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 Figure 2 and Figure 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.

19.2 Screwed connections

19.2.1 Screwed connections, not tested in Clause 11, electrical or other, shall withstand the mechanical stresses occurring in normal use.

19.2.2 Screws transmitting contact pressure shall be in engagement with a metal thread. Such screws shall not be of metal which is soft or liable to creep, such as zinc or aluminium.

19.2.3 Mechanical connections to be used during installation of switches may be made using thread-forming tapping screws or thread-cutting tapping screws, only if the screws are supplied together with the piece in which they are intended to be inserted. In addition, thread-cutting tapping screws intended to be used during installation shall be captive with the relevant part of the switch.

19.2.4 Thread-forming (metal sheet) screws shall not be used for the connection of current-carrying parts, unless they clamp these parts directly in contact with each other and are provided with a suitable means of locking. Thread-cutting (self-tapping) screws shall not be used for the electrical connection of current-carrying parts, unless they generate a full metric ISO thread or a thread of equivalent effectiveness. Such screws shall not, however, be used if they are likely to be operated by the user or installer, unless the thread is formed by a swaging action.

Compliance is checked by inspection.

For screws and nuts which are likely to be operated while the switches are being mounted and connected, compliance is checked by the following test.

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.

Nuts concentric with the button or lever are tightened and loosened five times. If either thread is of insulating material, the torque is 0,8 Nm. If the threads are of metal, the torque is 1,8 Nm.

Screws and nuts are tightened and loosened by means of a suitable test screwdriver or spanner. The torque applied when tightening being equal to that specified in the appropriate column of Table 10, if not otherwise specified.

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

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

Column II applies to nuts of mantle terminals with cap nuts which are tightened by means of a screwdriver.

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

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

Column V applies to nuts of mantle terminals which are tightened by means other than a screwdriver.

Where a screw has a hexagonal head with a slot and the values in columns III and IV are different, the test is made twice, first applying to the hexagonal head the torque specified in column IV, and then, on another set of specimens, applying the torque specified in column III by means of a screwdriver. If the values in columns III and IV are the same, only the test with the screwdriver is made.

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

For mantle terminals, the specified nominal diameter is that of the slotted stud (see Figure 5).

The shape of the blade of the test screwdriver shall suit the head of the screw to be tested. The screws and nuts shall not be tightened in jerks.

NOTE Screws or nuts which are likely to be operated while the switches are being mounted and connected include terminal screws or nuts, screws for fixing covers, etc.

Table 10
Torque values

Nominal diameter of thread		Torque				
mm		Nm				
Over	Up to and including	I	II	III	IV	V
–	1,6	0,05	–	0,1	0,1	–
1,6	2,0	0,10	–	0,2	0,2	–
2,0	2,8	0,2	–	0,4	0,4	–
2,8	3,0	0,25	–	0,5	0,5	–
3,0	3,2	0,3	–	0,6	0,6	–
3,2	3,6	0,4	–	0,8	0,8	–
3,6	4,1	0,7	1,2	1,2	1,2	1,2
4,1	4,7	0,8	1,2	1,8	1,8	1,8
4,7	5,3	0,8	1,4	2,0	2,0	2,0
5,3	6	–	1,8	2,5	3,0	3,0
6	8	–	2,5	3,5	6,0	4,0
8	10	–	3,5	4,0	10,0	6,0
10	12	–	4,0	–	–	8,0
12	15	–	5,0	–	–	10,0

19.2.5 Switches having screwed glands are submitted to the following test.

Screwed glands are fitted with a cylindrical metal rod having a diameter equal to the nearest integer value less than the internal diameter of the packing, in millimetres. The glands are then tightened by means of a suitable spanner, the torque specified in Table 11 being applied to the spanner for 60 s.

Table 11
Torque values for screwed glands

Diameter of the test rod mm		Torque Nm	
Over	Up to and including	Metal glands	Glands of insulating material
–	14	6,25	3,75
14	20	7,5	5,0
20	–	10,0	7,5

After the test neither the glands nor the enclosure of the specimen shall show any damage within the meaning of this standard.

19.2.6 Correct introduction of the screws which are operated during mounting or connection of the switch into the screw holes or nuts shall be ensured.

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

Compliance is checked by inspection and by manual test.

19.2.7 Screws which make a mechanical connection between different parts of the switch shall be locked against loosening if the connection carries current. Rivets used for current-carrying connections shall be secured against loosening if these connections are subject to torsion in normal use.

Compliance is checked by inspection and by manual test.

Spring washers may provide adequate locking. For rivets, a non-circular shank or an appropriate notch may be sufficient.

Sealing compound which softens in heat provides adequate locking only for screw connections not being subject to torsion in normal use.

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

Compliance is checked by inspection and by the tests of 19.2.

19.3 Current-carrying parts

Current-carrying parts and parts in an earthing path shall have adequate mechanical strength and resistance to corrosion.

Compliance is checked by inspection, in case of doubt, compliance is checked by the testing of Clause 22.

20 Clearances, Creepage Distances, Solid Insulation and Coatings of Rigid Printed Board Assemblies

20.1 General requirements

Switches shall be constructed so that the clearances, creepage distances, solid insulation and coatings of rigid printed board assemblies are adequate to withstand the electrical, mechanical and thermal stresses taking into account the environmental influences that may occur during the anticipated life of the switch. Creepage distances and clearances are measured as shown in Annex A.

Clearances, creepage distances, solid insulation and coatings of rigid printed board assemblies shall comply with the relevant subclauses 20.2 to 20.6.

NOTE The requirements and tests are based on IEC 60664-1 and IEC 60664-3.

Compliance is checked with detachable parts removed and movable parts which can be assembled in different orientations placed in the most unfavourable position.

Distances through slots or openings in surfaces of insulating material are measured to a metal foil in contact with the surface. The foil is pushed into comers and the like by means of the jointed test finger of IEC 61032 Probe B (IEC 60529:1989, Figure 1), but is not pressed into openings.

A force is applied to bare conductors and accessible surfaces in order to attempt to reduce clearances and creepage when making the measurement.

The force is:

– 2 N for bare conductors;