The prospective short-circuit current of the supply shall be between 3 kA and 4 kA at cos φ = 0,9 ± 0,05 (lagging).

F is a copper-wire fuse of 0,1 mm nominal diameter having a length not less than 50 mm.

R_1 is a resistor limiting the current to about 100 A.

The twin-core cable shall have a suitable length to give a resistance R_3 equal to 0,25 Ω in the test circuit to the load. It shall have a cross-sectional area of 1,5 mm^2 when switches with rated current up to and including 13 A are being tested and 2,5 mm^2 when switches with rated current over 13 A up to and including 20 A are being tested.

Load A shall consist of

- *C_1, a capacitor bank having a capacitance of 70 μF ± 10 % for 6 A switches and 140 μF ± 10 % for other switches. The capacitors shall be connected with 2,5 mm^2 conductors having the shortest possible length;*
- *L_1 and R_2, an inductor and a resistor adjusted to give the power factor of 0,9 ± 0,05 (lagging) and the test current $I_n {}^{+5}_{0}$ % through the specimen.*

NOTE The circuit parameters have been chosen to represent the externally ballasted lamp loads used in most practical applications.

For the test, new specimens are used.

The switches are tested at rated voltage and at the rated current assigned by the manufacturer for the externally ballasted lamp loads in the test apparatus and with the connections specified in 18.2.

The tolerance of the test voltage is ± 5 % and that for the test current is $^{+5}_{0}$ %. The circuit details and the manner of operation of the selector switch S are as described in 18.2.

The number of operations is as follows:

For switches with a rated externally ballasted lamp current of 6 A up to and including 13 A: 10 000 operations with 30 operations per minute.

For switches with rated current above 13 A up to and including 20 A: 5 000 operations with 15 operations per minute.

For rotary switches of pattern number 5 intended to be operated in either direction, the actuating member is turned in one direction for half the total number of operations and in the reverse direction for the remainder.

For other rotary switches intended to be operated in either direction, three quarters of the total number of operations are effected in the clockwise direction, and the remainder in the reverse direction.

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

Switches of pattern number 2 are tested with the poles connected in series.

The two circuits of switches of pattern number 5 are tested as two switches of pattern number 1. If the circuits are identical, only one circuit need be tested.

Switches of pattern numbers 4 and 6 shall be tested for half the number of operations on one way and half of the number of operations on the other way.

Switches of pattern number 6/2 are tested as one switch of pattern number 6, if the two pairs of poles are identical. Otherwise, they are tested as two switches of pattern number 6.

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

The test specimens shall be connected to the test circuit with cables of length (1 ± 0,1) m. The load shall be as specified in Figure 12a, load A.

The metal support of the switch, if any, on which the switch is mounted, and the accessible metal parts of the switch, if any, shall be earthed through a wire fuse which shall not blow during the test. The fuse element shall consist of a copper wire of 0,1 mm in diameter not less than 50 mm in length.

During this test, the switch shall be operated so that the test apparatus does not interfere with the normal action of the switch mechanism and the free movement of the actuating member.

There shall be no forced actuation. The "on" period shall be 25 $(^{+5}_{0})$ % of the total cycle and the "off" period 75 $(^{0}_{-5})$ %.

During the test, no sustained arcing nor welding of the contacts shall occur.

Sticking of the contacts which does not prevent further operation of the switch is not regarded as welding.

Sticking of contacts is permitted if the contacts can be separated with a force applied to the actuator of a value which does not damage the switch mechanically.

For the purpose of this test, blows which are intended to separate welded contacts are not permitted.

During the test, the specimens shall function correctly.

After the test, the specimens shall withstand an electric strength test as specified in Clause 16 and a terminal temperature rise test as specified in Clause 17.

For the electric strength test, the test voltage of 4 000 V shall be reduced by 1 000 V and the other test voltages by 500 V. For the terminal temperature rise test, the test current shall be reduced to the value of the rated current and the only measurement made shall be at the terminals.

After these tests, it shall also be possible to make and break the switch by hand in the test circuit and the specimen shall not show

– *wear impairing further use;*

– *discrepancy between the position of the actuating member and that of the moving contacts, if the position of the actuating member is indicated;*

– *deterioration of the enclosures, insulating lining or barriers to such an extent that the switch cannot be further operated or that it no longer complies with the requirements of Clause 10;*

– *loosening of electrical or mechanical connections;*

– *seepage of sealing compound;*

– *relative displacement of the moving contacts of switches of pattern numbers 2, 3 or 6/2.*

Breakage of the replaceable pull cord not involving the part entering the cord-operated switch shall not be considered a failure to pass the test.

19.3 Test for switches intended for self ballasted lamp loads

Switches intended for self ballasted lamp (SBL) loads shall withstand, without excessive wear or other harmful effect, the electrical and thermal stresses occurring when controlling self ballasted lamp circuits.

Compliance is checked by connecting the load as given in Figure 12b via the switch under test to a power supply.

The calculations are based on the following parameters in order to have the required values for inrush current and I^2t:

– *a prospective short-circuit current (rms) of the supply of 3 kA at cos φ = 0,9 (lagging);*

– *a resistance R_3 equal to 0,25 Ω in the test circuit to the load. This value is obtained with a wire having a cross-sectional area of 1,5 mm^2 when switches with rated current up to and including 13 A are being tested and 2,5 mm^2 when switches with rated current over 13 A up to and including 20 A are being tested.*

The load shall be in accordance with Figure 12b. The values for the maximum peak value and the maximum I^2t of the inrush current are given in Table 19.

NOTE 1 R_2 is the total series resistance in the lamp circuit including the ESR (equivalent series resistance) value of the capacitor.

The values of R_2 and C in load B shall be chosen in order to reach the values ($\pm$5 %) for I_{peak} and I^2t as given in Table 19 when the switching contact closes at 90° $\pm$ 5° phase-angle.

The value of R_4 shall be chosen to reach the current in amperes to reach the corresponding SBL power as given in Table 19.

〈C〉 **Table 19 – Values for I_{peak} and I^2t**

(A)	I_{peak} [A]	I^2t [A^2s]	Rated power of the SBL circuit [W]
Up to and including 10	108	2,8	100
Above 10 up to and including 13	142	5,5	150
Above 13 up to and including 16	170	9	200
Above 16 up to and including 20	192	13	250

〈C〉

Switches with a rated voltage of 250 V shall be considered as switches for a distribution system 230/400 V.

〈C〉 *Text deleted* 〈C〉

〈C〉 **Table 20 – Calculated circuit parameters**

Rated current (A)	230 V	
	R_2 [Ω]	C [µF]
Up to and including 10	1,9	125
Above 10 up to and including 13	1,25	180
Above 13 up to and including 16	0,95	240
Above 16 up to and including 20	0,8	310

〈C〉

For other rated voltages and currents the values need to be recalculated

The values in Table 20 are given for information only. The circuit shall be adjusted to reach the I_{peak} and I^2t values of Table 19.

Compliance is checked by the following test:

For the test, new specimens are used.

The switches are tested at rated voltage in the apparatus and with the connections specified in 18.2.

The tolerance of the test voltage is ±5 %.

The circuit details and the manner of operation of the selector switch S are as described in 18.2.

The number of operations is shown in Table 18.

The rate of operation is as specified in 18.2.

The on period shall be (25^{+5}_{0}) % of the total cycle and the off period (75^{0}_{-5}) %.

For rotary switches of pattern number 5 intended to be operated in either direction, the actuating member is turned in one direction for half the total number of operations and in the reverse direction for the remainder.

For other rotary switches intended to be operated in either direction, three quarters of the total number of operations are effected in the clockwise direction, and the remainder in the reverse direction.

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

Switches of pattern number 2 are tested with the poles connected in series.

The two circuits of switches of pattern number 5 are tested as two switches of pattern number 1. If the circuits are identical, only one circuit need be tested.

Switches of pattern numbers 4 and 6 shall be tested for half the number of operations on one way and half the number of operations on the other way.

Switches of pattern number 6/2 are tested as one switch of pattern number 6, if the two pairs of poles are identical. Otherwise, they are tested as two switches of pattern number 6.

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

The test specimens shall be connected to the test circuit with cables of length (1 ± 0,1) m.

The metal support of the switch, if any, on which the switch is mounted, and the accessible metal parts of the switch, if any, shall be earthed through a wire fuse (F) which shall not blow during the test. The fuse element shall consist of a copper wire of 0,1 mm diameter and not less than 50 mm in length. R_1 is a resistor limiting the current to about 100 A.

During this test, the switch shall be operated so that the test apparatus does not interfere with the normal action of the switch mechanism and the free movement of the actuating member.

There shall be no forced actuation.

No sustained arcing or welding of the contacts shall occur.

Sticking of the contacts which does not prevent the next operation of the switch is not regarded as welding.

Sticking of contacts is permitted if the contacts can be separated with a force applied to the actuator of a value which does not damage the switch mechanically.

For the purpose of this test, it is not permitted to apply blows to open welded contacts.

After the test, the specimens shall withstand an electric strength test as specified in Clause 16 and a terminal temperature rise test as specified in Clause 17.

For the electric strength test, the test voltage of 4 000 V shall be reduced by 1 000 V and the other test voltages by 500 V. For the terminal temperature rise test, the test current shall be reduced to the value of the rated current and the only measurement made shall be at the terminals.

After these tests, it shall also be possible to make and break the switch by hand in the test circuit and the specimen shall not show:

– *wear impairing further use;*
– *discrepancy between the position of the actuating member and that of the moving contacts, if the position of the actuating member is indicated;*
– *deterioration of the enclosures, insulating lining or barriers to such an extent that the switch cannot be further operated or that it no longer complies with the requirements of Clause 10;*
– *loosening of electrical or mechanical connections;*
– *seepage of sealing compound;*
– *relative displacement of the moving contacts of switches of pattern numbers 2, 3 or 6/2.*

Breakage of the replaceable pull cord not involving the part entering the cord-operated switch shall not be considered a failure to pass the test.

20 Mechanical strength

20.1 General

The test of the relevant subclauses 20.5 to 20.9 shall be applied according to the type of construction as specified in 13.3.

Accessories, surface mounting boxes, screwed glands and shrouds shall have adequate mechanical strength so as to withstand the stresses imposed during installation and use.

Compliance is checked by the following tests:

– *〖C〉 for all types of switches and their dedicated boxes, where applicable 〈C〗..... 20.2*
– *for switches with a base intended to be mounted directly on a surface. 20.3*

〖C〉 Text deleted 〈C〗

– *for screwed glands of switches that have an IP code higher than IP20 ..... 20.4*
– *for operating members of cord-operated switches..... 20.10*

Combinations of switches or of switches and socket-outlets are tested in the following way:

– *in the case of one common cover, as a single product;*
– *in the case of separate covers, as separate products.*

20.2 Pendulum hammer test

The specimens are checked by applying blows by means of the pendulum hammer test apparatus as described in IEC 60068-2-75 (test Eha), with an equivalent mass of 250 g.

The specimens are mounted on a sheet of plywood, 8 mm nominal thickness and approximately 175 mm square, secured at its top and bottom edges to a rigid bracket which is part of the mounting support.

The mounting support shall have a mass of (10 ± 1) kg and shall be mounted on a rigid frame by means of pivots. The frame is fixed to a solid wall.

The design of the mounting is such that

– *the specimen can be so placed that the point of impact lies in the vertical plane through the axis of the pivot;*
– *the specimen can be removed horizontally and turned about an axis perpendicular to the surface of the plywood;*
– *the plywood can be turned 60°, in both directions, about a vertical axis.*

The switches and boxes are mounted on the plywood as in normal use.

Inlet openings which are not provided with knock-outs, are left open; if they are provided with knock-outs, one of them is opened.

For flush-type switches the specimen is mounted in a recess provided in a block of hornbeam or similar material, which is fixed to a sheet of plywood, and not in its relevant mounting box. If wood is used for the block, the direction of the wood fibres shall be perpendicular to the direction of the impact.

Flush-type screw fixing switches shall be fixed by means of the screws to lugs recessed in the hornbeam block. Flush-type claw fixing switches shall be fixed to the block by means of the claws.

Before applying the blows, fixing screws of main parts and covers are tightened with a torque equal to two-thirds of the relevant value specified in column 3 or 5 as applicable, of Table 5.

The specimens are mounted so that the point of impact lies in a vertical plane through the axis of the pivot.

The striking element is allowed to fall from a height which is specified in Table 21.

Table 21 – Height of fall for impact test

Height of fall mm	**Parts of enclosures to be subjected to the impact[a]**	
	Switches having an IP code IPX0	**Switches having an IP code higher than IPX0**
80	A and B	–
120	C	A and B
160	D	C
200	–	D

[a] Parts of enclosures are defined as follows:

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.

The impact energy determined by the part of the specimen which projects most from the mounting surface is applied on all parts of the specimen, with the exception of its parts A.

Parts of accessories exclusively intended for mounting in panel-boards are submitted to impacts which are obtained by allowing the striking element to fall from the height of 100 mm; impacts shall only be applied on parts which are accessible after mounting the accessory in the panel board.

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

The specimens are subjected to nine blows, which are evenly distributed over the specimens. The blows are not applied to knock-out areas. The following blows are applied:

– *for parts A, five blows:*
  - *one blow in the centre, after the specimen has been moved horizontally;*
  - *one each on the unfavourable points between the centre and the edges; and then*
  - *one each on similar points after the specimen has been turned 90° about its axis perpendicular to the plywood;*
– *for parts B (as far as applicable), C and D, four blows:*
  - *two blows on each of the two sides of the specimen on which blows can be applied after the plywood sheet has been turned 60° in each of the opposite directions;*
  - *two blows on each of the other two sides of the specimen on which blows can be applied after the specimen has been turned 90° about its axis perpendicular to the plywood sheet and the plywood sheet has been turned 60° in each of the opposite directions.*

If inlet openings are provided, the specimen is so mounted that the two lines of blows are as nearly as possible equidistant from these openings.

Cover plates and other covers of multiple switches are treated as cover plates or covers of single switches.

For switches that have an IP code higher than IPX0 the test is carried out with any lids closed and the appropriate number of blows is then applied to those parts which are exposed when the lids are open.

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

After the test on a lens (window for pilot lights), the lens may be cracked and/or dislodged, but it shall not be possible to touch live parts with

– *the test probe B of IEC 61032 under the conditions stated in 10.1;*
– *the test probe 11 of IEC 61032 under the conditions stated in 10.1, but with a force of 10 N.*

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

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

Damage to the finish, small dents which do not reduce creepage distances or clearances below the value specified in 23.1 and small chips which do not adversely affect the protection against electric shock are neglected.

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

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

20.3 Test on the main parts of surface-type switches

The main parts of surface-type switches are first fixed to a cylinder of rigid steel sheet, which has a radius equal to 4,5 times the distance between fixing holes but in any case no less than 200 mm. The axes of the holes are in a plane perpendicular to the axis of the cylinder and parallel to the radius through the centre of the distance between the holes.

The fixing screws of the main part are gradually tightened, the maximum torque applied being 0,5 Nm for screws with a thread diameter up to and including 3 mm and 1,2 Nm for screws with a larger thread diameter.

The main parts are then fixed in a similar manner to a flat steel sheet.

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

20.4 Screwed glands

Screwed glands are fitted with a cylindrical metal rod having a diameter, in millimetres, equal to the nearest whole number below the internal diameter, in millimetres, of the packing.

The glands are then tightened by means of a suitable spanner, the torque shown in Table 22 being applied to the spanner for 1 min.

Table 22 – Torque for the verification of the mechanical strength of glands

Diameter of test rod mm	Torque Nm	
	Metal glands	Glands of moulded material
Up to and including 14	6,25	3,75
Above 14 and up to and including 20	7,5	5,0
Above 20	10,0	7,5

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

20.5 Covers, cover plates or actuating members – accessibility to live parts

20.5.1 General

When testing the force necessary for covers, cover plates or actuating members to come off or not come off, the switches are mounted as for normal use. Flush-type switches are fixed in appropriate mounting boxes, which are installed as for normal use so that the rims of the boxes are flush with the walls, and the covers, cover plates or actuating members are fitted. If they are provided with locking means which can be operated without the aid of a tool, these means are unlocked.

Compliance is then checked by the tests of 20.5.2 and 20.5.3.

20.5.2 Verification of the non-removal of covers, cover plates or actuating members

Forces are gradually applied in directions perpendicular to the mounting surfaces, in such a way that the resulting force acting on the centre of the covers, cover plates, actuating members or parts of them is

– *40 N, for covers, cover plates, actuating members or parts of them complying with the tests of 20.8 and 20.9; or*

– *80 N, for other covers, cover plates, actuating members or parts of them.*

The force is applied for 1 min. The covers, cover plates, or actuating members shall not come off.

The test is then repeated on new specimens, the cover or cover plate being fitted on the wall after a sheet of hard material, 1 mm ± 0,1 mm thick, has been fitted around the supporting frame, as shown in Figure 13.

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

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

20.5.3 Verification of the removal of covers, cover plates or actuating members

A force not exceeding 120 N is gradually applied, in directions perpendicular to the mounting/supporting surfaces, to covers, cover plates, actuating members or parts of them by means of a hook placed in turn in each of the grooves, holes, spaces or the like provided for removing them.

The covers, cover plates or actuating members shall come off.

The test is made 10 times on each separable part the fixing of which is not dependent on screws (the application points being equally distributed as far as practicable). The removal force is applied each time to the different grooves, holes or the like provided for removing the separable part.

The test is then repeated on new specimens, the cover, cover plate, or actuating member being fitted on the wall after a sheet of hard material, (1 ± 0,1) mm thick has been fitted around the supporting frame, as shown in Figure 13.

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

20.6 Covers, cover plates or actuating members – accessibility to non-earthed metal parts separated from live parts

The test is made as described in 20.5, but applying, for 20.5.2, the following forces:

– *10 N, for covers or cover plates or actuating members complying with the tests of 20.8 and 20.9;*

– *20 N, for other covers or cover plates or actuating members.*

20.7 Covers, cover plates or actuating members – accessibility to insulating parts, earthed metal parts, the live parts of SELV ≤ 25 V AC ⟦AC1⟩ and 60 V DC ⟨AC1⟧ or metal parts separated from live parts

The test is made as described in 20.5, but applying, for 20.5.2, the force of 10 N for all covers, cover plates, or actuating members.

20.8 Covers, cover plates or actuating members – application of gauges

The gauge shown in Figure 14 is pushed toward each side of each cover, cover plate or actuating member which is fixed without screws on a mounting or supporting surface, as shown in Figure 15. With face B resting on the mounting/supporting surface, and face A perpendicular to it, the gauge is applied at right angles to each side under test.

In the case of a cover or cover plate fixed without screws to another cover or cover plate or to a mounting box, having the same outline dimensions, face B of the gauge shall be placed at the same level as the junction; the outline at the cover or cover plate shall not exceed the outline of the supporting surface.

The distances between face C of the gauge and the outline of the side under test, measured parallel to face B, shall not decrease (with the exception of grooves, holes, reverse tapers or the like, placed less than 7 mm from a plane including face B and complying with the test of 20.9) when measurements are repeated starting from point x in the direction of the arrow y (see Figure 16).

20.9 Grooves, holes and reverse tapers

A gauge according to Figure 17, applied with a force of 1 N, shall not enter more than 1,0 mm from the upper part of any groove, hole or reverse taper or the like when the gauge is applied parallel to the mounting/supporting surface and at right angles to the part under test, as shown in Figure 18.

NOTE The verification whether the gauge according to Figure 17 has entered more than 1,0 mm is made with reference to a surface perpendicular to face B and including the upper part of the outline of the grooves, holes, reverse tapers or the like.

20.10 Additional test for cord-operated switch

The operating member of a cord-operated switch shall have adequate strength.

Compliance is checked on a new specimen by the following test:

The switch is mounted on a support as in normal use.

A pull of 100 N is applied for 1 min on the operating member as in normal use, after which a pull of 50 N is applied for 1 min in the most unfavourable direction within a conical surface with the centre being the operating cord and the angle not exceeding 80° to the vertical.

After the test the switch shall show no damage within the meaning of this document. The operating member shall not have broken and the cord-operated switch shall still operate.

21 Resistance to heat

21.1 General

Switches and boxes shall be sufficiently resistant to heat.

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

Compliance is checked

a) for surface mounting boxes, separable covers, separable cover plates and separable frames by the test of 21.4;