12.1.4 Full disconnection or micro-disconnection can only be achieved using a series mechanical contact (without a parallel path or a parallel path evaluated using the impulse withstand test).

12.1.5 Electronic disconnection is formed by any parallel components or path across a series contact, or when no mechanical contact is provided in the switch.

12.2 Constructional requirements relating to safety during mounting and normal operation of the switch

12.2.1 Covers, cover plates, removable actuators and the like providing safety shall be fixed in such a way that they cannot be displaced or removed except by use of a tool. The fixings for a cover or cover plate shall not serve to fix any other part except an actuating member.

It shall not be possible to mount removable parts, for example cover plates bearing indicators or knobs, such that indication of switch positions does not correspond with the actual switch position.

12.2.2 Fixing screws of covers or cover plates shall be captive.

The use of tight-fitting washers of cardboard or similar material is deemed to be adequate for this purpose.

12.2.3 A switch shall not be damaged when its actuating member is removed as intended.

Compliance with the requirements of 12.2.1, 12.2.2 and 12.2.3 is checked by inspection after removing the actuating member and, by the tests of 18.3 and 18.4.

12.2.4 A pull-cord shall be insulated from live parts and designed such that it shall be possible to fit or to replace it without removing parts causing live parts to become accessible.

Compliance is checked by inspection.

12.2.5 If an illuminated indicator is incorporated in a switch, it shall provide the correct indication as declared by the manufacturer.

Compliance is checked by connecting the switch to a voltage not deviating by more than ± 10 % of the marked voltage for the lamp circuit or rating of the switch, whichever is applicable.

12.3 Constructional requirements relating to the mounting of switches and to the attachment of cords

12.3.1 Switches shall be designed so that the methods of mounting in accordance with the manufacturer's declarations do not adversely affect compliance with this standard.

These methods of mounting shall be such that the switch cannot rotate, or be otherwise displaced, and cannot be removed from an appliance without the aid of a tool. If the removal of a part, such as a key, is necessary during the normal use of the switch, then the requirements of Clauses 9, 15 and 20 shall be satisfied before and after such removal.

Compliance is checked by inspection and by manual test.

a) Switches fixed by a nut and a single bush concentric with the actuating means are deemed to comply with this requirement, provided that the tightening and/or loosening of the nut requires the use of a tool, and that the parts have adequate mechanical strength.

b) An incorporated switch mounted by screwless fixing is deemed to comply with this requirement if the use of a tool is required before the switch can be removed from the appliance.

12.3.2 A conductor intended to be disconnected, shall indicate an obvious method for insertion and disconnection of the conductors. The intended disconnection of a conductor shall require an operation, other than a pull at the conductor.

12.3.3 Openings for the use of a tool intended to assist the insertion or disconnection shall be clearly distinguishable from the opening for the conductor.

13 Mechanism

Switches with series contacts shall comply with the following:

13.1 For DC switches with a voltage rating above 28 V dc in combination with a current rating above 0,1 A the speed of contact making and breaking shall be sufficiently independent of the speed of actuation.

Compliance is checked during the test TC10 according to Clause 17 of IEC 61058-1-1:2016 or IEC 61058-1-2:2016.

13.2 A switch with an intermediate position shall not create an unintended operation.

Compliance with the requirement is checked by the test in 15.3. With the actuator in the intermediate position, apply the withstand test voltage in Table 8 for declared type of disconnection in 7.14 between the adjacent terminals associated with the disconnection.

13.3 When the actuating member is released, it shall take up automatically or stay in the position corresponding to that of the moving contacts, except that, for switches which have only one rest position, the actuating member may take up its normal rest position.

Compliance with the requirements of 13.3 is checked by manual test, the switch being mounted according to the manufacturer's declarations and the actuating member being actuated as in normal use.

If necessary, the adequacy of the separation of the contacts in an intermediate position is determined by a dielectric strength test in accordance with 15.3, the test voltage being applied between the relevant terminals, without removing any cover.

13.4 A cord-operated switch (pull cord) shall be constructed so that, after actuating the switch and releasing the cord, the relevant parts of the mechanism are in a position from which they allow the immediate performance of the next movement in the cycle of actuation.

Compliance is checked by inspection and by the following test.

Cord-operated switches shall be actuated from any one position, to the next position, by the application and removal of a steady pull not exceeding 45 N vertically downwards, or 70 N at 45° to the vertical, with the switch mounted as declared.

13.5 Multi-pole switches shall make and break all related poles substantially together unless otherwise declared according to Table 3 ″Operating sequence″. For switches with switched neutral, the neutral may make before and break after the others.

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

14 Protection Against Ingress of Solid Foreign Objects, Ingress of Water and Humid Conditions

14.1 Protection against ingress of solid foreign objects

Switches shall provide the declared degree of protection as in 13.3 of IEC 60529:1989, against solid foreign objects when mounted and used as declared.

Compliance is checked by the appropriate test specified in IEC 60529.

Detachable parts are removed. A switch which relies on mounting in, or on, an appliance for the declared degree of protection against solid foreign objects shall be suitably mounted in, or on, a closed box to simulate the appliance, and the tests shall be performed using this simulated assembly.

For numerals 5 and 6, the test is carried out according to category 2 with the specimen in the most unfavourable position considering the manufacturer's declarations continued for a period of 8 h. During the 8 h period, the specimen under test shall be alternatively loaded for 1 h with the maximum rated current and 1 h without current.

For the test for first characteristic numeral 5, the switch is deemed to comply if

– all actions function as declared;

– the temperature rise at the terminals does not exceed 55 K when tested in accordance with Clause 16, with the exception that the temperature-rise test at the terminals is carried out at rated current and at an ambient temperature of 25 °C ± 10 °C;

– the dielectric strength requirement of 15.3 applies with the exception that the specimens are not subjected to the humidity treatment before the application of the test voltage. The test voltage shall be 75 % of the corresponding test voltage specified in 15.3;

– there is no evidence that transient fault between live parts and earth metal, accessible metal parts, or actuating members has occurred.

For the test for first characteristic numeral 6, the protection is satisfactory if no deposit of dust is observable inside the switch at the end of the test.

14.2 Protection against ingress of water

Switches shall provide the declared degree of protection against ingress of water when mounted and used as declared.

Compliance is checked by the appropriate tests specified in IEC 60529 with the switch placed in any position of normal use. Switches are allowed to stand at 25 °C ± 10 °C for 24 h before being subjected to the following test.

The test is then carried out according to IEC 60529 as follows:

– IPX1 switches as described in 14.2.1 with the drain holes open;

– IPX2 switches as described in 14.2.2 with the drain holes open;

– IPX3 switches as described in 14.2.3 with the drain holes closed;

– IPX4 switches as described in 14.2.4 with the drain holes closed;

– IPX5 switches as described in 14.2.5 with the drain holes closed;

– IPX6 switches as described in 14.2.6 with the drain holes closed;

– IPX7 switches as described in 14.2.7 with the drain holes closed;

– IPX8 switches as described in 14.2.8 with the drain holes closed;

– IPX9 switches as described in 14.2.9 with the drain holes closed.

Immediately after the appropriate test, the switch shall withstand the dielectric strength test specified in 15.3, and inspection shall show that there is no trace of water on insulation which could result in a reduction of creepage and clearance below the values specified in Clause 20.

a) The switch shall not be electrically loaded during these tests. The water temperature shall not differ from that of the switch by more than 5 K.

b) Detachable parts are removed.

c) Switches incorporating separate gaskets, screwed glands, membranes or other sealing means, manufactured from rubber or thermoplastic materials are aged in a heating cabinet with an atmosphere having the composition and pressure of the ambient air and ventilated by natural circulation.

d) Switches declared 7.3.1 are kept in the cabinet at a temperature of 70 °C ± 2 °C, and switches declared 7.3.2 and 7.3.3 are kept in the cabinet at a temperature of T + 30 °C for 240 h. If the switch is declared according to 7.3.3, the "T" equals the lower of the two values following the letter T in 8.4.2. Switches with glands or membranes are fitted and connected with conductors as specified in Clause 11. Glands are tightened with a torque as specified in Table 11. Fixing screws for enclosures are tightened with a torque as specified in Table 10.

e) Immediately after ageing, the parts are taken out of the cabinet and left at 25 °C ± 10 °C, avoiding direct daylight, for at least 16 h.

f) A switch which relies on mounting in, or on, an appliance for the declared degree of protection against harmful ingress of water shall be suitably mounted in, or on, a closed box to simulate the appliance, and the tests shall be performed using this simulated assembly.

g) For the tests of second characteristic numerals 3 and 4, preferably the hand-held spray nozzle specified in IEC 60529 shall be used.

14.3 Protection against humid conditions

All switches shall be protected against humid conditions which may occur in normal use.

Compliance is checked by the humidity treatment described in this subclause, followed immediately by the tests of 15.2 and 15.3. Cable inlet openings, if any, and drain-holes are left open. If a drain-hole is provided for a water-tight switch, it is opened.

a) Before being placed in the humidity cabinet, the specimens are brought to a temperature between t and t + 4 °C (where t is the steady state temperature of the humidity chamber).

b) Detachable parts are removed and subjected, if necessary, to the humidity treatment with the main part.

c) The humidity treatment is carried out in a humidity cabinet containing air maintained within ±5 °C of any convenient value (t) between 20 °C and 30 °C, with a relative humidity above 91 %. The specimens are kept in the cabinet for a minimum of 96 h.

d) After removing the specimens from the cabinet, the testing of 15.2 and 15.3 shall be completed within 2 h under ambient conditions.

The switch shall not show any damage such as to impair compliance with this standard.

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.

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

15 Insulation Resistance and Dielectric Strength

15.1 General requirements

The insulation resistance and the dielectric strength of switches shall be adequate.

Compliance is checked by the tests of 15.2 and 15.3, these tests being made immediately after the test of 14.3.

The test voltage according to Table 8 is applied in the case of:

– Functional insulation: between the different poles of a switch. For the purpose of the test, all the parts of each pole are connected together;

– Basic insulation: between all live parts connected together and a metal foil covering the outer accessible surface of the basic insulation and accessible metal parts in contact with the basic insulation;

– Double insulation: between all live parts connected together and a metal foil covering the outer, normally not accessible surface of basic insulation and non-accessible metal parts; and following this: between two metal foils covering separately the inner, normally not accessible surface of supplementary insulation and connected to non-accessible metal parts, and the outer, accessible surface of supplementary insulation and connected to accessible metal parts;

– Reinforced insulation: between all live parts connected together and a metal foil covering the outer accessible surface of reinforced insulation and accessible metal parts.

– Contacts: between the open contacts of each pole of a switch.

The foils are not pressed into openings but are pushed into corners and the like by means of the jointed test finger (test probe B according to IEC 61032).

In cases where basic insulation and supplementary insulation cannot be tested separately, the insulation provided is subjected to the test voltages specified for reinforced insulation.

The tests are not carried out across protective impedances and poles interconnected by components.

15.2 Measurement of insulation resistance

The insulation resistance is measured with a DC voltage of approximately 500 V applied, the measurement being made 60 s after application of the voltage.

The insulation resistance shall not be less than specified in Table 7.

NOTE Materials such as ceramic or porcelain are considered to have adequate insulation resistance and are not subjected to the insulation resistance tests.

Table 7 – Minimum insulation resistance

Insulation to be tested	Insulation resistance
	MΩ
Functional	2
Basic	2
Supplementary	5
Reinforced	7

15.3 Insulation test voltage

The insulation is subjected to a voltage of substantially sine-wave form, having a frequency of 50 Hz or 60 Hz. The test voltage shall be raised uniformly from a value not greater than the rated voltage to the value specified in Table 8 within not more than 5 s and held at that value for 60 s.

No flashover or breakdown shall occur. Glow discharges without drop in voltage are neglected.

Table 8 – Dielectric strength

Insulation or disconnection to be tested[2)]	Test voltage (r.m.s.)[1)]			
	rated voltage up to and including 50 V	rated voltage above 50 V up to and including 130 V	rated voltage above 130 V up to and including 250 V	rated voltage above 250 V up to and including 480 V
	V	V	V	V
Functional insulation[3)]	500	1 300	1 500	1 500
Basic insulation[4)]	500	1 300	1 500	1 500
Supplementary insulation[4)]	–	1 300	1 500	1 500
Reinforced insulation[4)] [5)]	500	2 600	3 000	3 000
Across electronic disconnection	100	400	500	700
Across micro-disconnection	100	400	500	700
Across full disconnection	500	1 300	1 500	1 500

NOTE 1 Up to 50 V: Not intended to be connected direct to the mains and not expected to be subjected to temporary overvoltages as defined in IEC 61140.

NOTE 2 Over 50 V: The values are based on IEC 61140.

– For functional, basic and supplementary insulation, and for full disconnection, the values are calculated with the formula: U_N + 1 200 V and rounded.

– For micro and electronic disconnection, the values are calculated with the formula: U_N + 250 V and rounded.

[1)] The overcurrent relay shall not trip when the output current is less than 100 mA. Care is taken that the r.m.s. value of the test voltage is measured within ±3 %.

[2)] Special components which might render the test impractical such as discharge lamps, coils, windings, or capacitors are disconnected at one pole, or bridged, as appropriate to the insulation being tested. Where this is not practical on the specimens to be used for the test of Clauses 16 and 17 in IEC 61058-1-1:2016 or IEC 61058-1-2:2016, the test of 15.3 shall be carried out on additional specimens. These may be special specimens with the appropriate components omitted.

[3)] An example is the insulation between poles (see definition 3.1.4).

[4)] For the test of basic, SUPPLEMENTARY and REINFORCED INSULATION, all LIVE PARTS are connected together and care is taken to ensure that all moving parts are in the most onerous position.

[5)] For SWITCHES incorporating REINFORCED INSULATION as well as DOUBLE INSULATION, care is taken that the voltage applied to the REINFORCED INSULATION does not overstress the basic or the supplementary parts of the DOUBLE INSULATION.

16 Heating

16.1 General requirements

Switches shall be constructed so that they do not attain excessive temperatures in normal use. The materials used shall be such that the performance of the switches is not adversely affected by operation in normal use at the rated temperature of the switch.

The procedure to conduct the compliance test is described in 16.4.

16.2 Contacts and terminals

The material and design of the contacts and terminals shall be such that the operation and performance of the switch is not adversely affected by their oxidation or other deterioration.

Compliance is checked by Clause 17.

16.3 Other parts

16.3.1 Switch parts other than the contacts and terminals, in normal use, shall not attain temperatures which impair the performance or operation of the switch or create a hazard to the user.

Compliance is checked by Clauses 17 and 21.

16.3.2 Insulation for conductors provided with the switch shall be rated not less than the relevant maximum temperature rating of the switch.

Compliance is checked/verified on data provided by switch manufacturer.

16.4 Heating test

Unless declared otherwise, the test is carried out on 3 specimens mounted as declared by the manufacturer.

a) Conductors of an approximate length of 1 m, are fitted to the terminals or leads. The cross-sectional area shall be as declared or specified in Table 4 "medium".

NOTE In case of doubt, the cross-sectional area of the conductor is measured to verify that the marked value is the measured value declared or given in Table 4.

b) Connected conductors when provided are joined to conductors in item a) per the manufacturer's instructions.

c) Screw terminals and/or nuts are tightened with a torque equal to two-thirds (2/3) of the appropriate column of Table 10 (see Figures 2 and 6).

d) Heating cabinets for testing switches shall be without forced convection or a draught free condition. A cabinet with forced convection may be used, provided the test specimens are not affected by the forced convection.

e) The temperature of the air in the heating cabinet is measured as near as possible to the center of the space occupied by the specimens and at a distance not closer than 50 mm to the specimen.

f) Switches declared as 7.3.2 or 7.3.3, are placed in a heating cabinet and the temperature is raised to the maximum T-rating of the switch. The temperature of the cabinet is maintained at T ± 5 °C or T ± 5 % (T ± 0,05 T), whichever is greater.

g) Partially suitable rated switches declared as 7.3.3, with accessible parts (after the switch is mounted as declared) rated 0 to 55 °C, shall be exposed to a temperature not higher than 55 °C. The internal switch enclosure with a T rating is tested as described for "all parts".

h) The temperature of mounting surfaces of the test equipment shall be between T and 20 °C.

i) The specimens are subjected to 20 operating cycles with no current flowing. The actuating member is left in the most unfavourable "ON" position. If there are more "ON" positions, then the verification shall be realized at the most unfavourable one. Actuating members of biased switches are fixed in the declared "ON" position.

j) Multi-way switches are loaded as specified in 5.3 resulting in the maximum heating.

k) Switches designed for DC only or AC and DC voltage where no polarity is given, the test performed with DC voltage shall be performed in both polarities and an average value calculated.

l) During the test, the switch state shall not change. Fuses and other protective devices shall not operate. Small unintended variations of the switch state, for example reversible variation of phase angle, are disregarded.

m) Any convenient AC or DC voltage may be used for the test circuit as far as the result is not affected.

n) The load is adjusted to allow the maximum rated current. Resistive loads are used unless declared specifically.

o) If the switch is provided with components generating heat in addition to the heat generated by the contacts, these have to be operated in the most unfavourable mode (e.g. semiconducting devices)

p) The ON period is maintained with the test current until a constant temperature at the terminals is attained. A temperature is considered to be constant when three successive readings taken at intervals of 5 min indicate no change greater than ± 2 °C. For a cycling load, after 1 h, the maximum temperature of the cycle is measured.

q) Thermocouples shall measure the temperature of the surfaces of the switch indicated below. Temperatures shall be determined by means of fine wire thermocouples or other equivalent means, so chosen and positioned that they do have the minimum effect on the temperature of the part under test.

During the test, the temperatures necessary to perform the ball pressure test of 21.1 are to be measured. The non-metallic surfaces likely to attain the highest temperature are measured without disassembling the switch.

17 Endurance

Reference IEC 61058-1-1 for mechanical switch testing.

Reference IEC 61058-1-2 for electronic switch testing.

NOTE Refer to Figure 16.

18 Mechanical Strength

18.1 General requirements

Accessible parts shall have adequate mechanical strength to withstand a minimum level of force during normal use.

The specimen may be used for more than 1 test, if cumulative stress as a result of sequential testing is avoided. When a specimen is damaged a new specimen shall be used for the next test.

18.2 Impact

Switches rated equal to or above 0 °C are tested at 25 °C ± 10 °C.

Switches rated below 0 °C are cooled to the minimum rated temperature T + 0/-5 °C for 2 h prior to testing.

The impact is delivered using the spring hammer test apparatus of IEC 60068-2-75. The impact is equal to 0,5 Nm ± 0,04 Nm, for foot operated switches the impact is equal to 1,0 Nm ± 0,05 Nm.

One specimen is mounted in the test plate of Figure 11. Remove the mounting device and specimen from the cold cabinet, when required. Immediately apply 3 blows, in a direction perpendicular to the switch.

Compliance is checked by inspection and in case of doubt by Clause 9.

18.3 Pull

18.3.1 Cord-operated switches are submitted to an additional pull test as follows.

The switch is mounted as declared by the manufacturer, and the pull-cord is subjected to a force, applied without jerks, first for 60 s in the normal direction, and then for 60 s in a direction 45° maximum from the normal direction. The minimum values of the pull force shall be as specified in Table 9 or three times the values of the normal operating force if that is greater.

Table 9 – Minimum values of pull force

Rated current	Force N	
A	Normal direction	45° from normal direction
Up to and including 4	50	25
Over 4	100	50

The sample shall not be damaged in a way that reduces the electrical safety.

Compliance is checked by inspection.

18.3.2 Pull (switches other than cord operated switches).

One specimen is used for testing, only parts accessible after mounting are tested. Testing is completed at 25 °C ± 10 °C.

A pull force shall be applied for 60 s to try to pull off the actuating member.

The pull to be applied is 15 N, but if the actuating member is intended to be pulled in normal use, the force is increased to 30 N.

The sample shall not be damaged in a way that reduces the electrical safety.

Compliance is checked by inspection.

18.4 Push

A push force of 30 N, using a switch not subjected to the pull force, shall be applied for 60 s to try to push the actuating members in.

The sample shall not be damaged in a way that reduces the electrical safety.

Compliance is checked by inspection.

19 Screws, Current-Carrying Parts and Connections

19.1 General requirements for electrical connections

Electrical connections shall be designed so 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 visual evidence of sufficient resiliency in the metallic parts to compensate for any possible shrinkage or distortion of the insulating material.

The suitability of the material is considered in respect to the stability of the dimensions within the temperature range applicable to the switch.

This requirement is not applicable to connections internal to a switch where the connection is used for lamps for indicating purposes and where the current in this circuit is equal or below 20 mA.

Compliance is checked by inspection.