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Switches for household and similar fixed-electrical installations –

Part 1: General requirements

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International Electrotechnical Commission
Международная Электротехническая Комиссия

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SWITCHES FOR HOUSEHOLD AND SIMILAR FIXED-ELECTRICAL
INSTALLATIONS –****Part 1: General requirements**

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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: Electrical accessories.

This consolidated version of IEC 60669-1 consists of the third edition (1998) [documents 23B/535/FDIS and 23B/539/RVD], its amendment 1 (1999) [documents 23B/580/FDIS and 23B/590/RVD] and its amendment 2 (2006) [documents 23B/828/FDIS and 23B/845/RVD].

The technical content is therefore identical to the base edition and its amendments and has been prepared for user convenience.

It bears the edition number 3.2.

A vertical line in the margin shows where the base publication has been modified by amendments 1 and 2.

Annexes A and B form an integral part of this standard.

In this standard the following print types are used:

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

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
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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 switches, for a.c. only with a rated voltage not exceeding 440 V and 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.

Switches covered by this standard are intended for the control in normal use of:

- a circuit for a tungsten filament lamp load; or
- a circuit for a fluorescent lamp load (including electronic ballast); or
- a circuit for a substantially resistive load with a power factor not less than 0,95; or
- a monophasic circuit for motor load with a rated current up to 10 A and a power factor not less than 0,6; or
- a combination of these.

NOTE 1 An extension of the scope to switches for rated voltages higher than 440 V is under consideration.

NOTE 2 An increase of the rated current of 10 A for motor load is under consideration.

NOTE 3 For the time being, switches with a rated current more than 10 A are considered as a 10 A current for motor load switch.

The standard also applies to boxes for switches, with the exception of mounting boxes for flush type switches.

NOTE 4 General requirements for boxes for flush-type switches are given in IEC 60670.

It also applies to switches such as:

- switches incorporating pilot lights;
- electromagnetic remote control switches (particular requirements are given in the relevant part 2);
- switches incorporating a time-delay device (particular requirements are given in the relevant part 2);
- combinations of switches and other functions (with the exception of switches combined with fuses);
- electronic switches (particular requirements are given in the relevant part 2);
- switches having facilities for the outlet and retention of flexible cables (see annex B);
- isolating switches (particular requirements are given in the relevant Part 2).

NOTE 5 The minimum length of the flexible cable used with these switches may be governed by National Wiring Rules.

Switches complying with this standard are suitable for use at ambient temperatures not normally exceeding 25 °C, but occasionally reaching 35 °C.

NOTE 6 Switches complying with this standard 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 constructions may be required.

2 Normative references

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

IEC 60050-442:1998, *International Electrotechnical Vocabulary – Part 442: Electrical accessories*

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

IEC 60212: 1971, *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, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 5: Flexible cables (cords)*
Amendment 1 (1987)

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

IEC 60245-4: 1994, *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*

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

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

IEC 60998-1: 1990, *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 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 mm² up to 35 mm² (included)*

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

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

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

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

3 Definitions

For the purpose of this part of IEC 60669 the following definitions apply.

Where the terms "voltage" and "current" are used, they imply r.m.s. 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

3.1.2

momentary contact switch

switching device which returns automatically to the initial state after operation

NOTE Momentary contact switches are intended to operate bells, electromagnetic remote control switches or time-delay switches.

3.1.3

momentary push-button switch

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

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 open contacts which is 3 mm or greater and meeting the performance requirements for normal-gap construction

3.1.6**switch of mini-gap construction**

switch construction having a clearance between the open contacts which is 1,2 mm or greater and meeting the performance requirements for mini-gap construction

3.1.7**switch of micro-gap construction**

switch construction without specified clearance between the open contacts and meeting the performance requirements for micro-gap construction

3.2**one operation**

the transfer of the moving contacts from one operating position to another

3.3**terminal**

the 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**terminal with screw clamping**

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

3.6**pillar terminal**

terminal with screw clamping in which the conductor is inserted into the hole or cavity, where it is clamped under the end of the screw or screws. The clamping pressure may be applied directly by the end of the screw or through an intermediate clamping member to which pressure is applied by the end of the screw

NOTE Examples of pillar terminals are shown in figure 1.

3.7**screw terminal**

terminal with screw clamping in which the conductor is clamped under the head of the screw. The clamping pressure may be applied directly by the head of the screw or through an intermediate part, such as a washer, clamping plate or anti-spread device

NOTE Examples of screw terminals are shown in figure 2.

3.8**stud terminal**

terminal with screw clamping in which the conductor is clamped under a nut. The clamping pressure may be applied directly by a suitably shaped nut or through an intermediate part, such as a washer, clamping plate or anti-spread device

NOTE Examples of stud terminals are shown in figure 2.

3.9**saddle terminal**

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

NOTE Examples of saddle terminals are shown in figure 3.

3.10**lug terminal**

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

NOTE Examples of lug terminals are shown in figure 4.

3.11**mantle terminal**

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. 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 Examples of mantle terminals are shown in figure 5.

3.12**screwless terminal**

connecting device 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

3.13**thread-forming screw**

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

NOTE An example of a thread-forming screw is shown in figure 6.

3.14**thread-cutting screw**

screw having an interrupted thread which, by screwing in, forms a thread by removing material

NOTE An example of a thread-cutting screw is shown in figure 7.

3.15**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

3.16**base**

part of the switch retaining current-carrying parts and, in general, the mechanism in position

3.17**rated voltage**

voltage assigned to the switch by the manufacturer

3.18**rated current**

current assigned to the switch by the manufacturer

3.19**operating member**

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

3.20**pole (of a switch)**

part of a switch associated with one conductive path (way) of its circuit(s) 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

A conducting path may be constituted by portions common to other conducting paths of the switch.

3.21**actuating member**

a part which is pulled, pushed, turned or otherwise moved to cause an operation of the switch [IEV 442-04-14]

3.22**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

4 General requirements

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

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

5 General notes on tests

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

5.2 *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 this facility.

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

5.3 *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 °C ± 5 °C.

5.4 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 the tests of clause 16, three additional specimens may be required in the case of switches fitted with pilot lights.

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, where two (or four for switches of pattern number 2) further sets of three specimens are used.

A switch marked 250/380 V is tested as a 380 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 18.2 and 19.2.

NOTE A table showing the number of specimens needed for the tests is given in annex A.

5.5 The specimens are submitted to all the relevant tests and the requirements are satisfied if all the 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 5.4, the additional set of specimens which may be wanted, should one specimen fail. The testing station will then, without further request, test additional specimens and will reject 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.

6 Ratings

6.1 Switches shall preferably have rated voltages of 130 V, 230 V, 250 V, 277 V, 380 V, 400 V, 415 V and 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 be not less than 120 V.

6.2 Switches shall preferably have rated currents of 6 A, 10 A, 16 A, 20 A, 25 A, 32 A, 40 A, 45 A, 50 A and 63 A.

The rated current shall be not less than 6 A, except that rated currents of 1 A, 2 A and 4 A are 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 lamp current rating equal to the rated current.

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.

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

6.3 Switches shall preferably have a degree of protection IP20, IP40, IP44, IP54 or IP55.

7 Classification

7.1 Switches are classified:

7.1.1 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 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.

7.1.2 according to the contact opening and switch performance:

- 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 having a semiconductor switching device have no contact gap.

NOTE 2 Switches according to this standard are intended for functional purposes.

7.1.3 Void**7.1.4** according to the degree of protection against harmful effects due to the ingress of water:

- IPX0: switches not protected against ingress of water;
- IPX4: switches protected against splashing water;
- IPX5: switches protected against water jets.

NOTE For an explanation of IP codes, see IEC 60529.

7.1.5 according to the method of actuating the switch:

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

7.1.6 according to the method of mounting the switch:

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

7.1.7 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.

7.1.8 according to the type of terminal:

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

7.1.9 according to the degree of protection against access to hazardous parts and against harmful effects due to the ingress of solid foreign objects

- IP2X: switches protected against access to hazardous parts with a finger and against harmful effects due to ingress of solid foreign objects of 12,5 mm diameter and greater;
- IP4X: switches protected against access to hazardous parts with a wire and against harmful effects due to ingress of solid foreign objects of 1,0 mm diameter and greater;
- IP5X: switches protected against access to hazardous parts with a wire and protected against dust.

7.2 Preferred combinations of number of poles and ratings are shown in table 1.

Table 1 – Preferred combinations of numbers of poles and ratings

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

8 Marking

8.1 Switches shall be marked with:

- rated current 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);
- rated voltages in volts;
- symbol for nature of supply;
- manufacturer's or responsible vendor's name, trade mark or identification mark;
- type reference, which may be a catalogue number;
- symbol for mini-gap construction, if applicable;
- symbol for micro-gap construction, if applicable;
- symbol for semiconductor switching device, if applicable;
- 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 higher than 2, in which case the second characteristic numeral shall also be marked,
- second characteristic numeral for the degree of protection against harmful effects due to the ingress of water, if declared higher than 0, in which case the first characteristic numeral shall also be marked.

NOTE 1 Marking of the pattern number given in 7.1.1 is recommended 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, for example 1+6 or 1+1+1.

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 When symbols are used, they shall be as follows:

Amperes (fluorescent lamp current)	AX
(other currents)	A
Volts	V
Alternating current	~
Neutral	N
Line	L
Earth	⏏
"open" position (off)	O
"closed" position (on)	I
Mini-gap construction	m
Micro-gap construction	μ
Without contact gap (semiconductor switching device)	ε

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

Degree of protection, when relevant

IPXX

NOTE 2 Details of construction of certain symbols are given in IEC 60417.

NOTE 3 In the IP code the letter "X" is replaced by the relevant number.

NOTE 4 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 5 The marking for current, voltage and nature of supply may 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 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.

NOTE 1 The type reference may be the series reference only.

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 IP code, when applicable, shall be marked so as to be easily discernible when the switch is mounted and wired as in normal use.

The marking 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. These markings shall be placed on parts which cannot be removed without the use of a tool.

NOTE 2 Additional type references may 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 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. which 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 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 Terminals intended exclusively for the neutral conductor shall be indicated by the letter N.

Earthing shall be indicated by the symbol $\perp$.

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

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 are not considered to be conductors for the purpose of this subclause.

8.6 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 be used, e.g. indicator lamps.

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 indications for push-button switches.

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

8.7 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.

8.8 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, 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 standard are achieved, the instruction sheet should include 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;
- details of lamps to be used in cases where switches have replaceable pilot lamps.

8.9 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.

NOTE 1 Marking made by impression, moulding, pressing 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/cm³.

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 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 1 of IEC 60529 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 $35\text{ °C} \pm 2\text{ °C}$, 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.

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.

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

10.2 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 Accessible parts of switches which have a rated current not exceeding 16 A shall be made of insulating material with the exception of the following:

- a) small screws and the like which are isolated from live parts and which are used for fixing bases and covers or cover plates;
- b) actuating members complying with 10.2;
- c) the covers or cover plates of metal which comply with the requirements of 10.3.1 or 10.3.2.

10.3.1 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 are 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 this subclause.

10.3.2 The earthing of metal covers or cover plates is made while fixing the covers or cover plates and may be made without requiring the use of means other than the fixing 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 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, 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 Metal parts of the mechanism, such as the spindle or the pivot of the dolly or rocker, shall not be accessible 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.

The additional requirement does 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, if necessary, by measurement and by the tests of clauses 10 and 16.

NOTE 2 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 3 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 have at least twice the values specified in clause 23.

10.6 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 16.2 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 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 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 10.3.1.

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 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 mm².

11.3 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.

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 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 a.c. source having a no-load voltage not exceeding 12 V and equal to 1,5 times 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 Ω.

NOTE Care should be 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.

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 of copper conductors having cross-sectional areas as shown in table 2.

Table 2 – Relationship between rated currents and connectable cross-sectional areas of copper conductors

Ranges of rated currents A	Rigid conductors (solid or stranded) ³⁾	
	Nominal cross-sectional areas mm ²	Diameter of largest conductor mm
up to and including 4 ¹⁾	–	–
above 4 up to and including 6	From 0,75 up to 1,5 inclusive	1,45
above 6 up to and including 10 ²⁾	From 1 up to 2,5 inclusive	2,13
above 10 up to and including 16 ²⁾	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
¹⁾ For special purposes such as ELV applications, where flexible conductors are used (from 0,5 mm ² up to 1 mm ² inclusive). ²⁾ Each supply terminal of switches, other than those of pattern numbers 3, 03 and 7, shall allow the connection of two 2,5 mm ² conductors. For switches having a rated voltage not exceeding 250 V a round hole is sufficient for the connection of two 2,5 mm ² conductors. ³⁾ 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 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:

The terminal is placed in the test apparatus according to figure 10 and fitted with rigid (solid or stranded) conductor(s), according to table 2, first with the smallest and then with the largest cross-sectional area, the clamping screw(s) or nut(s) being tightened with the torque according to table 3.

Table 3 – Tightening torque for the verification of the mechanical strength of screw-type terminals

Nominal diameter of thread mm	Torque 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 4.

The end of the conductor is passed through an appropriate bushing in a platen positioned at a height (H) below the equipment as given in table 4. The bushing is positioned in a horizontal plane so that its centre line describes a circle of 75 mm diameter, concentric with the centre of the clamping unit in the horizontal plane; the platen is then rotated at a rate of (10 ± 2) rev/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 4. The bushing may be lubricated to prevent binding, twisting, or rotation of the insulated conductor.

A mass as specified in table 4 is suspended from the end of the conductor. The duration of the test is approximately 15 min.

During the test, the 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.

Table 4 – Test values for flexion and pull out for copper conductors

Conductor cross-sectional area ¹⁾ mm ²	Diameter of bushing hole ²⁾ mm	Height H ³⁾ mm	Mass for conductor 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

1) AWG sizes corresponding to mm² can be found in IEC 60999.
 2) 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.
 3) 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:

The terminals are fitted with rigid stranded conductors of the smallest and largest cross-sectional area specified in table 2, the terminal screws being tightened with a torque equal to two-thirds of the torque shown in the appropriate column of table 3.

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 3.

Each conductor is then subjected to a pull as specified in table 5, applied without jerks, for 1 min, in the direction of the axis of the conductor space.

Table 5 – Test values for pulling out test

Cross-section of conductors accepted by the terminal mm ²	From 0,5 up to 1 inclusive	From 0,75 up to 1,5 inclusive	From 1,5 up to 2,5 inclusive	From 2,5 up to 4 inclusive	From 4 up to 6 inclusive	From 6 up to 10 inclusive	From 10 up to 16 inclusive	From 16 up to 25 inclusive
Pull N	30	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 In the following country 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: Sweden.

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:

The terminals are fitted with conductors having the largest cross-sectional area specified in table 2.

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, being fitted with the permissible number of conductors.

The terminals are fitted with conductors having the composition shown in table 6.

Table 6 – Composition of conductors

Cross-sectional area mm ²	Number of wires and nominal diameter of wires mm	
	Solid conductor	Stranded conductor
1	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 and 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. The clamping screw is then tightened with a torque equal to two-thirds of the torque shown in the appropriate column of table 3.

After the test no wire of the conductor shall have escaped outside the clamping unit thus reducing creepage distances and clearances to values lower than those indicated in clause 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, but any movement should be sufficiently limited so as to prevent non-compliance with this standard.

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 standard.

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 2 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 3 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 2, 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 This subclause 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 7.

Table 7 – Relationship between rated currents and connectable cross-sectional areas of copper conductors for screwless terminals

Rated current A	Conductors		
	Nominal cross-sectional areas mm ²	Diameter of largest rigid conductor mm	Diameter of largest flexible conductor mm
4	0,75 to 1	1,19	-
6	1 to 1,5	1,45	1,73
10 up to and including 16 ¹⁾	1,5 to 2,5	2,13	2,21

¹⁾ Each supply terminal of switches other than those of pattern numbers 3, 03 and 7 shall allow the connection of two 2,5 mm² 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 of the other conductor(s);
- during the disconnecting, the conductors can be 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 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 20, 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 rev/min $\pm$ 2 rev/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 4.

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 loading the screwless terminals for 1 h with an alternating current as specified in table 8 and connecting rigid solid conductors 1 m long having the cross-sectional area as specified in table 8.

The test is carried out on each clamping unit.

Table 8 – Test current for the verification of electrical and thermal stresses in normal use of screwless terminals

Rated current A	Test current A	Cross-sectional area of the conductor mm ²
4	9	0,75
6	13,5	1
10	17,5	1,5
16	22	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.

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 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 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 8 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.

In no case shall the voltage drop exceed 22,5 mV or two times 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, 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 11a, 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 11b.

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 may 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 8 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 10, 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 9 – Cross-sectional areas of rigid copper conductors for deflection test of screwless terminals

Rated current of the switch A	Cross-sectional area of the test conductor mm ²	
	1st test sequence	2nd test sequence
≤6	1,0 ¹⁾	1,5
above 6 up to and including 16	1,5	2,5

¹⁾ Only for countries allowing the use of 1,0 mm² conductors in fixed installations.

Table 10 – Deflection test forces

Cross-sectional area of the test conductor mm ²	Force for deflecting the test conductor ¹⁾ N
1,0	0,25
1,5	0,5
2,5	1,0

¹⁾ 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 10 is applied to the test conductor inserted in the clamping unit under test in one of the 12 directions shown in figure 11a 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 11a 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 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 Switches shall be constructed so as to permit:

- easy introduction and connection of the conductors in the terminals;
- 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 and the surface on which the base is mounted or between the sides of the base 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.

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

NOTE 1 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.

NOTE 2 For surface-type switches, mounted on a mounting plate, a wiring channel may be needed to comply with this requirement.

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

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 2.

13.3 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 fixings of covers, cover plates or actuating members be 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 20, are not considered as accessible if the requirements of this subclause are met.

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

Compliance is checked according 13.3.1, 13.3.2 or 13.3.3.

13.3.1 *For covers, cover plates or actuating members whose fixing is of the screw-type:*

by inspection only.

13.3.2 *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 11),*

– when their removal may give access, with the standard test finger, to live parts:

by the tests of 20.4;

– when their removal may give access, with the standard test finger, to non-earthed metal parts separated from live parts in such a way that creepage distances and clearances have the values shown in table 20:

by the test of 20.5;

– when their removal may give access, with the standard test finger, 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 twice the values shown in table 20, or*
- *live parts of SELV circuits not greater than 25 V a.c.:*

by the test of 20.6.

Table 11 – Forces to be applied to covers, cover-plates or actuating members whose fixing is not dependent on screws

Accessibility with the test finger after removal of covers, cover plates or parts of them	Test according to	Force to be applied N			
		Switches complying with 20.7 and 20.8		Switches not complying with 20.7 and 20.8	
		Shall not come off	Shall come off	Shall not come off	Shall come off
To live parts	20.4	40	120	80	120
To non-earthed metal parts separated from live parts by creepage distances according to table 20	20.5	10	120	20	120
To insulating parts, earthed metal parts, the live parts of SELV ≤ 25 V a.c. or metal parts separated from live parts by creepage distances and by clearances twice those according to table 20	20.6	10	120	10	120

13.3.3 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 13.3.2 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 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 2.

NOTE Drain holes, small gaps between enclosures and conduits or cables, or between enclosures and operating means are neglected.

13.5 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.

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 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.

13.7 Combinations of switches, or of switches and socket-outlets, comprising separate bases shall be so designed that the correct position of each base is ensured. The fixing of each base 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 shall comply with their standard, if any, unless a standard exists for the combination.

13.9 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 or IPX5 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 mm² 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 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 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 2.

13.11 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 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 protective covering 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 12 or be as specified by the manufacturer.

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

Table 12 – External cable diameter limits for surface type switches

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

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 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 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 $40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

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.

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 country compliance with this requirement is considered as necessary, due to installation practices in cold conditions: Sweden.

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 refrigerator at a temperature of $-15\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

After this period, the switches are removed from the refrigerator 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 in 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 standard.

14 Mechanism

14.1 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 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 16.2, 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 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 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.

14.5 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 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 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.

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, protection provided by enclosures of switches, and resistance to humidity

15.1 Resistance to ageing

Switches shall be resistant to ageing.

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 15.2.1.

The temperature in the cabinet is $70\text{ °C} \pm 2\text{ °C}$.

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 standard.

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

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 15.2.1 and 15.2.2.

15.2.1 Protection against access to hazardous parts and against harmful effects due to ingress of solid foreign objects

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 condition 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 2. Glands are tightened with a torque equal to two-thirds of that applied during the test of 20.3.

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.

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

15.2.1.1 Protection against access to hazardous parts

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

15.2.1.2 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; dust shall not penetrate in quantity to interfere with satisfactory operation or to impair safety.

15.2.2 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 8.8).

Where the manufacturer's instructions do not specify a type of wall, the test wall according to figure 27 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.

NOTE 1 If sealing material is used in order to seal the box into the wall it should not influence the sealing properties of the specimen to be tested.

NOTE 2 Figure 27 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 2, 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 3.

Glands are tightened with a torque equal to two-thirds of the appropriate value given in table 19.

NOTE 3 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 have an IP code less than IPX5 is designed with drain holes, one drain hole is opened as in normal use and in the lowest position. If an enclosure of a switch that have an IP code equal or greater than IPX5 is designed with drain holes, they are not to be opened.

Care shall be taken not to disturb, e.g. 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 16.2 which shall be started within 5 min of completion of the tests according to this subclause.

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 this subclause, 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 ± 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 1 In most cases, the specimens may 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 (Na_2SO_4) or potassium nitrate (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 standard.

16 Insulation resistance and electric strength

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

One pole of any pilot light is disconnected for the test of this clause.

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.

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

The measurements are made consecutively as indicated in table 13, the switch position and the connections necessary for items 1, 2 and 3 being as shown in table 13.

Table 13 – Points of application of the test voltage for the verification of insulation resistance

Pattern number	Diagrams of connections	Position	Application of the voltage*	
			between terminal No.	between body (B) together with terminal No.
1		Off	1 2	B + 2 B + 1
		On	1 – 2	B
2		Off	1 + 3 2 + 4	B + 2 + 4 B + 1 + 3
		On	1 – 2 1 – 2 + 3 – 4	B + 3 – 4 B
3		Off	1 + 3 + 5 2 + 4 + 6	B + 2 + 4 + 6 B + 1 + 3 + 5
		On	1 – 2 3 – 4 5 – 6	B + 3 – 4 + 5 – 6 B + 1 – 2 + 5 – 6 B + 1 – 2 + 3 – 4
03		Off	1 + 3 + 5 + 7 2 + 4 + 6 + 8	B + 2 + 4 + 6 + 8 B + 1 + 3 + 5 + 7
		On	1 – 2 + 5 – 6 1 – 2 + 7 – 8	B + 3 – 4 + 7 – 8 B + 3 – 4 + 5 – 6
4		Off	1	B + 2 + 3
		On	1 – 2 1 – 3	B + 3 B + 2
5		Off	2 + 3 1	B + 1 B + 2 + 3
		On	1 – 3 1 – 2 – 3	B + 2 B
6		–	1 – 3 1 – 2	B + 2 B + 3
6/2		–	1 – 3 + 2 – 4 1 – 5 + 2 – 6	B + 5 + 6 B + 3 + 4
7		–	1 – 2 3 – 4 1 – 4 2 – 3	B + 3 – 4 B + 1 – 2 B + 2 – 3 B + 1 – 4

* – denotes an existing electrical connection.

+ 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 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 14.

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.

16.2 *The insulation is subjected for 1 min to a voltage of substantially sinewave 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.*

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 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 should not trip when the output current is less than 100 mA.

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

NOTE 4 Glow discharges without drop in voltage are neglected.

Table 14 – Test voltage, points of application and minimum values of insulating resistance for the verification of dielectric strength

Insulation to be tested	Minimum value of insulation resistance MΩ	Test voltage 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 2)	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 base, 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 insulation 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.

17 Temperature rise

17.1 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 copper conductors as specified in table 15, the terminal screws or nuts being tightened with a torque equal to two-thirds of that specified in table 3.

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 15.

Table 15 – Temperature-rise test currents and cross-sectional areas of copper conductors

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

¹⁾ For switches having a rated voltage not exceeding 250 V, other than those of pattern Nos 3 and 03, and when terminals for rated current 10 A are used, the test shall be carried out with conductors having a cross-sectional area of 2,5 mm².

NOTE 2 The test currents for switches having other rated currents are determined by interpolation between the next lower and higher ratings.

For switches of pattern Nos 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 4 The sides of the cavity in the pinewood block may 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 mm $\pm$ 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 21.3 shall be determined.

NOTE 5 Undue oxidation of the contacts may be prevented by sliding action or by the use of silver or silver-faced 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 or intended to incorporate pilot lights shall be so designed that in normal use the temperature of the accessible surface 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 temperature rise of the external surface of the switch shall not exceed:

60 K for knobs, handles, sensing surfaces, etc., of non-metallic material;

70 K for other external parts of non-metallic material;

40 K for knobs, handles, sensing surfaces, etc., of metallic material;

50 K for other external parts of metallic material.

NOTE Pilot lights using neon lamps are not tested.

18 Making and breaking capacity

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 18.1 and, for switches having a rated current not exceeding 16 A and having a rated voltage up to and including 250 V and for switches of pattern Nos 3 and 03 and rated voltage over 250 V, by the additional tests of 18.2.

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 13.

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

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

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

- 30 operations per minute if the rated current does not exceed 10 A;
- 15 operations per minute if the rated current exceeds 10 A but is less than 25 A;
- 7,5 operations per minute if the rated current is 25 A or more.

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 ($\cos \varphi = 0,3 \pm 0,05$). 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 has substantially sinewave 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 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 16 – Fractions of total number of operations

<i>Pattern number</i>	<i>Type of switch</i>	<i>Fraction for switch S</i>
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 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 are tested as two switches of pattern number 1, the tests being made consecutively.

While testing one part, the other part is in the "off" position.

During the test no sustained arcing shall occur.

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 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.

18.2 Switches are normally tested at the rated voltage and at 1,2 times the rated current.

The test is carried out by using a number of 200 W tungsten filament lamps.

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 18.1.

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 operation of the switch is not considered as welding.

After the test, the specimens shall show no damage which may impair their further use.

NOTE 3 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:

$$\frac{240 \times 1,2 \times 10}{200} = 14,4 \rightarrow 15$$

19 Normal operation

19.1 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 is $^{+5}_0$ %.

The circuit details and the manner of operation of the selector switch S are described in 18.1, unless otherwise specified.

The number of operations is shown in table 17.

Table 17 – 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 a.c., except pattern Nos 3 and 03	40 000
Up to and including 16 A, for switches having a rated voltage exceeding 250 V a.c., and for pattern Nos 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 18.1.

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 directions, 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, 3/4 of the total number of operations is 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 with a.c. ($\cos \varphi = 0,6 \pm 0,05$).

Switches of pattern No. 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 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 poles of switches of pattern No. 4 and No. 5 are tested as two switches of pattern No. 1. If the poles are identical, only one pole need be tested.

For switches of pattern No. 5 with a single mechanism, each circuit is loaded with 0,5 times rated current.

Switches of pattern No. 6 shall be tested for half the number of operations on one pole and half the number of operations for the other pole.

Switches of pattern No. 6/2 are tested as one switch of pattern No. 6 if the two pairs of poles are identical. Otherwise, as two switches of pattern No. 6.

Switches of pattern No. 7 are tested as a double switch of pattern No. 6.

The test specimens shall be connected to the test circuit with cables of length $1\text{ m} \pm 0,1\text{ m}$ 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 temperature rise test as specified in clause 17, the test current being reduced to the value of the rated current.

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 the requirements of clause 10 are no longer complied with;
- seepage of sealing compound;
- loosening of electrical or mechanical connections;
- relative displacement of the moving contacts of switches of pattern number 2, 3, 03 or 6/2.

NOTE 1 The humidity treatment of 15.3 is not repeated before the electric strength test of this subclause.

NOTE 2 During the test, the specimens are not lubricated.

The test is followed by the test of 14.3.

19.2 Switches intended for fluorescent lamp loads shall withstand, without excessive wear or other harmful effect, the electrical and thermal stresses occurring when controlling fluorescent lamp circuits.

Compliance is checked by the test circuit indicated in figure 14 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.

R₁ is a resistor limiting the current to about 100 A.

The twin-core cable shall have a suitable length to give a resistance R₃ equal to 0,25 Ω in the test circuit to the load. It shall have a cross-sectional area of 1,5 mm² when switches with rated current up to and including 10 A are being tested and 2,5 mm² when switches with rated current over 10 A up to and including 20 A are being tested.

Load A shall consist of:

- *a capacitor bank C₁, giving a capacitance 70 μ F $\pm$ 10 % for 6 A switches and 140 μ F $\pm$ 10 % for other switches. The capacitors shall be connected with 2,5 mm² conductors having the shortest possible length;*
- *an inductor, L₁, and a resistor, R₂, adjusted to give the power factor 0,9 $\pm$ 0,05 (lagging) and the test current I_n $^{+5}_{-0}$ % through the specimen.*

Load B shall consist of:

- *a capacitor, C₂, of 7,3 μ F $\pm$ 10 %;*
- *an inductor, L₂, of 0,5 H $\pm$ 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 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 rated current in the apparatus and with the connections specified in 18.1.

The tolerance of the test voltage is ± 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 18.1.

The number of operations is as follows:

For switches with a rated fluorescent lamp current of 6 A up to and including 10 A: 10 000 operations with 30 operations per minute.

For switches with rated current above 10 A up to and including 20 A: 5 000 operations with 15 operations per minute.

For rotary switches of pattern No. 5 intended to be operated in either directions, 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 directions, 3/4 of the total number of operations is 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 No. 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 of switches of pattern No. 4 and 5 are tested as two switches of pattern No. 1. If the poles are identical, only one pole need be tested.

Switches of pattern No. 6 shall be tested for half the number of operations on one pole and one half of the number of operations for the other pole.

Switches of pattern No. 6/2 are tested as one switch of pattern No. 6, if the two pairs of poles are identical. Otherwise, as two switches of pattern No. 6.

Switches of pattern No. 7 are tested as a double switch of pattern No. 6.

The test specimens shall be connected to the test circuit with cables of length $1 \text{ m} \pm 0,1 \text{ m}$ so that the temperature rise measurement can be made without disturbing the terminals. The load shall be as specified in figure 14, 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 diameter and 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 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.

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 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 the requirements of clause 10 are no longer complied with;
- loosening of electrical or mechanical connections;
- seepage of sealing compound;
- relative displacement of the moving contacts of switches of pattern Nos. 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

Switches, boxes and screwed glands of switches other than ordinary shall have adequate mechanical strength so as to withstand the stresses imposed during installation and use.

Compliance is checked by the following tests:

– for all types of switches	20.1
– for switches with a base intended to be mounted directly on a surface.....	20.2
– for boxes	20.1
– for screwed glands of switches that have an IP code higher than IP20.....	20.3

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.

20.1 The specimens are subjected to blows by means of an impact-test apparatus as shown in figures 15, 16, 17 and 18.

The striking element has a hemispherical face of 10 mm radius, made of polyamide having a Rockwell hardness of HR between 85 and 100, and a mass of 150 ± 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 $1\,000 \text{ mm} \pm 1 \text{ mm}$ 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 $12,700 \text{ mm} \pm 0,0025 \text{ mm}$, the initial load being $100 \text{ N} \pm 2 \text{ N}$ and the extra load $500 \text{ N} \pm 2,5 \text{ N}$.

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 $1,9 \text{ N}$ and $2,0 \text{ N}$ 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 $10 \text{ kg} \pm 1 \text{ kg}$ 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 bases and covers are tightened with a torque equal to two-thirds of the relevant value specified in table 3.

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 18.

Table 18 – Height of fall for impact test

Height of fall mm	Parts of enclosures to be subjected to the impact *	
	switches having an IP code IPX0	switches having an IP code higher than IPX0
100	A and B	–
150	C	A and B
200	D	C
250	–	D
* A parts on the front surface, including the parts which are recessed; 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; 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; 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, after the specimen has been turned 90° about its axis perpendicular to the plywood, one each on similar points;
- 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 standard. 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 under the conditions stated in 10.1;
- the standard unjointed test finger 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 standard 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.

20.2 The bases 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 base 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 are then fixed in a similar manner to a flat steel sheet.

During and after the tests the bases of the switch shall show no damage likely to impair their future use.

20.3 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 19 being applied to the spanner for 1 min.

Table 19 – Torque for the verification of the mechanical strength of glands

Diameter of test rod mm	Torque Nm	
	Metal glands	Glands of moulded material
Up to and including 14	6,25	3,75
Above 14 and up to 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 standard.

20.4 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 20.4.1 and 20.4.2.

20.4.1 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 20.7 and 20.8; 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 ± 0,1 mm thick, has been fitted around the supporting frame, as shown in figure 19.

NOTE The sheet of hard material is used to simulate wallpaper and may consist of a number of pieces.

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

20.4.2 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 mm ± 0,1 mm thick has been fitted around the supporting frame, as shown in figure 19.

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

20.5 *The test is made as described in 20.4, but applying, for 20.4.1, the following forces:*

- 10 N, for covers or cover plates or actuating members complying with the test of 20.7 and 20.8;
- 20 N, for other covers or cover plates, actuating members.

20.6 *The test is made as described in 20.4, but applying, for 20.4.1, the force of 10 N for all covers, cover plates, or actuating members.*

20.7 *The gauge shown in figure 20 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 21. The face B resting on the mounting/supporting surface, with the 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, the 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 the 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 20.8) when measurements are repeated starting from point X in the direction of the arrow Y (see figure 22).

20.8 *A gauge according to figure 23, 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 24.*

NOTE The verification whether the gauge according to figure 23 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.

20.9 *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 standard. The operating member shall not have broken and the cord-operated switch shall still operate.

21 Resistance to heat

Switches and boxes shall be sufficiently resistant to heat.

Compliance is checked:

- a) for surface mounting boxes, separable covers, separable cover plates and separable frames by the test of 21.3;
- b) for switches, with the exception of the parts, if any, covered by a), by the tests of 21.1, 21.2 and, with the exception for the switches made from natural or synthetic rubber or a mixture of both, by the test of 21.3.

21.1 The specimens are kept for 1 h in a heating cabinet at a temperature of $100\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

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 standard test finger 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 standard.

21.2 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 25, except the insulating parts necessary to retain the earthing terminals in a box shall be tested as specified in 21.3.

NOTE When it is not possible to carry out the test on the specimens, the test should be carried out on a piece at least 2 mm thick which is cut out of the specimen. If this is not possible, up to and including four layers, each cut out of the same specimen, may be used, in which case the total thickness of the layers should 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 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 $125\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

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.

21.3 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 21.2, but the test is made at a temperature of $70\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ or $40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ 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 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 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 of a switch.

NOTE 3 Screwed connections are considered as partially checked by the tests of clauses 19 and 20.

22.2 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 requirements 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 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, which serve as electrical as well as mechanical connections, shall be locked against loosening or turning.

Compliance is checked by inspection.

NOTE 1 Spring washers may provide satisfactory locking.

NOTE 2 For rivets, a non-circular shank or an appropriate notch may 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 Current-carrying parts, including those of terminals (also earthing terminals), shall be of a metal having, under the conditions occurring in the equipment, mechanical strength, electrical conductivity and resistance to corrosion adequate for their intended use.

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

Examples of suitable metals, when used within 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 % 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.
- 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.
- 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.

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 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 by chemical analysis.

22.7 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 Creepage distances, clearances and distances through sealing compound shall be not less than the values shown in table 20.

Table 20 – Creepage distances, clearances and distances through insulating sealing compound

Description	Mm
<i>Creepage distances</i>	
1 Between live parts which are separated when the contacts are open	3
2 Between live parts of different polarity	4 ^{1) 6)}
3 Between live parts and: - accessible surfaces of parts of insulating material; - earthed metal parts, including the earthing circuit; - metal frames supporting the base of flush-type switches; - screws or devices for fixing bases, covers or cover-plates; - metal parts of the mechanism, if required to be insulated from live parts (see 10.4)	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 bases, covers or cover-plates; - metal frames supporting the base of flush-type switches; - accessible metal parts	3
5 Between live parts and accessible unearthed metal parts, with the exception of screws and the like	6 ²⁾
<i>Clearances</i>	
6 Between live parts which are separated when the contacts are open	3 ^{3) 4)}
7 Between live parts of different polarity	3 ⁶⁾
8 Between live parts and: - accessible surfaces of insulating material; - earthed metal parts, including the earthing circuit, not mentioned under items 9 and 11; - metal frames supporting the base of flush-type switches; - screws or devices for fixing bases, covers, or cover-plates; - metal parts of the mechanism, if required to be insulated from live parts (see 10.4)	3
9 Between live parts and: - exclusively earthed metal boxes ⁵⁾ with the switch mounted in the most unfavourable position; - unearthed metal boxes, without insulating lining, with the switch mounted in the most unfavourable position	3 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 bases, covers or cover-plates; - metal frames supporting the base of flush-type switches; - accessible metal parts when the base is fixed directly on the wall	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
12 Between live parts and the bottom of the space, if any, for external conductors, for surface-type switches	3
13 Between live parts and accessible unearthed metal parts, with the exception of screws and the like	6 ²⁾
<i>Distances through insulating sealing compound</i>	
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 ¹⁾
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
1) This value is reduced to 3 mm for switches having a rated voltage up to and including 250 V. 2) This value is reduced to 4,5 mm for accessories having a rated voltage up to and including 250 V. 3) 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. 4) 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. 5) Exclusively earthed metal boxes are those suitable only for use in installations where earthing of metal boxes is required. 6) 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 with external resistor.	

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 1 of IEC 60529, 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 base 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 20 or the clearance mentioned under item 5 in table 20 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 5 The surface on which the base of a surface-type switch 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 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

The test is performed according to IEC 60695-2-1 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.*

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 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 diameter on any of the surfaces, are not subjected to the test of this subclause (see figure 26 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 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:

- *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 the interval between drops 30 s ± 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 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 °C ± 5 °C.

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

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

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 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.

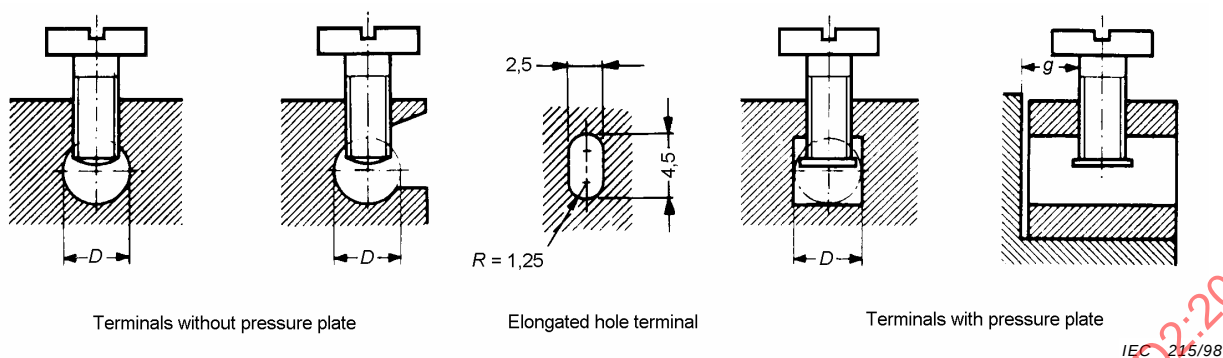
26 EMC requirements

26.1 Immunity

Switches within the scope of this standard 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

Cross- Section of conductor accepted by the terminal	Minimum diameter <i>D</i> (or minimum dimensions) of conductor space	Minimum distance <i>g</i> between clamping screw and end of conductor when fully inserted mm		Torque Nm					
				1*		3*		4*	
				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 (circular hole)	3,0	1,5	1,5	0,25	0,2	0,5	0,4	0,5	0,4
2,5 (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

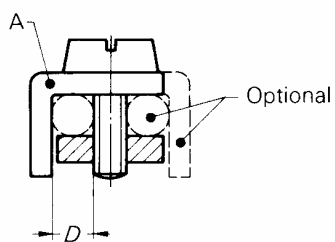
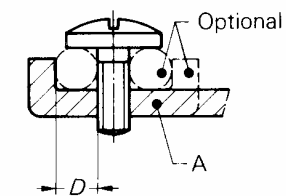
* The values specified apply to the screws covered by the corresponding columns in table 3.

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 mm² can be inscribed.

Figure 1 – Pillar terminals

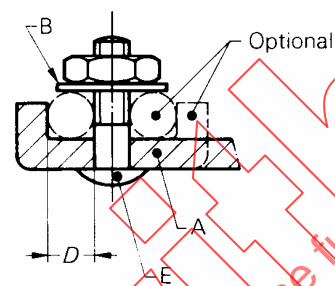
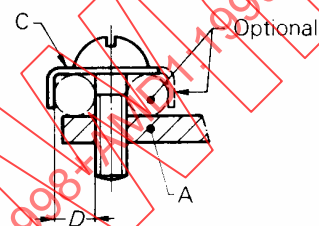
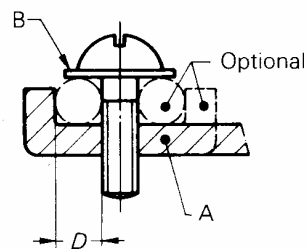
Screw not requiring washer, clamping plate or anti-spread device



Screw terminals

IEC 216/98

Screw requiring washer, clamping plate or anti-spread device



Stud terminals

IEC 217/98

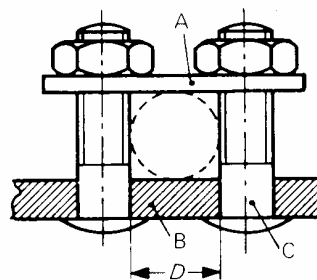
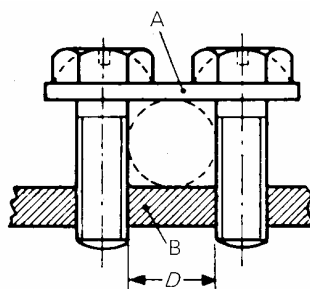
- A = Fixed part
- B = Washer or clamping plate
- C = Anti-spread device
- D = Conductor space
- E = Stud

Cross-sectional of conductor accepted by the terminal mm ²	Minimum diameter <i>D</i> of conductor space mm	Torque Nm			
		3*		4*	
		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
* The values specified apply to the screws covered by the corresponding columns in table 3.					

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 mm² may be used for the connection of the second conductor, when it is required to connect two 2,5 mm² conductors.

Figure 2 – Screw terminals and stud terminals



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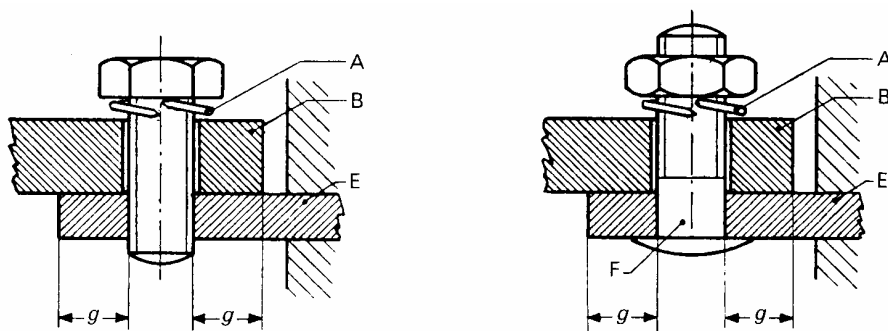
- A Saddle
- B Fixed part
- C Stud
- D Conductor space

Cross-section of conductor accepted by the terminal mm ²	Minimum diameter <i>D</i> of conductor space mm	Torque 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



IEC 817/93

- A Locking means
B Cable lug or bar
E Fixed part
F Stud

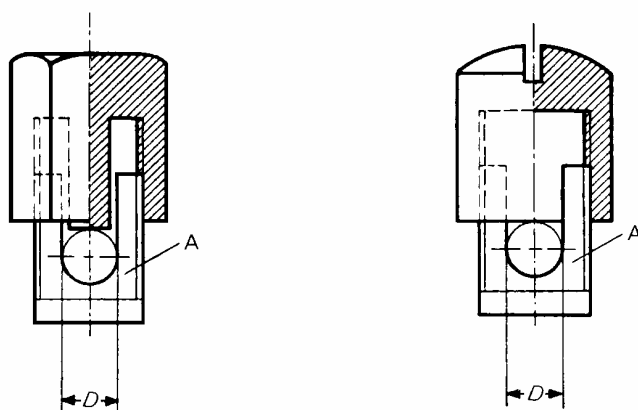
Cross-section of conductor accepted by the terminal mm ²	Minimum distance <i>g</i> between edge of hole and side of clamping area mm	Torque Nm	
		3*	4*
Up to 16	7,5	2,0	2,0
Up to 25	9,0	2,5	3,0

* The values specified apply to the screws covered by the corresponding columns in table 3.

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



IEC 81893

- A Fixed part
D Conductor space*

Cross-section of conductor accepted by the terminal mm ²	Minimum diameter <i>D</i> of conductor space* mm	Minimum distance between fixed part and end of conductor when fully inserted 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

* The bottom of the conductor space must 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 3, as appropriate.

Figure 5 – Mantle terminals