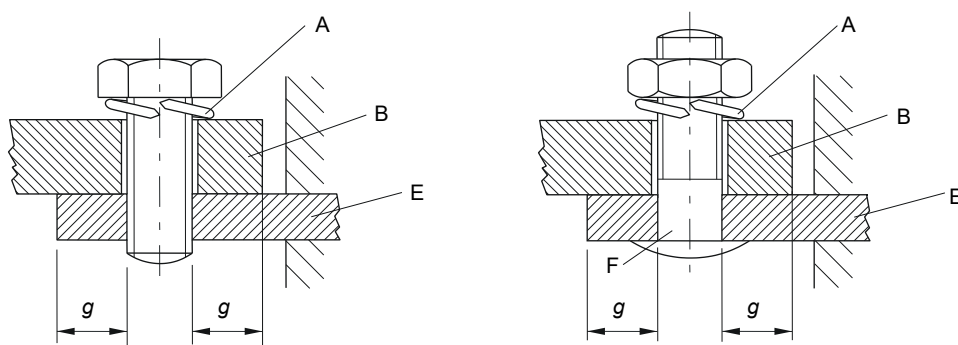
- A saddle
- B fixed part
- C stud
- D conductor space

| Cross-section of conductor accepted by the terminal<br>mm <sup>2</sup> | Minimum diameter <i>D</i> of conductor space<br>mm | Torque<br>Nm |
|------------------------------------------------------------------------|----------------------------------------------------|--------------|
| Up to 4                                                                | 3,0                                                | 0,5          |
| Up to 6                                                                | 4,0                                                | 0,8          |
| Up to 10                                                               | 4,5                                                | 1,2          |
| Up to 16                                                               | 5,5                                                | 1,2          |
| Up to 25                                                               | 7,0                                                | 2,0          |

The shape of the conductor space may differ from that shown in the figure, provided that a circle with a diameter equal to the minimum value specified for *D* can be inscribed.

The shape of the upper and lower faces of the saddle may be different to accommodate conductors of either small or large cross-sectional areas by inverting the saddle.

**Figure 3 – Saddle terminals**



- A locking means  
 B cable lug or bar  
 E fixed part  
 F stud

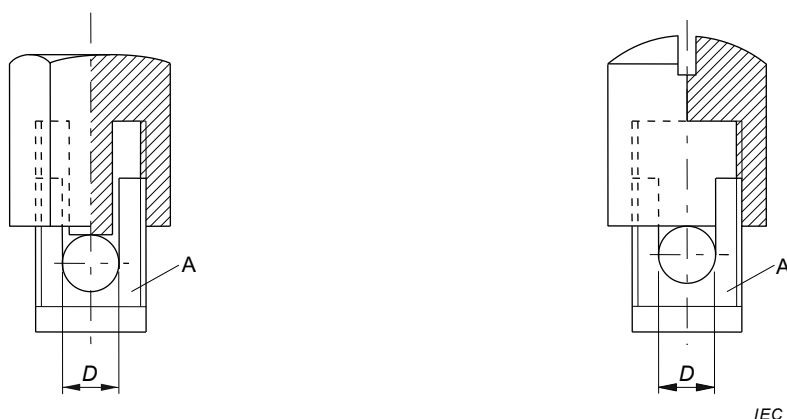
| Cross-section of conductor<br>accepted by the terminal<br><br>mm <sup>2</sup> | Minimum distance <i>g</i> between<br>edge of hole and side of clamping<br>area<br><br>mm | Torque<br>Nm   |                |
|-------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|----------------|----------------|
|                                                                               |                                                                                          | 3 <sup>a</sup> | 4 <sup>a</sup> |
| Up to 16                                                                      | 7,5                                                                                      | 2,0            | 2,0            |
| Up to 25                                                                      | 9,0                                                                                      | 2,5            | 3,0            |

<sup>a</sup> The values specified apply to the screws covered by the corresponding columns in Table 5.

For this type of terminal, a spring washer or equally effective locking means shall be provided and the surface within the clamping area shall be smooth.

For certain types of switches, the use of lug terminals of sizes smaller than that specified is allowed.

**Figure 4 – Lug terminals**



- A fixed part  
D conductor space<sup>a</sup>

| Cross-section of conductor accepted by the terminal<br>mm <sup>2</sup> | Minimum diameter <i>D</i> of conductor space <sup>a</sup><br>mm | Minimum distance between fixed part and end of conductor when fully inserted<br>mm |
|------------------------------------------------------------------------|-----------------------------------------------------------------|------------------------------------------------------------------------------------|
| Up to 1,5                                                              | 1,7                                                             | 1,5                                                                                |
| Up to 2,5                                                              | 2,0                                                             | 1,5                                                                                |
| Up to 4                                                                | 2,7                                                             | 1,8                                                                                |
| Up to 6                                                                | 3,6                                                             | 1,8                                                                                |
| Up to 10                                                               | 4,3                                                             | 2,0                                                                                |
| Up to 16                                                               | 5,5                                                             | 2,5                                                                                |
| Up to 25                                                               | 7,0                                                             | 3,0                                                                                |

<sup>a</sup> The bottom of the conductor space shall be slightly rounded in order to obtain a reliable connection.

The value of the torque to be applied is that specified in column 2 or 4 of Table 5, as appropriate.

**Figure 5 – Mantle terminals**

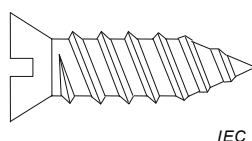


**Figure 6 – Thread-forming screw**

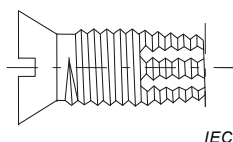
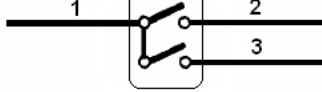
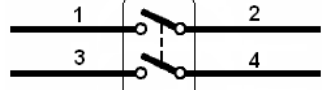
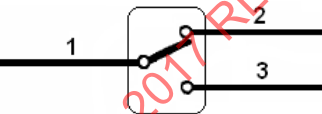
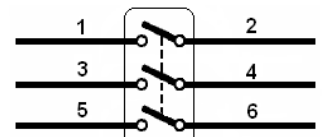
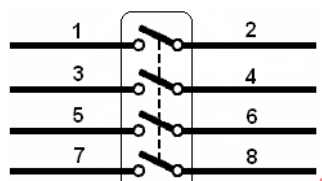
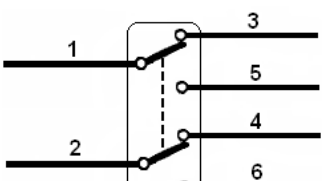
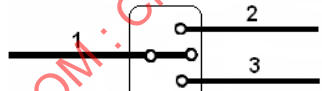
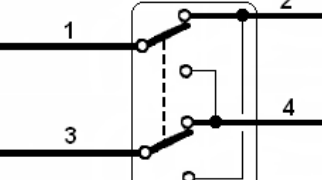


**Figure 7 – Thread-cutting screw**

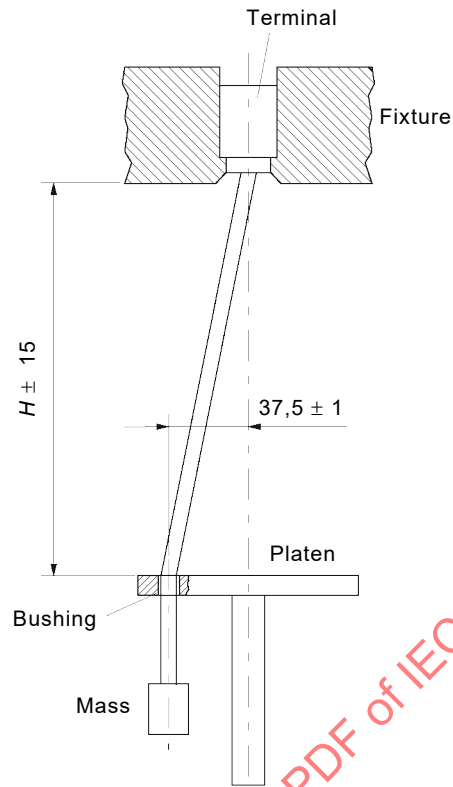
| Pattern number | Number of poles | Possible connections                                                                | Pattern number | Number of poles | Possible connections                                                                  |
|----------------|-----------------|-------------------------------------------------------------------------------------|----------------|-----------------|---------------------------------------------------------------------------------------|
| 1              | 1               |    | 5              | 1               |    |
| 2              | 2               |    | 6              | 1               |    |
| 3              | 3               |    |                |                 |                                                                                       |
| 03             | 4               |   | 6/2            | 2               |   |
| 4              | 1               |  | 7              | 1               |  |

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The figures indicating the terminals are given for test purposes only and are not those required to be marked.

**Figure 8 – Classification according to connections**

*Dimensions in millimetres*

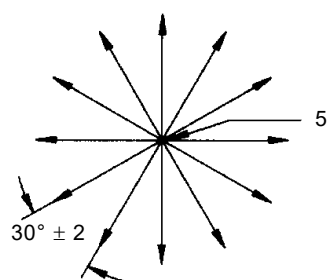


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NOTE The bushing hole is made in a way which ensures that the force extended to the cable is a pure pulling force and that the transmission of any torque to the connection in the clamping means is avoided.

**Figure 9 – Test apparatus for checking damage to conductors**

Dimensions in millimetres



Directions of application of the forces

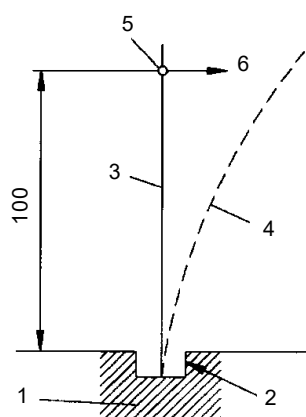
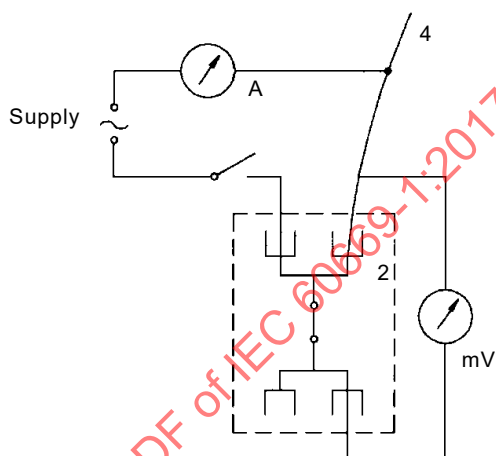


**Figure 10a – Principle of the test apparatus for deflecting test on screwless terminal**



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**Figure 10b – Example of test arrangement to measure the voltage drop during deflecting test on screwless terminal**

|    |                                                                |
|----|----------------------------------------------------------------|
| A  | ammeter                                                        |
| S  | switch                                                         |
| mV | millivoltmeter                                                 |
| 1  | specimen                                                       |
| 2  | clamping unit under test                                       |
| 3  | conductor                                                      |
| 4  | conductor deflected                                            |
| 5  | point of application of the force for deflecting the conductor |
| 6  | deflecting force (perpendicular to the straight conductor)     |

**Figure 10 – Information for deflection test**

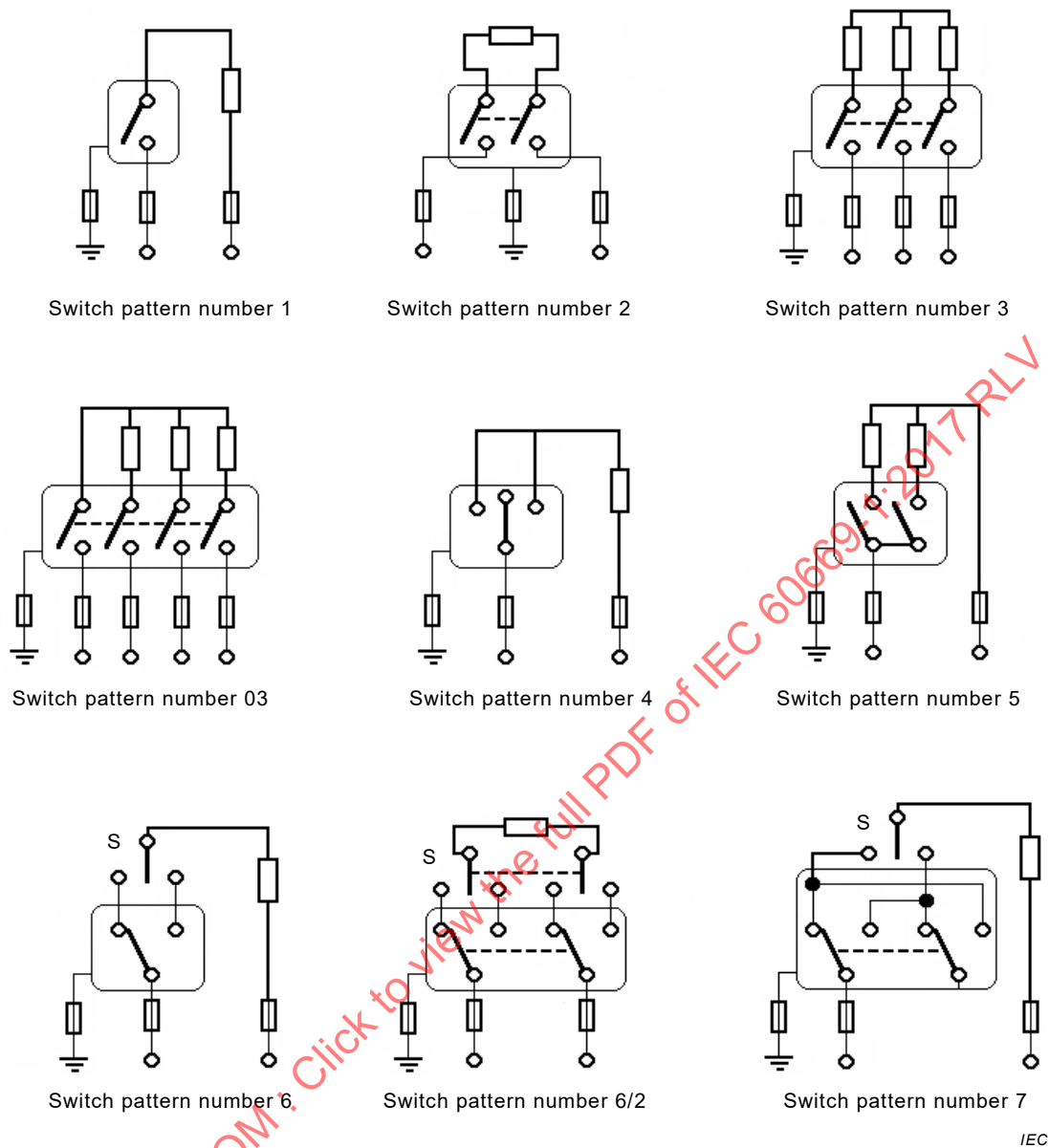


**Figure 11 – Circuit diagrams for making and breaking capacity and normal operation**



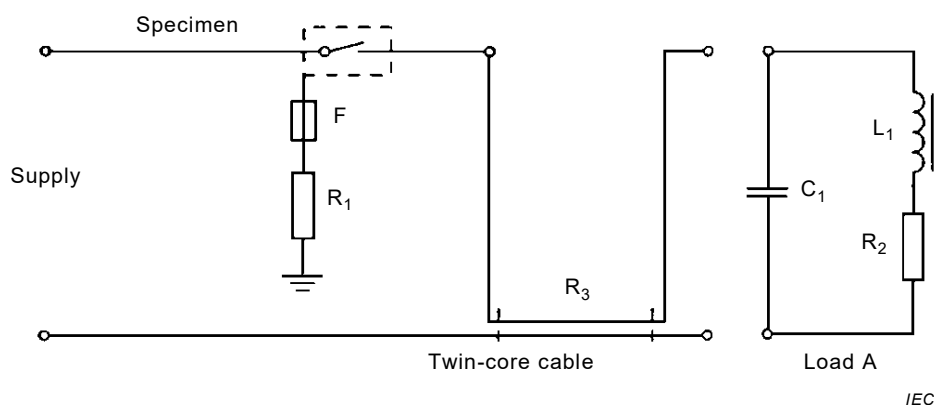


Figure 12a – Circuit diagrams for testing switches for use on externally ballasted lamp loads

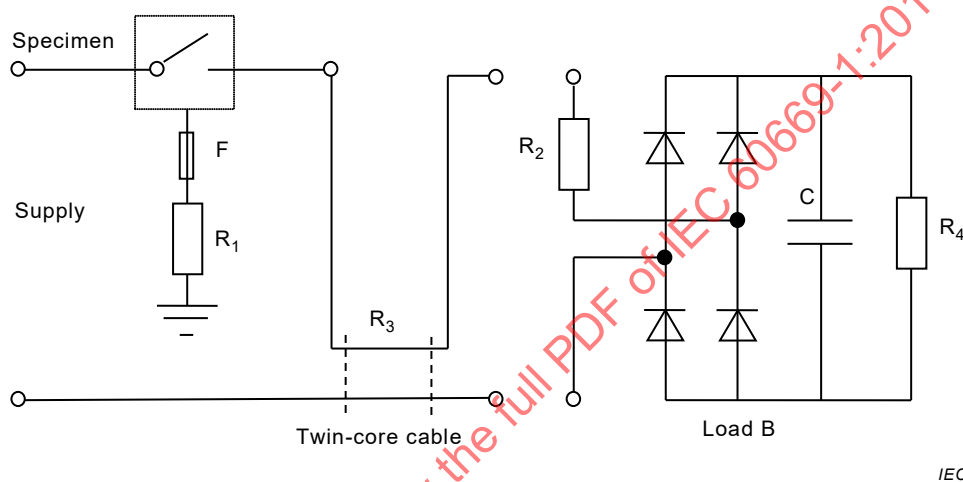


Figure 12b – Circuit diagrams for testing switches according to 19.3

Figure 12 – Circuit diagrams for testing switches

Dimensions in millimetres

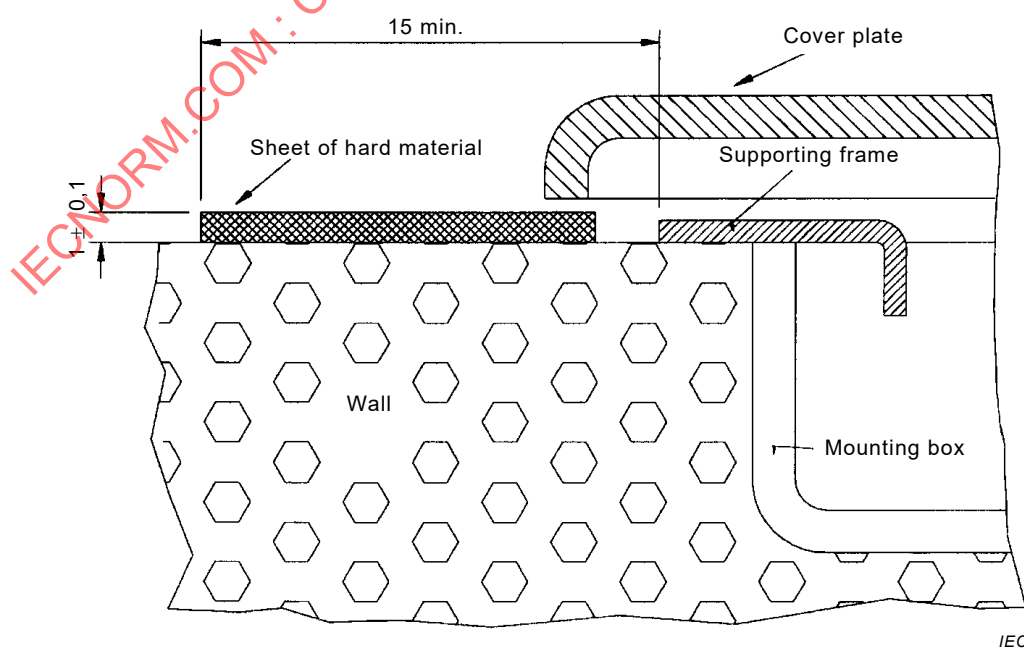


Figure 13 – Arrangement for test on cover-plates

*Dimensions in millimetres*

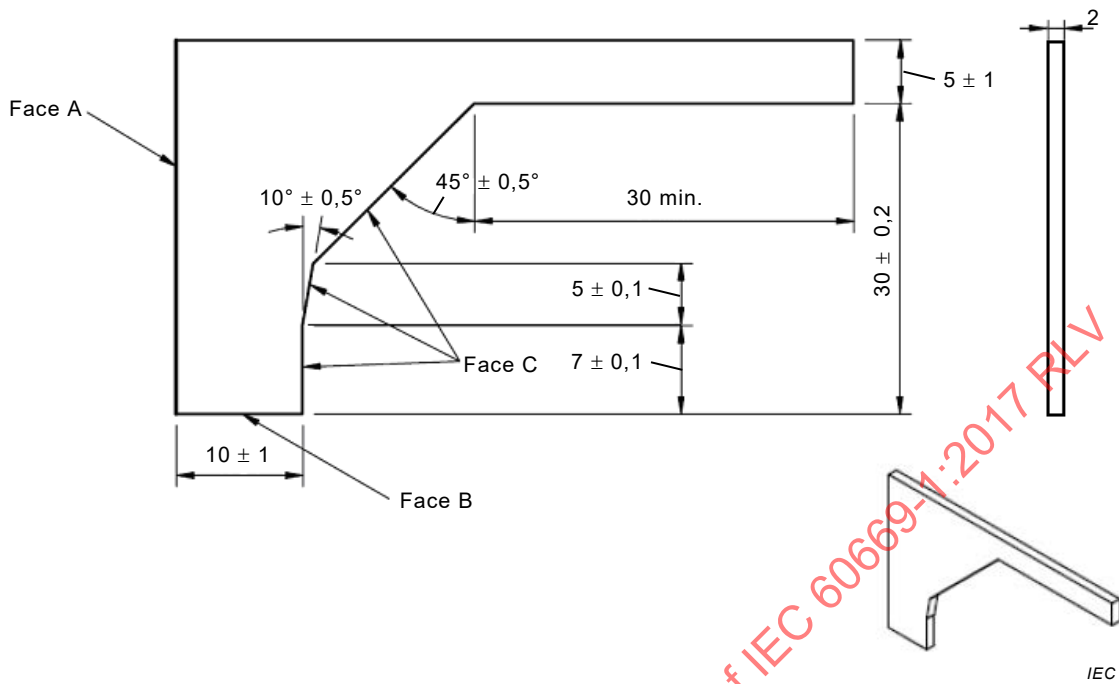
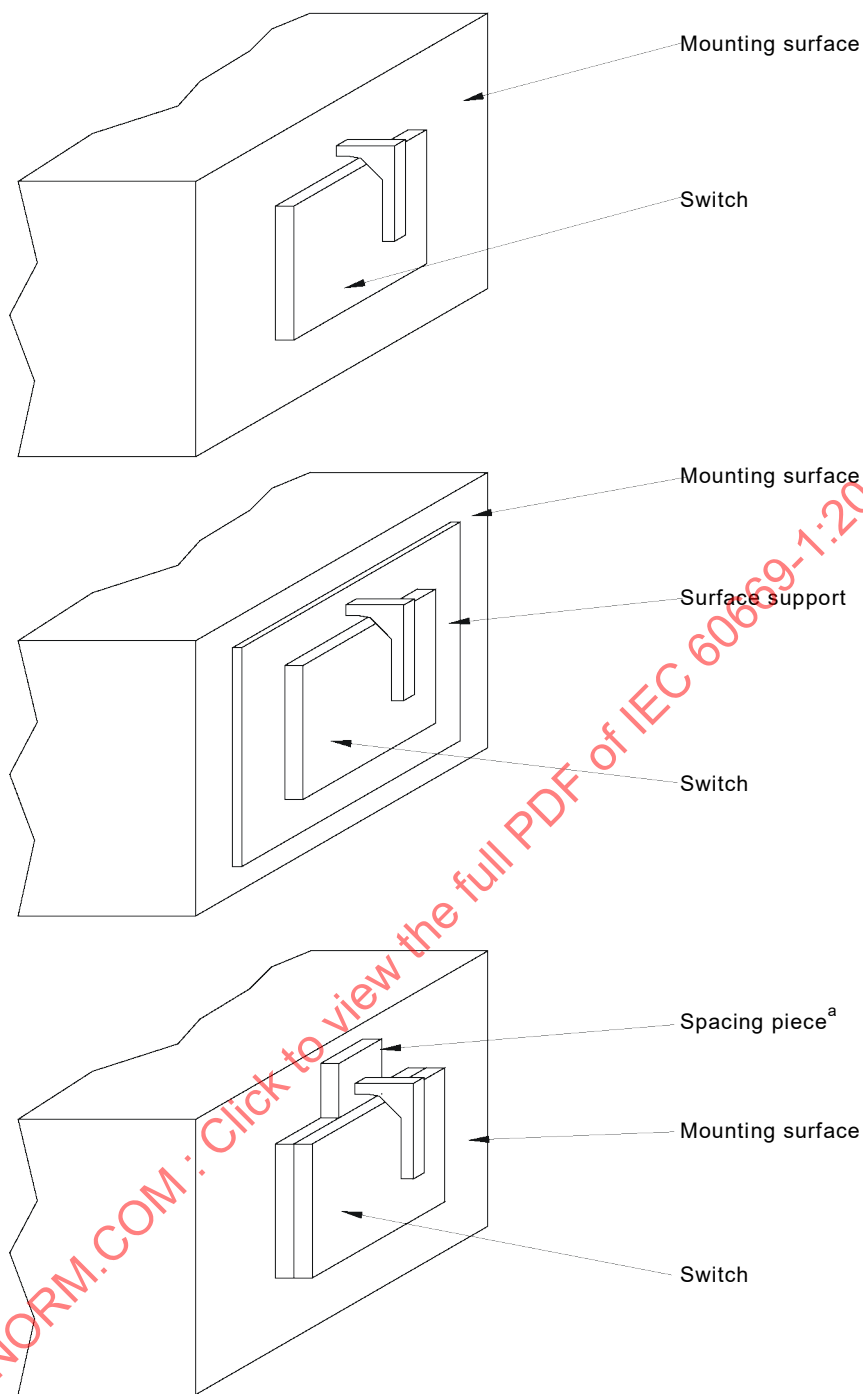


**Figure 14 – Gauge (thickness: about 2 mm) for the verification of the outline of covers, cover-plates or actuating members**

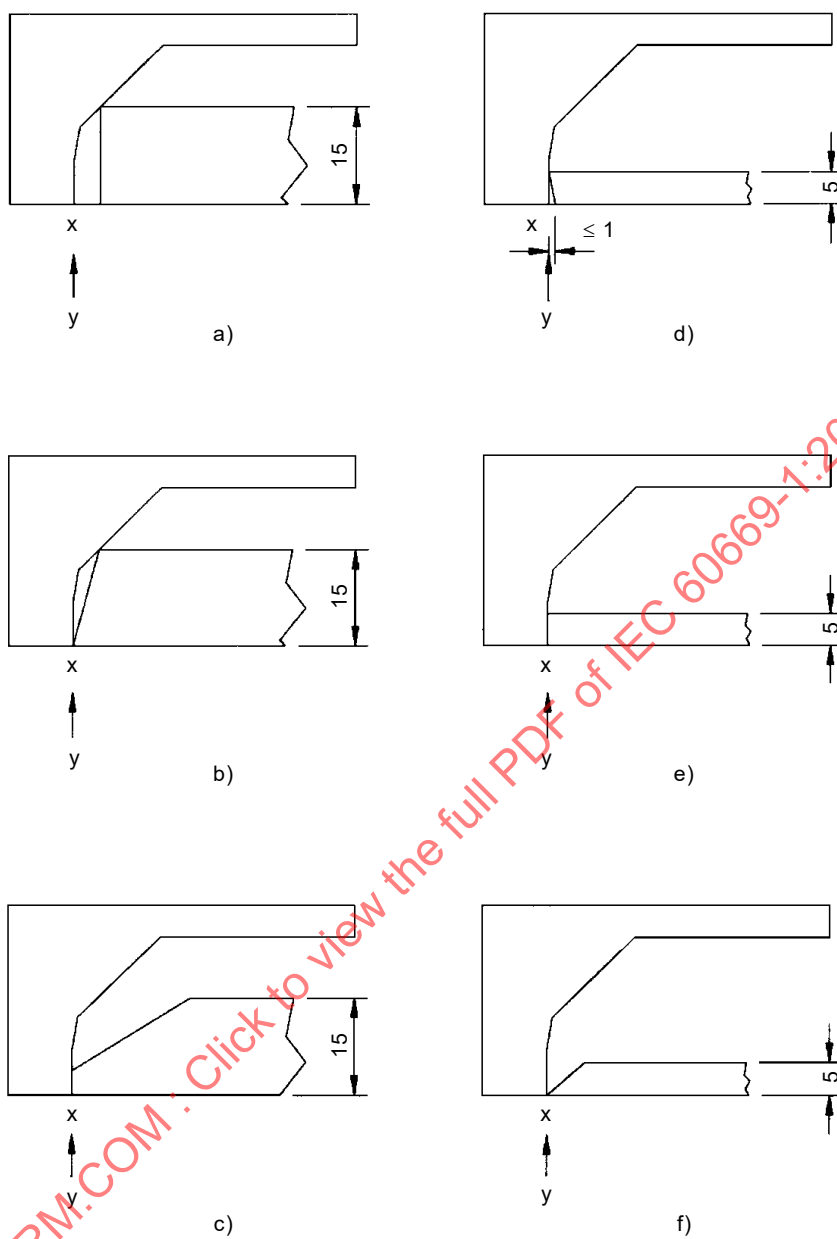


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<sup>a</sup> The spacing piece has the same thickness as the supporting part.

**Figure 15 – Example of application of the gauge of Figure 14 on covers fixed without screws on a mounting surface or supporting surface**

*Dimensions in millimetres*



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Cases a) and b):

do not comply.

Cases c), d), e) and f):

comply (compliance shall however be checked also with the requirements of 20.8 using the gauge shown in Figure 17).

**Figure 16 – Examples of applications of the gauge of Figure 14 in accordance with the requirements of 20.8**

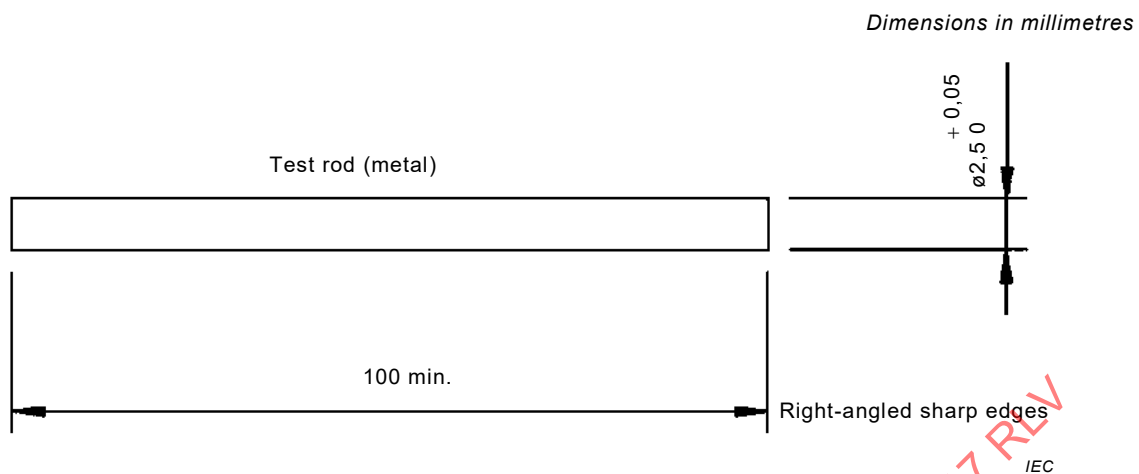


**Figure 17 – Gauge for verification of grooves, holes and reverse tapers**

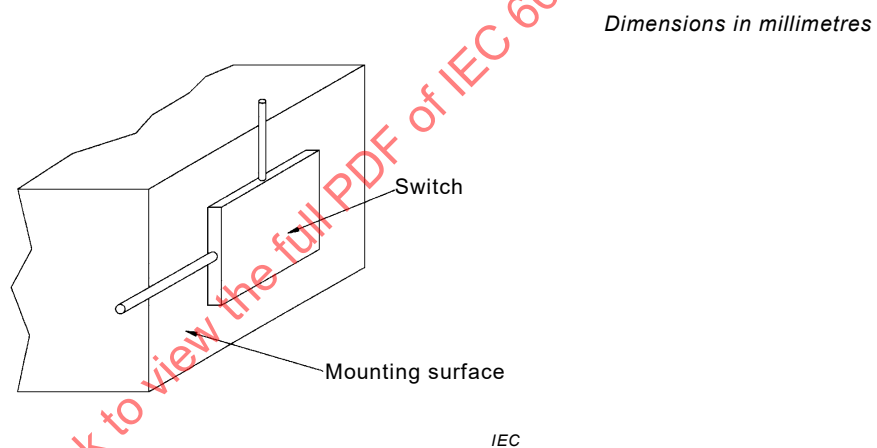


**Figure 18 – Sketch showing the direction of application of the gauge of Figure 17**

*Dimensions in millimetres*

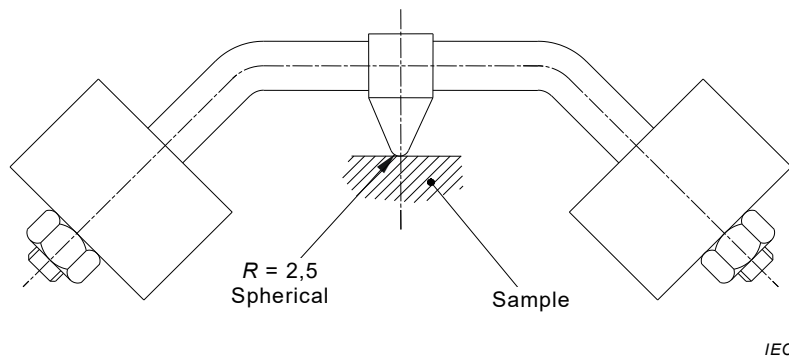
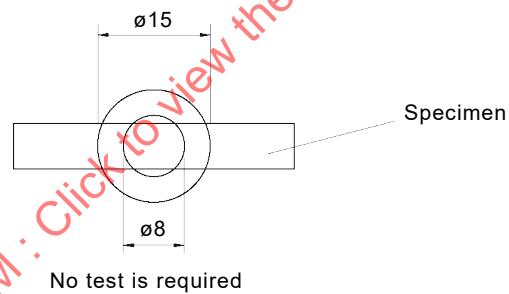
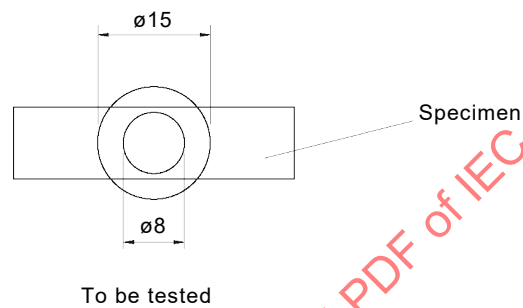


**Figure 19 – Ball-pressure apparatus**

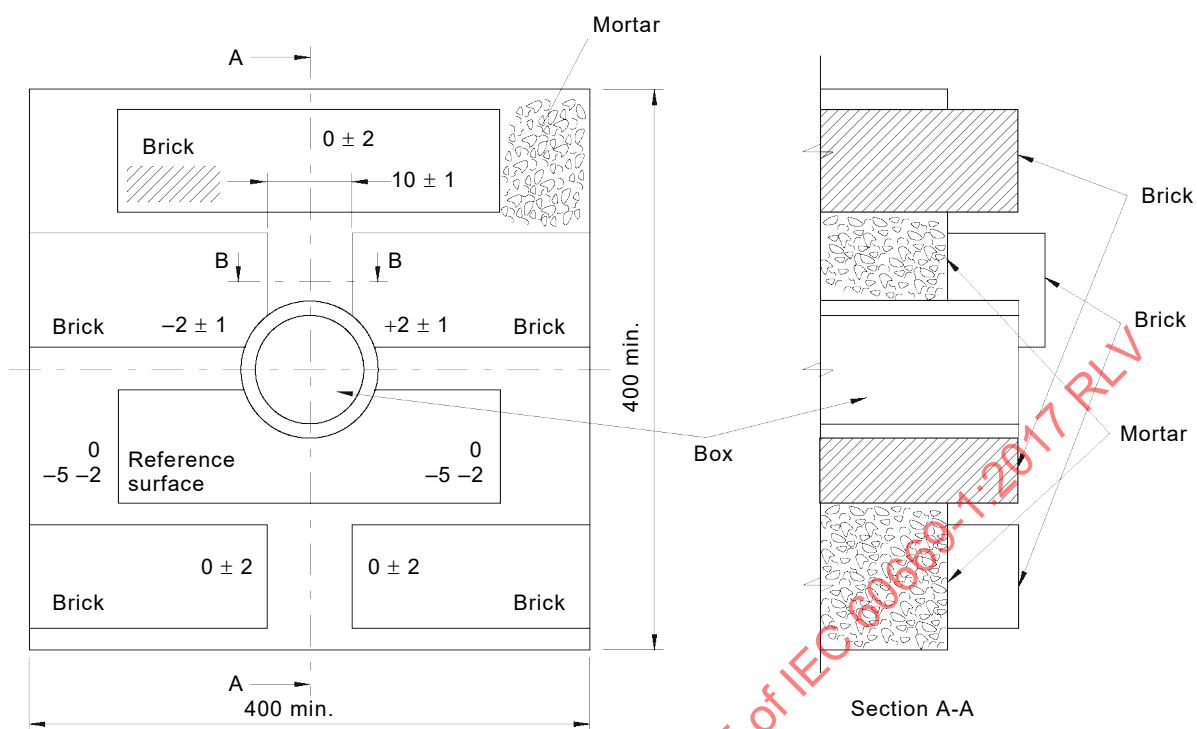
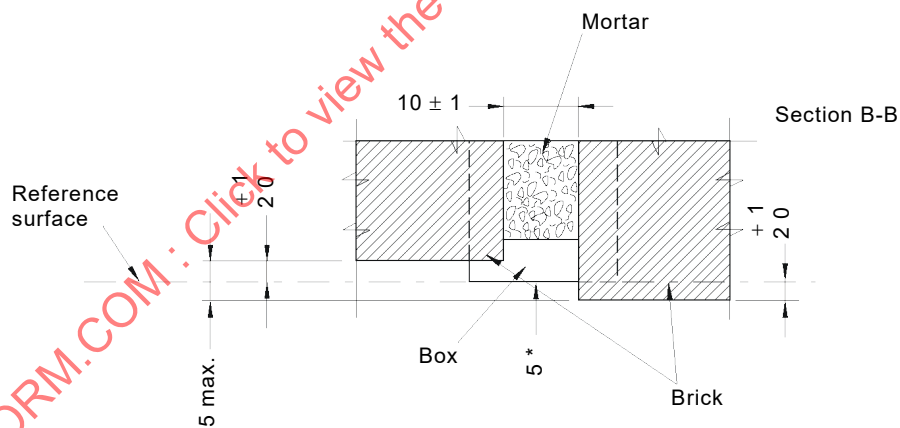
*Dimensions in millimetres*



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**Figure 20 – Determining parts of insulating material to be tested – Diagrammatic representation (see 24.1)**

Dimensions in millimetres

All mortar joints  $10 \pm 5$  mm thick unless otherwise specified

\*or in accordance with the manufacturer's instructions

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Figure 21 – Test wall in accordance with the requirements of 15.2.3

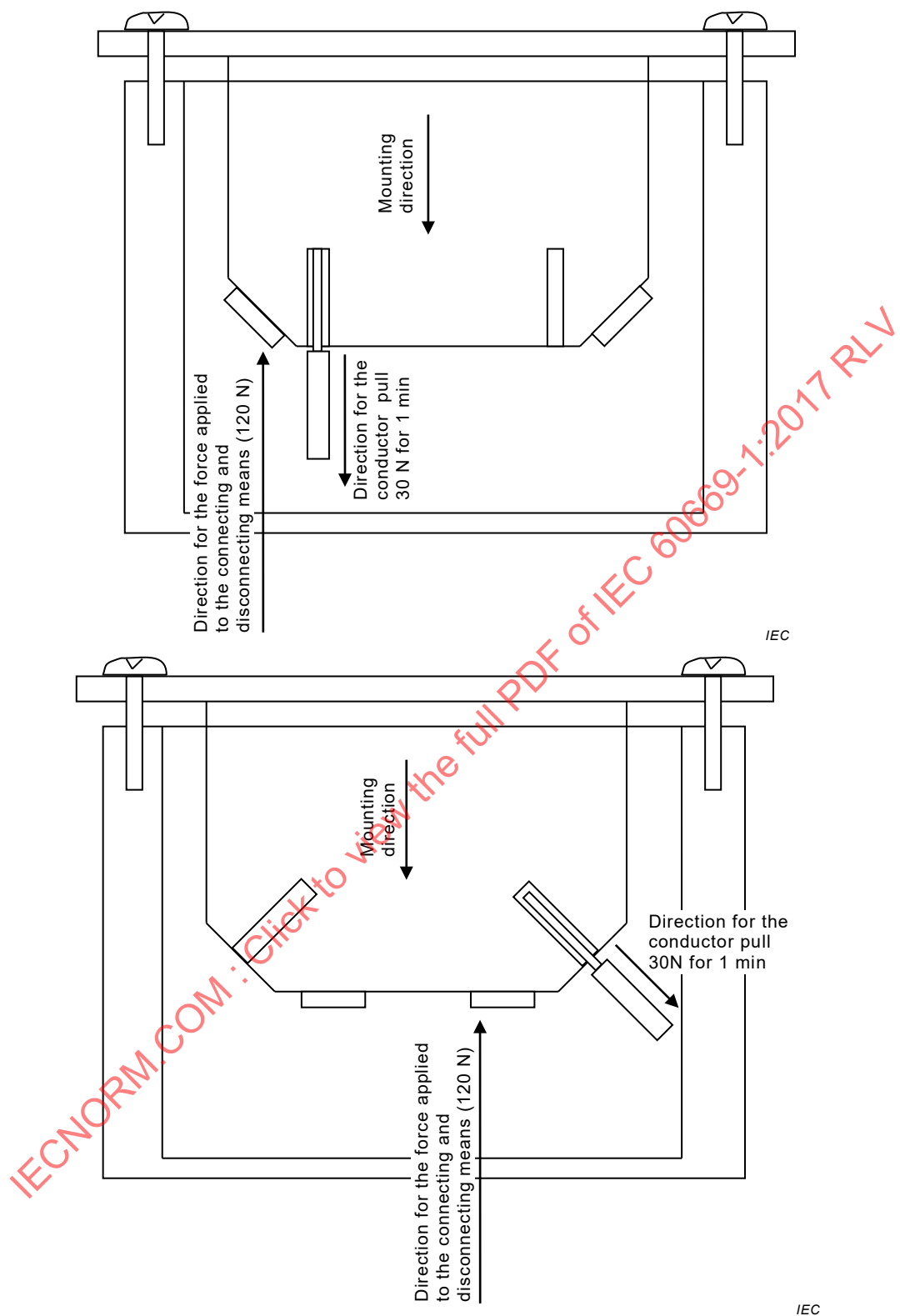


Figure 22a – Determination of the direction of the forces to be applied



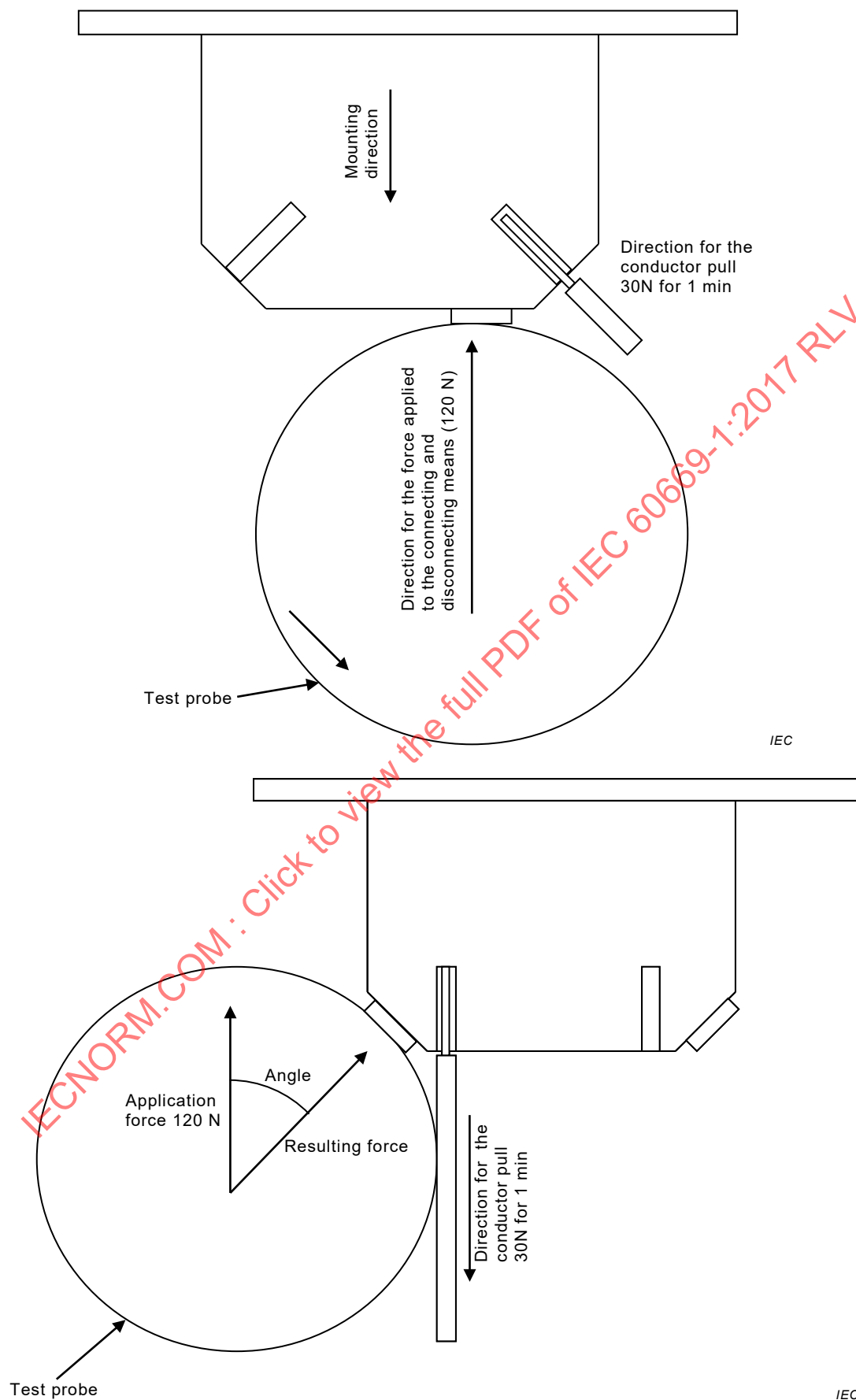
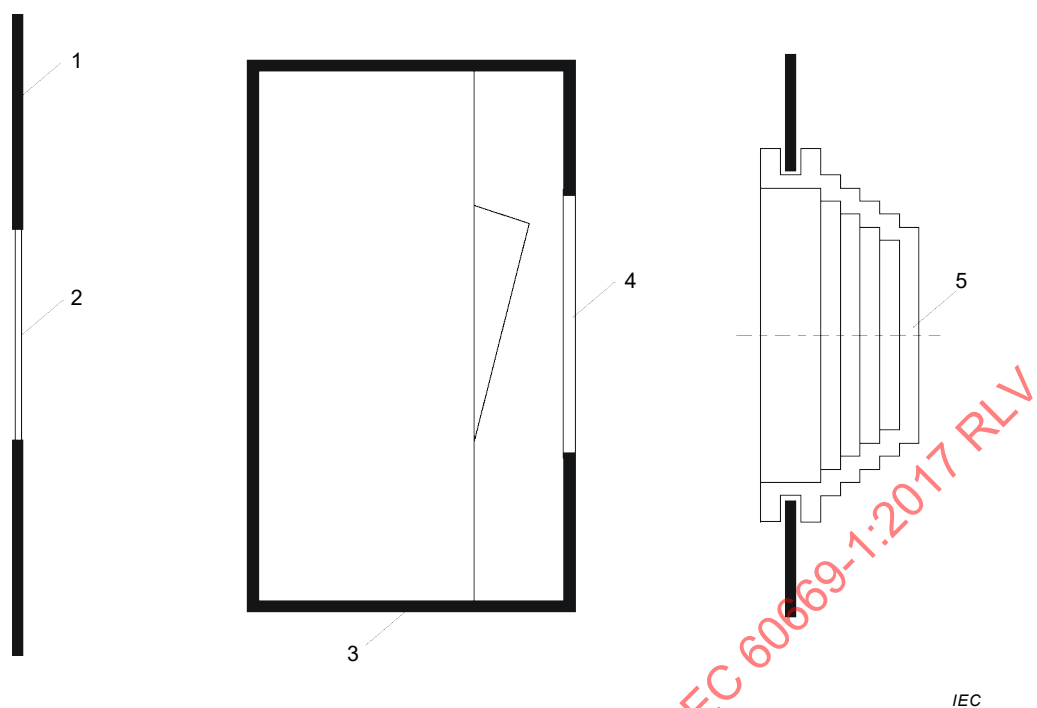


Figure 22b – Test set up

Figure 22 – Direction for the conductor pull of 30 N for 1 min



**Key**

- 1 Box
- 2 Entry membrane
- 3 Envelope
- 4 Protective membrane
- 5 Grommet

**Figure 23 – Examples of membranes and grommets**

## **Annex A**

(normative)

### **Additional requirements for switches having facilities for the outlet and retention of flexible cables**

The purpose of Annex A is to bring additional explanations and requirements to the normative text of this document. Therefore the numbering of clauses, subclauses, figures and tables follows that of the main body of the text. Only the relevant clauses, subclauses, tables and figures are cited. Any additional tables and figures are numbered starting from A.

### **3 Terms and definitions**

*Add the following definition:*

#### **3.23**

##### **flexible cable outlet switch**

switch having provision for a flexible cable outlet

### **7 Classification**

*Add the following subclause:*

**7.10** according to the presence of a flexible cable outlet:

- without flexible cable outlet;
- with flexible cable outlet.

### **10 Protection against electric shock**

**10.1** Prevention of access to live parts

*Add the following text at the end of the fourth paragraph:*

*For flexible cable outlet switches the test is carried out without the flexible cable fitted.*

### **12 Terminals**

**12.2.5** *Add the following text after the fifth paragraph:*

*For flexible cable outlet switches, the test is repeated with flexible cables of the appropriate size (see 13.15) following the same procedure.*

### **13 Constructional requirements**

*Add the following subclause:*

**13.17** Flexible cable outlet switches shall be so designed that an appropriate flexible cable, complying with IEC 60245-4, code designation 60245 IEC 66 or IEC 60227-5, code designation 60227 IEC 53, or as specified by the manufacturer, may enter the switch through a suitable hole, groove or gland. The entry shall accept the maximum dimensions (outer sheath) of the appropriate flexible cable, having conductors of the cross-sectional area

specified in Table A.1, according to the current rating of the switch, but with a minimum of 1,5 mm<sup>2</sup> and the entry shall be so shaped as to prevent damage to the flexible cable.

A cable anchorage for the flexible cable shall be provided such that the conductors are relieved from strain, including twisting, where they are connected to the terminals or terminations.

The cable anchorage shall contain the sheath and shall be either of insulating material or, if of metal, shall be provided with an insulating lining fixed to the metal parts.

Cable anchorages shall anchor the flexible cable securely to the switch.

The design shall ensure that

- the cable anchorage cannot be released from the outside;
- clamping the cable does not require the use of a special purpose tool.

**Table A.1 – Limits of external dimensions of flexible cables**

| Rated current<br>A | Cross-sectional area of conductors<br>mm <sup>2</sup> | Number of conductors | Limits of external dimensions of flexible cables |               |
|--------------------|-------------------------------------------------------|----------------------|--------------------------------------------------|---------------|
|                    |                                                       |                      | Minimum<br>mm                                    | Maximum<br>mm |
| 6                  | 0,75 up to and including 1,5                          | 2                    | 5,7<br>or<br>3,7 × 6,0                           | 11,0          |
|                    |                                                       | 3                    |                                                  | 11,9          |
|                    |                                                       | 4                    |                                                  | 13,1          |
|                    |                                                       | 5                    |                                                  | 14,4          |
| 10 and 13          | 1 up to and including 2,5                             | 2                    | 5,9<br>or<br>3,9 × 6,2                           | 13,1          |
|                    |                                                       | 3                    |                                                  | 14,0          |
|                    |                                                       | 4                    |                                                  | 15,5          |
|                    |                                                       | 5                    |                                                  | 17            |
| 16                 | 1,5 up to and including 4                             | 2                    | 6,8                                              | 15,1          |
|                    |                                                       | 3                    |                                                  | 16,2          |
|                    |                                                       | 4                    |                                                  | 17,9          |
|                    |                                                       | 5                    |                                                  | 19,9          |
| 20 to 25           | 2,5 up to and including 6                             | 2                    | 8,4                                              | 16,8          |
|                    |                                                       | 3                    |                                                  | 18,0          |
|                    |                                                       | 4                    |                                                  | 20,0          |
|                    |                                                       | 5                    |                                                  | 22,2          |

NOTE The limits of the external diameter of cables specified in this table are based on type 60227 IEC 53 according to IEC 60227-5 and type 60245 IEC 66 according to IEC 60245-4 and are given for information.

Screws which are used when clamping the flexible cable shall not serve to fix any other component unless the switch is rendered manifestly incomplete if the component is omitted or is replaced in an incorrect position, or the component intended to be fixed cannot be removed without further use of a tool.

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

*Switches are fitted with a flexible cable complying with IEC 60227-5, code designation 60227 IEC 53, having a nominal conductor cross-sectional area of 1,5 mm<sup>2</sup> and the number of cores corresponding to the number of poles of the switch.*

NOTE For the purposes of this test, earth is considered as a pole.

*The conductors are introduced into the terminals and the terminal screws tightened just sufficiently to prevent the conductors easily changing their position. The cable anchorage is used in the normal way, the clamping screws, if any, being tightened to a torque of two-thirds of that given in Table 5.*

*After this preparation, it shall not be possible to push the flexible cable into the switch to such an extent as to impair safety or so that the cable anchorage is loosened.*

*The flexible cable is then subjected 25 times to a pull of 30 N. The pulls are applied without jerks in the most unfavourable direction, each time for 1 s. Immediately afterwards, the flexible cable is subjected for 1 min to a torque of 0,15 Nm as near as practicable to the cable entry.*

*The above test is then repeated, the switch being fitted with the appropriate largest diameter flexible cable complying with IEC 60245-4, code designation 60245 IEC 66. The pull is increased to 60 N and the torque is increased to 0,35 Nm.*

*After the test the flexible cable shall not have been displaced by more than 2 mm.*

*For the measurement of longitudinal displacement a mark is made on the flexible cable whilst it is subjected to a pull, at a distance of approximately 20 mm from the cable anchorage, before starting the test. After the test the displacement of the mark on the flexible cable in relation to the cable anchorage is measured whilst the flexible cable is again subjected to a pull.*

*An AC voltage of 2 000 V is applied for 1 min between the conductors and the cord anchorage.*

*During the test, the insulation of the flexible cable shall not be damaged. Breakdown or flashover is considered to indicate damage to the flexible cable.*

## Annex B (informative)

### Changes planned for the future in order to align IEC 60669-1 with the requirements of IEC 60998 (all parts), IEC 60999 (all parts) and IEC 60228

Annex B is provided for information to show the large number of changes planned for the future to align IEC 60669-1 with the requirements of IEC 60998 (all parts), IEC 60999 (all parts) and IEC 60228.

There is no intention that Annex B be used for any conformity testing or certification.

The purpose of Annex B is to bring additional explanations and requirements to the normative text of this document. Therefore the numbering of clauses, subclauses, figures and tables follows that of the main body of the text. Only the relevant clauses, subclauses, tables and figures are cited. Any additional tables and figures are numbered starting from B.

## 12 Terminals

*Replace Clause 12 by the following:*

### 12.1 General

Switches shall be provided with terminals having screw clamping or with screwless terminals.

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

The test of 12.2.8 and 12.3.9 including 12.3.10 shall be carried out after the test of 15.1. Rigid solid conductors shall be of Class 1, rigid stranded conductors shall be of Class 2 and flexible conductor shall be of Class 5 according to IEC 60228.

*Compliance is checked by inspection and by the tests of 12.2 or 12.3, as applicable.*

*Terminals having screw clamping complying with IEC 60998-2-1 are considered to be in compliance with the requirements and tests of 12.2 provided they are chosen according to Table 4, except for the requirements according to 12.2.7 and 12.2.8. The tests of 12.2.7 and 12.2.8 shall be carried out in addition.*

The connecting capability of terminals for circuits other than those of the main circuit (for example terminals for pilot lights) need not be in relation with the rated current of the switch. This means that these terminals need not necessarily have the same connecting capability as the mains terminals of the switch. Terminals for circuits other than those of the main circuit shall fulfil the requirements of IEC 60998 (all parts) or IEC 60999 (all parts).

Terminals having screwless clamping complying with IEC 60998-2-2 are considered to be in compliance with the requirements and tests of 12.3 provided they are chosen according to Table 8, except for the requirements of 12.3.7 and 12.3.9. The tests of 12.3.7 and 12.3.9 shall be carried out in addition.

### 12.2 Terminals with screw clamping for external copper conductors

**12.2.1** Terminals with screw clamping shall be of the type suitable for rigid copper conductors only or of the type suitable for both rigid and flexible copper conductors having cross-sectional areas as shown in Table 4.

**Table 4 – Relationship between rated currents and connectable cross-sectional areas of copper conductors**

| Ranges of rated currents<br>A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Conductors                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Nominal cross-sectional areas<br>mm <sup>2</sup> |
| up to and including 6 <sup>a</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | From 0,75 up to 1,5 inclusive                    |
| above 6 up to and including 13 <sup>b</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | From 1 up to 2,5 inclusive                       |
| above 13 up to and including 16 <sup>b</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | From 1,5 up to 4 inclusive                       |
| above 16 up to and including 25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | From 2,5 up to 6 inclusive                       |
| above 25 up to and including 32                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | From 4 up to 10 inclusive                        |
| above 32 up to and including 50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | From 6 up to 16 inclusive                        |
| above 50 up to and including 63                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | From 10 up to 25 inclusive                       |
| <sup>a</sup> For rated current up to 4 A when used for special purposes such as ELV applications, where flexible conductors are used (from 0,5 mm <sup>2</sup> up to and including 1 mm <sup>2</sup> ).<br><sup>b</sup> Each supply terminal of switches, other than those of pattern numbers 3, 03 and 7, shall allow the connection of two 2,5 mm <sup>2</sup> conductors. For switches having a rated voltage not exceeding 250 V, one hole is sufficient for the connection of two 2,5 mm <sup>2</sup> conductors. |                                                  |

The conductor space shall be at least that specified in Figures 1, 2, 3, 4 and 5 or shall accept the conductor(s) of the largest nominal cross-sectional area as specified in Table 4 and with dimensions as specified in IEC 60999-1:1999, Annex B.

*Compliance is checked by inspection, by measurement according to the Figures 1 to 5 or by fitting conductors with the largest theoretical diameter as specified in IEC 60999-1:1999, Annex B for the largest nominal cross-sectional area as specified in Table 4 or by using the relevant gauges as specified in IEC 60999-1:1999, Annex B.*

**12.2.2** Terminals with screw clamping shall allow the conductor to be connected without special preparation.

*Compliance is checked by inspection.*

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

**12.2.3** Terminals with screw clamping shall have adequate mechanical strength.

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

Screws and nuts of terminals shall be of metal and in engagement with a metal thread.

Screws shall not be of metal which is soft or liable to creep, such as zinc or aluminium.

NOTE 1 The use of aluminium alloy screws in aluminium alloy terminals requires additional tests, according to IEC 61545.

*Compliance is checked by inspection and by the tests of 12.2.6 and 12.2.8.*

NOTE 2 Provisionally SI, BA, and UN threads are considered to be comparable in pitch and mechanical strength to metric ISO thread.

**12.2.4** Terminals with screw clamping shall be resistant to corrosion.

Terminals, the body of which is made of copper or copper alloy as specified in 22.5 are considered as complying with this requirement.

*Compliance is checked by inspection or by chemical analysis if necessary.*

**12.2.5** Terminals with screw clamping shall be so designed and constructed that they clamp the conductor(s) without undue damage to the conductor(s).

*Compliance is checked by the following tests which are performed on three new specimens of each type of terminal:*

*Terminals suitable for rigid conductors only are checked with rigid solid conductors and on a new set of specimens with rigid stranded conductors, if existing.*

NOTE "if existing" means that the conductor is available in the market where the product is sold and installed.

*Terminals suitable for rigid and flexible conductors are checked with rigid solid conductors as above and on a new set of specimens with flexible conductors.*

*The terminal is placed in the test apparatus according to Figure 9.*

The following tests shall be carried out using new specimens for each of the following:

*The terminal is fitted with*

- a) *the minimum number of conductors of the smallest nominal cross-sectional area;*
  - b) *the minimum number of conductors of the largest nominal cross-sectional area;*
- and, if applicable,*
- c) *the maximum number of conductors of the smallest nominal cross-sectional area of the same type;*
  - d) *the maximum number of conductors of the largest nominal cross-sectional area of the same type, according to Table 4.*

*The clamping screw(s) or nut(s) is(are) tightened with the torque according to Table 5.*

*Where a screw has a hexagonal head with a slot for tightening with a screwdriver and the values of columns 3 and 5 are different, the test is made twice, first applying to the hexagonal head the torque specified in column 5 and then applying the torque specified in column 3 by means of a screwdriver. If the values of columns 3 and 5 are the same, only the test with the screwdriver is made.*

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

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

*The screws and nuts shall be tightened in one smooth and continuous motion.*

*If the terminal is fitted with more than one conductor, the test is done on each of the conductors consecutively.*

*The length of the test conductor shall be at least 75 mm longer than the height (H) specified in Table 6.*

*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 6. The bushing shall be*



*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 distance between the mouth of the clamping unit and the upper surface of the bushing shall be as specified in Table 6 with a tolerance of  $\pm 15$  mm. The bushing may be lubricated to prevent binding, twisting, or rotation of the insulated conductor.*

*A mass as specified in Table 6 is to be suspended from the end of the conductor.*

*Then the platen is rotated 150 turns at a speed of  $(10 \pm 2)$  r/min.*

*During the test, the rigid conductor, or any wire of rigid stranded, or flexible conductor, shall neither slip out of the clamping unit nor break near the clamping unit, nor shall the conductor be damaged in such a way as to render it unfit for further use.*

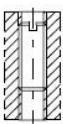
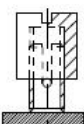
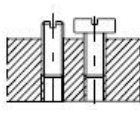
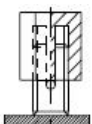
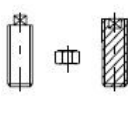
*In the case of the flexible conductor, the break of a few wires shall not be taken into account provided it does not exceed 15 % of the original number of wires.*

*Immediately after each rotation test, the test of 12.2.6 is performed.*

*The terminals shall not be tightened or untightened.*

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**Table 5 – Tightening torque for the verification of the mechanical strength of screw-type terminals**

| Nominal diameter of thread<br>mm | Torque<br>Nm                                                                      |                                                                                   |                                                                                   |                                                                                     |                                                                                     |                                                                                     |
|----------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|                                  | 1                                                                                 | 2                                                                                 | 3                                                                                 | 4                                                                                   | 5                                                                                   | 6                                                                                   |
|                                  |  |  |  |  |  |  |
| Up to and including 2,8          | 0,2                                                                               | –                                                                                 | 0,4                                                                               | –                                                                                   | 0,4                                                                                 | –                                                                                   |
| Over 2,8 up to and including 3,0 | 0,25                                                                              | –                                                                                 | 0,5                                                                               | –                                                                                   | 0,5                                                                                 | –                                                                                   |
| Over 3,0 up to and including 3,2 | 0,3                                                                               | –                                                                                 | 0,6                                                                               | –                                                                                   | 0,6                                                                                 | –                                                                                   |
| Over 3,2 up to and including 3,6 | 0,4                                                                               | –                                                                                 | 0,8                                                                               | –                                                                                   | 0,8                                                                                 | –                                                                                   |
| Over 3,6 up to and including 4,1 | 0,7                                                                               | 1,2                                                                               | 1,2                                                                               | 1,2                                                                                 | 1,2                                                                                 | –                                                                                   |
| Over 4,1 up to and including 4,7 | 0,8                                                                               | 1,2                                                                               | 1,8                                                                               | 1,8                                                                                 | 1,8                                                                                 | –                                                                                   |
| Over 4,7 up to and including 5,3 | 0,8                                                                               | 1,4                                                                               | 2,0                                                                               | 2,0                                                                                 | 2,0                                                                                 | –                                                                                   |
| Over 5,3 up to and including 6,0 | –                                                                                 | 1,8                                                                               | 2,5                                                                               | 3,0                                                                                 | 3,0                                                                                 | –                                                                                   |
| Over 6                           | –                                                                                 | –                                                                                 | –                                                                                 | –                                                                                   | –                                                                                   | 0,8                                                                                 |

Column 1 applies to screws without heads if the screw, when tightened, does not protrude from the hole, and to other screws which cannot be tightened by means of a screwdriver with a blade wider than the diameter of the screw.

Column 2 applies to nuts of mantle terminals which are tightened by means of a screwdriver.

Column 3 applies to other screws which are tightened by means of a screwdriver.

Column 4 applies to nuts of mantle terminals in which the nut is tightened by means other than a screwdriver.

Column 5 applies to screws or nuts, other than nuts of mantle terminals, which are tightened by means other than a screwdriver.

Column 6 applies to nuts of switches with central hole fixing.

**Table 6 – Test values for flexion and pull out of copper conductors**

| Conductor cross-sectional area<br>mm <sup>2</sup> | Diameter of bushing hole <sup>a</sup><br>mm | Height $H$ <sup>b</sup><br>mm | Mass for conductor<br>kg |
|---------------------------------------------------|---------------------------------------------|-------------------------------|--------------------------|
| 0,5                                               | 6,5                                         | 260                           | 0,3                      |
| 0,75                                              | 6,5                                         | 260                           | 0,4                      |
| 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                      |
| 25,0                                              | 13,0                                        | 300                           | 4,5                      |

NOTE AWG sizes corresponding to mm<sup>2</sup> can be found in IEC 60999-1.

<sup>a</sup> If the bushing hole diameter is not large enough to accommodate the conductor without binding, a bushing having the next larger hole size may be used.

<sup>b</sup> Tolerance for height  $H = \pm 15$  mm.

**12.2.6** Terminals with screw clamping shall be so designed that they clamp the conductor reliably between metal surfaces.

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

*After each rotation test of 12.2.5, the pulling force given in Table 7 shall be applied to the conductor under test in accordance with 12.2.5. Clamping screws or nuts, if any, shall not be retightened for this test. The force shall be applied in one smooth and continuous application, for 1 min, in the direction of the axis of the conductor. During the test the conductor shall not come out of the terminal.*

**Table 7 – Relationship between pull force and cross-sectional area**

| Cross-sectional area<br>mm <sup>2</sup> | Pull force<br>N |
|-----------------------------------------|-----------------|
| 0,5                                     | 20              |
| 0,75                                    | 30              |
| 1,0                                     | 35              |
| 1,5                                     | 40              |
| 2,5                                     | 50              |
| 4                                       | 60              |
| 6                                       | 80              |
| 10                                      | 90              |
| 16                                      | 100             |
| 25                                      | 135             |

*After these tests, neither the terminals nor the clamping means shall have worked loose and the conductors shall show no deterioration impairing their further use.*

NOTE In the following countries, terminals allowing connection of two conductors are additionally tested with one rigid solid conductor and one rigid stranded conductor with the same cross-sectional area connected at the same time: DK, FI, NO, SE, ZA.

**12.2.7** Terminals with screw clamping shall be so designed or placed that neither a rigid solid conductor nor a wire of a stranded conductor can slip out while the clamping screws or nuts are tightened.

This requirement does not apply to lug terminals.

*Compliance is checked by the following test:*

*Terminals suitable for rigid conductors only are checked with rigid solid conductors and on a new set of specimens with rigid stranded conductors, if existing.*

NOTE “if existing” means that the conductor is available in the market where the product is sold and installed.

*Terminals suitable for rigid and flexible conductors are checked with rigid conductors as above and on a new set of specimens with flexible conductors.*

*The terminals are fitted with conductors having the largest cross-sectional area specified in Table 4.*

*Terminals intended for the looping-in of two or more conductors are checked fitted with the permissible number of conductors.*

*The terminals are fitted with conductors having the composition given in IEC 60228.*

*Before insertion into the clamping means of the terminal, wires of rigid (solid or stranded) conductors are straightened; rigid stranded conductors may, in addition, be twisted to restore them approximately to their original shape and flexible conductors are twisted in one direction so that there is a uniform twist of one complete turn in a length of approximately 20 mm.*

*The conductor is inserted into the clamping means of the terminal for the minimum distance prescribed or, where no distance is prescribed, until it just projects from the far side of the terminal and in the position most likely to allow the wire to escape.*

*The clamping screw(s) or nut(s) is (are) then tightened with a torque equal to two-thirds of the torque shown in the appropriate column of Table 5.*

*After the test, no wire of the conductors shall have escaped outside the clamping unit thus reducing creepage distances and clearance distances to values lower than those indicated in Table 23.*

**12.2.8** Terminals with screw clamping shall be so fixed or located within the switch that, when the clamping screws or nuts are tightened or loosened, the terminals shall not work loose from their fixing to the switch.

Movement of the terminal is allowed as long as it is sufficiently limited so as to prevent non-compliance with this document.

The use of sealing compound or resin is considered to be sufficient for preventing a terminal from working loose, provided that:

- the sealing compound or resin is not subject to stress during normal use, and
- the effectiveness of the sealing compound or resin is not impaired by temperatures attained by the terminal under the most unfavourable conditions specified in this document.

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

*A solid rigid copper conductor of the largest cross-sectional area specified in Table 4 is placed in the terminal.*

*Where rigid solid conductors do not exist, the test may be made with rigid stranded conductors.*

*Before insertion into the clamping means of the terminal, wires of rigid (solid or stranded) are straightened; rigid stranded conductors may, in addition, be twisted to restore them approximately to their original shape.*

*The conductor is inserted into the clamping means of the terminal for the minimum distance prescribed or, where no distance is prescribed, until it just projects from the far side of the terminal and in the position most likely to allow the wire to escape.*

*Screws and nuts are tightened and loosened five times by means of a suitable test screwdriver or spanner, the torque applied when tightening being equal to the torque shown in the appropriate column of Table 5 or in the table of the appropriate Figures 1 to 4, whichever is the highest.*

*A new conductor end is used each time the screw or nut is loosened.*

Where a screw has a hexagonal head with a slot and the values in columns 3 and 5 of Table 5 are different, the test is made twice, first on a set of three specimens applying to the hexagonal head the torque specified in column 5 and then on another set of three specimens, applying the torque specified in column 3 by means of a screwdriver. If the values in columns 3 and 5 are the same, only the test with the screwdriver is made.

During the test, terminals shall not work loose and there shall be no damage, such as breakage of screws or damage to the heads, slots (rendering the use of the appropriate screwdriver impossible), threads, washers or stirrups that will impair the further use of the terminals.

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

The shape of the blade of the test screwdriver shall suit the head of the screw to be tested. The screws and nuts shall be tightened in one smooth and continuous application of the torque.

**12.2.9** Clamping screws or nuts of earthing terminals with screw clamping 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 manual test.*

In general, the designs of terminals shown in Figures 1, 2, 3, 4 and 5 provide sufficient resiliency to comply with this requirement; for other designs, special provisions, such as the use of an adequately resilient part which is not likely to be removed inadvertently, may be necessary.

**12.2.10** Earthing terminals with screw clamping 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 terminals 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 other metal no less resistant to corrosion.

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

*Compliance is checked by inspection.*

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

**12.2.11** In case where the figures are used to verify the requirements of 12.2.1, the following applies.

For pillar terminals, the distance between the clamping screw and the end of the conductor, when fully inserted, shall be at least that specified in Figure 1.

NOTE The minimum distance between the clamping screw and the end of the conductor applies only to pillar terminals in which the conductor cannot pass right through.

For mantle terminals, the distance between the fixed part and the end of the conductor, when fully inserted, shall be at least that specified in Figure 5.

*Compliance is checked by measurement, after a solid conductor of the largest nominal cross-sectional area specified, for the appropriate rated current in Table 4, has been fully inserted and fully clamped.*

**12.2.12** Lug terminals shall be used only for switches having a rated current of 40 A or greater; if such terminals are provided, they shall be fitted with spring washers or equally effective locking means.

*Compliance is checked by inspection.*

### 12.3 Screwless terminals for external copper conductors

**12.3.1** Screwless terminals may be of the type suitable for rigid copper conductors only or of the type suitable for both rigid and flexible copper conductors.

*Terminals suitable for rigid conductors only are checked with rigid solid conductors and on a new set of specimens with rigid stranded conductors, if existing.*

NOTE “if existing” means that the conductor is available in the market where the product is sold and installed.

*For screwless terminals suitable for both rigid and flexible copper conductors, the tests are carried out with rigid conductors first and then repeated with flexible conductors.*

12.3 is not applicable to switches provided with:

- screwless terminals requiring the fixing of special devices to the conductors before clamping in the screwless terminal, for example flat push-on connectors;
- screwless terminals requiring twisting of the conductors, for example those with twisted joints;
- screwless terminals providing direct contact to the conductors by means of edges or points penetrating the insulation.

**12.3.2** Screwless terminals shall be provided with clamping units which allow the proper connection of rigid or of rigid and flexible copper conductors having nominal cross-sectional areas as shown in Table 8.

**Table 8 – Relationship between rated currents and connectable cross-sectional areas of copper conductors for screwless terminals**

| Rated current<br>A                                                                                                                                                                                                                                                  | Conductors                                       |                                           |                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|-------------------------------------------|----------------------------------------------|
|                                                                                                                                                                                                                                                                     | Nominal cross-sectional areas<br>mm <sup>2</sup> | Diameter of largest rigid conductor<br>mm | Diameter of largest flexible conductor<br>mm |
| Up to and including 4 <sup>a</sup>                                                                                                                                                                                                                                  | 0,75 to 1,5                                      | 1,5                                       | 1,8                                          |
| Above 4 and including 6                                                                                                                                                                                                                                             | 1 to 1,5                                         | 1,5                                       | 1,8                                          |
| Above 6 and including 16 <sup>b</sup>                                                                                                                                                                                                                               | 1,5 to 2,5                                       | 2,2                                       | 2,4                                          |
| NOTE In the following country, the largest diameter of flexible conductors above 6 A and including 16 A is 2,21 mm: CH.                                                                                                                                             |                                                  |                                           |                                              |
| <sup>a</sup> For special purposes such as ELV applications, conductors from 0,5 mm <sup>2</sup> up to 1 mm <sup>2</sup> inclusive can be used.                                                                                                                      |                                                  |                                           |                                              |
| <sup>b</sup> Each supply terminal of switches other than those of pattern numbers 3, 03 and 7 shall allow the connection of two 2,5 mm <sup>2</sup> conductors. In such cases a terminal with separate independent clamping means for each conductor shall be used. |                                                  |                                           |                                              |

*Compliance is checked by inspection and by fitting conductors of the smallest and largest cross-sectional areas specified.*

**12.3.3** Screwless terminals shall allow the conductor to be connected without special preparation.

*Compliance is checked by inspection.*

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.

**12.3.4** Parts of screwless terminals mainly intended for carrying current shall be of materials as specified in 22.5.

*Compliance is checked by inspection or by chemical analysis.*

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

**12.3.5** Screwless terminals shall be so designed that they clamp the specified conductors with sufficient contact pressure and without undue damage to the conductor.

The conductor shall be clamped reliably and between metal surfaces.

*Compliance is checked by inspection and by the test of 12.3.10.*

**12.3.6** It shall be clear how the connection and disconnection of the conductors is to be made.

The intended disconnection of a conductor shall require an operation, other than a pull on the conductor, so that it can be made manually with or without the help of a general purpose tool.

It shall not be possible to confuse the opening intended for the use of a tool to assist the connection or disconnection with the opening intended for the conductor.

In case the screwless terminal is intended for flexible conductors, the system shall allow release of the opening of the contact in order to allow the introduction and the disconnection of all the wires of the flexible conductor.

*Compliance is checked by inspection and by the following tests which are performed on new specimens:*

*Screwless-type clamping units are tested with the relevant conductors as given in 12.3.2 having the largest diameter.*

*Five insertions and disconnections are made with each type of conductor for which the clamping unit is intended to be used.*

*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 clamping units shall not be damaged in such a way as to impair their further use.*

**12.3.7** Screwless terminals which are intended to be used for the interconnection of two or more conductors shall be so designed that:

- each conductor is clamped individually;

NOTE The clamping of one of the conductors is independent of the clamping of the other conductor(s).

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

It shall be possible to clamp securely any number of conductors up to the maximum as designed.

*Compliance is checked by inspection and by manual tests with the appropriate conductors (in number and size).*

**12.3.8** Screwless terminals shall be so designed that adequate insertion of the conductor is obvious and over-insertion is prevented if further insertion is liable to reduce the creepage distances and/or clearances required in Table 23, or to influence the operation of the switch.

*Compliance is checked by inspection and by the test of 12.3.10.*

**12.3.9** Screwless terminals shall be properly fixed to the switch.

They shall not work loose when the conductors are connected or disconnected during installation.

*Compliance is checked by inspection and by the test of 12.3.10.*

Covering with sealing compound without other means of locking is not sufficient. However, self-hardening resins may be used to fix terminals which are not subject to mechanical stress in normal use.

**12.3.10** Screwless terminals shall withstand the mechanical stresses occurring in normal use.

*Compliance is checked by the following tests which are performed on three specimens of each type of terminal which has been used for 12.3.2.*

*Terminals suitable for rigid conductors only are checked with rigid solid conductors and on a new set of specimens with rigid stranded conductors, if existing.*

NOTE "if existing" means that the conductor is available in the market where the product is sold and installed.

*Terminals suitable for rigid and flexible conductors are checked with rigid conductors as above and on a new set of specimens with flexible conductors.*

*The terminal is placed in the test apparatus according to Figure 9.*

*The terminal is fitted first with*

- a) *the maximum number of conductors of the largest nominal cross-sectional area of the same type;*

*Then the test is repeated with*

- b) *the maximum number of conductors of the smallest nominal cross-sectional area of the same type,*

*according to Table 8.*

*If the terminal is fitted with more than one conductor, the test is done on each of the conductors consecutively.*



*The length of the test conductor shall be at least 75 mm longer than the height H specified in Table 6.*

*The test conductor is then connected in the clamping unit in the intended manner.*

*The end of the conductor shall be passed through an appropriate sized bushing in a platen positioned at a height H below the equipment as given in Table 6. The bushing shall be positioned, in a horizontal plane, such that its centre line describes a circle of 75 mm diameter, concentric with the centre of the clamping unit, in the horizontal plane; the platen is then rotated at a rate of  $(10 \pm 2)$  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 6. The bushing may be lubricated to prevent binding, twisting or rotation of the insulated conductor.*

*Each conductor introduced in the screwless terminal is subjected for 15 min to a circular motion with  $(10 \pm 2)$  r/min using an apparatus, an example of which is shown in Figure 9. The conductor is subjected to a pull having a value shown in Table 6.*

*During the test the conductors shall not move noticeably in the clamping unit.*

*After each rotation test, the pulling force given in Table 7 shall be applied to the conductor under test. The force shall be applied in one smooth and continuous application, for 1 min, in the direction of the axis of the conductor.*

*During the test, the rigid conductor, or any wire of rigid stranded or flexible conductor, shall neither slip out of the clamping unit nor break near the clamping unit, nor shall the conductor be damaged in such a way as to render it unfit for further use.*

*In the case of the flexible conductor, the break of a few wires shall not be taken into account provided it does not exceed 15 % of the original number of wires.*

*After these tests, neither the terminals nor the clamping means shall have worked loose and the conductors shall show no deterioration impairing their further use.*

**12.3.11** Screwless terminals shall withstand the electrical and thermal stresses occurring in normal use.

*Compliance is checked by the following tests a) and b), which are carried out on five screwless terminals of accessories which have not been used for any other test.*

*Both tests are carried out with new copper conductors.*

- a) *For screwless terminals accepting rigid solid conductors, the test is carried out by loading the screwless terminals for 1 h with an alternating current (DC current and extra low voltage may be used) as specified in Table 9 and connecting rigid solid conductors 1 m long having the nominal cross-sectional area as specified in the same table.*

*The test is carried out on each clamping unit.*

**Table 9 – Test current for the verification of electrical and thermal stresses in normal use for screwless terminals**

| Rated current             | Test current | Nominal cross-sectional area of the conductor |
|---------------------------|--------------|-----------------------------------------------|
| A                         | A            | mm <sup>2</sup>                               |
| Up to and including 4     | 9            | 0,75                                          |
| Above 4 and including 6   | 13,5         | 1                                             |
| Above 6 and including 13  | 17,5         | 1,5                                           |
| Above 13 and including 16 | 22           | 2,5                                           |

*During the test, the current is not passed through the accessories but only through the terminals.*

*Immediately after this period, the voltage drop across each screwless terminal is measured with rated current flowing.*

*In no case shall the voltage drop exceed 15 mV.*

*The measurements are made across each screwless terminal and as near as possible to the place of contact.*

*If the back connection of the terminal is not accessible, the second connecting point in the case of two-way switches may be used for the returning wire; in the case of one-way switches the specimens may be adequately prepared by the manufacturer; care should be taken not to affect the behaviour of the terminal.*

*Care should be taken to ensure that, during the period of the test, including the measurements, the conductors and the measurement devices are not moved noticeably.*

*b) The screwless terminals already subjected to the determination of the voltage drop specified in the previous test a) are tested as follows.*

*During the test, a current equal to the test current value given in Table 9 is passed.*

*The whole test arrangement, including the conductors, shall not be moved until the measurements of the voltage drop have been completed.*

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

- *the current flows for approximately 30 min;*
- *for a further period of approximately 30 min no current flows.*

*The voltage drop in each screwless terminal is determined as prescribed for the test of a) and is done at the following moments:*

- *after the first 24 temperature cycles and after the 192 temperature cycles;*
- *additional measurements to be done after any three of the following temperature cycles: after the 48th, 72nd, 96th, 120th, 144th or 168th temperature cycles.*

*In no case shall the voltage drop exceed 22,5 mV or twice the value measured after the 24th cycle, whichever is the smaller.*

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

**12.3.12** Screwless terminals shall be so designed that the connected rigid conductor remains clamped, even when it has been deflected during normal installation, for example during mounting in a box, and the deflecting stress is transferred to the clamping unit.

This test need not be carried out with flexible conductors.

*Compliance is checked by the following test which is made on three specimens of switches which have not been used for any other test.*

*Terminals are checked with rigid solid and rigid stranded conductors, if existing.*

NOTE 1 “if existing” means that the conductor is available in the market where the product is sold and installed.

*The test apparatus, the principle of which is shown in Figure 10a, shall be so constructed that:*

- *a specified conductor properly inserted into a terminal is allowed to be deflected in any of the 12 directions differing from each other by 30°, with a tolerance referred to each direction of  $\pm 5^\circ$ , and*
- *the starting point can be varied by 10° and 20° from the original point.*

*A reference point need not be specified.*

*The deflection of the conductor from its straight position to the testing positions shall be effected by means of a suitable device applying a specified force to the conductor at a certain distance from the terminal.*

*The deflecting device shall be so designed that:*

- *the force is applied in the direction perpendicular to the undeflected conductor;*
- *the deflection is attained without rotation or displacement of the conductor within the clamping unit, and*
- *the force remains applied while the prescribed voltage drop measurement is made.*

*Provision shall be made so that the voltage drop across the clamping unit under test can be measured when the conductor is connected, as shown for example in Figure 10b.*

*The specimen is mounted on the fixed part of the test apparatus in such a way that the specified conductor inserted into the clamping unit under test can be freely deflected.*

*To avoid oxidation, the insulation of the wire shall be removed immediately before starting the test.*

NOTE 2 If necessary, the inserted conductor can be permanently bent around obstacles, so that these do not influence the results of the test.

NOTE 3 In some cases, with the exception of the case of guidance for the conductor, it may be advisable to remove those parts of the specimens which do not allow the deflection of the conductor corresponding to the force to be applied.

*A clamping unit is fitted as for normal use with a rigid solid copper conductor having the smallest cross-sectional area specified in Table 10 and is submitted to a first test sequence. The same clamping unit is submitted to a second test sequence using the conductor having the largest cross-sectional area, unless the first test sequence has failed.*

The force for deflecting the conductor is specified in Table 11, the distance of 100 mm being measured from the extremity of the terminal, including the guidance, if any, for the conductor, to the point of application of the force to the conductor.

**Table 10 – Cross-sectional areas of rigid copper conductors  
for deflection test of screwless terminals**

| Rated current of the switch<br>A                                                                           | Cross-sectional area of the test conductor<br>mm <sup>2</sup> |                               |
|------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|-------------------------------|
|                                                                                                            | 1 <sup>st</sup> test sequence                                 | 2 <sup>nd</sup> test sequence |
| ≤ 6                                                                                                        | 1,0 <sup>a</sup>                                              | 1,5                           |
| Above 6 up to and including 16                                                                             | 1,5                                                           | 2,5                           |
| <sup>a</sup> Only for countries allowing the use of 1,0 mm <sup>2</sup> conductors in fixed installations. |                                                               |                               |

**Table 11 – Deflection test forces**

| Cross-sectional area of the test conductor<br>mm <sup>2</sup>                                           | Force for deflecting the test conductor <sup>a</sup><br>N |
|---------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| 1,0                                                                                                     | 0,25                                                      |
| 1,5                                                                                                     | 0,5                                                       |
| 2,5                                                                                                     | 1,0                                                       |
| <sup>a</sup> The forces are chosen so that they stress the conductors close to the limit of elasticity. |                                                           |

The test is made with continuous current (i.e. the current is not switched on and off during the test). A suitable power supply should be used and an appropriate resistance should be inserted in the circuit so that the current variations are kept within  $\pm 5\%$  during the test.

A test current equal to the rated current of the switch is passed through the clamping unit under test. A force according to Table 11 is applied to the test conductor inserted in the clamping unit under test in one of the 12 directions shown in Figure 10a and the voltage drop across this clamping unit is measured. The force is then removed.

The force is then applied successively in each one of the remaining 11 directions shown in Figure 10a following the same test procedure.

If for any of the 12 test directions the voltage drop is greater than 25 mV, the force is maintained in this direction until the voltage drop is reduced to a value below 25 mV, but for not more than 1 min. After the voltage drop has reached a value below 25 mV, the force is 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 specimens of switches of the set are tested following the same test procedure, but moving the 12 directions of the force so that they differ by approximately  $10^\circ$  for each specimen. If one specimen has failed at one of the directions of application of the test force, the tests are repeated on another set of specimens, all of which shall comply with the repeated tests.

## 22 Screws, current-carrying parts and connections

### 22.1 General

Add the following requirement after the third paragraph:

The requirements of Clause 22 are not applicable to terminals unless otherwise mentioned. The requirements for the verification of terminals are given in Clause 12.

*Replace the fourth paragraph by the following:*

*Compliance is checked by inspection and, for screws and nuts transmitting contact pressure or which are operated when connecting up the accessory, by the following test.*

*Delete NOTE 1.*

*Replace the seventh paragraph by the following:*

*The test is made by means of a suitable test screwdriver or a suitable tool, applying the relevant torque as specified in Table 5.*

*Delete the eighth paragraph:*

*The conductor is moved each time the screw or nut is loosened.*

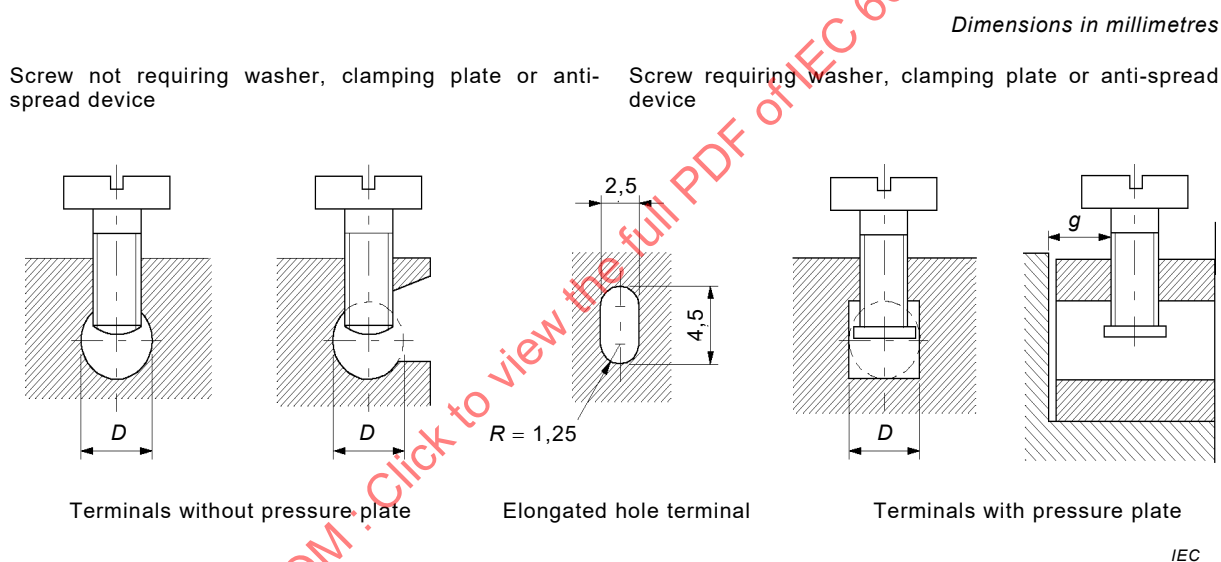


**Figure 1 – Pillar terminals**

*Replace Figure 1 with the following new Figure 1, which includes modified minimum diameter values for 10 mm<sup>2</sup>, 16 mm<sup>2</sup> and 25 mm<sup>2</sup> cross-sections:*

| Cross-section of conductor accepted by the terminal<br>mm <sup>2</sup> | Minimum diameter <i>D</i> (or minimum dimensions) of conductor space<br>mm | Minimum distance <i>g</i> between clamping screw and end of conductor when fully inserted<br>mm |     | Torque<br>Nm   |            |                |            |                |            |
|------------------------------------------------------------------------|----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-----|----------------|------------|----------------|------------|----------------|------------|
|                                                                        |                                                                            |                                                                                                 |     | 1 <sup>a</sup> |            | 3 <sup>a</sup> |            | 4 <sup>a</sup> |            |
|                                                                        |                                                                            |                                                                                                 |     | One screw      | Two screws | One screw      | Two screws | One screw      | Two screws |
| Up to 1,5                                                              | 2,5                                                                        | 1,5                                                                                             | 1,5 | 0,2            | 0,2        | 0,2            | 0,4        | 0,4            | 0,4        |
| 2,5<br>(circular hole)                                                 | 3,0                                                                        | 1,5                                                                                             | 1,5 | 0,25           | 0,2        | 0,5            | 0,4        | 0,5            | 0,4        |
| 2,5<br>(elongated hole)                                                | 2,5 × 4,5                                                                  | 1,5                                                                                             | 1,5 | 0,25           | 0,2        | 0,5            | 0,4        | 0,5            | 0,4        |
| 4                                                                      | 3,6                                                                        | 1,8                                                                                             | 1,5 | 0,4            | 0,2        | 0,8            | 0,4        | 0,7            | 0,4        |
| 6                                                                      | 4,0                                                                        | 1,8                                                                                             | 1,5 | 0,4            | 0,25       | 0,8            | 0,5        | 0,8            | 0,5        |
| 10                                                                     | 5,2                                                                        | 2,0                                                                                             | 1,5 | 0,7            | 0,25       | 1,2            | 0,5        | 1,2            | 0,5        |
| 16                                                                     | 6,4                                                                        | 2,5                                                                                             | 2,0 | 0,8            | 0,7        | 2,0            | 1,2        | 2,0            | 1,2        |
| 25                                                                     | 7,9                                                                        | 3,0                                                                                             | 2,0 | 1,2            | 0,7        | 2,5            | 1,2        | 3,0            | 1,2        |

<sup>a</sup> The values specified apply to the screws covered by the corresponding columns in Table 5.

## Annex C (informative)

### Circuit development (19.3)

#### C.1 Rationale

Due to the phasing out of incandescent lamps and the replacement of these lamps by self ballasted lamps, a joint forum between IEC technical committees 23B, 34A, 77A and 17B was formed to discuss the technical consequences of this change.

One of the main impacts for switches is the change in inrush currents when switching these energy efficient lamps in comparison to incandescent lamps.

The joint forum fixed the maximum values for one lamp. The source impedance  $Z_{\text{mains}}$  as shown in Table C.1 was added to be able to test the lamp. This will be covered by the lamp standards (for example IEC 60969).

**Table C.1 – Lamp**

| $P$ [W]          | $V_{\text{mains}}$ [Vrms] | $I_{\text{peak}}$ [A] | $I^2t$ [A <sup>2</sup> s] | $Z_{\text{mains}}$                     |
|------------------|---------------------------|-----------------------|---------------------------|----------------------------------------|
| $P \leq 15$      | 120                       | 60                    | 0,5                       | $0,450 \, \Omega + 100 \, \mu\text{H}$ |
| $P \leq 15$      | 230                       | 20                    | 0,08                      | $0,2 \, \Omega + 400 \, \mu\text{H}$   |
| $15 < P \leq 25$ | 120                       | 60                    | 0,5                       | $0,450 \, \Omega + 100 \, \mu\text{H}$ |
| $15 < P \leq 25$ | 230                       | 35                    | 0,15                      | $0,2 \, \Omega + 400 \, \mu\text{H}$   |

The value of  $I_{\text{peak}}$  and  $I^2t$  shown in Table C.1 represent the highest value that can occur at the moment the contact mechanism closes.

#### C.2 $I_{\text{peak}}$ and $I^2t$ for normal operation tests

##### C.2.1 General

Where 19.2 in IEC 60669-1:1998 and IEC 60669-1:1998/AMD2:2006 is based on the principle to define an equivalent circuit which results in an  $I_{\text{peak}}$  and  $I^2t$  value, 19.3 in this document uses the values of  $I_{\text{peak}}$  and  $I^2t$  as the reference. This approach has been preferred, as within testing environments it is not always possible to reach the ideal parameters of  $Z_{\text{mains}}$ . In this approach equivalent circuits can be adjusted to reach the required values within the tolerances given in this document.

##### C.2.2 Switching a single lamp

For the purpose of this test the lamp with a  $P = 15 \text{ W}$  has been used. This load results in the higher  $I_{\text{peak}}/W$  ratio compared to the  $25 \text{ W}$  lamp and is used for C.2.3 when added to get higher loads.

For the calculation a prospective short circuit current of  $3\,000 \text{ A}$  was used which was considered adequate.

The  $R$  and  $C$  values of the equivalent circuit of the lamps in Figure C.1 and Figure C.2 are calculated from Table C.1.

The  $Z_{\text{mains}}$  of these networks are:

- (120 V; 60 Hz;  $I_{pSCC} = 3\,000\text{ A}$ ;  $\cos \varphi = 0,9$ ):  
 $0,036\ \Omega + 46,25\ \mu\text{H} + \text{cables } 0,25\ \Omega + 20\ \mu\text{H} = 0,286\ \Omega + 66,25\ \mu\text{H}$
- (230 V; 50 Hz;  $I_{pSCC} = 3\,000\text{ A}$ ;  $\cos \varphi = 0,9$ ):  
 $0,069\ \Omega + 106\ \mu\text{H} + \text{cables } 0,25\ \Omega + 20\ \mu\text{H} = 0,319\ \Omega + 126\ \mu\text{H}$

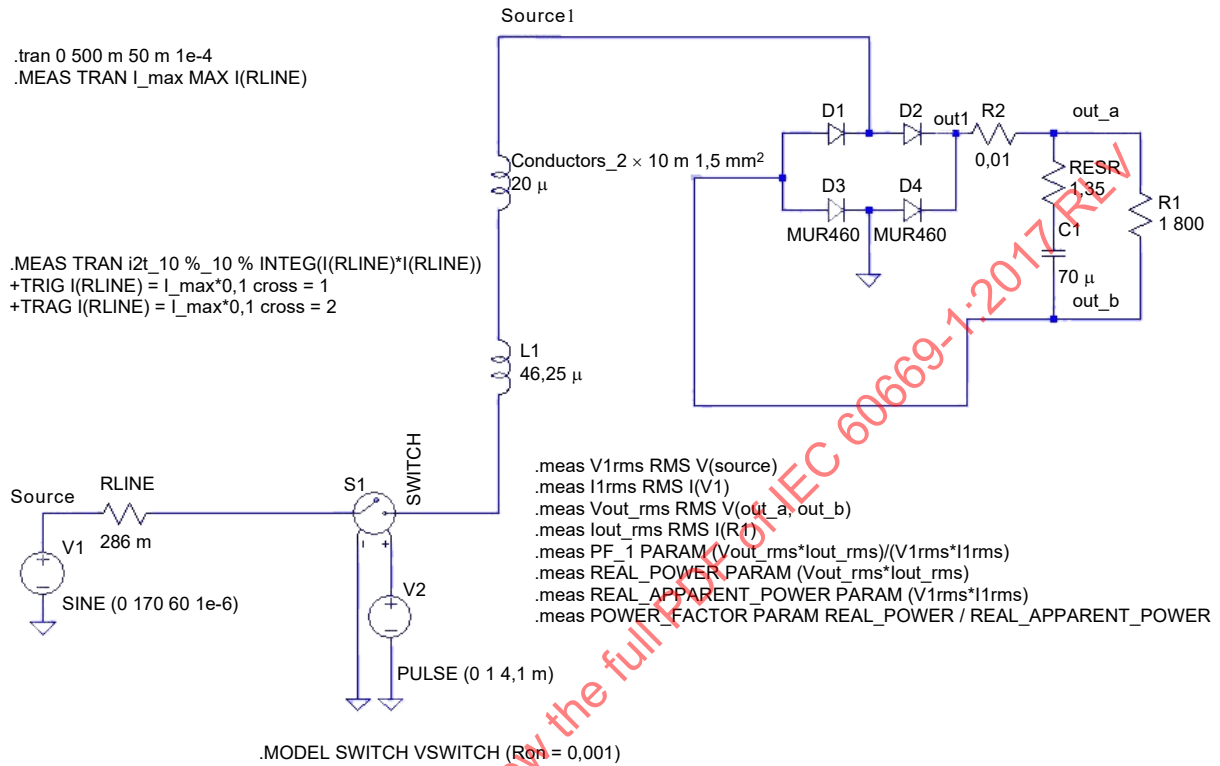
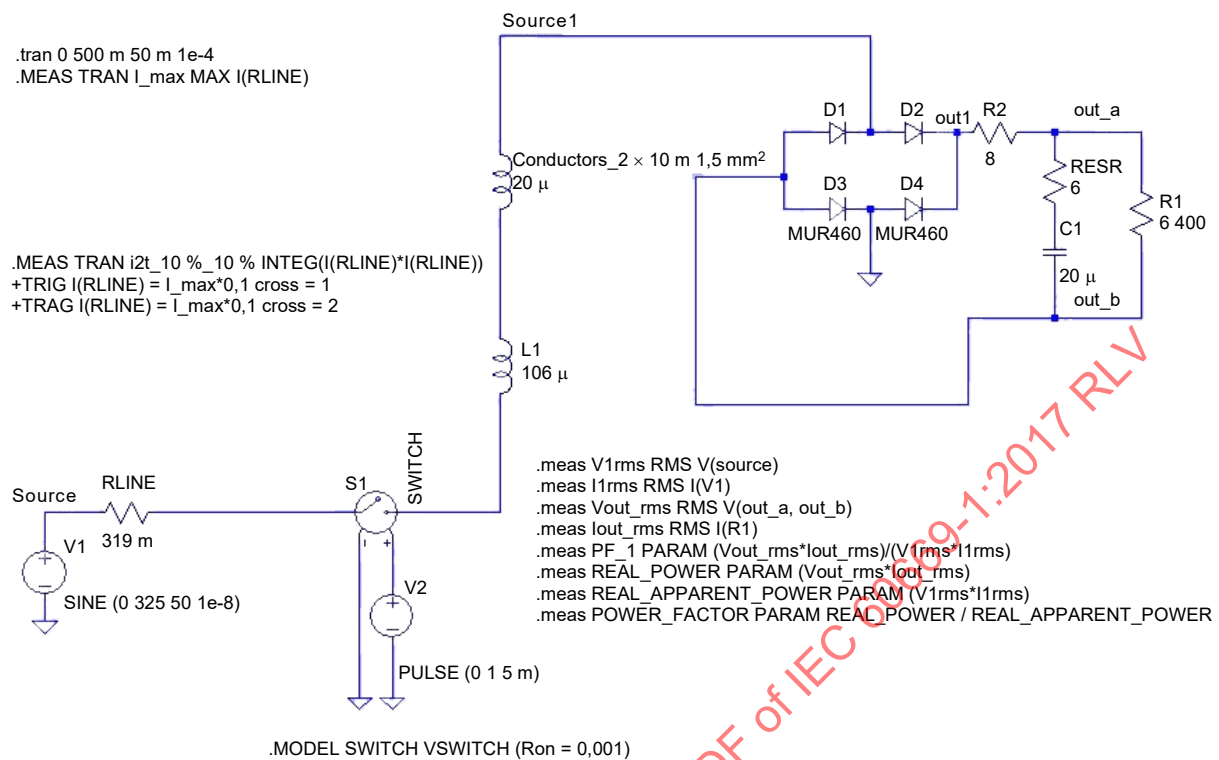


Figure C.1 – 120 V 15 W (LT spice model)





IEC

Figure C.2 – 230 V 15 W (LT spice model)

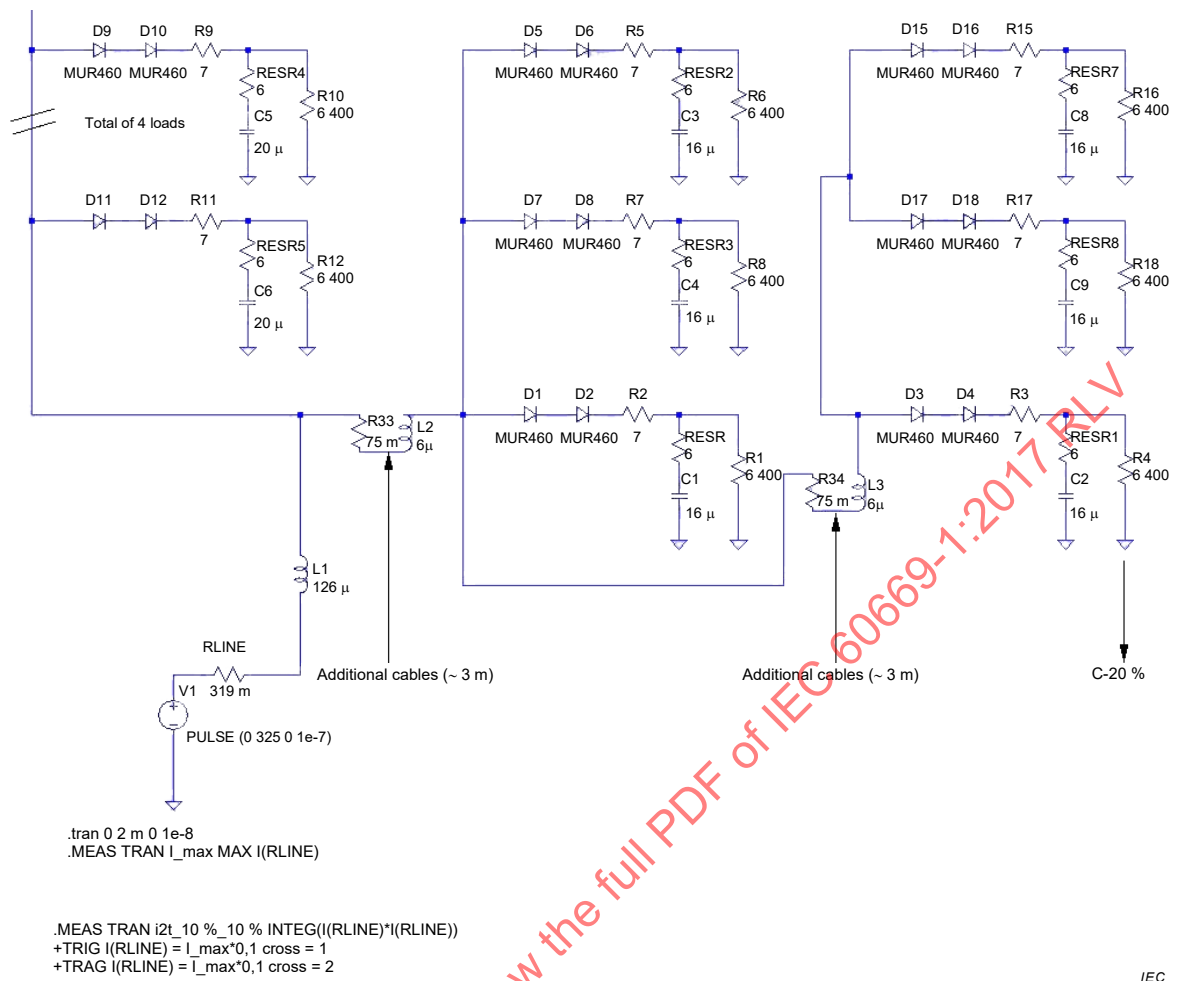
Attention: R1 in Figures C.1 and C.2 is not the  $R_1$  of Figure 12.

### C.2.3 Switching multiple lamps

Multiple lamp loads, an example of which is shown in Figure C.3, are obtained by combining single lamps with a power of 15 W.

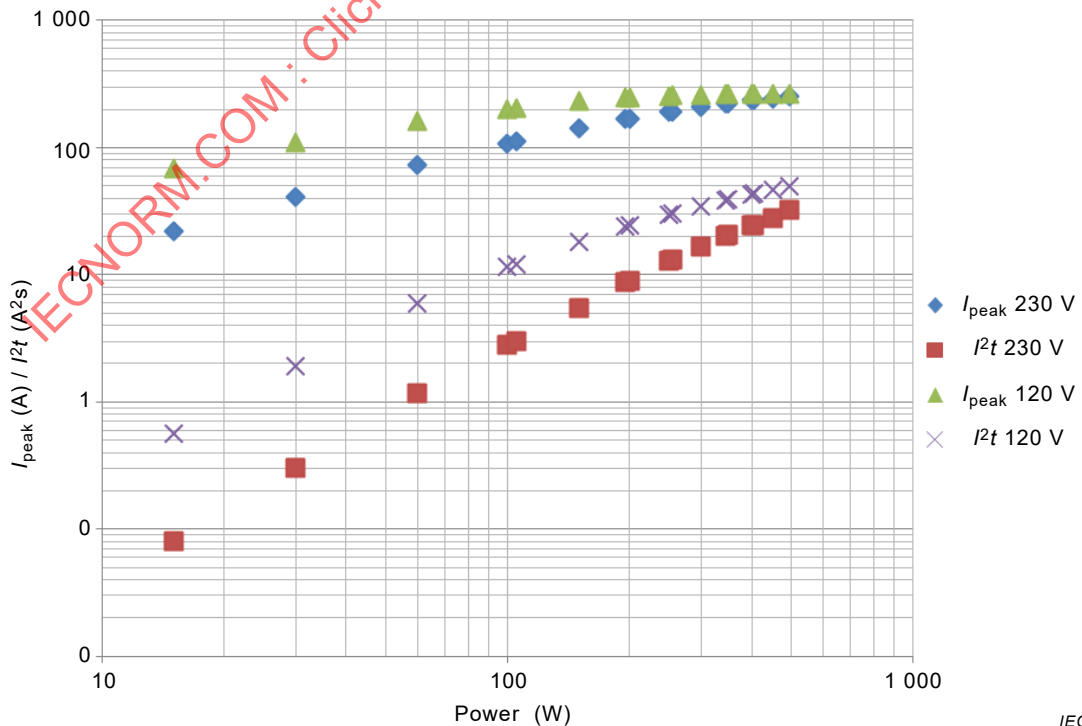
The  $I_{peak}$  and  $I^2t$  values (see Figure C.4) for multiple lamps are based on the following principles:

- Up to 60 W (four lamps) the worst conditions apply:
  - 15 W lamps which give the highest  $I_{peak}$  and  $I^2t$  value as given in Table C.1;
  - the network impedance as given in C.2.2.
- For higher power lamp loads:
  - for every three additional lamps 3 m of cables have been added (75 mΩ + 6 μH);
  - the bulk capacitor within each additional lamp uses the nominal value and not the worst case as given in Table C.1;
  - the values have been interpolated to fit the nominal values of Table 19.



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Figure C.3 – Model for multiple lamp loads



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Figure C.4 –  $I_{peak}$  and  $I^2t$  for multiple lamp loads

## **Annex D** (informative)

### **Additional requirements for insulation-piercing terminals**

Annex D is provided for information to show the changes planned for the future to introduce requirements for insulation-piercing terminals into IEC 60669-1.

The purpose of Annex D is to bring additional explanations and requirements to the normative text of this document. Therefore the numbering of clauses, subclauses, figures and tables follows that of the main body of the text. Only the relevant clauses, subclauses, tables and figures are cited. Any additional tables and figures are numbered starting from D.

Annex D is written in such a way that it will amend the main text, when the requirements for IPT are incorporated.

#### **1 Scope**

*Replace the second paragraph by:*

For switches provided with screwless terminals or insulation-piercing terminals, the rated current is limited to 16 A.

#### **3 Terms and definitions**

*Add the following new definitions:*

##### **3.24**

##### **insulation-piercing terminal IPT**

connecting device for the connection and possible disconnection of one conductor or two or more conductors, the connection being made by piercing, boring through, cutting through, removing, 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 sheath of the cable, if necessary, is not considered as a previous stripping.

Note 2 to entry: Examples of insulation-piercing terminals are given in Figure D.1.

##### **3.24.1**

##### **reusable insulation-piercing terminal**

insulation-piercing terminal that can be used more than once

##### **3.24.2**

##### **non-reusable insulation-piercing terminal**

insulation-piercing terminal that can be used only once

Note 1 to entry: The accessory can only be removed from the circuit by cutting the conductors or when removing the accessory, it is damaged in such a way that it can not be reused.

##### **3.25**

##### **clamping unit**

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

## 5 General remarks on tests

Add the following Table D.1 at the end of Clause 5:

**Table D.1 – Specimens needed for Clause 12 for insulation-piercing terminals (IPTs)**

| Subclause                                                                                                                                                                                                                                                                                                                                                              | Reusable                                                                                           | Non-reusable                                                                                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| 12.4.2                                                                                                                                                                                                                                                                                                                                                                 | 2 new terminals of each type of construction                                                       | 2 new terminals of each type of construction                                                |
| 12.4.3                                                                                                                                                                                                                                                                                                                                                                 | 4 new terminals of each type of construction                                                       | NA                                                                                          |
| 12.4.10                                                                                                                                                                                                                                                                                                                                                                | 6 new terminals <sup>a</sup> of each type of construction previously submitted to the test of 15.1 | 6 or 12 new terminals of each type of construction previously submitted to the test of 15.1 |
| 12.4.11                                                                                                                                                                                                                                                                                                                                                                | 12 new terminals of each type of construction                                                      | 12 new terminals of each type of construction                                               |
| <sup>a</sup> The terminals of specimens “ABC” shall be used. If more terminals are necessary, new specimens which have been previously submitted to the test of 15.1 may be used.<br><br>NOTE If the IPT is declared as suitable for stripped and unstripped conductors, the specimens needed are twice the number of specimens shown in the table, except for 12.4.3. |                                                                                                    |                                                                                             |

## 7 Classification

**7.8** according to the type of terminal:

Add the following new list items at the end:

- switches with IPTs for rigid conductors only;
- switches with IPTs for rigid and flexible conductors.

Add the following new numbered paragraphs:

**7.10** IPT classification according to the method of making the connection

- with a general purpose tool;
- with a special tool; only allowed for non-reusable IPT;
- by hand.

**7.11** IPT classification according to reusability:

- reusable IPTs;
- non-reusable IPTs.

Switches provided with non-reusable IPTs can only be used in trunking systems according to IEC 61084 (all parts).

## 8 Marking

### 8.1 General

Add the following new list item after m):

- n) length of the conductor to be inserted into the IPT, if applicable.

Add the following new subclause:

## 8.9 Manufacturer information

The following shall be indicated on the manufacturer's documentation for IPTs:

- the connection and disconnection procedure, if necessary;
- the method of connection according to 7.1.10, if necessary;
- for non-reusable IPTs, information that the product shall only be used in cable trunking systems and how the product shall be installed in order to have the possibility to replace it without impairing the safety of the installation;
- an indication that the switch is equipped with non-reusable IPTs, if applicable;
- a clear information that the conductor shall not be stripped before connecting it to the terminal, unless the manufacturer has designed the product for this purpose.

## 12 Terminals

### 12.1 General

*Replace the first paragraph by the following:*

Switches shall be provided with either terminals having screw clamping, screwless terminals, or insulation-piercing terminals (IPTs).

*Replace the third paragraph by the following:*

The tests of 12.2.8, 12.3.9 (including the test of 12.3.10), and 12.4.9 (including the test of 12.4.10) shall be carried out after the test of 15.4.

*Replace the fourth paragraph by the following:*

*Compliance is checked by inspection and by the tests of 12.2 or 12.3 or 12.4, as applicable.*

*Add the following new subclause:*

### 12.4 IPTs for external copper conductors

**12.4.1** IPTs shall be of the type suitable for rigid copper conductors only or shall be of the type suitable for both rigid and flexible conductors.

**12.4.2** IPTs shall be provided with clamping units which allow the proper connection of rigid or of rigid and flexible copper conductors having nominal cross-sectional areas as shown in Table D.2. IPTs shall accept insulated conductors having the maximum outer diameter specified in Table D.2 or as specified by the manufacturer for other insulation types.

It shall be possible to connect an unprepared conductor into the IPTs.

The construction of IPTs shall be such that the contact pressure is transmitted by metallic parts. An IPT where the contact pressure is transmitted only through insulating material is not allowed.

**Table D.2 – Relationship between rated currents and connectable cross-sectional areas of copper conductors for insulation-piercing terminals**

| Rated current<br>A                                                                                                                                                                                                                   | Nominal cross-sectional areas<br>mm <sup>2</sup> | Conductors                                        |                                                      | Isolated conductor                                                               |                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|---------------------------------------------------|------------------------------------------------------|----------------------------------------------------------------------------------|----------------------------------------------------------------------------|
|                                                                                                                                                                                                                                      |                                                  | Diameter of the largest rigid conductor<br><br>mm | Diameter of the largest flexible conductor<br><br>mm | Outer diameter of the largest rigid stranded conductor<br>60227 IEC 01<br><br>mm | Outer diameter of the largest flexible conductor<br>60227 IEC 08<br><br>mm |
| Up to and including 4 <sup>a</sup>                                                                                                                                                                                                   | 0,75 to 1,5                                      | 1,7                                               | 1,8                                                  | 3,3                                                                              | 3,4                                                                        |
| Above 4 and including 6                                                                                                                                                                                                              | 1 to 1,5                                         | 1,7                                               | 1,8                                                  | 3,3                                                                              | 3,4                                                                        |
| Above 6 and including 16 <sup>b</sup>                                                                                                                                                                                                | 1,5 to 2,5                                       | 2,2                                               | 2,4                                                  | 4,0                                                                              | 4,1                                                                        |
| NOTE These values are based on PVC isolated conductors according to IEC 60227 (all parts); for rubber isolated conductors according to IEC 60245 (all parts) other values can apply.                                                 |                                                  |                                                   |                                                      |                                                                                  |                                                                            |
| <sup>a</sup> For special purposes such as ELV applications, conductors from 0,5 mm <sup>2</sup> up to 1 mm <sup>2</sup> inclusive can be used.                                                                                       |                                                  |                                                   |                                                      |                                                                                  |                                                                            |
| <sup>b</sup> Each switch other than those of pattern numbers 3 and 03 shall be designed to permit the continuity of the supply line. This can be achieved by a terminal with separate independent clamping units for each conductor. |                                                  |                                                   |                                                      |                                                                                  |                                                                            |

*Compliance is checked for each type of terminal construction by inspection made by measurement and/or by fitting conductors of the smallest and largest cross-sectional areas of all kinds of conductor accepted by the terminal, and when applicable, with unstripped and stripped conductors.*

**12.4.3** Reusable IPTs shall be designed in such a way that no insulating material of the conductor remains inside the terminal impairing their further use if a new conductor is connected and disconnected.

*Compliance is checked by connecting and disconnecting five times the same conductor with the largest and smallest cross-sectional area of all kinds of conductor accepted by the terminal as given in Table D.2, rotating the conductor for each application in such a way that it is not connected twice at the same place.*

*If the insulating material of the conductor remains inside the switch, it shall be possible to withdraw it, and the terminal shall not be damaged in such a way as to impair its further use.*

**12.4.4** Parts of IPTs mainly intended for carrying current shall be of materials as specified in 22.5.

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

NOTE Additional springs and the like are not considered as parts mainly intended to carry current.

**12.4.5** IPTs shall be so designed that they clamp the specified conductors with sufficient contact pressure and without undue damage to the conductor.

The conductor shall be clamped reliably and between metal surfaces.

*Compliance is checked by inspection and by the test of 12.4.10.*

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

It shall not be possible to confuse the opening for the use of a tool to assist the connection or disconnection with the opening intended for the connection of the conductor.

*Compliance is checked by inspection and by the test of 12.4.10.*

**12.4.7** IPTs which are intended to be used for the interconnection of two or more conductors shall be so designed that:

- each conductor is clamped individually;  
NOTE The clamping of one of the conductors is independent of the clamping of the other conductor(s).
- during the connection or for reusable IPT disconnection, the conductors can be connected or disconnected either at the same time or separately;
- each conductor is introduced in a separate clamping unit (not necessarily in separate holes).

It shall be possible to clamp securely any number of conductors up to the maximum as designed.

*Compliance is checked by inspection.*

**12.4.8** IPTs shall be designed so that adequate insertion of the conductor is obvious and over-insertion is prevented if further insertion is liable to reduce the creepage distances and/or clearances required in Table 23, or to influence the operation of the accessory.

*Compliance is checked by inspection.*

**12.4.9** IPTs shall be properly fixed to the switch.

They shall not work loose when the conductors are connected or disconnected during installation.

*Compliance is checked by inspection and by the test of 12.4.10.*

Covering with sealing compound without other means of locking is not sufficient. However, self-hardening resins may be used to fix terminals which are not subject to mechanical stress in normal use.

**12.4.10** IPTs shall withstand the mechanical stresses occurring in normal use.

*For reusable IPT, compliance is checked by the following tests which are performed on one terminal of each type of terminal construction of the three specimens.*

*Terminals suitable for rigid conductors only are checked with rigid solid and rigid stranded conductors in a new set of specimens, if existing.*

NOTE “if existing” means that the conductor is available in the market where the product is intended to be sold and installed.

*Terminals suitable for rigid and flexible conductors are checked with rigid solid conductors and on a new set of specimens with flexible conductors.*

*For non-reusable IPTs for rigid conductors, compliance is checked by the following test which is performed on six specimens of each type of terminal: three with the smallest conductor cross-sectional area and three with the largest conductor cross-sectional area. The same number of specimens is also needed if the IPT is also suitable for flexible conductors.*

If the terminals are also designed to connect stripped conductors, then all tests need to be repeated on a new set of specimens with stripped conductors.

*The terminal is placed in the test apparatus according to Figure 10.*

*The terminal is fitted first with*

- a) the maximum number of conductors of the largest nominal cross-sectional area of the same type;*

*then the test is repeated with*

- b) the maximum number of conductors of the smallest nominal cross-sectional area of the same type,*

*according to Table D.2.*

*If the terminal is fitted with more than one conductor, the test is done on each of the conductors consecutively.*

*The length of the test conductor shall be at least 75 mm longer than the height H specified in Table 6.*

*The test conductor is then connected in the clamping unit in the intended manner.*

*The end of the conductor shall be passed through an appropriate sized bushing in a platen positioned at a height H below the equipment as given in Table 6. The bushing shall be positioned, in a horizontal plane, such that its centre line describes a circle of 75 mm diameter, concentric with the centre of the clamping unit, in the horizontal plane; the platen is then rotated at a rate of  $(10 \pm 2)$  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 6. The bushing may be lubricated to prevent binding, twisting or rotation of the insulated conductor.*

*Each conductor introduced in the IPT is subjected for 15 min to a circular motion with  $(10 \pm 2)$  r/min using an apparatus, an example of which is shown in Figure 10. The conductor is subjected to a pull having a value shown in Table 6.*

*After each rotation test, the pulling force given in Table 7 shall be applied to the conductor under test. The force shall be applied in one smooth and continuous application, for 1 min, in the direction of the axis of the conductor.*

*During the test, the rigid solid conductor, or any wire of rigid stranded, or flexible conductor, shall neither slip out of the clamping unit nor break near the clamping unit.*

*After these tests, neither the terminals nor the clamping means shall have worked loose and the conductors shall show no deterioration impairing their further use.*

*In the case of the flexible conductor, the break of individual wires of the conductor shall not be taken into account.*

*In addition, no lack of the insulating material of the conductor shall be observed, in order to be sure that no piece of insulating material has remained inside the terminal.*

**12.4.11** IPTs shall withstand the electrical and thermal stresses occurring in normal use.



*Compliance is checked by the following test, which is carried out on 12 new IPTs which have not been used for any other test.*

*Terminals suitable for rigid conductors only are checked with rigid solid and rigid stranded conductors, if existing.*

NOTE “if existing” means that the conductor is available in the market where the product is intended to be sold and installed.

*Terminals suitable for rigid and flexible conductors are checked with rigid solid conductors and with flexible conductors.*

If the terminals are also designed to connect stripped conductors, then all tests need to be repeated on a new set of specimens with stripped conductors.

*The test is made with new copper conductors having the minimum and maximum cross-sectional areas according to Table D.2.*

*Before the test on the reusable IPTs, a rigid solid conductor having the largest cross-sectional area is connected and disconnected once.*

*Conductors having the smallest cross-sectional area are connected, as in normal use, to each of three IPTs and conductors having the largest cross-sectional area are connected, as in normal use, to each of the other three IPTs.*

*To ensure normal cooling of terminals, the conductors connected to them shall have a length of at least 1 m.*

*The use of alternating current is preferable but direct current and extra low voltage are 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  $(20 \pm 2) ^\circ\text{C}$ .*

*Except during the cooling period the test current as defined in Table 8 is applied. The test current shall be applied for the initial 30 min of each cycle.*

*The IPTs 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  $40 ^\circ\text{C}$ .*

*It is maintained within  $\pm 5 ^\circ\text{C}$  of this value for approximately 10 min. The IPTs are then allowed to cool down in approximately 20 min to a temperature of approximately  $30 ^\circ\text{C}$ , forced cooling being allowed. They are kept at this temperature for approximately 10 min and, if necessary, for measuring the voltage drop, allowed to cool down further to a temperature of  $(20 \pm 2) ^\circ\text{C}$  (see Figure D.3).*

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

*The voltage drop in the IPTs is measured after the completion of the 24th and 192nd cycles and recorded.*

The maximum allowable voltage drop of each clamping unit, measured with the current as specified in Table D.3, shall not exceed the smaller of the two following values:

- either 22,5 mV, or
- 1,5 times the value measured after the 24<sup>th</sup> cycle.

The measuring points shall be as close as possible to the clamping unit of the IPT. 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. An example of test-points is shown in Figure D.2.

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

**Table D.3 – Test current for the verification of electrical and thermal stresses in normal use of insulation-piercing terminals**

| Rated current<br><br>A                                                                                                                                                                                                                                                                                             | Test current<br><br>A | Minimum cross-sectional area of the conductor<br><br>mm <sup>2</sup> | Test current<br><br>A | Maximum cross-sectional area of the conductor<br><br>mm <sup>2</sup> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|----------------------------------------------------------------------|-----------------------|----------------------------------------------------------------------|
| Up to and including 4                                                                                                                                                                                                                                                                                              | 9                     | 0,75                                                                 | 17,5                  | 1,5                                                                  |
| Above 4 and including 6                                                                                                                                                                                                                                                                                            | 13,5                  | 1                                                                    | 17,5                  | 1,5                                                                  |
| Above 6 and including 16                                                                                                                                                                                                                                                                                           | 17,5                  | 1,5                                                                  | 24                    | 2,5                                                                  |
| NOTE For switches having rated currents other than the preferred ones, the test current is determined by interpolation between the next lower and higher preferred rated currents, and the cross-sectional area of the conductor is chosen equal to the one specified for the next higher preferred rated current. |                       |                                                                      |                       |                                                                      |

**12.4.12** A non-reusable IPT shall be so designed and constructed that it is not possible to disconnect the product without destroying it or cutting the conductors. The damage shall be obvious.

*Compliance is checked by inspection.*

NOTE An IPT is considered to be permanently destroyed when, for its re-installation, new parts or materials other than the original ones have to be used.

**12.4.13** If an IPT uses screws for wire connection, the following test shall be performed before each test of 12.4:

*Screws of IPTs are tightened and loosened 5 times by means of an appropriate tool applying the torque as stated in the corresponding column of Table 3. A new conductor end is used each time the screw is loosened and subsequently re-tightened.*

*Higher values of torque may be used if so stated by the manufacturer of the IPT, when the relevant information is provided.*

*During the test an IPT shall not be damaged so as to impair its further use, for example, the breakage of screws or damage to the head slots, threads, washers, or stirrups.*

*The shape of the blade of the test screwdriver shall suit the head of the screw to be tested. The screws shall be tightened in one smooth and continuous application of the torque.*

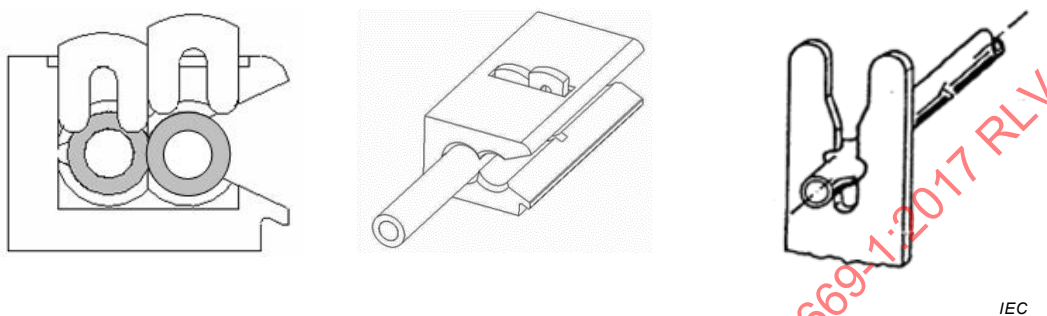
**12.4.14** Screws for making contact-pressure shall not serve to fix any other component, although they may hold the IPT in place or prevent it from turning.

Screws shall not be of metal which is soft or liable to creep.

NOTE The use of aluminium alloy screws in aluminium alloy bodied IPTs requires additional tests, according to IEC 61545.

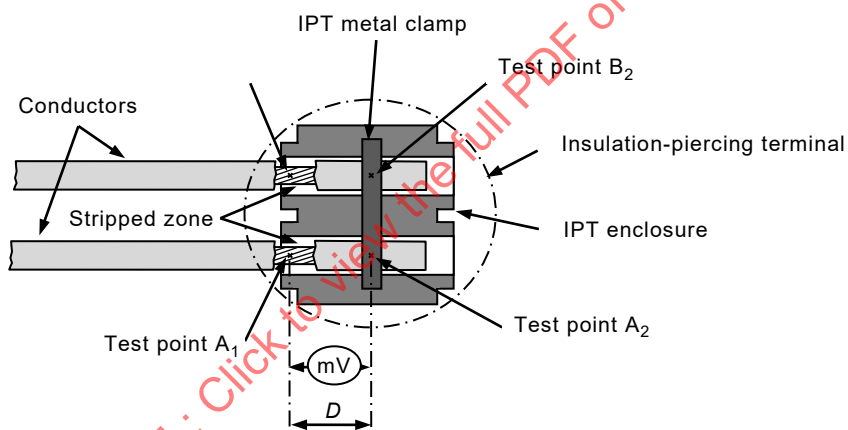
*Compliance is checked by inspection.*

IPT transmitting contact pressure via metal parts



IEC

**Figure D.1 – Example of insulation-piercing terminals**



IEC

Distance  $D$  between two test points shall be as short as possible to avoid including the voltage drop of the conductor when measuring the IPT's voltage drop.

**Figure D.2 – Example of test-points**

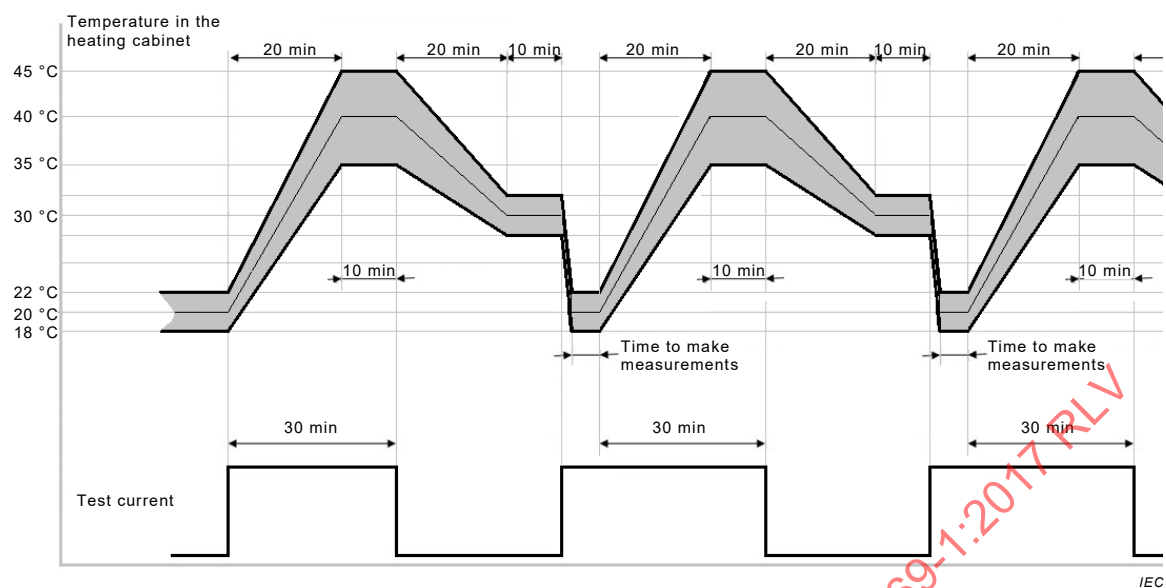


Figure D.3 – Temperature cycle for the voltage drop test of 12.4.11

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## Annex E (informative)

### Additional requirements and tests for switches intended to be used at a temperature lower than $-5\text{ °C}$

The purpose of Annex E is to bring additional explanations and requirements to the normative text of this document. Therefore the numbering of clauses, subclauses, figures and tables follows that of the main body of the text. Only the relevant clauses, subclauses, tables and figures are cited.

#### 1 Scope

Replace NOTE 4 by:

For switches intended to be used in temperatures below normal range, additional requirements and tests are given in informative Annex E.

NOTE 4 In the following countries, Annex E is normative: FI, NO, SE.

#### 5 General remarks on tests

Add at the end of Clause 5:

All tests in Annex E are related to a temperature of  $-25\text{ °C}$ . If a lower value is declared by the manufacturer, the declared value shall be a multiple of  $5\text{ °C}$ . All tests in Annex E shall be carried out at the declared temperature.

#### 8 Marking

##### 8.1 General

Add the following new list item after m):

n) Symbol for products declared as suitable for use at a temperature below the normal range.

##### 8.2 Symbols

Add the following marking:

– Intended for use in cold environment down to  $-25\text{ °C}$ , symbol IEC 60417-6292:2015-11



If a lower value of temperature is declared by the manufacturer, the declared value shall be a multiple of  $5\text{ °C}$ ; the symbol shall indicate this value.

##### 13.15.2

The test of 13.15.2 shall be performed at a temperature of  $(-25 \pm 2)\text{ °C}$ .

#### 19 Normal operation

Add the following new subclause at the end of Clause 19:

#### 19.4 Test for switches intended to be used in ambient temperature below $-5\text{ }^{\circ}\text{C}$

The following additional test shall be carried out on switches intended to be used below the normal temperature ranges if marking for low temperature is used:

- *Wire the switch with a signal circuit including an indicator to easily evaluate that the switch is working as intended during the test.*
- *The switches are then kept for 16 h in a freezer at a temperature of  $(-25 \pm 2)\text{ }^{\circ}\text{C}$ .*
- *For each of the last 4 h, the switches shall be mechanically operated by hand for 20 operations. The rate of operation shall be approximately 30 operations per minute, i.e. each test sequence shall be 40 s in duration. For these operations, the switch shall be taken out of the freezer, and immediately afterwards (within 3 min) while the switches are still cold, the specimens are subjected to the operations. Immediately after the operations, the switch shall be put again into the freezer.*
- *During and after this test the switch shall operate properly and show no visible harmful deformation, cracks or similar damage which would lead to non-compliance with this document.*
- *Verification of operation is checked by the test described in 19.4, immediately followed by the measurement of the insulation resistance and by the electric strength test specified in Clause 16.*

## 20 Mechanical strength

Add the following new subclause at the end of Clause 20:

### 20.11 Impact test at low temperatures

The following additional test shall be carried out on switches intended to be used below the normal temperature ranges if marking for low temperature is used:

- *The switch is mounted as given in 20.2 and kept for 16 h in a freezer at a temperature of  $(-25 \pm 2)\text{ }^{\circ}\text{C}$ .*
- *Then the switch assemblies shall be taken out of the freezer and immediately afterwards (within 3 min) while the switches are still cold, the specimens are subjected to the impact test and compliance according to 20.2.*

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IEC 60669-2-3, *Switches for household and similar fixed electrical installations – Part 2-3: Particular requirements – Time-delay switches (TDS)*

IEC 60669-2-4, *Switches for household and similar fixed electrical installations – Part 2-4: Particular requirements – Isolating switches*

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## COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

**INTERRUPTEURS POUR INSTALLATIONS ÉLECTRIQUES  
FIXES DOMESTIQUES ET ANALOGUES –****Partie 1: Exigences générales****AVANT-PROPOS**

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La Norme internationale IEC 60669-1 a été établie par le sous-comité 23B: Prises de courant et interrupteurs, du comité d'études 23 de l'IEC: Petit appareillage.

Cette quatrième édition annule et remplace la troisième édition parue en 1998, l'Amendement 1:1999 et l'Amendement 2:2006. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- a) modification du domaine d'application concernant les interrupteurs pour charge moteur;
- b) suppression de certaines références normatives datées;
- c) modifications relatives aux définitions;



- d) dans l'Article 5, le nombre d'échantillons à utiliser pour les essais est clairement indiqué dans le Tableau 1 (L'Annexe A correspondante de l'IEC 60669-1:1998 a donc été supprimée en conséquence);
- e) dans l'Article 5, ajout de précisions concernant les interrupteurs sur lesquels les essais de l'Article 19 doivent être effectués;
- f) ajout d'exigences relatives aux interrupteurs 13 A;
- g) indication obligatoire signalant qu'une borne est adaptée pour un conducteur rigide uniquement;
- h) ajout d'exigences et de conditions d'essai pour les conducteurs souples à l'Article 12;
- i) ajout d'exigences relatives aux lampes indicatrices;
- j) ajout d'un nouvel essai pour les charges par lampe à ballast intégré en 19.3;
- k) Le Tableau 20 a été entièrement revu afin de couvrir les interrupteurs à distance normale d'ouverture des contacts, à faible distance d'ouverture des contacts et à microdistance d'ouverture des contacts et a été renuméroté Tableau 23;
- l) ajout d'une nouvelle Annexe B informative comprenant les modifications prévues pour aligner l'IEC 60669-1 avec les exigences de l'IEC 60998 (toutes les parties), de l'IEC 60999 (toutes les parties) et de l'IEC 60228;
- m) ajout d'une nouvelle Annexe C informative relative au développement du circuit pour 19.3;
- n) ajout d'une nouvelle Annexe D informative comprenant des exigences complémentaires pour les bornes à perçage d'isolant;
- o) ajout d'une nouvelle Annexe E informative comprenant des exigences et des essais supplémentaires pour les interrupteurs à utiliser à une température inférieure à  $-5^{\circ}\text{C}$ .

Le texte de cette norme est issu des documents suivants:

| FDIS          | Rapport de vote |
|---------------|-----------------|
| 23B/1235/FDIS | 23B/1241/RVD    |

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

Cette publication a été rédigée selon les Directives ISO/IEC, Partie 2.

Dans la présente norme, les caractères d'imprimerie suivants sont employés:

- *déclarations de conformité: caractères italiques*

Une liste de toutes les parties de la série IEC 60669, publiées sous le titre général *Interrupteurs pour installations électriques fixes domestiques et analogues*, peut être consultée sur le site web de l'IEC.

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- reconduite,
- supprimée,
- remplacée par une édition révisée, ou
- amendée.

Le contenu du corrigendum de janvier 2020 a été pris en considération dans cet exemplaire.

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# INTERRUPTEURS POUR INSTALLATIONS ÉLECTRIQUES FIXES DOMESTIQUES ET ANALOGUES –

## Partie 1: Exigences générales

### 1 Domaine d'application

La présente partie de l'IEC 60669 s'applique aux interrupteurs fonctionnels pour courant alternatif seulement à commande manuelle pour usages courants, de tension assignée ne dépassant pas 440 V et de courant assigné ne dépassant pas 63 A, destinés aux installations électriques fixes domestiques et analogues soit intérieures soit extérieures.

Pour les interrupteurs équipés de bornes sans vis, le courant assigné est limité à 16 A.

NOTE 1 Le courant assigné est limité à 16 A pour les interrupteurs équipés de bornes à perçage d'isolant (BPI), conformément à l'Annexe D.

Les interrupteurs couverts par le présent document sont destinés à commander, en usage normal, les charges suivantes, telles qu'applicables:

- un circuit de charge par lampe à filament de tungstène;
- un circuit de charge par lampe à ballast externe (LED, CFL, charge par lampe à fluorescence, par exemple);
- un circuit pour charge par lampe à ballast intégré (LEDi ou CFLi, par exemple);
- un circuit de charge pratiquement résistive avec un facteur de puissance supérieur ou égal à 0,95;
- un circuit monophasé de charge par moteur de courant assigné ne dépassant pas 3 A à 250 V (750 VA) et 4,5 A à 120 V (540 VA) et de facteur de puissance supérieur ou égal à 0,6. Cela s'applique à la fois aux interrupteurs de courant assigné supérieur ou égal à 10 A n'étant pas soumis à des essais supplémentaires et aux interrupteurs à contact momentané de courant assigné supérieur ou égal à 6 A n'étant pas soumis à des essais supplémentaires.

NOTE 2 Dans le pays suivant, la capacité d'un interrupteur à commander le courant d'appel d'un moteur doit être vérifiée par des essais: AU.

Le présent document s'applique également aux boîtes des interrupteurs, à l'exception des boîtes de montage pour interrupteurs pour pose encastrée.

NOTE 3 Des exigences générales pour les boîtes pour interrupteurs pour pose encastrée sont données dans l'IEC 60670-1.

Le présent document s'applique aussi aux interrupteurs tels que

- les interrupteurs comprenant des lampes indicatrices;
- les télérupteurs électromagnétiques (les exigences particulières sont données dans l'IEC 60669-2-2);
- les interrupteurs comprenant un dispositif à action différée (les exigences particulières sont données dans l'IEC 60669-2-3);
- les combinaisons d'interrupteurs et d'autres fonctions (à l'exception des interrupteurs combinés avec des fusibles);
- les interrupteurs électroniques (les exigences particulières sont données dans l'IEC 60669-2-1);

- les interrupteurs ayant des dispositifs de sortie et de retenue pour câbles souples (voir Annexe A);
- les interrupteurs-sectionneurs (les exigences particulières sont données dans l'IEC 60669-2-4);
- les interrupteurs et appareils associés pour usage dans les systèmes électroniques des foyers domestiques et bâtiments (les exigences particulières sont données dans l'IEC 60669-2-5);
- les interrupteurs pompiers (les exigences particulières sont données dans l'IEC 60669-2-6).

Les interrupteurs conformes au présent document sont adaptés à un usage à des températures ambiantes ne dépassant pas habituellement +40 °C, mais dont la moyenne sur une période de 24 h ne dépasse pas +35 °C, avec une température de l'air ambiant dont la limite inférieure est de –5 °C.

NOTE 4 Voir l'Annexe E pour les températures inférieures.

Les interrupteurs conformes au présent document sont seulement prévus pour être incorporés dans un matériel de manière telle et à un emplacement tel qu'il soit improbable que l'environnement atteigne une température dépassant +35 °C.

Dans des emplacements présentant des conditions particulières, par exemple à bord de navires, dans des véhicules, etc., et dans des emplacements dangereux où par exemple des explosions peuvent se produire, des exigences constructives spécifiques et/ou supplémentaires peuvent être exigées.

## 2 Références normatives

Les documents suivants cités dans le texte 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 60038:2009, *Tensions normales de la CEI*

IEC 60068-2-75:2014, *Essais d'environnement – Partie 2-75: Essais – Essai Eh: Essais au marteau*

IEC 60112:2009, *Méthode de détermination des indices de résistance et de tenue au cheminement des matériaux isolants solides*

IEC 60212:2010, *Conditions normales à observer avant et pendant les essais de matériaux isolants électriques solides*

IEC 60227-5:2011, *Conducteurs et câbles isolés au polychlorure de vinyle, de tension assignée au plus égale à 450/750 V – Partie 5: Câbles souples*

IEC 60228:2004, *Âmes des câbles isolés*

IEC 60245-4:2011, *Conducteurs et câbles isolés au caoutchouc – Tension assignée au plus égale à 450/750 V – Partie 4: Câbles souples*

IEC 60417, *Symboles graphiques utilisables sur le matériel*. (disponible à l'adresse <http://www.graphical-symbols.info/equipment>)

IEC 60529:1989, *Degrés de protection procurés par les enveloppes (Code IP)*  
IEC 60529:1989/AMD1:1999  
IEC 60529:1989/AMD2:2013

IEC 60669-2-1:2002, *Interrupteurs pour installations électriques fixes domestiques et analogues – Partie 2-1: Prescriptions particulières – Interrupteurs électroniques*  
IEC 60669-2-1:2002/AMD1:2008  
IEC 60669-2-1:2002/AMD2:2015

IEC 60695-2-10:2000, *Essais relatifs aux risques du feu – Partie 2-10: Essais au fil incandescent/chauffant – Appareillage et méthode commune d'essai*

IEC 60695-2-11:2014, *Essais relatifs aux risques du feu – Partie 2-11: Essais au fil incandescent/chauffant – Méthode d'essai d'inflammabilité pour produits finis (GWEPT)*

IEC 60998-1:2002, *Dispositifs de connexion pour circuits basse tension pour usage domestique et analogue – Partie 1: Règles générales*

IEC 60998-2-1, *Dispositifs de connexion pour circuits basse tension pour usage domestique et analogue – Partie 2-1: Règles particulières pour dispositifs de connexion en tant que parties séparées avec organes de serrage à vis*

IEC 60998-2-2, *Dispositifs de connexion pour circuits basse tension pour usage domestique et analogue – Partie 2-2: Règles particulières pour dispositifs de connexion en tant que parties séparées avec organes de serrage sans vis*

IEC 60998-2-3, *Dispositifs de connexion pour circuits basse tension pour usage domestique et analogue – Partie 2-3: Règles particulières pour dispositifs de connexion en tant que parties séparées avec organes de serrage à perçage d'isolant*

IEC 60998-2-4, *Dispositifs de connexion pour circuits basse tension pour usage domestique et analogue – Partie 2-4: Règles particulières pour dispositifs de connexion par épissure*

IEC 61032:1997, *Protection des personnes et des matériels par les enveloppes – Calibres d'essai pour la vérification*

ISO 1456:2009, *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 2081:2008, *Revêtements métalliques et autres revêtements inorganiques – Dépôts électrolytiques de zinc avec traitements supplémentaires sur fer ou acier*

ISO 2093:1986, *Dépôts électrolytiques d'étain – Spécifications et méthodes d'essai*

### 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 Quand les termes «tension» et «courant» sont utilisés, ils sont exprimés en valeurs efficaces, sauf spécification contraire.

### **3.1**

#### **interrupteur**

dispositif destiné à établir ou à interrompre le courant dans un ou plusieurs circuits électriques

#### **3.1.1**

##### **interrupteur I/O**

commutateur destiné à fermer et ouvrir alternativement un ou plusieurs circuits électriques

[SOURCE: IEC 60050-151:2001, 151-12-23, modifiée — «I/O» a été ajouté]

#### **3.1.2**

##### **interrupteur à contact momentané**

interrupteur dont les contacts reviennent automatiquement à l'état initial après fonctionnement

Note 1 à l'article: Les interrupteurs à contact momentané sont destinés à commander des sonnettes, des télérupteurs électromagnétiques, des interrupteurs temporisés et des interrupteurs électroniques, par exemple.

#### **3.1.3**

##### **interrupteur à bouton poussoir**

interrupteur ayant un organe de manœuvre se déplaçant axialement dans la direction de la force manuelle externe appliquée, par exemple, par le doigt ou la paume de la main, et ayant emmagasiné de l'énergie pour son retour

#### **3.1.4**

##### **interrupteur à tirage**

interrupteur dont le dispositif de manœuvre est un cordon qui doit être tiré pour modifier l'état des contacts

#### **3.1.5**

##### **interrupteur à distance normale d'ouverture des contacts**

interrupteur ayant une distance d'isolement dans l'air entre les contacts ouverts au moins égale à 3 mm

#### **3.1.6**

##### **interrupteur à faible distance d'ouverture des contacts**

interrupteur ayant une distance d'isolement dans l'air entre les contacts inférieure à 3 mm mais au moins égale à 1,2 mm

#### **3.1.7**

##### **interrupteur à microdistance d'ouverture des contacts**

interrupteur ayant une distance d'isolement dans l'air entre les contacts ouverts inférieure à 1,2 mm

### **3.2**

#### **changement de position**

déplacement des contacts mobiles d'une position de fonctionnement à une autre

### **3.3**

#### **borne**

partie unipolaire conductrice composée d'un ou plusieurs organes de serrage, isolée si nécessaire

### **3.4**

#### **organe de serrage**

partie(s) d'une borne nécessaire(s) au serrage mécanique et au raccordement électrique du (des) conducteur(s)

### 3.5

#### **borne à vis**

borne destinée au raccordement, par serrage seulement, d'âmes d'un ou de plusieurs conducteurs extérieurs souples ou rigides

#### 3.5.1

##### **borne à trou**

borne de type à vis dans laquelle le (les) conducteurs(s) est introduit dans un trou ou une cavité et y est serré par le bout de la vis ou 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.

Note 2 à l'article: Des exemples de bornes à trou sont représentés à la Figure 1.

[SOURCE: IEC 60050-442:1998, 442-06-22, modifiée — «ou des vis» a été ajouté car il existe des constructions dans lesquelles il y a plusieurs vis.]

#### 3.5.2

##### **borne à serrage sous tête de vis**

borne à vis dans laquelle l'âme du 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'un organe intermédiaire, tel qu'une rondelle, une plaquette ou un dispositif empêchant le conducteur ou ses brins de s'échapper.

Note 2 à l'article: Des exemples de bornes à serrage sous tête de vis sont représentés à la Figure 2.

#### 3.5.3

##### **borne à goujon fileté**

borne à vis 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, tel qu'une rondelle, une plaquette ou un dispositif empêchant le conducteur ou ses brins de s'échapper.

Note 2 à l'article: Des exemples de bornes à goujon fileté sont représentés à la Figure 2.

[SOURCE: IEC 60050-442:1998, 442-06-23]

#### 3.5.4

##### **borne à plaquette**

borne à vis dans laquelle l'âme d'un conducteur est serrée sous une plaquette au moyen de plusieurs vis ou écrous

Note 1 à l'article: Des exemples de bornes à plaquettes sont représentés à la Figure 3.

[SOURCE: IEC 60050-442:1998, 442-06-09, modifiée — «à vis» a été ajouté.]

#### 3.5.5

##### **borne pour cosses et barrettes**

borne à serrage sous tête de vis ou borne à goujon fileté, prévue pour serrer une cosse ou une barrette au moyen d'une vis ou d'un écrou

Note 1 à l'article: Des exemples de bornes pour cosses et barrettes sont représentés à la Figure 4.

[SOURCE: IEC 60050-442:1998, 442-06-16, modifiée — «borne à serrage sous tête de vis ou borne à goujon fileté» remplace «borne à vis» et «directement ou indirectement» a été supprimé.]

### 3.5.6

#### **borne à capot taraudé**

borne à vis 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 de la 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.

Note 2 à l'article: Des exemples de bornes à capot taraudé sont représentés à la Figure 5.

[SOURCE: IEC 60050-442:1998, 442-06-14, modifiée — «à vis» a été ajouté et la dernière partie de la définition est incluse dans une note.]

### 3.6

#### **borne sans vis**

borne pour la connexion et la déconnexion d'un conducteur rigide (massif ou câblé) ou d'un conducteur souple ou l'interconnexion démontable de deux conducteurs, la connexion étant réalisée directement ou indirectement au moyen de ressorts, pièces de formes angulaire, excentrique ou conique, etc., sans autre préparation spéciale du conducteur concerné que l'enlèvement de l'isolant

[SOURCE: IEC 60050-442:1998, 442-06-11, modifiée]

### 3.7

#### **vis autotaraudeuse par déformation de matière**

vis ayant un filet ininterrompu qui, par vissage, forme le filetage par déformation du matériau de la cavité

Note 1 à l'article: Un exemple de vis autotaraudeuse par déformation de matière est représenté à la Figure 6.

[SOURCE: IEC 60050-442:1998, 442-06-04, modifiée — «de matière» a été ajouté.]

### 3.8

#### **vis autotaraudeuse à découpe de matière**

vis ayant un filet non continu qui, par vissage, forme le filetage en enlevant du matériau de la cavité

Note 1 à l'article: Un exemple de vis autotaraudeuse à découpe de matière est représenté à la Figure 7.

[SOURCE: IEC 60050-442:1998, 442-06-03, modifiée — «de matière» a été ajouté.]

### 3.9

#### **dispositif mécanique à action différée**

dispositif qui, par l'effet d'un auxiliaire mécanique, fonctionne un certain temps après l'instant où les conditions prévues pour son fonctionnement sont réalisées

### 3.10

#### **base**

partie de l'interrupteur maintenant en place les parties transportant le courant et qui maintient généralement le mécanisme en position

### 3.11

#### **tension assignée**

tension fixée par le fabricant pour un fonctionnement spécifié de l'interrupteur

[SOURCE: IEC 60050-442:1998, 442-01-03, modifiée — «appareil» a été remplacé par «interrupteur».]



**3.12****courant assigné**

courant fixé par le fabricant pour un fonctionnement spécifié de l'interrupteur

[SOURCE: IEC 60050-442:1998, 442-01-02, modifiée — «appareil» a été remplacé par «interrupteur».]

**3.13****liaison de manœuvre**

partie d'un interrupteur à tirage qui relie le mécanisme interne au cordon de tirage et qui est généralement fixée à l'organe de manœuvre de l'interrupteur

**3.14****pôle d'un appareil de connexion**

élément constituant d'un appareil de connexion associé exclusivement à un chemin conducteur électriquement séparé appartenant à son circuit principal, cet élément ne comprenant pas les éléments constitutifs assurant la fixation et le fonctionnement d'ensemble de tous les pôles

Note 1 à l'article: Un appareil de connexion est appelé unipolaire s'il n'a qu'un pôle. S'il a plus d'un pôle, il peut être appelé multipolaire (bipolaire, tripolaire, etc.) à condition que les pôles soient ou puissent être liés entre eux de façon qu'ils fonctionnent ensemble.

[SOURCE: IEC 60050-441:2000, 441-15-01]

**3.15****organe de manœuvre**

partie qui est tirée, poussée, tournée ou manipulée de toute autre façon pour provoquer le fonctionnement de l'interrupteur

[SOURCE: IEC 60050-442:1998, 442-04-14]

**3.16****lampe indicatrice**

dispositif incorporant une source lumineuse, soit intégré à un interrupteur soit prévu pour être installé dans un interrupteur, et destiné à donner, par exemple, une indication de l'état de l'interrupteur ou pour localiser l'interrupteur

**3.17****partie principale**

assemblage comprenant une base et d'autres parties et qui n'est destiné à être démonté à aucun moment après sa fabrication

**3.18****passe-fil**

composant utilisé pour maintenir et protéger les fils ou le câble ou le conduit à son entrée

Note 1 à l'article: Un passe-fil peut être aussi utilisé pour empêcher la pénétration de l'humidité ou plus généralement des agents atmosphériques polluants.

Note 2 à l'article: Des exemples sont représentés à la Figure 23.

[SOURCE: IEC 60050-581:2008, 581-27-19, modifiée — «pièce d'un composant ou d'un accessoire» a été remplacé par «composant», «ou le conduit» a été ajouté et la dernière partie de la définition est incluse dans une note.]

**3.19****membrane d'entrée**

composant ou partie intégrante de l'interrupteur utilisé(e) pour protéger les fils ou le câble et qui peut être utilisé(e) pour soutenir le câble ou le conduit au point d'entrée

Note 1 à l'article: Une membrane d'entrée peut être aussi utilisé(e) pour empêcher la pénétration de l'humidité ou des agents atmosphériques polluants et peut faire partie d'un passe-fil.

Note 2 à l'article: Des exemples sont représentés à la Figure 23.

### 3.20

#### **membrane de protection**

composant ou partie intégrante de l'interrupteur qui n'est pas destiné(e) à être traversé(e) en usage normal et qui est prévu(e) pour assurer une protection contre la pénétration d'eau ou de corps solides et/ou permettre le fonctionnement d'un appareil

Note 1 à l'article: Des exemples sont représentés à la Figure 23.

### 3.21

#### **lampe à ballast intégré**

##### **SBL**

unité qui ne peut être démontée sans être endommagée de manière permanente, qui est équipée d'un ou de plusieurs culot(s) de lampe et comporte une source lumineuse et tous les éléments additionnels nécessaires pour l'amorçage et le fonctionnement stable de la source lumineuse

Note 1 à l'article: Dans le texte, une lampe à ballast intégré est également appelée CFLi ou LEDi, où:

- l'abréviation «CLF» est dérivée du terme anglais développé correspondant «Compact Fluorescent Lamp» (lampe fluorescente compacte);
- l'abréviation «LED» est dérivée du terme anglais développé correspondant «Light Emitting Diode» (diode électroluminescente);
- «i» signifie que l'appareillage est intégré dans la lampe.

Note 2 à l'article: L'abréviation «SBL» est dérivée du terme anglais développé correspondant «Self Ballasted Lamp».

### 3.22

#### **lampe à ballast externe**

lampe autre qu'une lampe à incandescence et qui ne peut être démontée sans être endommagée de manière permanente, qui est équipée d'un culot de lampe et qui comporte une source lumineuse conçue pour être commandée par un appareillage de lampe séparé

Note 1 à l'article: Concernant l'appareillage de la lampe, voir les définitions de l'IEC 61347-1.

## **4 Exigences générales**

Les interrupteurs et les boîtes de montage pour appareils en saillie doivent être conçus et construits de sorte qu'en usage normal, leur fonctionnement soit fiable et que la sécurité soit atteinte en réduisant le risque à un niveau tolérable, comme cela est défini dans le Guide ISO/IEC 51:2014.

La conformité est vérifiée par l'exécution de tous les essais spécifiés qui s'appliquent et par la satisfaction à toutes les exigences correspondantes.

## **5 Généralités sur les essais**

*Les essais selon le présent document sont des essais de type.*

*Sauf spécification contraire, les échantillons sont soumis aux essais en l'état de livraison et dans les conditions normales d'emploi.*

*Les interrupteurs conçus pour l'incorporation de lampes indicatrices doivent être soumis aux essais équipés de leurs lampes indicatrices, sauf déclaration contraire. Les résultats des essais doivent être considérés comme s'appliquant aux interrupteurs du même type mais sans lampe indicatrice.*

*Les interrupteurs pour pose encastrée et semi-encastrée doivent être soumis aux essais lorsqu'ils sont installés dans une boîte conforme aux feuilles de normes, le cas échéant. Si l'interrupteur est fabriqué pour une boîte particulière, les essais doivent être menés lorsque l'interrupteur est installé dans la boîte correspondante, tel que spécifié par le fabricant.*

*Sauf spécification contraire, les essais sont réalisés dans l'ordre des articles, à une température ambiante comprise entre +15 °C et +35 °C.*

*En cas de doute, les essais sont réalisés à une température ambiante de  $(+20 \pm 5)$  °C.*

*Pour chacune des deux combinaisons de tension et courant assignés marqués sur l'interrupteur, trois échantillons sont soumis à tous les essais appropriés, sauf à celui de 19.2 et de 19.3, pour lesquels deux autres lots de trois échantillons sont utilisés.*

*Pour les interrupteurs à courant assigné jusqu'à 16 A inclus, les essais de 19.1, 19.2 et 19.3 doivent être réalisés.*

*Pour les interrupteurs à courant assigné supérieur à 16 A et jusqu'à 20 A inclus, les essais de 19.1 et de 19.3 doivent être réalisés.*

*Pour les interrupteurs à courant assigné supérieur à 16 A et jusqu'à 20 A inclus, l'essai de 19.2 doit être réalisé uniquement si le fabricant a attribué à l'interrupteur une valeur assignée de courant par lampe à ballast externe.*

*Pour les interrupteurs à courant assigné supérieur à 20 A, seuls les essais de 19.1 doivent être réalisés.*

*Un interrupteur marqué 250 V/400 V est soumis aux essais comme un interrupteur 400 V.*

*Les interrupteurs à contact momentané ne sont pas soumis aux essais de 18.3, 19.2 et 19.3.*

*Les interrupteurs de numéro de fonction 3 et 03 sont soumis aux essais de 18.3 si leur tension assignée dépasse 250 V, mais ils ne sont pas soumis aux essais de 19.2 et de 19.3.*

*Le nombre d'échantillons exigés pour les essais doit être celui spécifié au Tableau 1.*

**Tableau 1 – Nombre d'échantillons nécessaires pour les essais**

| Articles et paragraphes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                   | Nombre d'échantillons | Nombre d'échantillons supplémentaires pour deux courants assignés |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|-----------------------|-------------------------------------------------------------------|
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Caractéristiques assignées                                                                                        | A                     | JKL                                                               |
| 7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Classification                                                                                                    | A                     |                                                                   |
| 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Marquage                                                                                                          | A                     |                                                                   |
| 9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Vérification des dimensions                                                                                       | ABC                   |                                                                   |
| 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Protection contre les chocs électriques                                                                           | ABC                   |                                                                   |
| 11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Dispositions pour assurer la mise à la terre                                                                      | ABC                   |                                                                   |
| 12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Bornes <sup>a, f, l</sup>                                                                                         | ABC                   |                                                                   |
| 13                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Exigences constructives <sup>b, m</sup>                                                                           | ABC                   |                                                                   |
| 14                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Mécanisme                                                                                                         | ABC                   |                                                                   |
| 15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Résistance au vieillissement, protection procurée par les enveloppes des interrupteurs et résistance à l'humidité | ABC                   |                                                                   |
| 16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Résistance d'isolement et rigidité diélectrique <sup>c</sup>                                                      | ABC                   |                                                                   |
| 17                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Échauffement                                                                                                      | ABC                   |                                                                   |
| 18                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Pouvoir de fermeture et de coupure                                                                                | ABC <sup>i</sup>      |                                                                   |
| 19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Fonctionnement normal                                                                                             | ABC <sup>i</sup>      |                                                                   |
| 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Résistance mécanique <sup>d, g</sup>                                                                              | ABC                   |                                                                   |
| 21                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Résistance à la chaleur <sup>h</sup>                                                                              | ABC                   |                                                                   |
| 22                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Vis, parties transportant le courant et connexions                                                                | ABC                   |                                                                   |
| 23                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Lignes de fuite, distances d'isolement dans l'air et distances à travers la matière de remplissage                | ABC                   |                                                                   |
| 19.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Essai des interrupteurs destinés aux charges par lampes à ballast externe                                         | DEF <sup>j</sup>      | MNO                                                               |
| 19.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Essai des interrupteurs destinés aux charges par lampes à ballast intégré                                         | UVW <sup>k</sup>      | XYZ                                                               |
| 24.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Résistance à la chaleur anormale et au feu                                                                        | GHI                   | JKL                                                               |
| 24.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Résistance aux courants de cheminement <sup>e</sup>                                                               | GHI                   |                                                                   |
| 25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Résistance à la rouille                                                                                           | GHI                   |                                                                   |
| TOTAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                   | 12                    | 9                                                                 |
| <p><sup>a</sup> Cinq bornes sans vis supplémentaires sont utilisées pour l'essai de 12.3.11 et un lot supplémentaire d'échantillons est utilisé pour l'essai de 12.3.12.</p> <p><sup>b</sup> Un lot supplémentaire de membranes est nécessaire pour chacun des essais de 13.15.1 et 13.15.2.</p> <p><sup>c</sup> Un lot supplémentaire d'échantillons d'interrupteurs équipés de lampes indicatrices peut être utilisé pour les essais de l'Article 16.</p> <p><sup>d</sup> Un lot supplémentaire d'interrupteurs à tirage est nécessaire pour l'essai de 20.10.</p> <p><sup>e</sup> Un lot supplémentaire d'échantillons peut être utilisé.</p> <p><sup>f</sup> Deux lots supplémentaires d'échantillons de bornes appropriés aux conducteurs rigides et souples sont exigés pour 12.2.5, 12.2.6 et 12.2.7.</p> <p><sup>g</sup> Un lot supplémentaire d'échantillons est nécessaire pour les essais de 20.5.1 et 20.5.2.</p> <p><sup>h</sup> Un lot supplémentaire d'échantillons peut être utilisé pour les essais de 21.2 et 21.3. Dans ce cas, les échantillons doivent être préalablement soumis aux essais de 15.1.</p> <p><sup>i</sup> Un lot supplémentaire d'échantillons d'interrupteurs de numéro de fonction 7 est nécessaire pour 18 et 19.1.</p> <p><sup>j</sup> Un lot supplémentaire d'échantillons d'interrupteurs de numéro de fonction 7 est nécessaire pour 19.2.</p> <p><sup>k</sup> Un lot supplémentaire d'échantillons d'interrupteurs de numéro de fonction 7 est nécessaire pour 19.3.</p> <p><sup>l</sup> Un certain nombre d'échantillons exigés pour les bornes à perçage d'isolant (BPI) sont présentés au Tableau D.1.</p> <p><sup>m</sup> Pour les interrupteurs avec lampes indicatrices, si le circuit électronique est enfermé de telle façon que la mise en court-circuit ou la déconnexion des éléments constitutants soit impossible ou difficile, le fabricant doit fournir des échantillons d'essai supplémentaires.</p> |                                                                                                                   |                       |                                                                   |

*Les échantillons sont soumis à tous les essais applicables et sont conformes au présent document si toutes les exigences de tous les essais applicables sont satisfaites.*

Si l'un des échantillons ne satisfait pas à un essai en raison d'un défaut d'assemblage ou de fabrication, cet essai et tout essai qui l'a précédé et qui a pu avoir une influence sur les résultats de l'essai doivent être répétés et les essais suivants doivent aussi être effectués selon la séquence exigée sur un autre lot complet d'échantillons, qui doivent tous satisfaire aux exigences.

Le demandeur peut soumettre, en même temps que le nombre d'échantillons spécifié au Tableau 1, le lot supplémentaire d'échantillons qui peut être exigé si l'un des échantillons est défectueux. Il convient alors que le laboratoire d'essai, sans autre demande, soumette aux essais le lot supplémentaire et ne le rejette qu'en cas de nouveau défaut. Si le lot supplémentaire d'échantillons n'est pas soumis en même temps, un échantillon défectueux entraînera une non-conformité.

## **6 Caractéristiques assignées**

### **6.1 Tension assignée**

Les valeurs préférentielles de la tension assignée sont de 130 V, 220 V, 230 V, 240 V, 250 V, 277 V, 380 V, 400 V, 415 V ou 440 V.

S'il est fait usage d'autres tensions assignées, elles ne doivent pas être inférieures à la tension spécifiée dans l'IEC 60038:2009, Table 1.

### **6.2 Courant assigné**

Les valeurs préférentielles du courant assigné sont de 6 A, 10 A, 13 A, 16 A, 20 A, 25 A, 32 A, 40 A, 45 A, 50 A ou 63 A.

Le courant assigné des interrupteurs ne doit pas être inférieur à 6 A, à l'exception des interrupteurs à contact momentané pour lesquels un courant assigné de 1 A, 2 A ou 4 A est admis.

Les interrupteurs de courant assigné ne dépassant pas 16 A doivent avoir la caractéristique assignée de courant pour lampe à ballast externe égale au courant assigné. Cette exigence ne s'applique pas aux interrupteurs de numéros de fonction 3 et 03 ou aux interrupteurs à contact momentané.

Les interrupteurs de courant assigné ne dépassant pas 20 A doivent être soumis aux essais avec des circuits par lampe à ballast intégré (SBL), tel qu'indiqué en 19.3.

Les interrupteurs soumis aux essais conformément à 19.3 sont en mesure de commander la puissance assignée des circuits SBL conformément au Tableau 2.

NOTE Les valeurs supérieures de puissance assignée des circuits SBL peuvent être indiquées par le fabricant conformément au Tableau 19.

**Tableau 2 – Relation entre le courant assigné de l'interrupteur et la puissance assignée du circuit SBL**

| Courant assigné de l'interrupteur [A] | Réseau de distribution [V]:                                            | Réseau de distribution [V]:                                            |
|---------------------------------------|------------------------------------------------------------------------|------------------------------------------------------------------------|
|                                       | 220/380<br>230/400<br>240/415<br>Puissance assignée du circuit SBL [W] | 120/208<br>120/240<br>127/220<br>Puissance assignée du circuit SBL [W] |
| Jusqu'à 10 inclus                     | 100                                                                    | 60                                                                     |
| Au-dessus de 10 et jusqu'à 13 inclus  | 150                                                                    | 60                                                                     |
| Au-dessus de 13 et jusqu'à 16 inclus  | 200                                                                    | 100                                                                    |
| Au-dessus de 16 et jusqu'à 20 inclus  | 250                                                                    | 150                                                                    |

La conformité aux exigences de 6.1 et 6.2 est vérifiée par examen du marquage.

### 6.3 Combinaisons préférentielles du nombre de pôles et des caractéristiques assignées

Les combinaisons préférentielles du nombre de pôles et des caractéristiques assignées sont présentées dans le Tableau 3.

**Tableau 3 – Combinaisons préférentielles des nombres de pôles et des caractéristiques assignées**

| Courant assigné<br>A                | Nombre de pôles                             |                                        |
|-------------------------------------|---------------------------------------------|----------------------------------------|
|                                     | Tension assignée de<br>120 V à 250 V inclus | Tension assignée<br>supérieure à 250 V |
| 1, 2 et 4                           | 1                                           | –                                      |
| 6                                   | 1                                           | 1                                      |
|                                     | 2                                           | 2                                      |
| 10 et 13                            | 1                                           | 1                                      |
|                                     | 2                                           | 2                                      |
|                                     |                                             | 3                                      |
|                                     |                                             | 4                                      |
| 16, 20, 25, 32, 40, 45, 50<br>et 63 | 1                                           | 1                                      |
|                                     | 2                                           | 2                                      |
|                                     | 3                                           | 3                                      |
|                                     | 4                                           | 4                                      |

## 7 Classification

Les interrupteurs sont classés

**7.1** selon les connexions possibles (voir Figure 8) en:

|                                                                                   | Numéro de fonction |
|-----------------------------------------------------------------------------------|--------------------|
| – interrupteur unipolaire .....                                                   | 1                  |
| – interrupteur bipolaire .....                                                    | 2                  |
| – interrupteur tripolaire .....                                                   | 3                  |
| – interrupteur tripolaire avec neutre coupé .....                                 | 03                 |
| – interrupteur à deux directions .....                                            | 6                  |
| – interrupteur à deux allumages avec une ligne commune d'entrée .....             | 5                  |
| – interrupteur à deux directions avec une position arrêt.....                     | 4                  |
| – interrupteur bipolaire à deux directions .....                                  | 6/2                |
| – interrupteur inverseur à deux directions (ou interrupteurs intermédiaires)..... | 7                  |

NOTE 1 Plusieurs interrupteurs de numéros de fonction identiques ou différents peuvent être montés sur une base commune.

NOTE 2 Pour le numéro de fonction pour lequel une position arrêt existe, la classification ci-dessus s'applique aussi aux interrupteurs à bouton poussoir et aux interrupteurs à contact momentané.

**7.2** selon l'ouverture des contacts:

- interrupteur à distance normale d'ouverture des contacts;
- interrupteur à faible distance d'ouverture des contacts;
- interrupteur à microdistance d'ouverture des contacts;
- interrupteur sans distance d'ouverture des contacts (dispositifs de coupure à semi-conducteurs).

**7.3** selon le degré de protection contre l'accès aux parties dangereuses et contre les effets nuisibles dus à la pénétration de corps solides étrangers suivant l'IEC 60529.

**7.4** selon le degré de protection contre les effets nuisibles dus à la pénétration de l'eau suivant l'IEC 60529.

**7.5** selon le mode de commande de l'interrupteur:

- rotatif;
- à levier;
- à touche basculante;
- à bouton poussoir;
- à tirage.

**7.6** selon la méthode de montage de l'interrupteur:

- pour pose en saillie;
- pour pose encastrée;
- pour pose semi-encastrée;
- pour pose sur panneau;
- pour huisserie.

**7.7** selon la méthode d'installation, comme conséquence de la conception de l'interrupteur en:

- interrupteur dont le capot ou la plaque de recouvrement peut être enlevé sans déplacement des conducteurs (conception A);
- interrupteur dont le capot ou la plaque de recouvrement ne peut être enlevé sans déplacement des conducteurs (conception B).

NOTE Si un interrupteur a une base qui ne peut pas être séparée de son capot ou de sa plaque de recouvrement et exige, pour être conforme à la norme, une plaque supplémentaire qui peut être enlevée sans déplacement des conducteurs lors des travaux de décoration murale, il est considéré comme étant de conception A, à condition que la plaque supplémentaire satisfasse aux exigences relatives aux capots et plaques de recouvrement.

**7.8** selon le type de borne en:

- interrupteur avec bornes à vis;
- interrupteur avec bornes sans vis.

**7.9** selon la possibilité d'accepter des conducteurs:

- interrupteur avec bornes pour conducteurs rigides seulement;
- interrupteur avec bornes pour conducteurs rigides et souples.

NOTE 1 Dans les pays suivants, les interrupteurs avec bornes pour conducteurs rigides seulement ne sont pas admis: ES, IN et IT.

NOTE 2 Dans les pays suivants, les interrupteurs avec bornes à vis pour conducteurs rigides seulement ne sont pas admis: DE, DK, IN et ZA.

## 8 Marquage

### 8.1 Généralités

Les interrupteurs doivent porter les indications suivantes:

- a) le(s) courant(s) assigné(s)
  - en ampères (A) si l'interrupteur est soumis aux essais conformément à 19.1 uniquement
  - en ampères (A) si l'interrupteur est soumis aux essais conformément à 19.1 et 19.3 uniquement ou
  - en ampères (AX) si l'interrupteur est soumis aux essais conformément à 19.1, 19.2 et 19.3 si les courants assignés en ampères (A) et (AX) sont égaux ou
  - en ampères (A et AX) si l'interrupteur est soumis aux essais conformément à 19.1, 19.2 et 19.3 si les courants assignés en ampères (A) et (AX) ne sont pas égaux;
- b) la/les tension(s) assignée(s) en volts;
- c) le symbole de la nature du courant d'alimentation;
- d) le nom du fabricant ou du fournisseur responsable, la marque de fabrique ou la marque d'identification;
- e) la référence du type, qui peut être un numéro de catalogue;
- f) le symbole de la construction à faible distance d'ouverture des contacts, s'il y a lieu;
- g) le symbole de la construction à microdistance d'ouverture des contacts, s'il y a lieu;
- h) le symbole de la construction sans distance d'ouverture des contacts (dispositif de coupure à semi-conducteur), s'il y a lieu;
- i) le premier chiffre caractéristique pour le degré de protection contre l'accès aux parties dangereuses et contre la pénétration dangereuse de corps solides étrangers, si déclaré supérieur à 4, auquel cas le deuxième chiffre caractéristique doit aussi être marqué;



- j) le deuxième chiffre caractéristique pour le degré de protection contre les effets nuisibles de la pénétration de l'eau, si déclaré supérieur à 2, auquel cas le premier chiffre caractéristique doit aussi être marqué;
- k) la longueur de l'isolant à enlever avant l'introduction du conducteur dans la borne sans vis;
- l) le symbole relatif à la possibilité de n'introduire que des conducteurs rigides.

De plus, les informations suivantes doivent être données dans la documentation du fabricant:

- m) pour les charges SBL: la puissance assignée en watts et le type de charge si l'interrupteur est soumis aux essais conformément à 19.3.

NOTE 1 Le numéro de fonction donné en 7.1 peut être marqué lorsque la fonction n'apparaît pas clairement à l'examen de l'interrupteur; ce numéro peut être une partie de la référence du type.

NOTE 2 Si une base porte deux ou plusieurs interrupteurs avec des organes de commande séparés, les numéros de fonction peuvent être marqués, par exemple 1+6 ou 1+1+1.

NOTE 3 En l'absence de marquage, les bornes ont la possibilité d'accepter des conducteurs souples et des conducteurs rigides.

NOTE 4 Dans le pays suivant, l'indication de la référence du type n'est pas utilisée: UK.

NOTE 5 Dans le pays suivant, il est exigé de placer le symbole de l'expertise électrotechnique (voir IEC 60417-6182:2013-09) sur l'emballage: DE.

## 8.2 Symboles

Lorsqu'il est fait usage de symboles, les suivants doivent être utilisés:

|                                                                                                                       |                                                           |                                                                                            |
|-----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|--------------------------------------------------------------------------------------------|
| Ampères                                                                                                               | (Courant assigné pour les charges à ballast externe)..... | AX                                                                                         |
|                                                                                                                       | (autres courants) .....                                   | A                                                                                          |
| Volts                                                                                                                 | .....                                                     | V                                                                                          |
| Courant alternatif                                                                                                    | .....                                                     | ~                                                                                          |
| Watt                                                                                                                  | .....                                                     | W                                                                                          |
| Neutre                                                                                                                | .....                                                     | N                                                                                          |
| Phase                                                                                                                 | .....                                                     | L                                                                                          |
| Terre de protection (IEC 60417-5019:2006-08)                                                                          | .....                                                     |       |
| Position «ouvert» (arrêt)                                                                                             | .....                                                     | O                                                                                          |
| Position «fermé» (marche)                                                                                             | .....                                                     | I                                                                                          |
| Construction à faible distance d'ouverture des contacts                                                               | .....                                                     | m                                                                                          |
| Construction à microdistance d'ouverture des contacts                                                                 | .....                                                     | μ                                                                                          |
| Sans distance d'ouverture des contacts (dispositif de coupure à semi-conducteur)                                      | .....                                                     | ε                                                                                          |
| Degré de protection, s'il y a lieu                                                                                    | .....                                                     | IPXX                                                                                       |
| Degré de protection pour accessoires fixes pour installation sur des surfaces rugueuses (mur d'essai de la Figure 21) | .....                                                     |  IPXX |
| Aptitude à n'accepter que des conducteurs rigides                                                                     | .....                                                     | r                                                                                          |

NOTE 1 Les détails de construction de certains symboles sont donnés dans l'IEC 60417.

NOTE 2 Dans le code IP, la lettre «X» est remplacée par le chiffre approprié.

NOTE 3 Les lignes formées par la construction de l'outil ne sont pas considérées comme faisant partie du marquage.

Le symbole «AX» peut être remplacé par le symbole «X». Pour le marquage du courant assigné et de la tension assignée, des chiffres peuvent être utilisés seuls.

Le marquage de la nature du courant d'alimentation doit être placé juste après le marquage du courant assigné et de la tension assignée.

NOTE 4 Le marquage du courant, de la tension et de la nature du courant d'alimentation peut, par exemple, avoir les formes suivantes:

|                      |    |                |    |                              |
|----------------------|----|----------------|----|------------------------------|
| 10 AX 250 V ~        | ou | 10 X/250 ~     | ou | $\frac{10 X}{250} \sim$      |
| 20 A – 16 AX 250 V ~ | ou | 20 -16 X/250 ~ | ou | $\frac{20 - 16 X}{250} \sim$ |
| 10 AX 400 V ~        | ou | 10 X/400 ~     | ou | $\frac{10 X}{400} \sim$      |
| 25 AX 400 V ~        | ou | 25 X/400 ~     | ou | $\frac{25 X}{400} \sim$      |
| 25 A 250 V ~         | ou | 25/250 ~       | ou | $\frac{25}{250} \sim$        |
| 25 AX 440 V ~        | ou | 25 X/440 ~     | ou | $\frac{25 X}{440} \sim$      |

### 8.3 Visibilité des marquages

Le marquage doit être clairement visible à la vision normale ou corrigée, sans grossissement supplémentaire.

Les marquages a), b), c), d), e) et, s'il y a lieu, f), g), h), k) et l), donnés en 8.1, doivent être placés sur la partie principale de l'interrupteur.

NOTE 1 Le marquage e) peut être la référence de la série seulement.

NOTE 2 Dans le pays suivant, le marquage de la référence du type n'est pas utilisé: UK.

Les pièces telles que les plaques de recouvrement, qui sont nécessaires pour la sécurité et qui sont destinées à être vendues séparément, doivent porter le nom du fabricant ou du fournisseur responsable, la marque de fabrique ou d'identification et la référence du type.

Les marquages i) et j) doivent être apposés, s'il y a lieu, de façon à être facilement visibles quand l'interrupteur est monté et câblé comme en usage normal. Ces marquages doivent être placés sur une partie qui ne peut être démontée sans l'utilisation d'un outil.

NOTE 3 Des références supplémentaires de type peuvent être portées sur la partie principale ou sur la partie extérieure ou intérieure de l'enveloppe associée.

### 8.4 Marquage sur les bornes des conducteurs de phase

Les bornes destinées au raccordement des conducteurs de phase (conducteurs d'alimentation) doivent être identifiées, sauf si le mode de raccordement n'a pas d'importance, s'il est évident ou s'il est indiqué par un schéma de câblage. Une telle identification peut se faire sous la forme d'une lettre L ou, s'il y a plus d'une borne, par les lettres L1, L2, L3, etc. Les lettres L1, L2, L3 peuvent être accompagnées par une ou plusieurs flèches se dirigeant vers la ou les bornes appropriées.

Ces indications ne doivent pas être situées sur des vis ou sur d'autres pièces facilement démontables.

En variante, la surface de telles bornes doit être en laiton ou en cuivre nu, les autres bornes étant recouvertes d'une couche métallique d'une autre couleur.

Pour les interrupteurs de numéros de fonction 2, 3, 03 et 6/2, les bornes affectées à un même pôle doivent avoir, le cas échéant, une identification similaire et différente de celle des bornes affectées aux autres pôles, à moins que la relation ne soit évidente.

NOTE 1 Le schéma de câblage peut être une feuille d'instruction qui accompagne l'interrupteur.

NOTE 2 Les pièces «facilement démontables» sont les pièces qui peuvent être enlevées pendant l'installation normale de l'interrupteur.

### 8.5 Marquage sur les bornes des conducteurs de terre et neutres

Les bornes prévues uniquement pour le conducteur neutre doivent être repérées par la lettre N.

La borne de terre pour le raccordement du conducteur de protection doit être indiquée par le symbole  (IEC 60417-5019:2006-08).

Ces marquages ne doivent pas être placés sur des vis ou sur d'autres pièces facilement démontables.

NOTE Les pièces «facilement démontables» sont les pièces qui peuvent être enlevées pendant l'installation normale de l'interrupteur.

Les bornes prévues pour le raccordement des conducteurs ne faisant pas partie de la fonction principale de l'interrupteur doivent être clairement identifiées, à moins que leur usage soit évident ou clairement indiqué dans un schéma de câblage qui doit être fixé à l'appareil.

L'identification des bornes de l'interrupteur peut être obtenue par

- leur marquage avec des symboles graphiques selon l'IEC 60417, par des couleurs et/ou un système alphanumérique;
- leur dimension physique ou leur emplacement relatif.

Les fils des lampes indicatrices ne sont pas considérés comme des conducteurs pour les besoins de 8.5.

### 8.6 Marquage de la position des interrupteurs

Si les interrupteurs sont marqués afin d'indiquer la position de l'interrupteur, ils doivent aussi être marqués de sorte que la direction du mouvement de l'organe de manœuvre vers ses différentes positions ou que la position effective de l'interrupteur soit clairement indiquée. Pour les interrupteurs à plus d'un organe de manœuvre, l'indication correspondante doit indiquer, pour chacun des organes de manœuvre, l'effet réalisé par son fonctionnement.

Le marquage doit être clairement visible sur la face avant de l'interrupteur équipé de son capot ou de sa plaque de recouvrement.

Si ce marquage est placé sur le capot, sur la plaque de recouvrement ou sur les organes de manœuvre démontables, il ne doit pas être possible de les fixer dans une position telle que le marquage soit incorrect.

Les symboles «marche» (fermé) et «arrêt» (ouvert) ne doivent pas être utilisés pour l'indication des positions de l'interrupteur à moins qu'en même temps, ils n'indiquent clairement la direction du mouvement de l'organe de manœuvre.

NOTE 1 D'autres moyens appropriés pour l'indication de la position de l'interrupteur peuvent être utilisés, par exemple des lampes indicatrices.

Le tiret indiquant la position «marche» (fermé) doit être radial pour les interrupteurs rotatifs, perpendiculaire à l'axe de rotation de la manette pour les interrupteurs à levier et pour les interrupteurs à touche basculante et vertical pour les interrupteurs à bouton poussoir lorsqu'ils sont montés verticalement.

Ces exigences ne s'appliquent pas aux interrupteurs à tirage, ni aux interrupteurs de numéros de fonction 6, 6/2 et 7.

NOTE 2 Une telle indication peut être évitée pour les interrupteurs à bouton poussoir.

*La conformité aux exigences de 8.1 à 8.6 est vérifiée par examen.*

### **8.7 Exigences supplémentaires de marquage**

S'il est nécessaire de prendre des précautions spéciales lors de l'installation de l'interrupteur, les détails de celles-ci doivent être donnés sur une feuille d'instruction jointe à l'interrupteur.

Les feuilles d'instruction doivent être rédigées dans la ou les langues officielles du pays dans lequel l'interrupteur est destiné à être vendu.

*La conformité est vérifiée par examen.*

NOTE 1 Des précautions spéciales peuvent être nécessaires, par exemple, pour les interrupteurs non enfermés et pour les interrupteurs pour montage sur panneau.

NOTE 2 Après installation, les conditions nécessaires pour satisfaire aux exigences du présent document sont remplies lorsque la feuille d'instruction indique des informations claires concernant les points suivants:

- dimensions du logement à prévoir pour chaque interrupteur;
- dimensions et position des dispositifs pour fixer et soutenir l'interrupteur dans ce logement;
- distance d'isolement minimale dans l'air entre les différentes parties de l'interrupteur et les surfaces environnantes du logement, s'il y a lieu;
- dimensions minimales des ouvertures de ventilation, si nécessaire, et leur disposition correcte.

NOTE 3 Si nécessaire, des informations relatives à la connexion entre la borne de terre et les parties métalliques accessibles peuvent être fournies.

### **8.8 Durabilité**

Le marquage doit être durable et facilement lisible.

*La conformité est vérifiée par examen et par l'essai suivant.*

*Le marquage est frotté à la main pendant 15 s avec un chiffon imbibé d'eau, puis de nouveau pendant 15 s avec un chiffon imbibé de n-hexane à 95 %.*

NOTE 1 Les marques faites par empreintes, moulage, pression, marquage au laser ou gravure ne sont pas soumises à cet essai.

NOTE 2 Le n-hexane à 95 % (numéro CAS 110-54-3) est disponible comme solvant pour chromatographie en phase liquide sous haute pression (CLHP) chez une variété de fournisseurs de substances chimiques.

## 9 Vérification des dimensions

Les interrupteurs et les boîtes doivent être conformes aux éventuelles feuilles de norme appropriées.

*La conformité est vérifiée par mesurage.*

## 10 Protection contre les chocs électriques

### 10.1 Prévention de l'accès aux parties actives

Les interrupteurs doivent être conçus de sorte que, lorsqu'ils sont montés et équipés de leurs conducteurs comme en usage normal, les parties actives ne soient pas accessibles même après le retrait de pièces qui peuvent être enlevées sans l'utilisation d'un outil.

Les interrupteurs qui sont conçus pour être équipés de lampes indicatrices alimentées à une tension autre que la TBT doivent être équipés de moyens pour empêcher le contact direct avec la lampe.

*La conformité est vérifiée par examen et, si nécessaire, par l'essai suivant:*

*L'échantillon est installé comme en usage normal et équipé de conducteurs de la plus petite section spécifiée à l'Article 12; l'essai est répété en utilisant des conducteurs de la plus forte section spécifiée à l'Article 12.*

*Le calibre d'essai B de l'IEC 61032 est appliqué dans toutes les positions possibles, un contact éventuel avec les parties concernées étant décelé par un indicateur électrique utilisant une tension entre 40 V et 50 V.*

*Les interrupteurs ayant des enveloppes ou des capots en matières thermoplastiques ou élastomère sont soumis à l'essai supplémentaire suivant qui est effectué à une température ambiante de  $(35 \pm 2)$  °C, les interrupteurs étant à cette température.*

*Pendant cet essai supplémentaire, les interrupteurs sont soumis pendant 1 min à une force de 75 N, appliquée à l'aide de l'extrémité du calibre d'essai 11 de l'IEC 61032.*

*Ce doigt, avec l'indicateur électrique mentionné ci-dessus, est placé à tous les endroits dans lesquels un excès de souplesse du matériau isolant pourrait compromettre la sécurité de l'interrupteur; il n'est pas appliqué aux membranes ou analogues; il est appliqué aux parois minces défonçables avec une force de 10 N seulement.*

*Pendant cet essai, les interrupteurs et leurs dispositifs de montage associés ne doivent pas se déformer à un degré tel que les parties actives puissent être touchées par le calibre d'essai 11 de l'IEC 61032.*

NOTE Les membranes ou analogues sont soumises aux essais conformément à 13.15.1 seulement.

### 10.2 Exigences relatives aux parties en fonctionnement

Les boutons, leviers de commande, boutons poussoirs, touches basculantes et organes analogues doivent être en matériau isolant à moins que leurs parties métalliques accessibles ne soient séparées des parties métalliques du mécanisme par une double isolation ou une isolation renforcée ou, en variante, soient reliées efficacement à la terre.

*La conformité est vérifiée par examen et par les essais des Articles 16 et 23.*

Cette exigence ne s'applique ni aux clefs amovibles, ni aux organes intermédiaires tels que les chaînettes ou les tringles.

### 10.3 Exigences relatives aux parties métalliques accessibles

**10.3.1** Les parties accessibles des interrupteurs en usage normal doivent être en matériau isolant à l'exception de ce qui suit:

- des petites vis ou pièces similaires, séparées des parties actives et utilisées pour la fixation de la base et des capots, plaques de recouvrement et autres parties de l'enveloppe;
- des organes de manœuvre conformes aux exigences de 10.2;
- des capots, des plaques de recouvrement et autres parties de l'enveloppe en métal et conformes aux exigences indiquées en 10.3.2 ou 10.3.3.

**10.3.2** Les capots ou les plaques de recouvrement en métal doivent être protégés par une isolation supplémentaire faite de revêtements ou de cloisons isolants. Ces revêtements ou cloisons isolants doivent

- être fixés aux capots ou aux plaques de recouvrement ou au corps des interrupteurs de sorte qu'ils ne peuvent pas être retirés sans subir de dommages permanents, ou
- être conçus de sorte
  - qu'ils ne puissent être remis en place dans une position incorrecte;
  - que les appareils soient rendus inaptes à fonctionner ou manifestement incomplets en leur absence;
  - qu'il n'y ait aucun risque de contact accidentel entre les parties actives et les capots ou plaques de recouvrement métalliques, par exemple par l'intermédiaire de leurs vis de fixation, y compris dans le cas d'un conducteur se détachant de sa borne;
  - que des précautions soient prises pour qu'il n'y ait pas de diminution des valeurs des lignes de fuite ou distances d'isolement dans l'air au-dessous de celles spécifiées à l'Article 23.

*La conformité est vérifiée par examen.*

Les revêtements et les cloisons mentionnés ci-dessus doivent satisfaire aux essais des Articles 16 et 23.

NOTE Les revêtements isolants pulvérisés à l'intérieur ou à l'extérieur des capots ou plaques métalliques ne sont pas considérés comme des cloisons ou des revêtements isolants pour les besoins de 10.3.2.

**10.3.3** La mise à la terre des capots ou plaques de recouvrement métalliques peut être effectuée au moyen de vis de fixation ou d'autres moyens intégrés; la connexion résultante doit être de faible résistance.

*La conformité est vérifiée par examen et par les essais de 11.4.*

### 10.4 Exigences d'isolement du mécanisme

Les parties métalliques du mécanisme qui ne sont pas isolées des parties actives telles que l'axe ou le pivot de la manette ou de la touche basculante ne doivent pas faire saillie hors de l'enveloppe.

Toutefois, pour les interrupteurs manœuvrés à l'aide d'une clef amovible ou d'un dispositif analogue, de telles parties métalliques du mécanisme doivent être isolées des parties actives.

*La conformité est vérifiée par examen, si nécessaire, après que l'organe de manœuvre a été enlevé ou cassé.*

*Si l'organe de manœuvre doit être cassé, la conformité est vérifiée avec l'essai de l'Article 23.*

### **10.5 Exigences d'isolement du mécanisme par rapport à l'environnement**

Les parties métalliques du mécanisme ne doivent pas être accessibles et doivent être isolées des parties métalliques accessibles lorsque l'interrupteur est monté comme en usage normal.

Ces exigences ne s'appliquent pas si les parties métalliques du mécanisme sont séparées des parties actives de sorte que les lignes de fuite et les distances d'isolement dans l'air sont au moins égales à deux fois les valeurs spécifiées à l'Article 23, ou, en variante, si elles sont raccordées à la terre de manière fiable.

*La conformité est vérifiée par examen et, si nécessaire, par mesurage et par les essais des Articles 10 et 16.*

NOTE Lors de la vérification de l'inaccessibilité des parties métalliques du mécanisme des interrupteurs non enfermés et des interrupteurs pour huisserie, la protection assurée après leur montage normal est prise en compte.

Pour les interrupteurs à empilage non enfermés, dont l'axe métallique pivote dans une plaque de base métallique, l'exigence complémentaire implique que les lignes de fuite et les distances d'isolement dans l'air entre les parties actives et l'axe et entre les parties métalliques du mécanisme et la plaque de base doivent être au moins égales au double des valeurs spécifiées à l'Article 23.

### **10.6 Exigences relatives aux interrupteurs manœuvrés indirectement**

Les interrupteurs manœuvrés à l'aide d'une clef amovible ou à l'aide d'un organe intermédiaire, tel qu'un cordon, une chaînette ou une tringle, doivent être conçus de sorte que la clef ou l'organe intermédiaire ne puisse toucher que des parties isolées des parties actives.

La clef ou l'organe intermédiaire doit être isolé(e) des parties métalliques du mécanisme, à moins que les lignes de fuite et les distances d'isolement dans l'air entre les parties actives et les parties métalliques du mécanisme soient au moins égales à deux fois les valeurs spécifiées à l'Article 23.

*La conformité est vérifiée par examen, par les essais de 16.3 et, si nécessaire, par mesurage.*

NOTE Le vernis et l'émail ne sont pas considérés comme des matériaux isolants dans le cadre de 10.1 à 10.6.

### **10.7 Exigences relatives aux interrupteurs équipés d'un cordon de tirage remplaçable**

Lorsque les interrupteurs à tirage sont fournis avec un cordon de tirage qui peut être installé ou remplacé par l'utilisateur, ils doivent être conçus de telle façon qu'il soit impossible de toucher les parties actives lors de l'installation ou du remplacement du cordon de tirage de la façon normale.

*La conformité est vérifiée par examen.*

## **11 Dispositions pour assurer la mise à la terre**

### **11.1 Généralités**

Les parties métalliques accessibles qui peuvent être mises sous tension lors d'un défaut d'isolement doivent être équipées d'une borne de terre ou être reliées d'une façon permanente et sûre à une telle borne.

Cette exigence ne s'applique pas aux plaques de recouvrement métalliques mentionnées en 10.3.2.

Pour l'application de cette exigence, de petites vis et organes analogues, séparés des parties actives, ne sont pas considérés comme des parties accessibles susceptibles d'être mises sous tension en cas de défaut d'isolement.

## 11.2 Bornes de terre

Les bornes de terre doivent être des bornes à vis ou sans vis et doivent satisfaire aux exigences appropriées de l'Article 12.

## 11.3 Exigences relatives aux interrupteurs pour pose en saillie

Les interrupteurs pour pose en saillie à enveloppe isolante ayant un degré de protection IP supérieur à IPX0 et comportant plus d'une entrée de câble doivent être équipés soit d'une borne de terre interne fixe soit d'un espace adéquat pour une borne flottante permettant de raccorder l'arrivée et le départ d'un conducteur pour la continuité du circuit de mise à la terre.

Les exigences de l'Article 12 ne s'appliquent pas aux bornes flottantes qui doivent être conformes à l'IEC 60998-1 et à la sous-partie appropriée de l'IEC 60998-2.

*La conformité à 11.1 à 11.3 est vérifiée par examen et par les essais de l'Article 12.*

*La conformité de l'espace adéquat pour les bornes flottantes est vérifiée par un essai de connexion avec le type de borne spécifié par le fabricant.*

## 11.4 Essai de connexion de terre

La connexion entre la borne de terre et les parties métalliques accessibles qui doivent y être reliées doit être de faible résistance.

*La conformité est vérifiée par l'essai suivant.*

*Un courant produit par une source alternative de tension à vide ne dépassant pas 12 V et égal à 1,5 fois le courant assigné ou 25 A, selon la valeur la plus grande, circule entre la borne de terre et chacune des parties métalliques accessibles l'une après l'autre.*

*La chute de tension entre la borne de terre et les parties métalliques accessibles 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  $\Omega$ .*

NOTE Une attention particulière est accordée à la résistance de contact entre l'extrémité de la sonde de mesure et la partie métallique en essai afin qu'elle n'influence pas les résultats de l'essai.

# 12 Bornes

## 12.1 Généralités

Les interrupteurs doivent être équipés de bornes à vis ou de bornes sans vis.

Les dispositifs de serrage des conducteurs dans les bornes ne doivent servir à la fixation d'aucun autre constituant, bien qu'ils puissent maintenir en place les bornes ou les empêcher de tourner.

Tous les essais sur les bornes, à l'exception de l'essai de 12.3.11, doivent être effectués après l'essai de 15.1. Les conducteurs rigides massifs doivent être de Classe 1, les conducteurs rigides câblés doivent être de Classe 2 et les conducteurs souples doivent être de Classe 5 selon l'IEC 60228.



*La conformité est vérifiée par examen et par les essais de 12.2 ou 12.3, selon le cas.*

## 12.2 Bornes à vis pour conducteurs extérieurs en cuivre

**12.2.1** Les bornes à vis peuvent être du type acceptant des conducteurs en cuivre rigides seulement ou du type acceptant des conducteurs en cuivre à la fois souples et rigides ayant des sections telles qu'indiquées au Tableau 4.

**Tableau 4 – Relation entre les courants assignés et les sections des conducteurs en cuivre à connecter**

| Plage des courants assignés                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Conducteurs rigides (massifs ou câblés) <sup>c</sup> |                                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|-----------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Sections nominales<br>mm <sup>2</sup>                | Diamètre du plus grand conducteur<br>mm |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                      |                                         |
| jusqu'à 4 inclus <sup>a</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | –                                                    | –                                       |
| au-dessus de 4 et jusqu'à 6 inclus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | De 0,75 à 1,5 inclus                                 | 1,45                                    |
| au-dessus de 6 et jusqu'à 13 inclus <sup>b</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | De 1 à 2,5 inclus                                    | 2,13                                    |
| au-dessus de 13 et jusqu'à 16 inclus <sup>b</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | De 1,5 à 4 inclus                                    | 2,72                                    |
| au-dessus de 16 et jusqu'à 25 inclus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | De 2,5 à 6 inclus                                    | 3,34                                    |
| au-dessus de 25 et jusqu'à 32 inclus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | De 4 à 10 inclus                                     | 4,34                                    |
| au-dessus de 32 et jusqu'à 50 inclus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | De 6 à 16 inclus                                     | 5,46                                    |
| au-dessus de 50 et jusqu'à 63 inclus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | De 10 à 25 inclus                                    | 6,85                                    |
| <sup>a</sup> Pour applications spéciales telles que TBT quand des conducteurs souples sont utilisés (de 0,5 mm <sup>2</sup> à 1 mm <sup>2</sup> inclus).<br><sup>b</sup> Chaque borne d'alimentation des interrupteurs autre que celle des numéros de fonction 3, 03 et 7 doit permettre le raccordement de deux conducteurs de 2,5 mm <sup>2</sup> . Pour les interrupteurs ayant une tension assignée ne dépassant pas 250 V, un trou circulaire est suffisant pour la connexion de deux conducteurs de 2,5 mm <sup>2</sup> .<br><sup>c</sup> L'utilisation de conducteurs souples est permise. |                                                      |                                         |

Le logement des conducteurs doit être au moins celui spécifié aux Figures 1, 2, 3, 4 et 5.

*La conformité est vérifiée par examen et par introduction de conducteurs de la plus petite et de la plus grande section spécifiée.*

**12.2.2** Les bornes à vis doivent permettre le raccordement du conducteur sans préparation spéciale.

*La conformité est vérifiée par examen.*

NOTE Le terme «préparation spéciale» concerne l'étamage des fils du conducteur, l'utilisation de cosses, la formation d'œillets, etc., mais ne concerne pas la remise en forme du conducteur avant son introduction dans la borne ou le torsadage d'un conducteur souple pour en consolider l'extrémité.

**12.2.3** Les bornes à vis doivent avoir une résistance mécanique appropriée.

Les vis et les écrous pour le serrage des conducteurs doivent avoir un pas métrique ISO ou un pas comparable en filetage et en résistance mécanique.

Les vis ne doivent pas être en métal doux ou sujet à craquelures, tel que le zinc ou l'aluminium.

*La conformité est vérifiée par examen et par les essais des 12.2.6 et 12.2.8.*

NOTE Provisoirement, les pas SI, BA et UN sont considérés comme comparables en filetage et en résistance mécanique au pas métrique ISO.

#### **12.2.4** Les bornes à vis doivent résister à la corrosion.

Les bornes dont le corps est fait de cuivre ou d'alliage de cuivre, comme cela est spécifié en 22.5, sont considérées comme satisfaisant à cette exigence.

#### **12.2.5** Les bornes à vis doivent être conçues et construites de manière qu'elles serrent le ou les conducteurs sans le ou les endommager.

*La conformité est vérifiée par l'essai suivant:*

*Les bornes acceptant uniquement des conducteurs rigides sont vérifiées avec des conducteurs rigides massifs et sur un nouveau lot d'échantillons équipés de conducteurs rigides câblés, le cas échéant.*

NOTE «Le cas échéant» signifie que le conducteur est disponible sur le marché de vente et d'installation du produit.

*Les bornes acceptant les conducteurs rigides et souples sont vérifiées avec des conducteurs rigides, comme décrit ci-dessus, et sur un nouveau lot d'échantillons équipés de conducteurs souples.*

*La borne est placée dans l'appareil d'essai selon la Figure 9. Elle est tout d'abord équipée d'un conducteur de la plus petite section et ensuite d'un conducteur de la plus grande section selon le Tableau 4, la/les vis ou le/les écrou(s) de serrage étant serrés avec le couple de valeur conforme au Tableau 5.*

*Lorsqu'une vis est à tête hexagonale fendue pour être serrée à l'aide d'un tournevis et que les valeurs des colonnes 3 et 5 sont différentes, l'essai est effectué deux fois, d'abord en appliquant à la tête hexagonale le couple spécifié à la colonne 5, puis en appliquant le couple spécifié à la colonne 3 au moyen d'un tournevis. Si les valeurs des colonnes 3 et 5 sont identiques, seul l'essai avec le tournevis est effectué.*

*Pour les bornes à capot taraudé, le diamètre nominal spécifié est celui de la tige fendue.*

*La forme de la lame du tournevis d'essai doit être adaptée à la tête de la vis à soumettre à l'essai.*

*Les vis et les écrous doivent être serrés par un mouvement régulier et continu.*

**Tableau 5 – Couple de serrage pour la vérification de la résistance mécanique des bornes à vis**

| Diamètre nominal du filetage<br>mm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Couple<br>Nm |     |     |     |     |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----|-----|-----|-----|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1            | 2   | 3   | 4   | 5   | 6   |
| Jusqu'à 2,8 inclus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0,2          | –   | 0,4 | –   | 0,4 | –   |
| Comprise entre 2,8 et 3,0 inclus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0,25         | –   | 0,5 | –   | 0,5 | –   |
| Comprise entre 3,0 et 3,2 inclus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0,3          | –   | 0,6 | –   | 0,6 | –   |
| Comprise entre 3,2 et 3,6 inclus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0,4          | –   | 0,8 | –   | 0,8 | –   |
| Comprise entre 3,6 et 4,1 inclus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0,7          | 1,2 | 1,2 | 1,2 | 1,2 | –   |
| Comprise entre 4,1 et 4,7 inclus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0,8          | 1,2 | 1,8 | 1,8 | 1,8 | –   |
| Comprise entre 4,7 et 5,3 inclus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0,8          | 1,4 | 2,0 | 2,0 | 2,0 | –   |
| Comprise entre 5,3 et 6,0 inclus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | –            | 1,8 | 2,5 | 3,0 | 3,0 | –   |
| Au-dessus de 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | –            | –   | –   | –   | –   | 0,8 |
| <p>La colonne 1 s'applique aux vis sans tête, si la vis, lorsqu'elle est serrée, ne dépasse pas du trou, et aux autres vis qui ne peuvent être serrées au moyen d'un tournevis ayant une lame plus large que le diamètre de la vis.</p> <p>La colonne 2 s'applique aux écrous des bornes à capot taraudé qui sont serrés au moyen d'un tournevis.</p> <p>La colonne 3 s'applique aux autres vis qui sont serrées au moyen d'un tournevis.</p> <p>La colonne 4 s'applique aux écrous des bornes à capot taraudé dans lesquelles l'écrou est serré par d'autres moyens qu'un tournevis.</p> <p>La colonne 5 s'applique aux vis ou écrous, autres que les écrous des bornes à capot taraudé, qui sont serrés par d'autres moyens qu'un tournevis.</p> <p>La colonne 6 s'applique aux écrous des interrupteurs avec fixation à trou central.</p> |              |     |     |     |     |     |

La longueur du conducteur d'essai doit être de 75 mm supérieure à la hauteur (H) spécifiée dans le Tableau 6.

L'extrémité du conducteur est passée à travers un manchon de taille appropriée dans un plateau placé à une hauteur (H) en dessous de l'équipement comme indiqué au Tableau 6. Le manchon doit être placé dans un plan horizontal de sorte que sa ligne médiane décrive un cercle de 75 mm de diamètre, concentrique au centre de l'organe de serrage dans le plan horizontal. Le plateau est alors tourné à une vitesse de  $(10 \pm 2)$  r/min.

La distance entre l'entrée de l'organe de serrage et la surface supérieure du manchon doit être égale à  $\pm 15$  mm à la hauteur donnée dans le Tableau 6. Le manchon peut être lubrifié pour éviter de coincer, tordre ou faire tourner le conducteur isolé.

Une masse telle que spécifiée au Tableau 6 doit être suspendue à l'extrémité du conducteur. La durée de l'essai doit être de 15 min.

Pendant l'essai, aucun conducteur rigide ou aucun brin de conducteur rigide câblé ou souple ne doit ni s'échapper de l'organe de serrage, ni se casser près de l'organe de serrage et ni être endommagé de façon telle qu'il soit rendu impropre à un usage ultérieur.

Dans le cas d'un conducteur souple, la rupture de plusieurs brins ne doit pas être prise en compte sous réserve de ne pas toucher plus de 15 % du nombre initial de brins.

**Tableau 6 – Valeurs pour les essais de flexion et de traction des conducteurs en cuivre**

| Section<br>du conducteur <sup>a</sup><br>mm <sup>2</sup> | Diamètre<br>du trou du manchon <sup>b</sup><br>mm | Hauteur $H$ <sup>c</sup><br>mm | Masse<br>pour le conducteur<br>kg |
|----------------------------------------------------------|---------------------------------------------------|--------------------------------|-----------------------------------|
| 0,5                                                      | 6,5                                               | 260                            | 0,3                               |
| 0,75                                                     | 6,5                                               | 260                            | 0,4                               |
| 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                               |
| 25,0                                                     | 13,0                                              | 300                            | 4,5                               |

<sup>a</sup> Les tailles AWG correspondant aux dimensions en mm<sup>2</sup> peuvent être consultées dans l'IEC 60999-1.

<sup>b</sup> Si le diamètre du trou du manchon n'est pas assez grand pour recevoir le conducteur sans retenue, un manchon dont la taille du trou est la plus proche peut être utilisé.

<sup>c</sup> Tolérance pour la hauteur  $H = \pm 15$  mm.

**12.2.6** Les bornes à vis doivent être conçues de manière qu'elles serrent le conducteur de façon fiable entre des surfaces métalliques.

*La conformité est vérifiée par examen et par l'essai suivant:*

*Les bornes acceptant uniquement des conducteurs rigides sont vérifiées avec des conducteurs rigides massifs et sur un nouveau lot d'échantillons équipés de conducteurs rigides câblés, le cas échéant.*

NOTE 1 «Le cas échéant» signifie que le conducteur est disponible sur le marché de vente et d'installation du produit.

*Les bornes acceptant des câbles souples et des câbles rigides sont vérifiées avec des conducteurs rigides comme ci-dessus, et sur un nouveau lot d'échantillons avec des conducteurs souples.*

*Les bornes sont équipées de conducteurs de la plus petite et de la plus grande section spécifiées au Tableau 4, les vis de la borne étant serrées avec un couple égal aux deux tiers de celui mentionné dans la colonne appropriée du Tableau 5.*

*Si la vis a une tête hexagonale fendue, le couple appliqué est égal aux deux tiers de celui qui est indiqué dans la colonne 3 du Tableau 5.*

*Chaque conducteur est ensuite soumis à une traction comme indiqué au Tableau 7, appliquée sans à-coups, pendant 1 min, dans la direction de l'axe du logement du conducteur.*

*Si l'organe de serrage est prévu pour deux conducteurs, la traction appropriée est appliquée successivement à chaque conducteur.*

**Tableau 7 – Valeurs pour l'essai de traction**

| Section du conducteur<br>raccordé à la borne<br>mm <sup>2</sup> | 0,75 | 1  | 1,5 | 2,5 | 4  | 6  | 10 | 16 | 25  |
|-----------------------------------------------------------------|------|----|-----|-----|----|----|----|----|-----|
| Traction<br>N                                                   | 30   | 35 | 40  | 50  | 50 | 60 | 80 | 90 | 100 |

*Pendant l'essai, le conducteur ne doit pas se déplacer de façon appréciable dans la borne.*

*Si l'organe de serrage est destiné au raccordement de plus de deux conducteurs, pour les essais il est fait référence aux exigences de la partie appropriée de l'IEC 60998.*

NOTE 2 Dans les pays suivants, les bornes permettant le raccordement de deux conducteurs sont, de plus, soumises à l'essai avec un conducteur rigide massif et un conducteur rigide câblé de mêmes sections, raccordés simultanément: DK, FI, NO, SE et ZA.

**12.2.7** Les bornes à vis doivent être conçues ou placées de manière telle que ni un conducteur rigide massif ni un brin d'un conducteur câblé ne puissent s'échapper alors que les vis ou écrous sont serrés.

Cette exigence ne s'applique pas aux bornes pour cosses et barrettes.

*La conformité est vérifiée par l'essai suivant:*

*Les bornes acceptant uniquement des conducteurs rigides sont vérifiées avec des conducteurs rigides massifs et sur un nouveau lot d'échantillons équipés de conducteurs rigides câblés, le cas échéant.*

NOTE «Le cas échéant» signifie que le conducteur est disponible sur le marché de vente et d'installation du produit.

*Les bornes acceptant des câbles souples et des câbles rigides sont vérifiées avec des conducteurs rigides comme ci-dessus, et sur un nouveau lot d'échantillons avec des câbles souples.*

*Les bornes sont équipées de conducteurs ayant la section la plus grande spécifiée au Tableau 4.*

*Les bornes prévues pour le repiquage de deux ou trois conducteurs sont vérifiées en les équipant du nombre admissible de conducteurs.*

*Les bornes sont équipées de conducteurs ayant la constitution indiquée dans l'IEC 60228.*

*Avant insertion dans l'organe de serrage de la borne, les brins des conducteurs rigides (massifs ou câblés) sont redressés; les conducteurs rigides câblés peuvent être, en outre, torsadés pour les remettre approximativement dans leur forme initiale; les conducteurs souples sont torsadés dans un sens de manière à réaliser une torsion uniforme d'un tour complet sur une longueur approximative de 20 mm.*

*Le conducteur est introduit dans l'organe de serrage de la borne sur la distance minimale exigée ou, dans le cas où aucune distance n'est exigée, jusqu'à ce qu'il apparaisse sur la face opposée de la borne et dans la position la plus susceptible de favoriser l'échappement d'un brin.*

*La (les) vis ou le (les) écrou(s) de serrage est (sont) alors serré(s) avec un couple égal aux deux tiers de celui indiqué dans la colonne appropriée du Tableau 5.*

*Après l'essai, aucun brin des conducteurs ne doit s'être échappé de l'organe de serrage de façon telle que les lignes de fuite et distances d'isolement dans l'air soient réduites à des valeurs inférieures à celles indiquées au Tableau 23.*

**12.2.8** Les bornes à vis doivent être fixées ou situées dans l'interrupteur de façon que, lorsque les vis ou écrous de serrage sont serrés ou desserrés, les bornes ne doivent pas prendre de jeu par rapport à l'interrupteur.

Les mouvements de la borne sont permis sous réserve qu'ils soient suffisamment limités pour empêcher la non-conformité au présent document.

L'utilisation d'une résine ou d'une matière de remplissage est considérée comme suffisante pour empêcher une borne de prendre du jeu à condition que

- la résine ou la matière de remplissage ne soit pas soumise à des contraintes pendant l'usage normal, et
- l'efficacité de la résine ou de la matière de remplissage ne soit pas altérée par les températures atteintes par la borne dans les conditions les plus défavorables spécifiées dans le présent document.

*La conformité est vérifiée par examen, par mesurage et par l'essai suivant:*

*Un conducteur rigide massif en cuivre de la section la plus grande spécifiée au Tableau 4 est introduit dans la borne.*

*Les vis ou les écrous sont serrés et desserrés cinq fois au moyen d'un tournevis ou d'une clef d'essai approprié(e), le couple appliqué au moment du serrage étant égal à celui indiqué dans la colonne appropriée du Tableau 5 ou celui indiqué dans le tableau des Figures 1 à 4 appropriées, selon la plus grande des deux valeurs.*

*Le conducteur est déplacé chaque fois que la vis ou l'écrou est desserré.*

Pendant l'essai, les bornes ne doivent pas prendre de jeu et aucun dommage affectant l'usage ultérieur des bornes tel que le bris de vis ou la détérioration des têtes, des fentes, des filetages, des rondelles ou des étriers ne doit être constaté.

**12.2.9** Les vis ou écrous de serrage des bornes de terre à vis de serrage doivent être convenablement protégés 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 un essai manuel.*

*En général, les modèles de bornes représentés aux Figures 1, 2, 3, 4 et 5 procurent une élasticité suffisante pour satisfaire à cette exigence; pour d'autres modèles, des dispositions spéciales, telles que l'utilisation d'une pièce élastique convenable qui n'est pas susceptible d'être retirée fortuitement, peuvent être nécessaires.*

**12.2.10** Les bornes de terre à vis de serrage doivent être telles qu'il n'existe aucun risque de corrosion résultant du contact entre elles et le cuivre du conducteur de terre ou tout autre métal qui se trouve en contact avec elles.

Le corps des bornes de terre doit être en laiton ou autre métal aussi résistant à la corrosion, à moins qu'il ne fasse partie de l'armature ou de l'enveloppe métallique; dans ce dernier cas, la vis ou l'écrou doit être en laiton ou autre métal aussi résistant à la corrosion.

Si le corps de la borne de terre fait partie d'une armature ou d'une enveloppe en alliage d'aluminium, des mesures de prévention doivent être prises pour éviter le risque de corrosion résultant du contact entre le cuivre et l'aluminium ou ses alliages.

*La conformité est vérifiée par examen.*

NOTE Les vis ou écrous en acier traité pour supporter l'essai de corrosion sont considérés comme étant faits d'un métal aussi résistant à la corrosion que le laiton.

**12.2.11** Pour les bornes à trou, la distance entre la vis de serrage et l'extrémité du conducteur, lorsque celui-ci est introduit à fond, doit être au moins celle spécifiée à la Figure 1.

NOTE La distance minimale entre la vis de serrage et l'extrémité du conducteur s'applique seulement aux bornes à trou que le conducteur ne peut pas traverser directement.

Pour les bornes à capot taraudé, la distance entre la partie fixe et l'extrémité du conducteur, lorsque celui-ci est introduit à fond, doit être au moins celle spécifiée à la Figure 5.

*La conformité est vérifiée par mesurage après avoir introduit et serré à fond un conducteur massif de la section la plus grande spécifiée, pour le courant assigné approprié dans le Tableau 4.*

**12.2.12** Les bornes pour cosse et barrette doivent être utilisées seulement pour les interrupteurs de courant assigné supérieur ou égal à 40 A; si de telles bornes sont prévues, elles doivent être équipées de rondelles élastiques ou de tout autre dispositif aussi efficace.

*La conformité est vérifiée par examen.*

### **12.3 Bornes sans vis pour conducteurs extérieurs en cuivre**

**12.3.1** Les bornes sans vis peuvent être soit du type prévu uniquement pour les conducteurs rigides en cuivre, soit du type convenant à la fois aux conducteurs rigides et aux conducteurs souples en cuivre.

*Pour ce dernier type, les essais sont réalisés d'abord avec des conducteurs rigides et ensuite avec des conducteurs souples.*

12.3 ne s'applique pas aux interrupteurs équipés de

- bornes sans vis exigeant la fixation de pièces spéciales sur les conducteurs avant le serrage dans la borne sans vis, par exemple les raccords de connexion à clips;
- bornes sans vis exigeant un torsadage des âmes des conducteurs, par exemple celles avec épissures;
- bornes sans vis assurant un contact direct avec les conducteurs au moyen de lames ou de pointes pénétrant à travers l'enveloppe isolante.

**12.3.2** Les bornes sans vis doivent être équipées d'organes de serrage permettant le raccordement convenable des conducteurs rigides en cuivre ou de conducteurs en cuivre rigides et souples ayant les sections nominales telles qu'indiquées dans le Tableau 8.

**Tableau 8 – Relation entre les courants assignés et les sections des conducteurs en cuivre pouvant être raccordés aux bornes sans vis**

| Courant assigné<br><br>A                                                                                                                                                                                                                                                                                               | Conducteurs                         |                                                   |                                                   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|---------------------------------------------------|---------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                        | Section nominale<br>mm <sup>2</sup> | Diamètre du conducteur rigide le plus grand<br>mm | Diamètre du conducteur souple le plus grand<br>mm |
| Jusqu'à 4 inclus                                                                                                                                                                                                                                                                                                       | 0,75 à 1                            | 1,19                                              | -                                                 |
| Au-dessus de 4 et jusqu'à 6 inclus                                                                                                                                                                                                                                                                                     | 1 à 1,5                             | 1,45                                              | 1,73                                              |
| Au-dessus de 6 et jusqu'à 16 inclus <sup>a</sup>                                                                                                                                                                                                                                                                       | 1,5 à 2,5                           | 2,13                                              | 2,21                                              |
| <sup>a</sup> Chaque borne d'alimentation des interrupteurs autre que celles des modèles de numéro de fonction 3, 03 et 7 doit permettre le raccordement de deux conducteurs de 2,5 mm <sup>2</sup> . Dans ce cas, une borne avec organes de serrage séparés et indépendants pour chaque conducteur doit être employée. |                                     |                                                   |                                                   |

*La conformité est vérifiée par examen et par introduction de conducteurs de la plus petite et de la plus grande section spécifiée.*

**12.3.3** Les bornes sans vis doivent permettre le raccordement du conducteur sans préparation spéciale.

*La conformité est vérifiée par examen.*

NOTE Le terme «préparation spéciale» comprend l'étamage des fils du conducteur, l'utilisation d'embouts, etc., mais ne comprend pas la remise en forme du conducteur avant son introduction dans la borne ou le torsadage d'un conducteur souple pour en consolider l'extrémité.

**12.3.4** Les parties des bornes sans vis principalement affectées au transport du courant doivent être en un des matériaux tels que spécifiés en 22.5.

*La conformité est vérifiée par examen et par analyse chimique.*

NOTE Les ressorts, organes élastiques, plaquettes de serrage et organes analogues ne sont pas considérés comme des parties principalement destinées au transport du courant.

**12.3.5** Les bornes sans vis doivent être conçues de telle façon qu'elles serrent les conducteurs spécifiés avec une pression de contact suffisante et sans dommage excessif pour le conducteur.

Le conducteur doit être serré entre des surfaces métalliques.

*La conformité est vérifiée par examen et par l'essai de 12.3.10.*

**12.3.6** La façon de réaliser l'insertion et la déconnexion des conducteurs doit être facile à reconnaître.

La déconnexion d'un conducteur doit exiger une manœuvre autre qu'une traction sur le conducteur, de telle façon qu'elle puisse être effectuée manuellement à l'aide ou non d'un outil d'usage courant.

Il ne doit pas être possible de confondre l'ouverture pour l'utilisation d'un outil qui permet la connexion et la déconnexion avec l'ouverture destinée à l'insertion d'un conducteur.



*La conformité est vérifiée par examen et par l'essai de 12.3.10.*

**12.3.7** Les bornes sans vis destinées à être utilisées pour l'interconnexion d'au moins deux conducteurs doivent être conçues de sorte que

- l'organe de serrage d'un des conducteurs soit indépendant de celui de l'autre ou des autres conducteur(s);
- lors de la connexion ou de la déconnexion, les conducteurs puissent être branchés ou débranchés soit en même temps, soit séparément;
- chaque conducteur doit être introduit dans un organe de serrage séparé (pas nécessairement dans des orifices séparés);
- il doit être possible de serrer de façon sûre tout nombre de conducteurs jusqu'au nombre maximum prévu.

*La conformité est vérifiée par examen et par des essais avec les conducteurs appropriés.*

**12.3.8** Les bornes sans vis doivent être conçues de telle façon qu'une mauvaise insertion du conducteur soit empêchée et qu'une insertion convenable soit évidente.

Les bornes sans vis des interrupteurs doivent être conçues de telle façon qu'une insertion excessive du conducteur soit empêchée par une butée au cas où cette insertion est susceptible de réduire les lignes de fuite et/ou les distances d'isolement dans l'air exigées au Tableau 23 ou d'affecter le mécanisme de l'interrupteur.

*La conformité est vérifiée par examen et par l'essai de 12.3.10.*

**12.3.9** Les bornes sans vis doivent être fixées correctement à l'interrupteur.

Elles ne doivent pas prendre de jeu lors de la connexion ou de la déconnexion des conducteurs pendant l'installation.

*La conformité est vérifiée par examen et par l'essai de 12.3.10.*

Un recouvrement par de la matière de remplissage sans autre moyen de blocage n'est pas suffisant. Cependant, des résines autodurcissantes peuvent être utilisées pour bloquer les parties des bornes qui ne sont pas soumises à des contraintes mécaniques en usage normal.

**12.3.10** Les bornes sans vis doivent supporter les contraintes mécaniques se produisant en usage normal.

*La conformité est vérifiée par les essais suivants, qui sont effectués avec des conducteurs non isolés sur une borne sans vis de chaque échantillon, en utilisant un nouvel échantillon pour chaque essai.*

*L'essai est réalisé avec des conducteurs massifs en cuivre, d'abord avec des conducteurs de la plus grande section, puis avec des conducteurs de la plus petite section spécifiée en 12.3.2.*

*Les conducteurs sont connectés et déconnectés cinq fois, des conducteurs neufs étant utilisés à chaque fois sauf à la cinquième fois, les conducteurs utilisés pour la quatrième connexion étant alors serrés au même endroit. Pour chaque insertion, les conducteurs sont soit poussés aussi loin que possible dans la borne soit sont insérés de façon qu'un raccordement convenable soit évident.*

*Après chaque insertion, le conducteur est soumis à une force de traction de 30 N; la force est appliquée sans à-coups, pendant 1 min, dans la direction de l'axe longitudinal du logement du conducteur.*

*Pendant l'application de la traction, le conducteur ne doit pas sortir de la borne sans vis.*

*L'essai est alors répété avec des conducteurs rigides câblés en cuivre des plus grande et plus petite sections spécifiées en 12.3.2; ces conducteurs ne sont toutefois introduits et déconnectés qu'une seule fois.*

*Les bornes sans vis prévues pour conducteurs rigides et conducteurs souples doivent être soumises à l'essai aussi avec des conducteurs souples, en effectuant cinq insertions et cinq déconnexions.*

*Chacun des conducteurs des bornes sans vis est soumis pendant 15 min à un mouvement circulaire de  $(10 \pm 2)$  r/min en employant un appareil, dont un exemple est représenté à la Figure 9. Le conducteur est soumis à une traction ayant la valeur indiquée au Tableau 6.*

*Pendant l'essai, les conducteurs ne doivent pas se déplacer de manière notable dans l'organe de serrage.*

*Après ces essais, ni les bornes, ni les organes de serrage ne doivent avoir pris de jeu et les conducteurs ne doivent présenter aucune détérioration nuisant à leur usage ultérieur.*

**12.3.11** Les bornes sans vis doivent supporter les contraintes électriques et thermiques se produisant en usage normal.

*La conformité est vérifiée par les essais suivants a) et b) qui sont réalisés sur cinq bornes sans vis des interrupteurs qui n'ont pas été utilisés pour l'un quelconque des autres essais.*

*Les deux essais sont effectués avec des conducteurs en cuivre neufs.*

- a) *L'essai est effectué en faisant passer dans les bornes sans vis, pendant 1 h, un courant alternatif, comme spécifié dans le Tableau 9, et en raccordant les conducteurs rigides massifs longs de 1 m et ayant la section spécifiée dans le Tableau 9.*
- b) *L'essai est effectué sur chaque organe de serrage.*

**Tableau 9 – Courant d'essai pour la vérification des contraintes électriques et thermiques en usage normal des bornes sans vis**

| Courant assigné<br>A                 | Courant d'essai<br>A | Section du conducteur<br>mm <sup>2</sup> |
|--------------------------------------|----------------------|------------------------------------------|
| Jusqu'à 4 inclus                     | 9                    | 0,75                                     |
| Au-dessus de 4 et jusqu'à 6 inclus   | 13,5                 | 1                                        |
| Au-dessus de 6 et jusqu'à 13 inclus  | 17,5                 | 1,5                                      |
| Au-dessus de 13 et jusqu'à 16 inclus | 22                   | 2,5                                      |

*Pendant l'essai, le courant ne passe pas à travers l'interrupteur, mais seulement à travers les bornes.*

*Immédiatement après cette période, la chute de tension dans chaque borne sans vis est mesurée sous le courant assigné.*

*En aucun cas la chute de tension ne doit dépasser 15 mV.*

*Les mesurages sont effectués à travers chaque borne sans vis et aussi près que possible de la zone de contact.*

*Si le raccordement en arrière de la borne n'est pas accessible, le deuxième point de connexion dans le cas d'interrupteurs à deux directions peut être employé pour le conducteur de retour; dans le cas d'interrupteurs à une direction, l'échantillon peut être convenablement préparé par le fabricant; il convient d'accorder une attention particulière afin de ne pas compromettre l'utilisation ultérieure des bornes.*

*Pendant la période de l'essai, y compris les mesurages, les conducteurs et les dispositifs de mesure ne doivent pas être déplacés de sorte à affecter le résultat de l'essai.*

*Les bornes sans vis déjà soumises à la détermination des chutes de tension spécifiées dans l'essai précédent a) sont soumises à l'essai comme suit:*

- *Pendant l'essai, un courant égal à la valeur du courant d'essai indiquée au Tableau 9 circule.*

*Toute l'installation d'essai, y compris les conducteurs, ne doit pas être déplacée avant que les mesurages de chute de tension ne soient terminés.*

*Les bornes sont soumises à 192 cycles de température, chaque cycle ayant une durée de 1 h environ et étant réalisé comme suit:*

- *le courant circule pendant 30 min environ;*
- *le courant ne circule pas pendant les 30 min suivantes environ.*

*La chute de tension dans chaque borne sans vis est déterminée comme spécifié pour l'essai a) et est réalisée aux instants suivants:*

- *après les 24 premiers cycles de température et après achèvement des 192 cycles de température;*
- *des mesures supplémentaires sont à réaliser après trois des cycles de température choisis parmi les suivants: après le 48<sup>ème</sup>, 72<sup>ème</sup>, 96<sup>ème</sup>, 120<sup>ème</sup>, 144<sup>ème</sup> ou 168<sup>ème</sup> cycle de température.*

*En aucun cas la chute de tension ne doit dépasser 22,5 mV ou deux fois la valeur mesurée après le 24<sup>ème</sup> cycle, selon la valeur la plus faible.*

*Après cet essai, un examen sous une vue normale ou corrigée sans grossissement supplémentaire ne doit déceler aucune modification empêchant indiscutablement une utilisation ultérieure telle que craquelures, déformations ou similaire.*

*De plus, l'essai de résistance mécanique selon 12.3.10 est répété et tous les échantillons doivent y résister.*

**12.3.12** *Les bornes sans vis doivent être conçues de telle façon qu'un conducteur rigide massif qui y est inséré reste serré même lorsque le conducteur a subi une déflexion pendant son installation normale, par exemple pendant le montage dans une boîte, et que la contrainte en résultant a été transférée à l'organe de serrage.*

*La conformité est vérifiée par l'essai suivant, lequel est réalisé sur trois échantillons d'interrupteurs n'ayant été utilisés pour aucun autre essai.*

*L'appareil d'essai dont le principe est indiqué à la Figure 10a doit être construit de façon telle*

- *qu'un conducteur spécifié, convenablement introduit dans une borne, puisse subir une déflexion dans l'une quelconque des 12 directions, à 30° l'une de l'autre, avec une tolérance de  $\pm 5^\circ$ , et*
- *que le point de démarrage puisse être modifié de 10° et 20° par rapport au point original.*

*Il n'est pas nécessaire de spécifier une direction de référence.*

La déflexion du conducteur à partir de sa position droite vers les positions d'essai doit être effectuée au moyen d'un dispositif approprié exerçant sur le conducteur, à une certaine distance de la borne, une force spécifiée.

Le dispositif de déflexion doit être conçu de sorte que

- la force soit appliquée dans la direction perpendiculaire à l'axe du conducteur droit;
- la déflexion soit atteinte sans rotation ou déplacement du conducteur dans l'organe de serrage; et
- la force reste appliquée pendant que le mesurage de la chute de tension exigée est effectué.

Des dispositions doivent être prises pour que la chute de tension puisse être mesurée à travers l'organe de serrage en essai lorsque le conducteur est raccordé, comme indiqué à la Figure 10b par exemple.

L'échantillon est monté sur la partie fixe de l'appareil d'essai de telle façon que le conducteur spécifié puisse être dévié librement après avoir été inséré dans l'organe de serrage en essai.

Afin d'éviter l'oxydation, l'isolant des conducteurs doit être enlevé immédiatement avant le début de l'essai.

NOTE 1 Si nécessaire, le conducteur inséré peut être courbé de façon permanente autour d'obstacles de sorte que ceux-ci n'influencent pas les résultats de l'essai.

NOTE 2 Dans certains cas, à l'exception du cas de guidage de conducteur, il peut être utile de retirer les parties de l'échantillon qui ne permettent pas la déflexion du conducteur correspondant à la force à appliquer.

Un organe de serrage est équipé, comme en usage normal, d'un conducteur rigide massif en cuivre de la section la plus petite spécifiée au Tableau 10 et est soumis à une première séquence d'essais. Le même organe de serrage est soumis à une deuxième séquence d'essais en utilisant un conducteur de la section la plus grande, à moins que la première séquence n'ait pas été satisfaisante.

La force pour la déflexion du conducteur est spécifiée au Tableau 11, la distance de 100 mm étant mesurée depuis l'extrémité de la borne, y compris le guidage éventuel pour le conducteur, jusqu'au point d'application de la force sur le conducteur.

L'essai est réalisé avec un courant permanent (c'est-à-dire que le courant n'est ni établi ni coupé pendant l'essai). Il convient d'utiliser une alimentation appropriée et d'insérer dans le circuit une résistance adéquate de façon que les variations du courant soient maintenues à  $\pm 5\%$  pendant l'essai.

**Tableau 10 – Sections des conducteurs rigides en cuivre pour l'essai de déflexion des bornes sans vis**

| Courant assigné de l'interrupteur<br>A                                                                                                     | Section nominale du conducteur d'essai<br>mm <sup>2</sup> |                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|------------------------------------|
|                                                                                                                                            | 1 <sup>re</sup> séquence d'essais                         | 2 <sup>ème</sup> séquence d'essais |
| ≤ 6                                                                                                                                        | 1,0 <sup>a</sup>                                          | 1,5                                |
| Au-dessus de 6 et jusqu'à 16 inclus                                                                                                        | 1,5                                                       | 2,5                                |
| <sup>a</sup> Uniquement pour les pays où l'usage des conducteurs de section 1,0 mm <sup>2</sup> est autorisé dans les installations fixes. |                                                           |                                    |

**Tableau 11 – Forces pour l'essai de déflexion**

| Section du conducteur d'essai<br>mm <sup>2</sup> | Force pour la déflexion du conducteur d'essai <sup>a</sup><br>N |
|--------------------------------------------------|-----------------------------------------------------------------|
| 1,0                                              | 0,25                                                            |
| 1,5                                              | 0,5                                                             |
| 2,5                                              | 1,0                                                             |

<sup>a</sup> Ces forces sont choisies de telle façon qu'elles contraignent les conducteurs à une valeur proche de la limite d'élasticité.

*L'organe de serrage en essai est traversé par un courant d'essai égal au courant assigné de l'interrupteur. Une force conforme au Tableau 11 est appliquée au conducteur d'essai inséré dans l'organe de serrage en essai dans l'une des 12 directions représentées à la Figure 10a et la chute de tension dans cet organe de serrage est mesurée. La force est ensuite supprimée.*

*La force est ensuite appliquée successivement dans chacune des 11 directions restantes représentées à la Figure 10a en suivant la même procédure d'essai.*

*Si pour l'une des 12 directions d'essai la chute de tension est supérieure à 25 mV, la force est maintenue dans cette direction, mais pas plus de 1 min, jusqu'à ce que la chute de tension soit réduite à une valeur inférieure à 25 mV. Après que la chute de tension a atteint une valeur inférieure à 25 mV, la force est maintenue dans la même direction pendant encore 30 s pendant lesquelles la chute de tension ne doit pas augmenter.*

*Les deux autres échantillons d'interrupteurs du lot sont soumis aux essais en suivant la même procédure mais en décalant de 10° environ les 12 directions de la force pour chaque échantillon. Si un échantillon n'a pas satisfait à l'essai pour une des directions d'application de la force d'essai, les essais sont recommencés sur un autre lot d'échantillons qui doivent tous satisfaire aux essais recommencés.*

## **13 Exigences constructives**

### **13.1 Exigences mécaniques des moyens d'isolement**

Les revêtements isolants, cloisons et parties analogues doivent avoir une résistance mécanique suffisante et doivent être fixés de façon sûre.

*La conformité est vérifiée par examen, après les essais de l'Article 20.*

### **13.2 Exigences d'installation**

Les interrupteurs doivent être construits de façon à permettre

- une introduction facile dans la borne et une connexion fiable des conducteurs dans les bornes, sauf pour les conducteurs des lampes indicatrices;

NOTE 1 Les bornes à vis représentées aux Figures 1 à 5 sont considérées comme appropriées pour une connexion fiable des conducteurs.

- le positionnement correct des conducteurs;
- la fixation facile de l'interrupteur à une paroi ou dans une boîte;
- un espace convenable entre la face inférieure de la partie principale et la surface sur laquelle la partie principale est montée ou entre les côtés de la partie principale et son enveloppe (capot ou boîte), de façon qu'après l'installation de l'interrupteur, l'isolant des conducteurs ne soit pas nécessairement pressé contre des parties actives de polarité

différente ou contre des parties mobiles du mécanisme telles que l'axe d'un interrupteur rotatif.

NOTE 2 Cette exigence n'implique pas que les parties métalliques des bornes soient nécessairement protégées par des cloisons ou épaulements isolants, pour éviter les contacts, du fait d'une mauvaise installation des parties métalliques des bornes, avec l'isolant des conducteurs.

Les interrupteurs pour pose en saillie doivent être construits de sorte que les moyens de fixation n'endommagent pas l'isolant des câbles pendant l'installation.

*La conformité est vérifiée par examen et par un essai d'installation à l'aide de conducteurs de la plus grande section spécifiée pour les plages appropriées des courants assignés selon le Tableau 4.*

NOTE 3 Pour les interrupteurs pour pose en saillie montés sur une plaque de base, un passage pour les fils peut être nécessaire afin de satisfaire à cette exigence.

En outre, pour les interrupteurs comportant des bornes sans vis, les interrupteurs doivent être construits de sorte que les moyens de connexion et/ou déconnexion des bornes sans vis ne puissent être actionnés par les conducteurs pendant et après l'installation de l'interrupteur dans une boîte ou sur un mur.

NOTE 4 Cette exigence n'implique pas que les moyens de connexion et/ou déconnexion ne peuvent pas être touchés par les conducteurs.

NOTE 5 Cette exigence peut être satisfaite par l'emplacement des dispositifs de connexion et/ou de déconnexion et/ou l'utilisation de cloisons ou d'épaulements de protection placés autour des dispositifs de connexion et/ou de déconnexion.

*La conformité est vérifiée par examen et, en cas de doute, par l'essai suivant.*

*L'essai est réalisé avec un conducteur massif en cuivre ayant la plus petite section spécifiée en 12.3.2.*

*Le conducteur est poussé aussi loin que possible dans la borne en essai ou est inséré de sorte que la connexion appropriée soit évidente.*

*Un calibre d'essai 1 de l'IEC 61032 est poussé contre le moyen de connexion ou de déconnexion avec une force de 120 N dans la direction opposée à la direction de montage, tel que représenté à la Figure 22a.*

*Pendant l'application de la force, le conducteur, sauf les conducteurs des lampes indicatrices, est soumis à une traction de 30 N; la traction est appliquée selon un mouvement sans à-coups et continu, pendant 1 min, dans la direction de l'axe longitudinal du logement du conducteur.*

*Pendant l'application de la traction, le conducteur ne doit pas sortir de la borne sans vis.*

*La force de 120 N doit être appliquée avant l'application de la force de 30 N. La force de 30 N est maintenue sur le conducteur pendant toute la durée de l'essai.*

*Il convient de porter une attention particulière afin que le calibre d'essai ne touche pas le conducteur pendant l'application des forces.*

*Lorsque l'axe entre la force d'application et l'axe par lequel passe la force nécessaire pour actionner le moyen de connexion/déconnexion s'écarte de plus de 20°, il est admis d'exercer la force résultante calculée directement sur le moyen de connexion/déconnexion au moyen du calibre d'essai. Un exemple est représenté à la Figure 22b.*

*Si l'angle est supérieur à 60°, il n'est pas nécessaire de réaliser l'essai et le produit est considéré comme satisfaisant aux exigences sans essai supplémentaire.*

*S'il n'est pas possible d'exercer une force sur le moyen de connexion/déconnexion, le produit est considéré comme satisfaisant aux exigences sans essai supplémentaire.*

En outre, les interrupteurs de conception A doivent permettre la mise en place et l'enlèvement aisés du capot ou de la plaque de recouvrement, sans déplacement des conducteurs ni actionnement des moyens de connexion et/ou de déconnexion des bornes sans vis.

NOTE 6 Cette exigence n'implique pas que les moyens de connexion et/ou déconnexion ne peuvent pas toucher le capot ou la plaque de recouvrement.

### **13.3 Fixation des capots, plaques de recouvrement et organes de manœuvre**

**13.3.1** Les capots, plaques de recouvrement et organes de manœuvre ou leurs parties qui sont destinés à assurer une protection contre les chocs électriques, doivent être maintenus en place, à au moins deux endroits, par un moyen de fixation efficace.

Les capots, plaques de recouvrement et organes de manœuvre ou leurs parties peuvent être fixés au moyen d'une seule fixation, par exemple une vis, sous réserve qu'ils soient positionnés par un autre moyen (par exemple par un épaulement).

NOTE 1 Un moyen de fixation imperdable est une méthode appropriée pour assurer la fixation des capots, plaques de recouvrement et organes de manœuvre. L'utilisation de rondelles serrantes en carton ou moyen analogue est considérée comme une méthode convenable pour assurer que les vis sont imperdables.

NOTE 2 Les parties métalliques non raccordées à la terre, séparées des parties actives de telle façon que les lignes de fuite et les distances d'isolement dans l'air aient les valeurs spécifiées au Tableau 23, ne sont pas considérées comme accessibles si les exigences de 13.3 sont satisfaites.

Lorsque la fixation des capots, plaques de recouvrement et organes de manœuvre des interrupteurs de conception A sert à en fixer la partie principale, il doit y avoir un moyen pour maintenir la partie principale en place même après le retrait des capots, plaques de recouvrement et organes de manœuvre.

*La conformité est vérifiée selon 13.3.2, 13.3.3 ou 13.3.4.*

**13.3.2** *Pour les capots, plaques de recouvrement ou organes de manœuvre dont la fixation est du type à vis:*

*par examen seulement.*

**13.3.3** *Pour les capots, plaques de recouvrement ou organes de manœuvre dont la fixation ne dépend pas de vis et dont le démontage est obtenu en appliquant une force dans une direction à peu près perpendiculaire à la surface de montage/de support (voir Tableau 12),*

– *lorsque leur démontage peut donner accès aux parties actives avec le calibre d'essai B de l'IEC 61032:*

*par les essais de 20.5;*

– *lorsque leur démontage peut donner accès, avec le calibre d'essai B de l'IEC 61032, aux parties métalliques non raccordées à la terre, séparées des parties actives de telle façon que les lignes de fuite et les distances d'isolement dans l'air soient égales au moins aux valeurs spécifiées au Tableau 23:*

*par l'essai de 20.6;*

– *lorsque leur démontage peut donner accès avec le calibre d'essai B de l'IEC 61032 uniquement aux*

- *parties isolantes, ou*
- *parties métalliques raccordées à la terre, ou*



- parties métalliques séparées des parties actives de telle façon que les lignes de fuite et les distances d'isolement dans l'air soient au moins égales au double des valeurs spécifiées au Tableau 23, ou
- parties actives des circuits TBTS de tension inférieure ou égale à 25 V en courant alternatif et inférieure ou égale à 50 V en courant continu:

par l'essai de 20.7.

**Tableau 12 – Forces à appliquer aux capots, plaques de recouvrement ou organes de manœuvre dont la fixation ne dépend pas de vis**

| Accessibilité avec le calibre d'essai B de l'IEC 61032 après enlèvement des capots, plaques de recouvrement ou de leurs parties                                                                                                                                                                        | Essai selon... | Force à appliquer<br>N                 |                  |                                            |                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------------------------------|------------------|--------------------------------------------|------------------|
|                                                                                                                                                                                                                                                                                                        |                | Interrupteurs conformes à 20.8 et 20.9 |                  | Interrupteurs non conformes à 20.8 et 20.9 |                  |
|                                                                                                                                                                                                                                                                                                        |                | Ne doit pas se détacher                | Doit se détacher | Ne doit pas se détacher                    | Doit se détacher |
| Aux parties actives                                                                                                                                                                                                                                                                                    | 20.5           | 40                                     | 120              | 80                                         | 120              |
| Aux parties métalliques non mises à la terre, séparées des parties actives par des lignes de fuite selon 23.1                                                                                                                                                                                          | 20.6           | 10                                     | 120              | 20                                         | 120              |
| Aux parties isolantes, parties métalliques mises à la terre, parties actives de TBTS ≤ 25 V et 60 V en courant continu en courant alternatif ou parties métalliques séparées des parties actives par des lignes de fuite et des distances d'isolement dans l'air égales au double de celles selon 23.1 | 20.7           | 10                                     | 120              | 10                                         | 120              |

**13.3.4** Pour les capots, plaques de recouvrement et organes de manœuvre dont la fixation ne dépend pas de vis et dont l'enlèvement est obtenu par l'utilisation d'un outil, conformément aux instructions du fabricant données dans une feuille d'instruction ou dans un catalogue:

par les mêmes essais que ceux de 13.3.3, excepté qu'il n'est pas nécessaire que les capots, plaques de recouvrement et organes de manœuvre ou leurs parties se détachent lorsqu'une force ne dépassant pas 120 N leur est appliquée dans une direction perpendiculaire à la surface de montage/de support.

#### 13.4 Ouvertures en usage normal

Les interrupteurs doivent être construits de sorte que, lorsqu'ils sont montés et équipés de conducteurs comme en usage normal, leurs enveloppes ne présentent pas d'ouverture libre conformément à leur désignation IP.

La conformité est vérifiée par examen et par un essai d'installation à l'aide de conducteurs de la plus petite section spécifiée au Tableau 4.

NOTE Les trous d'écoulement, les petits interstices entre l'enveloppe et les conduits ou les câbles ou entre l'enveloppe et l'organe de manœuvre peuvent être ignorés s'ils sont conformes à la classification IP correspondante.

#### 13.5 Fixation des boutons

Les boutons des interrupteurs rotatifs doivent être fixés solidement sur l'axe ou la pièce commandant le mécanisme.



*La conformité est vérifiée par l'essai suivant.*

*S'il est possible d'appliquer une force de traction axiale en usage normal, une force de traction axiale doit être exercée pendant 1 min pour essayer de retirer l'organe de manœuvre.*

*Si la forme de l'organe de manœuvre est telle qu'il est possible d'appliquer une force de traction axiale en usage normal, la force est de 30 N.*

*Si la forme de l'organe de manœuvre est telle qu'il est peu probable de pouvoir appliquer une force de traction axiale en usage normal, la force est de 15 N.*

*Ensuite, les boutons des interrupteurs qui n'ont qu'un seul sens de fonctionnement sont, si possible et sans forcer, tournés 100 fois dans le sens opposé.*

*Pendant l'essai, le bouton ne doit pas se détacher.*

### **13.6 Moyens de montage**

Les vis ou organes analogues pour le montage d'un interrupteur sur une surface ou dans une boîte ou une enveloppe doivent être facilement accessibles par le devant. Ces organes ne doivent pas servir à d'autres fixations.

NOTE Lorsque les organes de montage d'un interrupteur sont utilisés pour bloquer la rotation de la boîte, ils ne sont pas considérés comme servant à d'autres fixations.

### **13.7 Combinaison d'interrupteurs**

Les combinaisons d'interrupteurs ou d'interrupteurs et de prises de courant, ayant des bases distinctes, doivent être conçues de façon que la position correcte de chacune des parties principales soit assurée. La fixation de chaque partie principale doit être indépendante de la fixation de la combinaison sur la surface de montage.

*La conformité aux exigences de 13.6 et 13.7 est vérifiée par examen.*

### **13.8 Appareillages combinés avec des interrupteurs**

Les appareillages combinés avec des interrupteurs doivent être conformes à leur norme applicable, le cas échéant, à moins qu'une norme n'existe pour la combinaison.

### **13.9 Interrupteurs pour pose en saillie ayant un degré de protection IP supérieur à IP20**

Les interrupteurs pour pose en saillie ayant un degré de protection IP supérieur à IP20 doivent être conformes à leur classification IP quand ils sont équipés de conduits ou de câbles gainés comme en usage normal.

Les interrupteurs pour pose en saillie ayant un degré de protection IPX4, IPX5 et IPX6 doivent être construits de manière à permettre l'ouverture d'un trou d'écoulement.

Si un interrupteur est prévu avec un trou d'écoulement, celui-ci doit avoir un diamètre minimal de 5 mm ou une surface minimale de 20 mm<sup>2</sup> avec une largeur et une longueur d'au moins 3 mm.

Si la conception de l'interrupteur est telle qu'une seule position de montage est possible, le trou d'écoulement doit être efficace dans cette position. En variante, le trou d'écoulement doit être efficace pour au moins deux positions de l'interrupteur lorsque celui-ci est monté sur un mur vertical, l'une de ces positions correspondant à l'entrée des conducteurs par le haut et l'autre à l'entrée des conducteurs par le bas.

Les ressorts de couvercle éventuels doivent être en matériau résistant à la corrosion, tel que le bronze ou l'acier inoxydable.

*La conformité est vérifiée par examen, par mesurage et par les essais appropriés de 15.2.*

NOTE Un trou d'écoulement pratiqué dans la face arrière de l'enveloppe n'est considéré comme efficace que si la conception de l'enveloppe ménage entre le mur et l'enveloppe un espace de 5 mm au moins ou un canal d'écoulement ayant au moins les dimensions spécifiées.

### **13.10 Installation dans une boîte**

Les interrupteurs pour installation dans une boîte doivent être conçus de façon que les extrémités des conducteurs puissent être préparées après mise en place de la boîte, mais avant le montage de l'interrupteur dans la boîte.

En outre, la partie principale doit avoir une stabilité suffisante lorsqu'elle est montée dans la boîte.

*La conformité est vérifiée par examen et par un essai d'installation avec les conducteurs de la plus grande section spécifiée pour la plage de courants assignés appropriée du Tableau 4.*

### **13.11 Connexion d'une deuxième partie transportant le courant**

Les interrupteurs pour pose en saillie ayant un degré de protection IP supérieur à IPX0, de numéros de fonction 1, 5 et 6 dont l'enveloppe comporte plus d'un orifice d'entrée, doivent être équipés pour le maintien de la continuité d'une deuxième partie transportant le courant soit par une borne fixe supplémentaire, satisfaisant aux exigences de l'Article 12, soit en comportant l'espace suffisant pour une borne flottante.

*La conformité est vérifiée par examen et par les essais appropriés de l'Article 12.*

### **13.12 Orifices d'entrée**

Les orifices d'entrée doivent permettre l'introduction du conduit ou de la gaine du câble de façon que soit assurée une protection mécanique complète.

Les interrupteurs pour pose en saillie doivent être construits de sorte que le conduit ou la gaine du câble prévu puisse pénétrer dans l'enveloppe sur une distance d'au moins 1 mm.

Dans les interrupteurs pour pose en saillie, l'orifice d'entrée pour conduits, ou deux au moins d'entre eux s'il y en a plus d'un, doivent être capables d'accepter des conduits des tailles 16, 20, 25 ou 32 ou une combinaison d'au moins deux de ces tailles, y compris deux de la même taille.

*La conformité est vérifiée par examen pendant l'essai de 13.10 et par mesurage.*

Dans les interrupteurs pour pose en saillie, l'orifice d'entrée pour câbles doit de préférence être capable d'accepter des câbles des tailles spécifiées au Tableau 13 ou être comme spécifié par le fabricant.

NOTE Des orifices d'entrée de taille appropriée peuvent aussi être obtenus par l'utilisation de parties défonçables ou de pièces d'insertion convenables.

**Tableau 13 – Limites du diamètre extérieur du câble  
pour les interrupteurs pour pose en saillie**

| Courant<br>assigné<br>A | Sections<br>mm <sup>2</sup> | Nombre de conducteurs | Limites du diamètre extérieur des<br>câbles |                |
|-------------------------|-----------------------------|-----------------------|---------------------------------------------|----------------|
|                         |                             |                       | Minimale<br>mm                              | Maximale<br>mm |
| 6                       | 1,5                         | 2                     | 7,6                                         | 11,0           |
|                         |                             | 3                     |                                             | 11,9           |
|                         |                             | 4                     |                                             | 13,1           |
|                         |                             | 5                     |                                             | 14,4           |
| 10 et 13                | 1,5 à 2,5 inclus            | 2                     | 7,6                                         | 13,1           |
|                         |                             | 3                     |                                             | 14,0           |
|                         |                             | 4                     |                                             | 15,5           |
|                         |                             | 5                     |                                             | 17             |
| 16                      | 1,5 à 4 inclus              | 2                     | 7,6                                         | 15,1           |
|                         |                             | 3                     |                                             | 16,2           |
|                         |                             | 4                     |                                             | 17,9           |
|                         |                             | 5                     |                                             | 19,9           |
| 20<br>25                | 2,5 à 6 inclus              | 2                     | 8,6                                         | 16,8           |
|                         |                             | 3                     |                                             | 18,0           |
|                         |                             | 4                     |                                             | 20,0           |
|                         |                             | 5                     |                                             | 22,2           |
| 32                      | 4 à 10 inclus               | 2                     | 9,6                                         | 22,6           |
|                         |                             | 3                     |                                             | 24,2           |
|                         |                             | 4                     |                                             | 26,5           |
|                         |                             | 5                     |                                             | 29,1           |
| 40<br>45<br>50          | 6 à 16 inclus               | 2                     | 10,5                                        | 25,7           |
|                         |                             | 3                     |                                             | 27,6           |
|                         |                             | 4                     |                                             | 30,1           |
|                         |                             | 5                     |                                             | 33,3           |
| 63                      | 10 à 25 inclus              | 2                     | 13                                          | 30,7           |
|                         |                             | 3                     |                                             | 33,0           |
|                         |                             | 4                     |                                             | 36,6           |
|                         |                             | 5                     |                                             | 40,4           |

NOTE Les limites du diamètre extérieur des câbles spécifiées dans ce tableau sont basées sur le type 60227 IEC 10 selon l'IEC 60227-4 et sur le type 60245 IEC 66 selon l'IEC 60245-4 et sont données pour information.

### 13.13 Disposition pour une entrée de conduit à l'arrière

Si des interrupteurs pour pose en saillie sont prévus avec une entrée de conduit à l'arrière, ils doivent être conçus de sorte que le conduit puisse pénétrer perpendiculairement à la surface de montage de l'interrupteur.

*La conformité est vérifiée par examen.*

### 13.14 Interrupteur équipé de membranes ou analogues en tant qu'orifices d'entrée

Si l'interrupteur est équipé de membranes ou analogues en tant qu'orifices d'entrée, ceux-ci doivent pouvoir être remplacés.

*La conformité est vérifiée par examen.*

### 13.15 Exigences pour les membranes dans les orifices d'entrée

**13.15.1** Les membranes doivent être fixées de façon sûre et ne doivent pas être déplacées par les contraintes mécaniques et thermiques se produisant en usage normal.

*La conformité est vérifiée par l'essai suivant:*

*Les membranes sont soumises à l'essai lorsqu'elles sont assemblées dans l'interrupteur.*

*Tout d'abord, les interrupteurs sont équipés de membranes qui ont été soumises à l'épreuve spécifiée en 15.1.*

*Les interrupteurs sont ensuite placés pendant 2 h dans l'étuve décrite en 15.1, la température étant maintenue à  $(40 \pm 2)$  °C.*

*Immédiatement après cette période, une force de 30 N est appliquée pendant 5 s à différentes parties des membranes au moyen de l'extrémité du calibre d'essai 11 de l'IEC 61032.*

*Au cours de ces essais, les membranes ne doivent pas subir de déformations telles que les parties actives deviennent accessibles.*

*Une force de traction axiale de 30 N est appliquée pendant 5 s aux membranes susceptibles d'être soumises à une traction axiale en usage normal.*

*Pendant cet essai, les membranes ne doivent pas se détacher.*

*L'essai est ensuite répété avec des membranes qui n'ont été soumises à aucun traitement.*

**13.15.2** Il est recommandé que les membranes soient conçues et fabriquées en un matériau tel que l'introduction de câbles dans l'interrupteur soit possible lorsque la température ambiante est basse.

NOTE Dans les pays suivants, la conformité à cette exigence est considérée comme nécessaire en raison des pratiques d'installation en conditions froides: SE, FI, DK et NO.

*La conformité est vérifiée par l'essai suivant:*

*Les interrupteurs sont équipés de membranes qui n'ont été soumises à aucun traitement de vieillissement, celles ne comportant pas d'ouverture étant percées de façon convenable.*

*Les interrupteurs sont ensuite maintenus pendant 2 h dans un congélateur à une température de  $(-15 \pm 2)$  °C.*

*Après cette période, les interrupteurs sont retirés du congélateur et immédiatement après, alors que les interrupteurs sont encore froids, il doit être possible d'introduire à travers les membranes, sans force excessive, des câbles du diamètre le plus grand selon la déclaration du fabricant.*

Après les essais de 13.15.1 et 13.15.2, les membranes ne doivent présenter aucune déformation nuisible, craquelures ou dommages analogues qui pourraient conduire à une non-conformité au présent document.

### 13.16 Lampes indicatrices

Les lampes indicatrices doivent être conformes aux exigences de l'IEC 60669-2-1:2002, de l'IEC 60669-2-1:2002/AMD1:2008 et de l'IEC 60669-2-1:2002/AMD2:2015, 101.1.1.1 et Article 102, dans la mesure du possible.

## 14 Mécanisme

### 14.1 Indication de la position

L'organe de manœuvre d'un interrupteur, lorsqu'il est relâché, doit prendre automatiquement la position correspondant à celle des contacts mobiles, excepté dans le cas des interrupteurs à tirage ou à bouton poussoir unique, pour lesquels l'organe de manœuvre peut prendre une seule position de repos.

### 14.2 Repos et position intermédiaire

Les interrupteurs doivent être construits de façon que les contacts mobiles ne viennent au repos que dans les positions "ouvert" ou "fermé", une position intermédiaire étant, toutefois, admise si elle correspond à la position intermédiaire de l'organe de manœuvre et si l'isolement entre les contacts fixes et mobiles est alors suffisant.

Si nécessaire, l'isolement entre les contacts fixes et mobiles dans une position intermédiaire est vérifié par un essai de rigidité diélectrique comme spécifié en 16.3, la tension d'essai étant appliquée entre les bornes correspondantes sans que le capot ou la plaque de recouvrement de l'interrupteur n'ait été enlevé.

*La conformité aux exigences de 14.1 et 14.2 est vérifiée par examen et par un essai manuel.*

### 14.3 Arc excessif

Les interrupteurs doivent être construits de façon qu'il ne se produise pas d'arc excessif lorsqu'ils sont manœuvrés lentement.

*La conformité est vérifiée en amenant l'interrupteur, à la fin de l'essai de 19.1, à couper dix nouvelles fois le circuit, l'organe de manœuvre étant toutefois manœuvré de façon continue à la main sur une période de 2 s et les contacts mobiles étant, si possible, arrêtés dans une position intermédiaire, l'organe de manœuvre étant alors relâché.*

*Pendant l'essai, il ne doit pas se produire d'arc permanent.*

### 14.4 Fermeture et coupure

Les interrupteurs de numéros de fonction 2, 3, 03 et 6/2 doivent fermer et couper pratiquement simultanément tous les pôles mais, pour les interrupteurs de numéro de fonction 03, le neutre ne doit pas être fermé après ni ouvert avant les autres pôles.

*La conformité est vérifiée par examen et par un essai manuel, l'interrupteur étant monté avec les capots, plaques de recouvrement ou organes de manœuvre installés comme en usage normal.*

#### 14.5 Action du mécanisme sans capot ou plaque de recouvrement

L'action du mécanisme, si le capot ou la plaque de recouvrement est démontable pour les besoins de l'installation, doit être indépendante de la présence du capot ou de la plaque de recouvrement.

NOTE L'organe de manœuvre, dans certaines constructions, peut constituer le capot.

*La conformité est vérifiée en raccordant en série l'interrupteur, sans son capot ou sa plaque de recouvrement, avec une lampe et en appuyant sans force excessive sur l'organe de manœuvre comme en usage normal.*

*Pendant l'essai, la lampe ne doit pas clignoter.*

#### 14.6 Force de traction des interrupteurs à tirage

Les interrupteurs à tirage doivent pouvoir être manœuvrés de la position «ouvert» à la position «fermé», et de la position «fermé» à la position «ouvert» par l'application et le retrait d'une force de traction constante ne dépassant pas 45 N appliquée verticalement et 65 N lorsqu'elle est appliquée à  $45^\circ \pm 5^\circ$  de la verticale et dans un plan perpendiculaire à la surface de montage, les interrupteurs étant montés comme en usage normal, tel que spécifié par le fabricant.

*La conformité est vérifiée par un essai manuel.*

### 15 Résistance au vieillissement, protection procurée par les enveloppes des interrupteurs et résistance à l'humidité

#### 15.1 Résistance au vieillissement

Les interrupteurs doivent résister au vieillissement.

Les pièces prévues uniquement pour la décoration, telles que certains couvercles, doivent être retirées si possible et ces pièces ne sont pas soumises à l'essai.

*La conformité est vérifiée par l'essai suivant:*

*Les interrupteurs et les boîtes, montés comme en usage normal, sont soumis à un essai dans une étuve dont l'atmosphère a la composition et la pression de l'air ambiant et est ventilée par circulation naturelle.*

*Les interrupteurs de degré IP supérieur à IPX0 sont soumis à l'essai après avoir été montés et assemblés comme spécifié en 15.2.2.*

*La température dans l'étuve est maintenue à  $(70 \pm 2)^\circ\text{C}$ .*

*Les échantillons sont maintenus dans l'étuve pendant 7 jours (168 h).*

*Il est recommandé d'utiliser une étuve électrique.*

*La circulation naturelle d'air peut être assurée par des trous dans les parois de l'étuve.*

*Après le traitement, les échantillons sont retirés de l'étuve et conservés à température ambiante et dans une humidité relative de 45 % à 55 % pendant au moins 4 jours (96 h).*

*Les échantillons ne doivent présenter aucune craquelure visible à la vision normale ou corrigée sans grossissement supplémentaire et le matériau ne doit pas être devenu collant ou gras, cette dernière condition étant appréciée comme suit:*

*L'index enveloppé d'un morceau de tissu rugueux et sec est appliqué sur l'échantillon avec une force de 5 N.*

*Aucune trace de tissu ne doit rester sur l'échantillon et le matériau de l'échantillon ne doit pas adhérer au tissu.*

*Après l'essai, les échantillons ne doivent présenter aucun dommage qui pourrait conduire à la non-conformité au présent document.*

NOTE La force de 5 N peut être obtenue de la manière suivante:

L'échantillon est placé sur l'un des plateaux d'une balance et l'autre plateau est chargé d'une masse égale à la masse de l'échantillon plus 500 g.

L'équilibre est ensuite rétabli en exerçant une pression sur l'échantillon avec l'index enveloppé d'un morceau de tissu rugueux et sec.

## **15.2 Protection procurée par les enveloppes d'interrupteurs**

### **15.2.1 Généralités**

Les enveloppes d'interrupteurs doivent assurer la protection contre l'accès aux parties dangereuses, contre les effets nuisibles dus à la pénétration de corps solides étrangers et contre les effets nuisibles dus à la pénétration de l'eau, conformément à la classification IP de l'interrupteur.

*La conformité est vérifiée par les essais de 15.2.2 et 15.2.3.*

### **15.2.2 Protection contre l'accès aux parties dangereuses et contre les effets nuisibles dus à la pénétration de corps solides étrangers**

#### **15.2.2.1 Généralités**

Les enveloppes d'interrupteurs doivent procurer un degré de protection contre l'accès aux parties dangereuses et contre les effets nuisibles dus à la pénétration de corps solides étrangers, conformément à leur classification IP.

*La conformité est vérifiée par les essais appropriés de l'IEC 60529 dans les conditions spécifiées ci-dessous.*

*Les interrupteurs sont montés comme en usage normal.*

*Les interrupteurs pour pose encastrée ou semi-encastrée sont montés dans une boîte appropriée selon les instructions du fabricant.*

*Les interrupteurs avec presse-étoupes filetés ou membranes sont équipés de câbles et connectés à ces derniers, qui se trouvent dans la plage spécifiée au Tableau 4. Les presse-étoupes sont serrés avec un couple égal aux deux tiers de celui appliqué pendant l'essai de 20.4.*

*Les vis des enveloppes sont serrées avec un couple égal aux deux tiers des valeurs indiquées au Tableau 5.*

*Les pièces qui peuvent être démontées sans l'aide d'un outil sont retirées.*

*Si un interrupteur a passé l'essai avec succès, alors cet essai est réputé être passé pour toute combinaison de ce type d'interrupteur.*

*Les presse-étoupes ne sont pas remplis avec la matière de remplissage ou analogue.*

#### **15.2.2.2 Protection contre l'accès aux parties dangereuses**

*L'essai approprié spécifié dans l'IEC 60529 est réalisé (voir aussi l'Article 10).*

#### **15.2.2.3 Protection contre les effets nuisibles dus à la pénétration de corps solides étrangers**

*L'essai approprié spécifié dans l'IEC 60529 est réalisé.*

*Les calibres d'essai ne sont pas appliqués aux trous d'écoulement.*

*Pour l'essai du premier chiffre caractéristique 5, les enveloppes d'interrupteurs sont considérées comme étant de catégorie 2 (voir l'IEC 60529:1989 and IEC 60529:1989/AMD1:1999, 13.4); la poussière ne doit pas pénétrer en une quantité telle que le fonctionnement correct du matériel ou la sécurité en soient affectés.*

*Pour l'essai du premier chiffre caractéristique 6, les enveloppes d'interrupteurs sont considérées comme étant de catégorie 1 (voir l'IEC 60529:1989, 13.6); la poussière ne doit pas pénétrer.*

#### **15.2.3 Protection contre les effets nuisibles dus à la pénétration de l'eau**

*Les enveloppes d'interrupteurs doivent procurer un degré de protection contre les effets nuisibles dus à la pénétration de l'eau, conformément à leur classification IP.*

*La conformité est vérifiée par les essais appropriés de l'IEC 60529 dans les conditions spécifiées ci-dessous.*

*Les interrupteurs pour pose encastrée et semi-encastrée sont fixés dans un mur d'essai représentant l'usage prévu de l'interrupteur en utilisant une boîte appropriée selon les instructions du fabricant.*

*Quand les instructions du fabricant spécifient des types particuliers de murs, ces murs ainsi que toute exigence spécifique de montage doivent être décrits avec suffisamment de détails (voir 8.7).*

*Quand le fabricant ne spécifie pas un type de mur, le mur d'essai de la Figure 21 est utilisé. Il est constitué de briques ayant une surface plate et lisse. Quand la boîte est montée dans ce mur d'essai, elle doit être ajustée sur le mur de façon que l'eau ne puisse pas pénétrer entre la boîte et le mur.*

*Si une matière de remplissage est utilisée pour sceller la boîte dans le mur, elle ne doit avoir aucune influence sur les caractéristiques d'étanchéité de l'échantillon à soumettre à l'essai.*

**NOTE** La Figure 21 représente un exemple dans lequel le bord de la boîte est positionné dans le plan de référence. D'autres positions sont possibles selon les instructions du fabricant.

*Le mur d'essai est placé en position verticale.*

*Les interrupteurs pour pose en saillie sont montés comme en usage normal sur un mur vertical et équipés de câbles de la plus grande section et de la plus petite section données au Tableau 4, selon ce qui s'applique en fonction de leurs valeurs assignées.*



*Les vis des enveloppes utilisées lors du montage de l'interrupteur sont serrées avec un couple égal aux deux tiers des valeurs appropriées données dans le Tableau 5.*

*Les presse-étoupes sont serrés avec un couple égal aux deux tiers de la valeur appropriée donnée dans le Tableau 22.*

*Les presse-étoupes ne sont pas remplis avec la matière de remplissage ou analogue.*

*Les pièces qui peuvent être démontées sans l'aide d'un outil sont retirées.*

*Si l'enveloppe d'un interrupteur ayant un degré de protection IP inférieur à IPX5 est conçue avec des trous d'écoulement, un trou d'écoulement est ouvert, dans la position la plus basse. Si l'enveloppe d'un interrupteur ayant un degré de protection IP égal ou supérieur à IPX5 est conçue avec des trous d'écoulement, ces derniers ne doivent pas être ouverts.*

*Il convient de porter une attention particulière afin de ne pas perturber l'assemblage, par exemple par des chocs ou des secousses susceptibles d'affecter les résultats de l'essai.*

*Si l'interrupteur est équipé d'un trou d'écoulement qui a été ouvert, il doit être vérifié par examen que l'eau qui a pénétré ne s'accumule pas et s'écoule sans avoir eu d'effets nuisibles à l'assemblage complet.*

*Les échantillons doivent supporter un essai de rigidité diélectrique comme spécifié en 16.3, qui doit commencer dans les 5 min après la fin des essais effectués conformément à 15.2.*

### **15.3 Résistance à l'humidité**

*Les interrupteurs doivent être protégés contre l'humidité qui peut se produire en usage normal.*

*La conformité est vérifiée par l'épreuve hygroscopique décrite en 15.3, suivie immédiatement par le mesurage de la résistance d'isolement et par l'essai de rigidité diélectrique spécifié à l'Article 16.*

*Les orifices d'entrée éventuels sont laissés ouverts; si des parties défonçables sont prévues, l'une d'elles est ouverte.*

*Les pièces qui peuvent être démontées sans l'aide d'un outil sont retirées et soumises à l'épreuve hygroscopique avec la partie principale; les couvercles à ressorts sont ouverts durant cette épreuve.*

*L'épreuve hygroscopique est réalisée dans une enceinte humide contenant de l'air ayant une humidité relative maintenue entre 91 % et 95 %.*

*La température de l'air à l'endroit dans lequel les échantillons sont placés est maintenue à  $\pm 1$  K de toute valeur «t» convenable entre 20 °C et 30 °C.*

*Avant d'être placés dans l'enceinte humide, les échantillons sont portés à une température comprise entre t et t + 4 °C.*

*Les échantillons sont maintenus dans l'enceinte pendant*

- deux jours (48 h) pour les interrupteurs ayant un degré IP égal à IPX0;*
- sept jours (168 h) pour les interrupteurs ayant un degré IP supérieur à IPX0.*

NOTE Dans la plupart des cas, des échantillons peuvent être portés à la température spécifiée en les maintenant à cette température pendant au moins 4 h avant l'épreuve hygroscopique. Une humidité relative comprise entre

91 % et 95 % peut être obtenue en plaçant dans l'enceinte humide une solution saturée de sulfate de sodium ( $\text{Na}_2\text{SO}_4$ ) ou de nitrate de potassium ( $\text{KNO}_3$ ) dans de l'eau ayant une surface de contact suffisamment grande avec l'air.

*Après cette épreuve, les échantillons ne doivent présenter aucun dommage au sens du présent document.*

## **16 Résistance d'isolement et rigidité diélectrique**

### **16.1 Généralités**

La résistance d'isolement et la rigidité diélectrique des interrupteurs doivent être convenables.

*Sur toutes les lampes indicatrices, un pôle est déconnecté pendant l'essai de l'Article 16.*

*La conformité est vérifiée par les essais suivants, exécutés immédiatement après les essais de 15.3 dans l'enceinte humide ou dans la salle dans laquelle les échantillons ont été portés à la température exigée, après remise en place des parties qui peuvent être retirées sans l'aide d'un outil et qui ont été enlevées pour l'essai.*

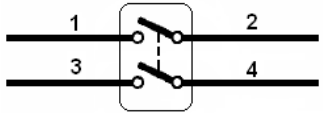
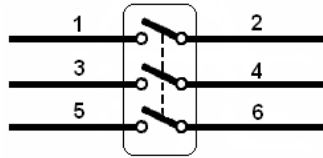
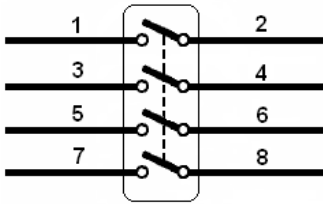
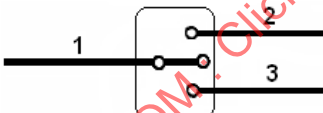
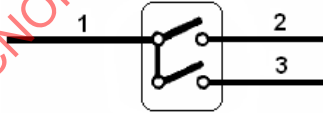
### **16.2 Essai de mesure de la résistance d'isolement**

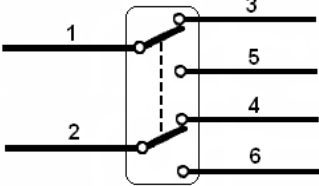
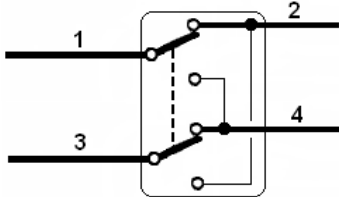
*La résistance d'isolement est mesurée sous une tension continue d'environ 500 V, le mesurage étant réalisé environ 1 min après l'application de la tension.*

*Les mesurages sont réalisés successivement pour les points 1, 2 et 3 du Tableau 15, la position de l'interrupteur et les connexions nécessaires étant celles indiquées au Tableau 14.*

*De plus, si des numéros de fonction indépendants d'un point de vue électrique sont combinés dans une base commune, les mesurages sont réalisés entre toutes les bornes d'un numéro de fonction connectées ensemble, et entre la masse et toutes les bornes des autres numéros de fonction connectées ensemble. Cette opération est répétée pour chaque position de contact et chaque numéro de fonction de la combinaison. La résistance d'isolement minimale doit être de 5 M $\Omega$ .*

**Tableau 14 – Points d'application de la tension d'essai pour la vérification de la résistance d'isolement et de la rigidité diélectrique**

| Numéro de fonction | Schéma des connexions                                                                                                                                | Position | Nombre de pôles | Application de la tension <sup>a</sup> |                                                             |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------|----------------------------------------|-------------------------------------------------------------|
|                    |                                                                                                                                                      |          |                 | Entre borne N°                         | Entre la masse (B) reliée aux bornes n°                     |
| 1                  | <br>Interrupteur unipolaire                                         | Ouvert   | 1               | 1<br>2                                 | B + 2<br>B + 1                                              |
|                    |                                                                                                                                                      | Fermé    |                 | 1 – 2                                  | B                                                           |
| 2                  | <br>Interrupteur bipolaire                                          | Ouvert   | 2               | 1 + 3<br>2 + 4                         | B + 2 + 4<br>B + 1 + 3                                      |
|                    |                                                                                                                                                      | Fermé    |                 | 1 – 2<br>1 – 2 + 3 – 4                 | B + 3 – 4<br>B                                              |
| 3                  | <br>Interrupteur tripolaire                                         | Ouvert   | 3               | 1 + 3 + 5<br>2 + 4 + 6                 | B + 2 + 4 + 6<br>B + 1 + 3 + 5                              |
|                    |                                                                                                                                                      | Fermé    |                 | 1 – 2<br>3 – 4<br>5 – 6                | B + 3 – 4 + 5 – 6<br>B + 1 – 2 + 5 – 6<br>B + 1 – 2 + 3 – 4 |
| 03                 | <br>Interrupteur tripolaire avec neutre coupé                     | Ouvert   | 4               | 1 + 3 + 5 + 7<br>2 + 4 + 6 + 8         | B + 2 + 4 + 6 + 8<br>B + 1 + 3 + 5 + 7                      |
|                    |                                                                                                                                                      | Fermé    |                 | 1 – 2 + 5 – 6<br>1 – 2 + 7 – 8         | B + 3 – 4 + 7 – 8<br>B + 3 – 4 + 5 – 6                      |
| 4                  | <br>Interrupteur à deux directions avec une position arrêt        | Ouvert   | 1               | 1                                      | B + 2 + 3                                                   |
|                    |                                                                                                                                                      | Fermé    |                 | 1 – 2<br>1 – 3                         | B + 3<br>B + 2                                              |
| 5                  | <br>Interrupteur à deux allumages avec une ligne commune d'entrée | Ouvert   | 1               | 2 + 3<br>1                             | B + 1<br>B + 2 + 3                                          |
|                    |                                                                                                                                                      | Fermé    |                 | 1 – 3<br>1 – 2 – 3                     | B + 2<br>B                                                  |
| 6                  | <br>Interrupteur à deux directions                                | –        | 1               | 1 – 3<br>1 – 2                         | B + 2<br>B + 3                                              |

| Numéro de fonction                                                                                                       | Schéma des connexions                                                                                                                                             | Position | Nombre de pôles | Application de la tension <sup>a</sup> |                                                  |
|--------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------|----------------------------------------|--------------------------------------------------|
|                                                                                                                          |                                                                                                                                                                   |          |                 | Entre borne N°                         | Entre la masse (B) reliée aux bornes n°          |
| 6/2                                                                                                                      |  <p>Interrupteur bipolaire à deux directions</p>                                 | –        | 2               | 1 – 3 + 2 – 4<br>1 – 5 + 2 – 6         | B + 5 + 6<br>B + 3 + 4                           |
| 7                                                                                                                        |  <p>Interrupteur inverseur à deux directions (ou interrupteur intermédiaire)</p> | –        | 1               | 1 – 2<br>3 – 4<br>1 – 4<br>2 – 3       | B + 3 – 4<br>B + 1 – 2<br>B + 2 – 3<br>B + 1 – 4 |
| <sup>a</sup> – représente une liaison électrique existante.<br>+ représente une liaison électrique établie pour l'essai. |                                                                                                                                                                   |          |                 |                                        |                                                  |

Le terme "masse" comprend les parties métalliques accessibles, les cadres métalliques servant de support à la base des interrupteurs pour pose encastrée, les clefs de manœuvre, une feuille métallique appliquée sur la surface externe des parties accessibles extérieures et clefs de manœuvre en matériau isolant, le point d'attache du cordon, de la chaînette ou de la tringle dans le cas des interrupteurs manœuvrés à l'aide de l'un de ces organes, les vis de fixation des parties principales, capots ou plaques de recouvrement, les vis d'assemblage extérieures, les bornes de terre et toutes les parties métalliques du mécanisme s'il est exigé qu'elles soient isolées des parties actives (voir 10.4).

Pour les mesurages indiqués aux points 1 et 2, la feuille métallique est appliquée de façon que la matière de remplissage soit effectivement soumise à l'essai.

L'essai du point 5 n'est effectué que si un revêtement isolant est nécessaire pour assurer l'isolement.

La résistance d'isolement ne doit pas être inférieure aux valeurs indiquées au Tableau 15.

Lorsque la feuille métallique est enroulée autour de la surface extérieure ou qu'elle est mise en contact avec la surface inférieure des parties en matériau isolant, elle est appuyée sur les trous ou rainures sans force appréciable au moyen du calibre d'essai 11 de l'IEC 61032.

### 16.3 Essai de rigidité diélectrique

L'isolement est soumis pendant 1 min à une tension de forme pratiquement sinusoïdale, de fréquence 50 Hz ou 60 Hz.

Les essais sont réalisés successivement comme indiqué au Tableau 14 aux points d'application décrits au Tableau 15, les positions de l'interrupteur et les connexions nécessaires pour les points 1, 2 et 3 du Tableau 15 étant indiquées au Tableau 14.

*De plus, si des numéros de fonction indépendants d'un point de vue électrique sont combinés dans une base commune, les essais sont réalisés entre toutes les bornes d'un numéro de fonction connectées ensemble, et entre la masse et toutes les bornes des autres numéros de fonction connectées ensemble. Cette opération est répétée pour chaque position de contact et chaque numéro de fonction de la combinaison. La tension d'essai appliquée doit être de 1 250 V pour les caractéristiques assignées ne dépassant pas 130 V ou de 2 000 V pour les caractéristiques assignées supérieures à 130 V.*

*Au début de l'essai, la tension appliquée ne dépasse pas la moitié de la valeur prescrite, puis elle est amenée rapidement à la pleine valeur. Au cours de l'essai, il ne doit se produire ni contournement ni perforation.*

*Le transformateur à haute tension utilisé pour l'essai doit être conçu de façon que, lorsque les bornes secondaires sont court-circuitées après avoir réglé la tension secondaire à la tension d'essai appropriée, le courant secondaire soit d'au moins 200 mA. Le relais à maximum de courant ne doit pas se déclencher lorsque le courant secondaire est inférieur à 100 mA. La valeur efficace de la tension d'essai appliquée doit être mesurée avec une exactitude de  $\pm 3\%$ .*

*Les effluves qui ne coïncident pas avec une diminution de la tension ne doivent pas être pris en considération.*

NOTE Dans le pays suivant, l'essai du point 8 du Tableau 15 est réalisé entre les parties actives et les boutons métalliques, les boutons poussoirs et la feuille métallique en contact avec la surface externe des parties accessibles extérieures et les clefs de manœuvre du matériau isolant: AU.

**Tableau 15 – Tension d'essai, points d'application et valeurs minimales de résistance d'isolement pour la vérification de la rigidité diélectrique**

| Isolation à soumettre à l'essai                                                                                                                                                                                                                                                                                                                                                                         | Valeur minimale de résistance d'isolement<br><br>MΩ | Tension d'essai<br>V                                     |                                                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|----------------------------------------------------------|---------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                         |                                                     | Interrupteurs de tension assignée ne dépassant pas 130 V | Interrupteurs de tension assignée dépassant 130 V |
| 1 Entre tous les pôles reliés entre eux et la masse, l'interrupteur étant en position "fermé".                                                                                                                                                                                                                                                                                                          | 5                                                   | 1 250                                                    | 2 000                                             |
| 2 Entre chaque pôle et tous les autres reliés à la masse, l'interrupteur étant en position "fermé".                                                                                                                                                                                                                                                                                                     | 2                                                   | 1 250                                                    | 2 000                                             |
| 3 Entre les bornes qui sont reliées électriquement entre elles lorsque l'interrupteur est en position "fermé", l'interrupteur étant en position "ouvert":                                                                                                                                                                                                                                               |                                                     |                                                          |                                                   |
| – à distance normale/à faible distance d'ouverture des contacts;                                                                                                                                                                                                                                                                                                                                        | 2                                                   | 1 250                                                    | 2 000                                             |
| – à microdistance d'ouverture des contacts;                                                                                                                                                                                                                                                                                                                                                             | 2                                                   | 500 (note 1)                                             | 1 250 (note 2)                                    |
| – dispositifs de coupure à semi-conducteur.                                                                                                                                                                                                                                                                                                                                                             | (note 3)                                            | (note 3)                                                 | (note 3)                                          |
| 4 Entre les parties métalliques du mécanisme lorsqu'elles sont isolées des parties actives, et                                                                                                                                                                                                                                                                                                          |                                                     |                                                          |                                                   |
| – les parties actives;                                                                                                                                                                                                                                                                                                                                                                                  | 5                                                   | 1 250                                                    | 2 000                                             |
| – une feuille métallique appliquée sur la surface du bouton ou organe de manœuvre similaire;                                                                                                                                                                                                                                                                                                            | 5                                                   | 1 250                                                    | 2 000                                             |
| – la clef des interrupteurs à clef, si son isolement est exigé (voir 10.6);                                                                                                                                                                                                                                                                                                                             | 5                                                   | 1 250                                                    | 2 000                                             |
| – le point d'attache du cordon, de la chaînette ou de la tringle, dans le cas des interrupteurs manœuvrés à l'aide de l'un de ces organes, si leur isolement est exigé (voir 10.6);                                                                                                                                                                                                                     | 5                                                   | 1 250                                                    | 2 000                                             |
| – les parties métalliques accessibles, y compris les vis de fixation de la partie principale, si leur isolement est exigé (voir 10.5).                                                                                                                                                                                                                                                                  | 5                                                   | 1 250                                                    | 2 000                                             |
| 5 Entre toute enveloppe métallique et une feuille métallique appliquée sur la surface interne de son revêtement isolant, s'il existe (note 4).                                                                                                                                                                                                                                                          | 5                                                   | 1 250                                                    | 2 000                                             |
| 6 Entre les parties actives et les parties métalliques accessibles, si les parties métalliques du mécanisme ne sont pas isolées des parties actives.                                                                                                                                                                                                                                                    | –                                                   | 2 000                                                    | 3 000                                             |
| 7 Entre les parties actives et les parties du mécanisme                                                                                                                                                                                                                                                                                                                                                 |                                                     |                                                          |                                                   |
| – si ces dernières parties ne sont pas isolées des parties métalliques accessibles (voir 10.5);                                                                                                                                                                                                                                                                                                         | –                                                   | 2 000                                                    | 3 000                                             |
| – si ces dernières parties ne sont pas isolées du point de contact avec une clef amovible ou un cordon, une chaînette ou une tringle de manœuvre (voir 10.6).                                                                                                                                                                                                                                           | –                                                   | 2 000                                                    | 3 000                                             |
| 8 Entre les parties actives et boutons métalliques, boutons poussoirs et organes analogues (voir 10.2).                                                                                                                                                                                                                                                                                                 | –                                                   | 2 500                                                    | 4 000                                             |
| NOTE 1 Cette valeur s'applique aussi pour l'essai de rigidité diélectrique après fonctionnement normal.                                                                                                                                                                                                                                                                                                 |                                                     |                                                          |                                                   |
| NOTE 2 Pour les interrupteurs de tension assignée jusqu'à 250 V inclus, cette valeur est réduite à                                                                                                                                                                                                                                                                                                      |                                                     |                                                          |                                                   |
| – 750 V pour l'essai de rigidité diélectrique après la vérification de la résistance à l'humidité;                                                                                                                                                                                                                                                                                                      |                                                     |                                                          |                                                   |
| – 500 V pour l'essai de rigidité diélectrique après fonctionnement normal.                                                                                                                                                                                                                                                                                                                              |                                                     |                                                          |                                                   |
| NOTE 3 Les essais pour la vérification de la position "ouverte" du dispositif de coupure à semi-conducteur selon le point 3 sont à l'étude.                                                                                                                                                                                                                                                             |                                                     |                                                          |                                                   |
| NOTE 4 Cet essai n'est réalisé que si le revêtement isolant est nécessaire.                                                                                                                                                                                                                                                                                                                             |                                                     |                                                          |                                                   |
| NOTE 5 Dans le pays suivant, l'essai du point 8 est réalisé entre les parties actives et les boutons métalliques, les boutons poussoirs et la feuille métallique en contact avec la surface externe des parties accessibles extérieures et les clefs de manœuvre du matériau isolant. La tension d'essai pour les interrupteurs ayant une tension assignée supérieure à 130 V doit être de 3 000 V: AU. |                                                     |                                                          |                                                   |