9.2.5 *Splash-proof luminaires (second characteristic IP numeral 4) are sprayed from every direction with water for 10 min by means of the spray apparatus shown in figure 7 and described in 9.2.4. The luminaire shall be mounted under the pivot line of the tube so that the ends of the luminaire receive adequate coverage from the jets.*

The tube shall be caused to oscillate through an angle of almost 360°, 180° on either side of the vertical, the time for one complete oscillation (2 × 360°) being about 12 s. The luminaire shall be turned about its vertical axis during the test at a rate of 1 rev/min.

The support for the equipment under test shall be grid shaped in order to avoid acting as a baffle. After this 10 min period, the luminaire shall be switched off and allowed to cool naturally whilst the water spray is continued for a further 10 min.

9.2.6 *Jet-proof luminaires (second characteristic IP numeral 5) are switched off and immediately subjected to a water jet for 15 min from all directions by means of a hose having a nozzle with the shape and dimensions shown in figure 8. The nozzle shall be held 3 m away from the sample.*

The water pressure at the nozzle shall be adjusted to achieve a water delivery rate of 12,5 l/min ± 5 % (approximately 30 kN/m²).

9.2.7 *Powerful water jet-proof luminaires (second characteristic IP numeral 6) are switched off and immediately subjected to a water jet for 3 min from all directions by means of a hose having a nozzle with the shape and dimensions shown in figure 8. The nozzle shall be held 3 m away from the sample.*

The water pressure at the nozzle shall be adjusted to achieve a water delivery rate of 100 l/min ± 5 % (approximately 100 kN/m²).

9.2.8 *Watertight luminaires (second characteristic IP numeral 7) are switched off and immediately immersed for 30 min in water, so that there is at least 150 mm of water above the top of the luminaire and the lowest portion is subjected to at least 1 m head of water. Luminaires shall be held in position by their normal fixing means. Luminaires for tubular fluorescent lamps shall be positioned horizontally, with the diffuser upwards, 1 m below the water surface.* (2)

NOTE – This treatment is not sufficiently severe for luminaires intended for operation under water.

9.2.9 *Pressure watertight luminaires (second characteristic IP numeral 8) are heated either by switching on the lamp or by other suitable means, so that the temperature of the luminaire enclosure exceeds that of the water in the test tank by between 5 °C and 10 °C.*

The luminaire shall then be switched off and subjected to a water pressure of 1,3 times that pressure which corresponds to the rated maximum immersion depth for a period of 30 min.

9.3 Humidity test

All luminaires shall be proof against humid conditions which may occur in normal use.

Compliance is checked by the humidity treatment described in 9.3.1, followed immediately by the tests of section 10.

15.5.2 Permanent connections

The connection shall remain fully effective when a pull-off force of 20 N is applied, for 1 min, in a direction opposite to that used for the application or insertion of the conductors.

In some cases, a special tool may be used to apply the force correctly (e.g. in the case of wire-wrapped terminals).

Multi-conductor terminals are tested with the above force applied to each conductor in turn.

15.6 Electrical tests

Terminals and connections shall have adequate electrical performance.

Compliance is checked by the tests of 15.6.1 and 15.6.2.

15.6.1 Contact resistance test

The electrical performance of terminals (or connections) is checked on a set of four terminals. If all the terminals contained within the luminaire are not of the same design, one set of four terminals of each design is subjected to the test.

15.6.1.1 *For spring-type terminals, the test according to 15.6.1.3 is made with four solid copper non-insulated conductors.*

If a range of conductors is specified, two of the terminals are tested with conductors having the smallest cross-sectional area and the two remaining terminals with conductors having the largest cross-sectional area.

15.6.1.2 *In the case of pin or tab and receptacle type terminals, the test of 15.6.1.3 is made with lead assemblies.*

15.6.1.3 *Each terminal with its conductor is loaded with the test current (a.c. or d.c.) and after 1 h, the voltage drop across the terminal, still at the test current, is measured. The measuring points are located as close as possible to the contact point across which the voltage drop is being measured. The measured voltage drop shall not exceed 15 mV.*

The voltage drop for each joint or contact is considered separately, for example, the junction of conductor to receptacle is considered separately from the junction of receptacle to pin.

The total voltage drop of two inseparable joints, when measured together, shall not exceed twice the value given in this subclause.

Cable entries, if any, shall be left open; if knock-outs are provided, one of them shall be opened.

Parts which can be removed by hand, e.g. electrical components, covers, protective glasses, etc., shall be removed and subjected, if necessary, to the humidity treatment with the main part.

9.3.1 *The luminaire is placed in the most unfavourable position of normal use, in a humidity cabinet containing air with a relative humidity maintained between 91 % and 95 %. The temperature of the air at all places where samples can be located shall be maintained within 1 °C of any convenient value "t" between 20 °C and 30 °C.*

Before being placed in the humidity cabinet, the sample shall be brought to a temperature between "t" and (t + 4) °C. The sample shall be kept in the cabinet for 48 h.

NOTE – In most cases, the sample may be brought to the specified temperature between "*t*" and (*t* + 4) °C by keeping it in a room 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 within, and in general to use a cabinet which is thermally insulated.

After this treatment, the sample shall show no damage affecting compliance with the requirements of this standard.

SECTION 10: INSULATION RESISTANCE AND ELECTRIC STRENGTH

10.1 General

This section specifies requirements and tests for the insulation resistance and electric strength of luminaires. (1)

10.2 Insulation resistance and electric strength

The insulation resistance and the electric strength of luminaires shall be adequate.

Compliance is checked by the tests of 10.2.1 and 10.2.2 in the humidity cabinet or the room in which the sample was brought to the prescribed temperature, after reassembly of those parts which may have been removed.

The switch, if any, shall be placed in the ON position for all tests, except for tests between live parts which are separated by the action of a switch.

During these tests the following components shall be disconnected, so that the test voltages are applied to the insulation of the components, but not to the capacitive or inductive functional elements of these components, as appropriate:

a) shunt-connected capacitors;

b) capacitors between live parts and the body;

c) chokes or transformers connected between live parts.

TERMINALS AND CONNECTIONS FOR INTERNAL WIRING

15.5 Mechanical tests

Terminals and connections shall have adequate mechanical strength.

Compliance is checked by the tests of 15.5.1 and 15.5.2.

15.5.1 Non-permanent connections

The mechanical strength of the terminals (or connections) is checked on a set of four terminals. If all the terminals contained within the luminaire are not of the same design, one set of four terminals of each design is subjected to the test.

This test shall only be applied to devices on which the user may work to complete assembly of the luminaire before it is put into service.

15.5.1.1 *In the case of spring-type terminals (see figure 18) the test is made with solid copper conductors of the size or sizes specified by the manufacturer. If a range of conductors is specified, the smallest and largest are selected for testing.*

Of the four terminals, two are tested with conductors having the smallest cross-sectional area and the two remaining samples with conductors having the largest cross-sectional area. These conductors are connected to, and disconnected from, each terminal five times.

For the first four connections, new conductors are used each time. For the fifth connection, the same conductor is used as for the fourth connection and it is clamped at the same place. For each connection, the conductors are pushed into the terminals as far as the stop.

If the terminal is suitable for stranded conductors, an additional test is then made with one rigid stranded copper conductor. If, however, a range of conductors is specified, those with the smallest and largest cross-sectional areas are selected for testing. Each conductor is subjected to only one connection and disconnection with the corresponding terminal used for the testing with solid conductors.

After the final connection, each conductor is subjected to a test pull of 4 N.

15.5.1.2 *Pin or tab and receptacle type connections are also subjected to a test pull of 4 N.*

The pull is applied without jerks, for 1 min, in the direction opposite to that used for the application or insertion of the conductor or lead assembly.

During the test, the conductor or lead assembly shall not move from the terminal and neither the terminal nor the conductor or lead assembly shall undergo any alteration impairing its future use.

The maximum force for the application or insertion of the conductor or lead assembly shall not exceed 50 N, and in the case of pin or tab and receptacle type connections the force for disconnection shall not exceed this value.

If it is impossible to place metal foil in position on linings or barriers, the tests shall be made on three pieces of the lining or barrier which have been taken out and placed between two metal balls having a diameter of 20 mm, which shall be pressed together with a force of 2 N ± 0,5 N.

The conditions of test for transistorized ballasts shall be as specified in IEC 60924.

NOTE – The insulation between live parts and the body, as well as between accessible metal parts and metal foil on the inside of insulating linings and barriers, are tested according to the required type of insulation. The term "body" includes accessible metal parts, accessible fixing screws and metal foil in contact with accessible parts of insulating material.

10.2.1 Test – Insulation resistance

The insulation resistance shall be measured with a d.c. voltage of approximately 500 V, 1 min after the application of the voltage.

For the insulation of SELV parts of luminaires, the d.c. voltage to be used for measurement is 100 V.

The insulation resistance shall be not less than the values specified in table 10.1.

The insulation between live parts and the body of class II luminaires shall not be tested if the basic insulation and the supplementary insulation can be tested separately.

Table 10.1 – Minimum insulation resistance

Insulation of parts	*Minimum insulation resistance MΩ*		
	Class 0 and Class I luminaires	*Class II luminaires*	*Class III luminaires*
SELV:			
Between current-carrying parts of different polarity	*a*	*a*	*a*
*Between current-carrying parts and the mounting surface **	*a*	*a*	*a*
Between current-carrying parts and metal parts of the luminaire	*a*	*a*	*a*
Other than SELV:			
Between live parts of different polarity	*b*	*b*	–
*Between live parts and the mounting surface **	*b*	*b and c, or d*	–
Between live parts and metal parts of the luminaire	*b*	*b and c, or d*	–
Between live parts which can become of different polarity through action of a switch	*b*	*b and c, or d*	–
Basic insulation for voltages of SELV (a)	*1*		
Basic insulation for voltages other than SELV (b)	*2*		
Supplementary insulation (c)	*2*		
Double or reinforced insulation (d)	*4*		

* *The mounting surface is covered with metal foil for the purpose of this test.*

15.3.8 Terminals shall be suitably fixed to the equipment or to a terminal block or otherwise fixed in position. They shall not work loose when conductors are inserted or withdrawn.

Compliance is checked by inspection and, if there is a doubt, by applying the mechanical test given in clause 15.5 or 15.8. During the test, the terminals shall not work loose and there shall be no damage that will impair their further use.

The above conditions apply not only to terminals which are fixed to equipment but also to terminals which are delivered separately. Covering with sealing compound without other means of locking is not sufficient. Self-hardening resins may however be used to lock terminals which are not subject to torsion in normal use.

15.3.9 Terminals and connections shall withstand the mechanical, electrical and thermal stresses occurring in normal use.

Compliance is checked by the tests of clauses 15.5, 15.6, 15.8 or 15.9 as appropriate.

15.3.10 Manufacturers shall state the conductor size or sizes for which the component is designed and the type of conductor, for example, solid or stranded.

15.4 General instructions on tests

15.4.1 Preparation of samples

The "tests for ingress of dust and moisture" of section 9, if appropriate, shall be carried out before testing terminals or connections contained within the luminaires.

15.4.2 Test conductors

Tests shall be carried out with copper conductors of the types and dimensions recommended by the manufacturer. If a range of conductors is specified, the smallest and largest shall be selected for testing.

15.4.3 Multi-conductor terminals

Screwless terminals having provision for the simultaneous connection of several conductors shall be tested with the number of conductors indicated in the data provided by the manufacturer.

15.4.4 Multi-way terminals

Each terminal in a group or strip of terminals, for example, a terminal block on a ballast, may be used as a separate sample.

15.4.5 Test quantities

The tests described in clauses 15.5 to 15.8 are carried out on four terminals (or connections). At least three terminals shall meet the requirements. If one terminal fails, four further terminals are tested and these shall meet the requirements.

The tests described in clause 15.9 are carried out on ten terminals.

Insulating linings and barriers shall be tested only if the distance between live parts and accessible metal parts, without the lining or barrier, would be less than that prescribed in section 11.

For the tests on the insulation of bushings, cord grips, wire carriers and clips, the cable or cord shall be covered by metal foil or replaced by a metal rod of the same diameter.

These requirements do not apply to starting aids which are purposely connected to the mains if they are not live parts.

NOTE – See annex A for a test for live parts.

10.2.2 Test – Electric strength

A voltage of substantially sine-wave form, having a frequency of 50 Hz or 60 Hz and the value specified in table 10.2, shall be applied for 1 min across the insulation shown in that table.

Initially, no more than half the prescribed voltage shall be applied, then it is raised gradually to the full value.

For the high-voltage transformer used for the test, when the output terminals are short-circuited after the output voltage has been adjusted to the appropriate test voltage, the output current shall be at least 200 mA.

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

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

Care shall also be taken that the metal foil is so placed that no flashover occurs at the edges of the insulation.

For class II luminaires incorporating both reinforced insulation and double insulation, care shall be taken that the voltage applied to the reinforced insulation does not overstress the basic insulation or the supplementary insulation.

Glow discharges without drop in voltage are ignored.

No flashover or breakdown shall occur during the test.

These requirements do not apply to starting aids which are purposely connected to the mains if they are not live parts.

For luminaires with ignitors, the electric strength of parts of the luminaire that are stressed by the pulse voltage is tested with the ignitor operating, to ensure that the luminaire insulation, wiring and similar parts are adequate.

15.3 General requirements

15.3.1 Parts of terminals or connections for carrying current shall be made of one of the following materials:

- copper;
- an alloy containing at least 58 % copper for parts that are worked cold or at least 50 % copper for other parts;
- another metal no less resistant to corrosion than copper and having mechanical properties no less suitable.

15.3.2 Terminals and connections shall clamp the conductor with sufficient pressure and without undue damage to the conductor.

The conductor shall be clamped between metal surfaces. However, terminals for circuits having a rated current not exceeding 2 A may have one non-metallic surface if the requirements of 15.3.5 are met.

Insulation piercing terminals are acceptable only if used in the SELV circuits of luminaires or as permanent, non-rewireable connections in other luminaires.

NOTE – Conductors are unduly damaged if they show deep or sharp indentations.

15.3.3 Terminals shall be so designed that, when the conductor has been adequately inserted into the terminal, further insertion of its end is prevented by a stop.

15.3.4 Terminals other than those for lead assemblies, shall accept "non-prepared conductors" (see 15.2.5).

Compliance with the requirements of 15.3.2, 15.3.3 and 15.3.4 is checked by inspection of the terminals or connections, after fitting with appropriate conductors, and after the heating test of 15.6.2 or 15.9.2.

15.3.5 Electrical connections shall be so designed that the pressure essential for good electrical conductivity is not transmitted through insulating material other than ceramic, pure mica, or other material with characteristics no less suitable, unless there is sufficient resilience in the metallic parts to compensate for any possible shrinking of the insulating material (see figures 17 and 18).

15.3.6 It shall be clear in which way the connection of the conductor to, and the disconnection from, spring-type non-permanent screwless terminals is effected.

The disconnection of a conductor shall require an operation other than a pull of the conductor and shall be such that it can be made by hand or with the aid of a simple, generally available device.

15.3.7 Terminals for connection to several conductors under spring clamps shall clamp each conductor independently.

For terminals designed for non-permanent connections, it shall be possible to withdraw the conductors together or separately.

For luminaires with ignitors and lampholders which, according to the lampholder manufacturer's instructions achieve their maximum impulse voltage protection only with a lamp inserted, a dummy lamp shall be inserted for this test.

NOTE 1 – The dummy lamp should be supplied with the type test sample.

NOTE 2 – This requirement enables the cap/holder design to be kept to a reasonable size while allowing the pulse voltage to rise to a level which will ensure hot restarting of a discharge lamp (for example in studio applications).

The luminaire with ignitors is connected to a supply of 100 % rated voltage, for a period of 24 h. Ignitors that become defective during this period are replaced immediately. The electric strength test with the values specified in table 10.2 is then applied to the luminaire with all the terminals (except any earthing terminal) of the ignitor connected together.

For luminaires with manual ignitors such as push-buttons, the luminaire is connected to a supply of 100 % rated voltage and subjected to a "3 s on/10 s off" switching cycle for a total period of 1 h. Only one ignitor is used for this test.

Luminaires with ignitors provided with ballasts which are marked for the exclusive use with an ignitor having a time limitation device, conforming to IEC 60922, shall be subjected to the same test but for a period consisting of 250 on/off cycles, keeping an off-period of 2 min.

No flashover or breakdown shall occur during the electric strength test.

Table 10.2 – Electric strength

Insulation of parts	*Test voltage V*		
	Class 0 and Class I luminaires	***Class II luminaires***	***Class III luminaires***
SELV:			
Between current-carrying parts of different polarity	*a*	*a*	*a*
*Between current-carrying parts and the mounting surface **	*a*	*a*	*a*
Between current-carrying parts and metal parts of the luminaire	*a*	*a*	*a*
Other than SELV:			
Between live parts of different polarity	*b*	*b*	–
*Between live parts and the mounting surface **	*b*	*b and c, or d*	–
Between live parts and metal parts of the luminaire	*b*	*b and c, or d*	–
Between live parts which can become of different polarity through action of a switch	*b*	*b and c, or d*	–
Basic insulation for voltages of SELV (a)	*500*		
Basic insulation for voltages other than SELV (b)	*2U + 1000*		
Supplementary insulation (c)	*2U + 1750*		
Double or reinforced insulation (d)	*4U + 2750*		
* *The mounting surface is covered with metal foil for the purpose of this test.*			

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SECTION 15: SCREWLESS TERMINALS AND ELECTRICAL CONNECTIONS

15.1 General

This section specifies requirements for all types of terminals and electrical connections, that do not employ screws, for solid or stranded copper conductors up to 2,5 mm^2 for internal wiring of luminaires and for connections to external wiring of luminaires. (2)

Some examples of screwless terminals and electrical connections are shown in figures 17, 18 and 19.

15.2 Definitions

15.2.1 Screwless terminals

Parts required to make connections in electrical circuits by mechanical means without screws.

15.2.2 Permanent connections

Connections designed to be made only once with the same conductor (for example wire wrapping or crimping).

15.2.3 Non-permanent connections

Connections which allow lead assemblies or conductors to be connected and disconnected several times (for example pin or tab and receptacle, or some spring-type terminals).

15.2.4 Lead assemblies

Conductors fitted with auxiliary parts, usually by permanent connection.

15.2.5 Non-prepared conductors

Conductors without special preparation or auxiliary parts. Insulation may, however, be stripped to expose the conductor.

NOTE – The term "special preparation" covers the application of additional solder to the strands of the conductor, use of cable lugs, tabs and receptacles, formation of eyelets, etc., but not the reshaping of the conductor for its introduction into the terminal or the twisting of a stranded conductor to consolidate the end.

The bonding together by heating of the tinned strands of a flexible conductor without the addition of solder is not considered to be special preparation.

15.2.6 Test current

Current assigned to a terminal or connection by the manufacturer. When terminals are part of a component, the test current shall be the rated current of the component.

10.3 Leakage current

The leakage current that may occur during normal operation of the luminaire between each pole of the supply source and the body of the luminaire (see table 10.2) shall not exceed the values of table 10.3.

Table 10.3 – Leakage current

Luminaire type	*Maximum, r.m.s. values of leakage current mA*
Class 0 and class II[1)]	*0,5*
Portable, class I[2)]	*1,0*
Fixed, class I up to 1 kVA rated input increasing by 1,0 mA/kVA up to a maximum of 5,0 mA[1)]	*1,0*

1) *Measured in accordance with 5.1.1 of IEC 60990 weighted for perception reaction (a.c.).*

2) *Measured in accordance with 5.1.2 of IEC 60990, weighted for let-go (a.c.).*

Compliance is checked in accordance with section 7 of IEC 60990.

NOTE – For luminaires incorporating a.c. supplied electronic ballasts, the leakage current may be greatly dependent upon the spacing between the lamp and the earthed starting aid, due to the high frequency operation of the lamp.

SECTION 11: CREEPAGE DISTANCES AND CLEARANCES

11.1 General

This section specifies minimum requirements for creepage distances and clearances in luminaires. (1)

11.2 Creepage distances and clearances

Live parts and adjacent metal parts shall be adequately spaced. SELV parts of luminaires shall also be adequately spaced. Creepage distances and clearances for ordinary luminaires shall be not less than the values given in tables 11.1 and 11.3 as appropriate, for luminaires classified IPX1 or higher not less than the values given in tables 11.2 and 11.3 as appropriate. (2)

Distances between current-carrying parts of opposite polarity shall comply with the requirements for basic insulation.

NOTE – For details of pollution degrees or overvoltage categories, IEC 60664-1 should be consulted.

For ordinary luminaires, the minimum distances specified in tables 11.1 and 11.3 are based on the following criteria:

- pollution degree 2 where normally only non-conductive pollution occurs but occasionally a temporary conductivity caused by condensation is to be expected;
- for basic insulation overvoltage category I;

14.4.7 Terminals shall clamp the conductor reliably between metal surfaces.

For lug terminals, a spring washer, or equally effective locking means, shall be provided and the surface within the clamping area shall be smooth.

For mantle terminals, the bottom of the conductor space shall be slightly rounded in order to obtain a reliable connection.

Compliance is checked by inspection and by the following test.

The terminals are fitted with rigid conductors of the smallest and largest cross-sectional areas given in table 14.2, the terminal screws being tightened with a torque equal to two-thirds of that given in the appropriate column of table 14.4.

If the screw has a hexagonal head with a slot, the torque applied is equal to two-thirds of that given in column III of that table.

Each conductor is then subjected to a pull of the value, in newtons, given in table 14.5; the pull is applied without jerks, for 1 min, in the direction of the axis of the conductor space.

Table 14.5 – Pull to be applied to conductor

Terminal size	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Pull (N)	*30*	*40*	*50*	*50*	*60*	*80*	*90*	*100*

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

14.4.8 Terminals shall clamp the conductor without undue damage to the conductor.

Compliance is checked by inspection of the conductors, after conductors of the smallest and largest cross-sectional areas given in table 14.2 have been clamped once and loosened, the torque applied to clamp the conductor being equal to two-thirds of that given in table 14.4.

If the screw has a hexagonal head with a slot, the torque applied is equal to two-thirds of that given in column IV of table 14.4.

NOTE – Conductors are unduly damaged if they show deep or sharp indentations.

- for supplementary and reinforced insulation, overvoltage category II;

  For luminaires classified IPX1 or higher, the minimum distances specified in tables 11.2 and 11.3 are based on the following criteria: (2)

- pollution degree 3 where dry non-conductive pollution occurs which becomes conductive due to condensation which can be expected;
- for all insulations, overvoltage category II.

11.2.1 *Compliance is checked by measurements made with and without conductors of the largest section connected to the terminals of the luminaires.*

The contribution to the creepage distance of any groove less than 1 mm wide is limited to its width.

Any air gap less than 1 mm wide is ignored in calculating the total clearance, unless the required distance is 1 mm or less.

For luminaires provided with an appliance inlet, the measurements are made with an appropriate connector inserted.

Distances through slots or openings in external parts of insulating material are measured with metal foil in contact with the accessible surface. The foil is pushed into corners and similar places by means of the standard test finger specified in IEC 60529, but it is not pressed into openings.

Internal creepage distances in permanently sealed components are not measured. Examples of permanently sealed components are components sealed-off or compound filled.

The values in the table do not apply to components for which separate IEC publications exist, but apply only to the mounting distances in the luminaire.

Creepage distances at a supply terminal shall be measured from the live part in the terminal to any accessible metal parts, and the clearance shall be measured between incoming supply wiring and accessible metal parts, i.e. from a bare conductor of the largest section to the metal parts which can be accessible. At the internal wiring side of the terminal the clearance shall be measured between live parts of the terminal and accessible metal parts (see figure 24).

NOTE – The measurements of the clearances from supply and from internal wiring differ because the luminaire manufacturer does not have control over the length of insulation removed from the supply wiring by the installer.

Table 14.4 – Torque to be applied to screws and nuts

Nominal diameter of thread mm		Torque Nm				
		I	II	III	IV	V
Up to and including 2,8		0,2	–	0,4	0,4	–
Over 2,8	up to and including3,0	0,25	–	0,5	0,5	–
Over 3,0	up to and including3,2	0,3	–	0,6	0,6	–
Over 3,2	up to and including3,6	0,4	–	0,8	0,8	–
Over 3,6	up to and including4,1	0,7	1,2	1,2	1,2	1,2
Over 4,1	up to and including4,7	0,8	1,2	1,8	1,8	1,8
Over 4,7	up to and including5,3	0,8	1,4	2,0	2,0	2,0
Over 5,3	up to and including6,0	–	1,8	2,5	3,0	3,0
Over 6,0	up to and including8,0	–	2,5	3,5	6,0	4,0
Over 8,0	up to and including10,0	–	3,5	4,0	10,0	6,0
Over10,0	up to and including12,0	–	4,0	–	–	8,0
Over12,0	up to and including15,0	–	5,0	–	–	10,0

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

Column I 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 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 in which the nut is tightened by means other than a screwdriver.

Where a screw has a hexagonal head with means for tightening with a screwdriver and the values in columns III and IV are different, the test is made twice, first applying to the hexagonal head the torque given in column IV, and then on another set of samples, applying the torque given 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 will impair the further use of the terminals.

NOTE – For mantle terminals, the specific nominal diameter is that of the slotted stud. The shape of the blade of the test screwdriver shall suit the head of the screw to be tested. The screws and nuts shall not be tightened in jerks.

Table 11.1 – Minimum distances for a.c. (50/60 Hz) sinusoidal voltages for ordinary luminaires (Conversion guide in annex M)

RMS working voltage not exceeding V / *Distances in mm*		50	150	250	500	750	1 000
Creepage distances							
– *Basic insulation PTI**	≥ 600	0,6	1,4	1,7	3	4	5,5
	< 600	1,2	1,6	2,5	5	8	10
– *Supplementary insulation PTI**	≥ 600	–	3,2	3,6	4,8	6	8
	< 600	–	3,2	3,6	5	8	10
– *Reinforced insulation*		–	5,5	6,5	9	12	14
Clearances							
– *Basic insulation*		0,2	1,4	1,7	3	4	5,5
– *Supplementary insulation*		–	3,2	3,6	4,8	6	8
– *Reinforced insulation*		–	5,5	6,5	9	12	14

** PTI (proof tracking index) in accordance with IEC 60112.*

Values of creepage distances and clearances may be found for intermediate values of working voltages by linear interpolation between tabulated values. No values are specified for working voltages below 25 V as the voltage test of table 10.2 is considered sufficient. (2)

Table 11.2 – Minimum distances for a.c. (50/60 Hz) sinusoidal voltages for luminaires classified IPX1 or higher (Conversion guide in annex M)

RMS working voltage not exceeding V / *Distances in mm*			50	150	250	500	750	1000
Creepage distance								
– *Basic insulation*	*PTI**	≥ 600	1,5	2	3,2	6,3	10	12,5
	*PTI**	≥ 175 < 600	1,9	2,5	4	8	12,5	16
– *Supplementary insulation*			–	3,2	4	8	12,5	16
– *Reinforced insulation*			–	5,5	6,5	9	12,5	16
Clearances								
– *Basic insulation*			0,8	1,5	3	4	5,5	8
– *Supplementary insulation*			–	3,2	3,6	4,8	6	8
– *Reinforced insulation*			–	5,5	6,5	9	12	14

** PTI (proof tracking index) in accordance with IEC 60112.*

In the case of creepage distances to parts not energized, or not intended to be earthed, where tracking cannot occur, the values specified for material with PTI ≥ 600 shall apply for all materials (in spite of the real PTI).

14.4.4 Terminals shall have adequate mechanical strength.

Screws and nuts for clamping the conductors shall have a metric ISO thread. Terminals for external wiring shall not serve to fix any other component, except that they may also clamp internal conductors if these are so arranged that they are unlikely to be displaced when fitting external conductors.

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 14.3.3, 14.4.6, 14.4.7 and 14.4.8.

14.4.5 Terminals shall be resistant to corrosion.

Compliance is checked by the corrosion test specified in section 4.

14.4.6 Terminals shall be fixed to the luminaire or to a terminal block or otherwise fixed in position. When the clamping screws or nuts are tightened or loosened, the terminals shall not work loose, internal wiring shall not be subjected to stress, and creepage distances and clearances shall not be reduced below the values specified in section 11.

These requirements do not imply that the terminals should be so designed that their rotation or displacement is prevented, but any movement shall be sufficiently limited so as to ensure compliance with this standard.

Covering with sealing compound or resin is sufficient to prevent 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 section 12.

Compliance is checked by inspection, by measurements and by the following test.

A rigid copper conductor of the largest cross-sectional area given in table 14.2 is placed in the terminal. Screws and nuts are tightened and loosened five times by means of a suitable test screwdriver or wrench, the torque applied when tightened being equal to that given in the appropriate column of table 14.4 or in the appropriate table of figure 12, 13, 14, 15 or 16, whichever is the higher.

For creepage distances subjected to working voltages of less than 60 s duration, the values specified for materials with PTI ≥ 600 shall apply for all materials.

For creepage distances not liable to contamination by dust or moisture, the values specified for material with PTI ≥ 600 shall apply (independent of the real PTI).

Table 11.3 – Minimum distances for sinusoidal or non-sinusoidal pulse voltages

	Rated pulse peak voltage kV								
	2,0	**2,5**	**3,0**	**4,0**	**5,0**	**6,0**	**8,0**	**10**	**12**
Minimum clearance in mm	*1*	*1,5*	*2*	*3*	*4*	*5,5*	*8*	*11*	*14*
	Rated pulse peak voltage kV								
	15	**20**	**25**	**30**	**40**	**50**	**60**	**80**	**100**
Minimum clearance in mm	*18*	*25*	*33*	*40*	*60*	*75*	*90*	*130*	*170*

Creepage distances shall not be less than the required minimum clearance.

For distances subjected to both sinusoidal voltage as well as non-sinusoidal pulses, the minimum required distance shall be not less than the highest value indicated in either table.

SECTION 12: ENDURANCE TEST AND THERMAL TEST

12.1 General

This section specifies requirements relating to the endurance test and thermal tests of luminaires.

12.2 Selection of lamps and ballasts

Lamps used for the tests of this section shall be selected in accordance with annex B.

The lamps used in the endurance test are operated above their rated wattage for extended periods, and shall not be used for the thermal tests. However, it is usually convenient to retain in the thermal test for abnormal operation those lamps that have been used in the thermal test for normal operation.

If the luminaire requires a separate ballast and this is not supplied with the luminaire, a ballast shall be selected for test purposes which is typical of normal production, and which complies with the relevant ballast specification. The power delivered to a reference lamp by the ballast under reference conditions shall be within ±3 % of rated lamp power.

NOTE 1 – For reference conditions, see the relevant IEC auxiliary standard.

NOTE 2 – In the relevant lamp performance standards the rated wattage may still be indicated as "objective" wattage. This wording will be corrected in future editions of these standards.

For fixed luminaires intended solely for permanent connection to fixed (external) wiring this requirement applies only to the use of solid or rigid stranded conductors. The test is made with rigid stranded conductors.

Compliance is checked by the following test.

Terminals are fitted with a conductor having the composition given in table 14.3.

Table 14.3 – Composition of conductors

Terminal size	*Number of strands and nominal diameter of strands (n x mm)*	
	Flexible conductors	*Rigid stranded conductors*
0	*32 x0,20*	–
1	*30 x0,25*	*7 x0,50*
2	*50 x0,25*	*7 x0,67*
3	*56 x0,30*	*7 x0,85*
4	*84 x0,30*	*7 x1,04*
5	*84 x0,30*	*7 x1,35*
6	*80 x0,40*	*7 x1,70*
7	*126 x0,40*	*7 x2,14*

Before insertion in the terminal, strands of rigid conductors are straightened and flexible conductors are twisted in one direction so that there is a uniform twist of one complete turn in a length of approximately 20 mm.

The conductor is inserted in 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 assist the strand to slip out. The clamping screw is then tightened with a torque equal to two-thirds of that given in the appropriate column of table 14.4.

For flexible conductors, the test is repeated with a new conductor which is twisted as before, but in the opposite direction.

After the test, no strand of the conductor shall have slipped out through the gap between the clamping means and the retaining device.

14.4.3 Terminal sizes up to and including size 5 shall allow the conductor to be connected without special preparation.

Compliance is checked by inspection.

NOTE – The term "special preparation" covers the application of additional solder to the strands of the conductor, use of cable lugs, formation of eyelets, etc., but not the reshaping of the conductor for its introduction into the terminal or the twisting of a stranded conductor to consolidate the end.

The bonding together by heating of the tinned strands of a flexible conductor without the addition of solder is not considered special preparation.

12.3 Endurance test

Under conditions representing cyclic heating and cooling in service, the luminaire shall not become unsafe or fail prematurely.

Compliance is checked by carrying out the test described in 12.3.1.

12.3.1 Test

a) The luminaire shall be mounted in a thermal enclosure with means for controlling the ambient temperature within the enclosure.

The luminaire shall be positioned on a similar supporting surface (and in the same operating position) as for the normal operation thermal test (see 12.4.1).

b) The ambient temperature within the enclosure shall be maintained within ±2 °C of (t_a + 10) °C during the test; t_a is 25 °C unless otherwise marked on the luminaire.

The ambient temperature within the enclosure shall be measured in accordance with annex K. Ballasts for operation separate from the luminaire shall be mounted in free air, not necessarily in the thermal enclosure, and shall be operated in an ambient temperature of 25 °C ± 5 °C.

c) The luminaire shall be tested in the enclosure for a total duration of 168 h consisting of seven successive cycles of 24 h. Supply voltage as specified in item d) below shall be applied to the luminaire for the first 21 h and disconnected for the remaining 3 h of each cycle. The initial heating period of the luminaire is part of the first test cycle.

The circuit condition shall be as in normal operation for the first six cycles, and as in abnormal operation (see annex C) for the seventh cycle. For luminaires containing an electrical motor (e.g. a fan) the abnormal condition which most adversely affects the result of the test shall be selected. (2)

For luminaires for which there is no abnormal condition for example fixed non-adjustable filament lamp luminaires, the total test duration shall be 240 h (i.e. 10 × 24 cycles at normal operation).

d) During operating periods, the supply voltage for filament lamp luminaires shall be 1,05 ± 0,015 times the voltage at which the rated wattage of the lamp is obtained and 1,10 ± 0,015 times (the rated voltage or the maximum of the rated voltage range) for tubular fluorescent and other discharge lamp luminaires.

Table 14.2 – Nominal cross-sectional areas of conductors according to maximum current

Maximum current carried by the terminal A	Flexible conductors		Rigid conductors solid or stranded	
	Nominal cross-sectional areas * mm²	Terminal size	Nominal cross-sectional areas * mm²	Terminal size
2	0,4	0	–	–
6	0,5 to 1	0	0,75 to 1,5	1
10	0,75 to 1,5	1	1 to 2,5	2
16	1 to 2,5	2	1,5 to 4	3
20	1,5 to 4	3	1,5 to 4	3
25	1,5 to 4	3	2,5 to 6	4
32	2,5 to 6	4 or 5 **	4 to 10	5
40	4 to 10	6	6 to 16	6
63	6 to 16	7	10 to 25	7

* These requirements do not apply to terminals used for the interconnections of different components of luminaires by means of cables or flexible cords not complying with IEC 60227 or IEC 60245, if the other requirements of this standard are met.

** Terminal size 4 is not suitable for 6 mm² of flexible conductors of some special constructions, in which case terminal size 5 should be used.

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

14.3.4 Terminals shall provide adequate connection of the conductors.

Compliance is checked by carrying out all tests of clause 14.4.

14.4 Mechanical tests

14.4.1 For pillar terminals, the distance between the clamping screw and the end of the conductor, when fully inserted, shall be at least that given in figure 12.

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

For mantle terminals, the distance between the fixed part and the end of the conductor, when fully inserted, shall be at least that given in figure 16.

Compliance is checked by measurement, after a solid conductor of the largest cross-sectional area given in table 14.2 has been fully inserted and fully clamped.

14.4.2 Terminals shall be so designed or placed that neither a solid conductor nor a strand of a stranded conductor can slip out while the clamping screws or nuts are being tightened.

This requirement does not apply to lug terminals.

e) If the luminaire ceases to operate because of a failure, the following shall apply:

- *Chance failure of a part of the luminaire (including the lamp), the instructions of item g) of 12.4.1 shall apply.*
- *If a thermal protective device operates during the first six cycles the test shall be modified as follows:*

  1) For luminaires with cyclic protective devices, the luminaire shall be allowed to cool until the device resets. For luminaires with one-shot thermal protective devices (thermal links), the device shall be replaced.

  2) For all kinds of luminaires the test shall then be continued up to 240 h in total with the circuit and the temperature adjusted in such a way that the protective device just fails to operate. The luminaire is deemed to have failed the test if adjustment below the luminaires rated characteristics is necessary to prevent the protective device operating. (2)

- *If a thermal protective device operates during the seventh (abnormal conditions) cycle it shall either be allowed to cool, or, in the case of a one-shot device, it shall be replaced, and the test continued with the circuit and temperature adjusted in such a way that the protective device just fails to operate.*

NOTE – It is considered that if a cut-out device operates during the seventh (abnormal condition) cycle then the functioning of the intended protection has been proven.

Arrangements should be made to signal a break in operation. The effective test duration shall not be reduced as a consequence of such a break.

12.3.2 Compliance

After the test of 12.3.1 the luminaire, and for track-mounted luminaires also the track and component parts of the track system, shall be visually inspected. No part of the luminaire shall have become unserviceable (other than as a chance failure as described in item e) of 12.3.1) and plastic ES lampholders shall not be deformed. The luminaire shall not have become unsafe and shall not have caused damage to the track system. The marking of the luminaire shall be legible.

NOTE – Symptoms of possible unsafe conditions include cracks, scorches and deformation.

12.4 Thermal test (normal operation)

Under conditions representing normal service, no part of the luminaire (including the lamp), the supply wiring within the luminaire, or the mounting surface shall attain a temperature which would impair safety.

During the test for compliance, the through wiring shall not be loaded.

In addition, parts intended to be touched, handled, adjusted or gripped by hand while the luminaire is at operating temperature shall not be too hot for the purpose.

Luminaires shall not cause excessive heating of lighted objects.

Track-mounted luminaires shall not cause excessive heating of tracks on which they are mounted.

14.3.2.2 In general, terminals will be suitable for the connection of cables and flexible cords without special preparation of the conductor but provision is made in certain cases for connection by means of cable lugs or for connection to bars.

14.3.2.3 A numerical classification for terminals is adopted, based on the nominal cross-sectional areas of the conductors that the terminal can accept. According to this classification each terminal can accept any one of three successive sizes of conductors in the range of nominal cross-sectional areas specified in IEC 60227 or IEC 60245.

With one exception, the sizes of the conductors within each range advance by one step for each increase in the size of the terminal.

The nominal cross-sectional areas of the conductors assigned to each terminal are given in table 14.1, which also gives the diameter of the largest conductor that each terminal can accept.

Terminals may be used with conductors smaller than the nominal given range, provided the conductor is clamped with sufficient pressure to ensure adequate electrical and mechanical connection.

Table 14.1 – Nominal cross-sectional areas of conductors according to terminal sizes

Terminal size	Flexible conductors				Rigid conductors, solid or stranded			
	Nominal cross-sectional areas mm²			Diameter of largest conductor mm	Nominal cross-sectional areas mm²			Diameter of largest conductor mm
0 *	0,5	0,75	1	1,45	–	–	–	–
1 **	0,75	1	1,5	1,73	0,75	1	1,5	1,45
2	1	1,5	2,5	2,21	1	1,5	2,5	2,13
3	1,5	2,5	4	2,84	1,5	2,5	4	2,72
4 ***	2,5	4	6	3,87	2,5	4	6	3,34
5	2,5	4	6	4,19	4	6	10	4,32
6	4	6	10	5,31	6	10	16	5,46
7	6	10	16	6,81	10	16	25	6,83

* Not suitable for rigid conductors. Suitable for flexible conductors of 0,4 mm² cross-sectional area (see 5.3.1).

** Also suitable for flexible conductors having a nominal cross-sectional area of 0,5 mm² if the end of the conductor is folded back on itself.

*** Not suitable for 6 mm² flexible conductors of some special constructions.

14.3.3 Terminals shall allow the proper connection of copper conductors having nominal cross-sectional areas as given in table 14.2 and the conductor space shall be at least that given in figure 12, 13, 14 or 16, as appropriate.

These requirements do not apply to lug terminals.

Compliance is checked by carrying out the test described in 12.4.1. The test conditions for measuring the track temperature shall be as given in 11.1 of IEC 60570.

For luminaires containing an electrical motor, this motor shall operate as intended during the test. ②

12.4.1 Test

The temperature shall be measured as indicated in 12.4.2 in accordance with the following conditions:

a) The luminaire shall be tested in a draught-proof enclosure designed to avoid excessive changes in ambient temperature. A luminaire suitable for surface mounting shall be mounted on a surface as described in annex D. An example of a draught-proof enclosure is given in annex D, but other types of enclosure may be used if the results obtained are compatible with those that would be obtained by the use of the enclosure described in annex D. (For ballasts separate from the luminaire, see item h) of the present subclause.)

The luminaire shall be connected to the power supply with the wiring and any materials (for example insulating sleeves) supplied with the luminaire for the purpose.

In general, connection shall be in accordance with the instructions provided with the luminaire or marked on it. Otherwise, wiring required to connect the luminaire under test to the supply and not supplied with it should be of a type representative of common practice. Such wiring not supplied with the luminaire is hereafter referred to as the test piece.

Temperature measurements shall be made in accordance with annexes E and K.

b) The operating position shall be the thermally most onerous operating position which may reasonably be adopted in service. For fixed non-adjustable luminaires, a position shall not be selected if it is stated to be not permissible in instructions supplied with, or marked on, the luminaire. For adjustable luminaires, the required distance from lighted objects shall be respected if marked on the luminaire, except for luminaires without provision for mechanical locking in any position, when the front rim of the reflector if any, otherwise the lamp, shall be positioned 100 mm from the mounting surface.

c) The ambient temperature within the draught-proof enclosure shall be within the range 10 °C to 30 °C and should preferably be 25 °C. It shall not vary by more than ±1 °C during measurements and during a preceding period long enough to affect the results.

If, however, a lamp has temperature-sensitive electrical characteristics (e.g. a fluorescent lamp), or if the t_a rating of the luminaire exceeds 30 °C, the ambient temperature within the draught-proof enclosure shall be within 5 °C of the t_a rating and should preferably be the same as the t_a rating.

d) The test voltage for the luminaire shall be as follows.

- *Filament lamp luminaires: that voltage which produces 1,05 times the rated wattage of the test lamp (see annex B) except that heat test source (HTS) lamps are always operated at the voltage marked on the lamp.*
- *Tubular fluorescent and other discharge lamp luminaires: 1,06 times the rated voltage or the maximum of the rated voltage range.*
- *For motors contained in luminaires: 1,06 times the rated voltage (or the maximum of the rated voltage range of the luminaire).* ②

14.2.4 Saddle terminal

A terminal in which the conductor is clamped under a saddle by means of two or more screws or nuts.

Examples of saddle terminals are shown in figure 14.

14.2.5 Lug terminal

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

Examples of lug terminals are shown in figure 15.

14.2.6 Mantle terminal

A terminal in which the conductor is clamped against the base of a 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.

Examples of mantle terminals are shown in figure 16.

14.3 General requirements and basic principles

14.3.1 These requirements apply to terminals with screw clamping carrying a current not exceeding 63 A, intended for the connection, by clamping only, of copper conductors of cables and flexible cords.

These requirements do not exclude terminals of types other than those shown in figures 12 to 16.

14.3.2 Terminals are of varied design and have different shapes: they include, among others, terminals in which the conductor is clamped directly or indirectly under the shank of the screw, terminals in which the conductor is clamped directly or indirectly under the head of the screw, terminals in which the conductor is clamped directly or indirectly under a nut, and terminals intended solely for use with cable lugs or bars.

The basic principles governing these requirements are specified in 14.3.2.1 to 14.3.2.3.

14.3.2.1 Terminals are primarily for the connection of only one conductor, although, owing to the wide range of conductors that each terminal is required to clamp, they may in some cases be suitable for clamping two conductors having the same nominal cross-sectional area, which is smaller than the maximum value for which the terminal is designed.

Certain types of terminals, in particular pillar terminals and mantle terminals, may be used for looping-in, when two or more conductors of the same or different nominal cross-sectional area or composition have to be connected. In such cases, the terminal sizes specified in this standard may not be applicable.

Exception

For determination of the average temperature of the winding of a component with t_w marking and for the determination of the case temperature of a component with t_c marking, except capacitors, the test voltage shall be 1,00 times the rated voltage. This exception applies only to the measurement of the winding or case temperature and does not apply, for example, to the measurement of a terminal block on the same component.

Capacitors whether carrying t_c or not are tested at 1,06 times rated voltage when operated within fluorescent and other discharge luminaires.

NOTE – If a luminaire contains both a filament lamp and a tubular fluorescent or other discharge lamp or a motor, it may be necessary to provide it temporarily with two separate supplies. (2)

e) *During and immediately before a measurement, the supply voltage shall be held within ±1 % and preferably within ±0,5 % of the test voltage. The supply voltage shall be held within ±1 % of the test voltage during such preceding period as may affect the measurement; this period shall be not less than 10 min.*

f) *Measurements shall not be taken until the luminaire has stabilized thermally, i.e. temperatures are changing at a rate less than 1 °C per hour.*

g) *If the luminaire ceases to operate because of a defective part of the luminaire (including the lamp), the part should be replaced and the test continued. Measurements already made need not be repeated, but the luminaire shall be stabilized before further measurements are made. If, however, a hazardous condition has arisen, or if any part becomes unserviceable as a type defect, then the luminaire is deemed to have failed the test. If a protective device in the luminaire operates, the luminaire is deemed to have failed.*

h) *If remote control gear/components are supplied as part of a luminaire, they shall be mounted and operated in accordance with the manufacturer's instructions. Temperatures of all parts shall comply with the limits specified by section 12.*

If remote control gear is not supplied as part of the luminaire, the manufacturer will provide control gear typical of normal use. The control gear shall be operated in free air and in an ambient temperature of 25 °C ± 5 °C. The temperature of the control gear shall not be measured.

i) *In case of doubt in the test for filament lamp luminaires, the test shall be repeated with heat test source (HTS) lamps, if available. For temperatures which are mainly governed by the cap temperature of the lamp, the values obtained by HTS lamps are decisive. For those temperatures which are mainly governed by radiation, the values obtained by normal production lamps with clear bulbs are decisive.*

j) *The light beam from the luminaire, for luminaires covered by 3.2.13, is directed towards a matt black painted wooden vertical surface similar to that described in annex D. Luminaires are mounted at the distance from the surface which is marked on the luminaire.*

During the tests, measurements shall be made of the temperature of certain insulating parts, as required for the tests of section 13.

k) *For the measurement of lampholder temperatures for double-capped fluorescent lamps, the hot junction of the thermocouple shall be located flush with that surface of the holder adjacent to the lamp cap. If this is not possible, it should be placed as close as possible to this point but without touching the lamp cap.*

NOTE – It is recommended that the luminaire manufacturer provides the type test sample already with a thermocouple attached to the lampholder. Usually, only one lampholder should be prepared in such a way.

- The test shall be made at three places of the specimen or on three specimens.
- The electrodes shall be of platinum and test solution A, described in 5.4 of IEC 60112, shall be used.

13.4.2 The specimen shall withstand 50 drops without failure at a test voltage of PTI 175.

A failure has occurred if a current of 0,5 A or more flows for at least 2 s by a conducting path between the electrodes on the surface of the specimen, thus operating the overcurrent relay, or if the specimen burns without releasing the overcurrent relay.

The note 1 of 6.4 of IEC 60112 regarding determination of erosion does not apply.

The note 2 of clause 3, of IEC 60112 regarding surface treatment, does not apply.

SECTION 14: SCREW TERMINALS

14.1 General

This section specifies requirements for all types of terminals which employ screws incorporated in luminaires. (1)

Examples of screw terminals are shown in figures 12 to 16.

14.2 Definitions

14.2.1 Pillar terminal

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

Examples of pillar terminals are shown in figure 12.

14.2.2 Screw terminal

A terminal 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 antispread device.

Examples of screw terminals are shown in figure 13.

14.2.3 Stud terminal

A terminal 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.

Examples of stud terminals are shown in figure 13.

12.4.2 Compliance

In the test of 12.4.1, none of the temperatures shall exceed the appropriate values given in tables 12.1 and 12.2 (subject only to the concession of item a) of this subclause when the luminaire is operated at its rated ambient temperature t_a.

In those cases where the temperature in the test enclosure differs from t_a, *this difference shall be taken into account when applying the limits in the tables (see also item c) of 12.4.1).*

a) *The temperature shall not exceed the values shown in tables 12.1 and 12.2 by more than 5 °C.*

NOTE – The allowance of 5 °C is made to take into account the inevitable variability of temperature measurements in luminaires.

b) *The temperature of any part of the luminaire liable to thermal degradation in service shall not exceed a value which corresponds to a reasonable service period for the particular type of luminaire. Generally agreed values for principal parts of luminaires are given in table 12.1 and values for common materials, when used in luminaires, are listed in table 12.2. These values are prescribed here to obtain uniform assessment; slightly different values may be quoted elsewhere on the basis of other forms of materials testing or for other applications.*

If materials are used which are claimed to withstand higher temperatures than those shown in table 12.2, or if other materials are used, they shall not be exposed to temperatures in excess of those which have been proved permissible for these materials.

c) *The temperature of the test piece (see item a) of 12.4.1) if PVC-insulated shall not exceed 90 °C (see note*** to table 12.2 relating to unsleeved fixed wiring) (or 75 °C where it is stressed, for example clamped), or such higher temperatures as may be indicated on the luminaire or in the manufacturer's instructions supplied with the luminaire in accordance with the requirements of section 3. The limit shall be 120 °C for any PVC-insulated wire (internal or external wiring) even when additionally protected by a heat-resisting sleeve supplied with the luminaire. The sleeve shall comply with the requirements of 4.9.2.* (1)

13.3.1 *Parts of insulating material retaining current-carrying parts in position shall withstand the following tests:*

The parts to be tested are subjected to the needle-flame test of IEC 60695-2-2, the test flame being applied to the sample for 10 s at the point where the highest temperatures are likely to occur, measured if necessary during the thermal tests of section 12.

The duration of burning shall not exceed 30 s after removal of the test flame, and any burning drop from the sample shall not ignite the underlying parts or tissue paper specified in 6.86 of ISO 4046, spread out horizontally 200 mm ± 5 mm below the sample.

The requirements of this subclause do not apply in those cases where the luminaire provides an effective barrier to burning drops.

13.3.2 *Parts of insulating material which do not retain live parts in position, but which provide protection against electric shock, and parts of insulating material retaining SELV, parts in position shall withstand the following test:*

Parts are subjected to a test using a nickel-chromium glow-wire heated to 650 °C. The test apparatus and test procedure shall be those described in IEC 60695-2-1.

Any flame or glowing of the sample shall extinguish within 30 s of withdrawing the glow-wire, and any burning or molten drop shall not ignite a single layer of tissue paper specified in 6.86 of ISO 4046, spread out horizontally 200 mm ± 5 mm below the sample.

The requirements of this subclause do not apply in those cases where the luminaires provide an effective barrier to burning drops or where the insulation material is ceramic.

13.4 Resistance to tracking

Insulating parts of luminaires, other than ordinary luminaires, which retain current-carrying parts or SELV parts in position or are in contact with such parts, shall be of material resistant to tracking unless they are protected against dust and moisture.

13.4.1 *Compliance is checked by the following test, which is made at three places on the test sample.*

For materials other than ceramic, compliance is checked by the proof tracking test in accordance with IEC 60112 subject to the following details:

- If the specimen has no flat surface of at least 15 mm × 15 mm, the test may be carried out on a flat surface with reduced dimensions provided drops of liquid do not flow off the specimen during the test. No artificial means should, however, be used to retain the liquid on the surface. In case of doubt the test may be made on a separate strip of the same material, having the required dimensions and manufactured by the same process.
- If the thickness of the specimen is less than 3 mm, two, or if necessary more, specimens should be stacked to obtain a thickness of at least 3 mm.

Table 12.1 – Maximum temperatures under the test conditions 12.4.2, for principal parts

Part	*Maximum temperature °C*
Lamp caps:	*As specified in the appropriate IEC lamp standard**
Windings in ballasts or transformers with t_w marking	t_w
Case (of capacitor, starting device, ballast or convertor etc.)	
If t_c is marked	t_c**
If t_c is not marked	*50*
Windings in transformers, motors, etc., if the winding insulation system according to IEC 60085 is:	
*– of class A material****	*100*
*– of class E material****	*115*
*– of class B material****	*120*
*– of class F material****	*140*
*– of class H material****	*165*
Insulation of wiring:	*See table 12.2 and 12.4.2b) and 12.4.2c)*
Contacts of ceramic lampholders and insulating material of lampholders and starterholders:	
*T_1 or T_2 marked (B15 and B22)***** (IEC 61184)*	*165 for T_1 and 210 for T_2*
*Other types with T marking (IEC 60238, IEC 60400, IEC 60838****** and IEC 61184)*	*T marking*
Other types without T marking	
(E14, B15) (IEC 60238 and IEC 61184)	*135*
(E27, B22) (IEC 60238 and IEC 61184) (E26)	*165*
(E40) (IEC 60238) (E 39)	*225*
*Fluorescent lampholder/starterholders and miscellaneous lampholders without T marking (IEC 60400 and IEC 60838******)*	*80*
Switches marked with individual ratings:	
With T marking	*T marking*
Without T marking	*55*
Other parts of the luminaire (according to material and use):	*See table 12.2 and subcl. 12.4.2b)*
Mounting surface:	
Normally flammable surface	*90*
Non-combustible surface	*Not measured*
*Parts intended to be handled or touched frequently***:*	
Metal parts	*70*
Non-metal parts	*85*
Parts intended to be gripped by hand:	
Metal parts	*60*
Non-metal parts	*75*
Objects lighted by spotlights (see 12.4.1 j)):	*90 (of test surface)*
Track (for track-mounted luminaires)	*As stated by the track manufacturer *****
Mains socket-outlet-mounted-luminaire and plug-ballast/transformer:	
– case parts intended to be gripped by hand	*75*
– the plug/socket interface	*70*
– all other parts	*85*

SECTION 13: RESISTANCE TO HEAT, FIRE AND TRACKING

13.1 General

This section specifies requirements and tests relating to the resistance to heat, fire and tracking of certain parts of insulating material of luminaires. ①

For printed wiring boards, reference should be made to the requirements of IEC 60249.

13.2 Resistance to heat

External parts of insulating material providing protection against electric shock, and parts of insulating material retaining current-carrying parts or SELV parts in position shall be sufficiently resistant to heat.

The ball pressure test does not have to be applied to plastic parts of a luminaire which provide supplementary insulation. ⑮

13.2.1 *Compliance is checked by the following test:*

The test is not made on parts of ceramic material or on insulation of wiring.

The test shall be made in a heating cabinet having a temperature 25 °C ± 5 °C in excess of the operating temperature of the relevant part determined during the temperature test (normal operation) of section 12, with a minimum temperature of 125 °C when parts retaining current-carrying parts or SELV parts in position are tested, and 75 °C for other parts.

The surface of the part to be tested shall be placed in the horizontal position and a steel ball of 5 mm diameter pressed against this surface with a force of 20 N. A suitable apparatus for this test is shown in figure 10. If the surface under test bends, the part where the ball presses should be supported.

After 1 h the ball shall be removed from the sample, and the sample shall be cooled by immersion in cold water for 10 s. The diameter of the impression shall be measured and shall not exceed 2 mm.

13.3 Resistance to flame and ignition

Parts of insulating material retaining current-carrying parts or SELV parts in position, and external parts of insulating material providing protection against electric shock shall be resistant to flame and ignition.

For materials other than ceramic, compliance is checked by the test of 13.3.1 or 13.3.2, as appropriate.

Table 12.1 *(continued)*

Part	*Maximum temperature* °C
Replaceable glow-starting devices	*80*
* *For luminaires marked with information concerning the use of special lamps, or if it is obvious that special lamps are to be used, a higher value, as specified by the lamp manufacturer, is allowed. IEC 60357 and IEC 60682 provide information for the measurement of pinch temperature for tungsten halogen lamps. These measurements are required for performance criteria of lamps and not safety criteria of the luminaire. (Single-capped fluorescent lamps are excluded from being measured under normal operation test conditions see table 12.3).* (2) *This does not apply to lamps covered by the scope of IEC 60432-2. The relevant information in this standard for luminaire design shall be observed.*	
** *Measured at the given reference point marked by the device manufacturer.*	
*** *Not applicable to parts intended to be touched only occasionally during adjustment, e.g. parts of spotlights.*	
**** *Temperature measured on the rim of a corresponding cap.*	
***** *For measuring conditions for the track temperature, see 11.1 of IEC 60570.*	
****** *For bi-pin lampholders, in case of doubt, the average of the contact temperature measurements should be used.*	
******* *The material classification is in accordance with IEC 60085 and IEC series 60216.* (2)	

The circuits subjected to abnormal conditions shall be operated at 1,1 times (the rated voltage or the maximum of the rated voltage range). When conditions are stable, the highest winding temperature and highest temperature of fixing points and most thermally influenced exposed parts shall be measured. It is not necessary to measure the temperature of small wound devices that are incorporated within electronic circuits. ②

Compliance

The values of the ambient temperature and the temperature measured at 1,1 times (the rated voltage or the maximum of the voltage range) are used for the linear regression formula in calculating the temperature of fixing points and other exposed parts in relation to a ballast/transformer winding temperature of 350 °C. The calculated value shall not exceed the temperature of the deflection under load of the material in accordance with method A as defined in ISO 75 (1987), *Plastics and ebonite – Determination of temperature of deflection under load*.

12.7.2 Test for luminaires with temperature sensing controls internal/external to the ballast or transformer

The luminaires shall be set up for this test as described in the first three paragraphs of 12.7.1.

The circuits subjected to abnormal conditions shall be operated with a slowly and steadily increasing current through the windings until the temperature sensing control operates.

Time intervals and increments in current shall be such that thermal equilibrium between winding temperatures and temperature of fixing points and most thermally influenced exposed parts is achieved as far as is practicable. During the test, the highest temperature of the spots tested shall be continuously measured.

For luminaires fitted out with manual-reset thermal cut-outs, the test shall be repeated six times allowing 30 min intervals between tests. At the end of each 30 min interval, the cut-out shall be reset.

For luminaires fitted out with auto-reset thermal cut-outs, the tests shall be continued until a stable temperature is achieved.

Compliance

The highest temperature of the fixing points and most thermally influenced exposed parts, shall not exceed the temperature of deflection under load of the material according to the method A as defined in ISO 75, at any time during the tests for thermal links, manual-reset thermal cut-outs, and auto-reset thermal cut-outs.

Table 12.2 – Maximum temperatures under the test conditions of 12.4.2, for common materials used in luminaires

Part	*Maximum temperature °C*
*Insulation of wiring (internal and external), supplied with luminaire**:*	
Glassfibre silicone-varnish impregnated	*200 **
Polytetrafluoroethylene (PTFE)	*250*
Silicone rubber (not stressed)	*200*
Silicone rubber (compressive stress only)	*170*
Ordinary polyvinyl chloride (PVC)	*90 **
Heat-resisting polyvinyl chloride (PVC)	*105 **
Ethylene vinyl acetate (EVA)	*140 **
Insulation of fixed wiring (as a fixed part of the installation not supplied with the luminaire):*	
Unsleeved	*90 ****
Appropriate sleeving supplied with the luminaire	*120*
Thermoplastics:	
Acrylonitrile-butadiene-styrene (ABS)	*95*
Cellulose acetate butyrate (CAB)	*95*
Polymethyl methacrylate (acrylic)	*90*
Polystyrene	*75*
Polypropylene	*100*
Polycarbonate	*130*
Polyvinyl chloride (PVC) (where NOT used for electrical insulation)	*100*
Polyamide (nylon)	*120*
Thermosetting plastics:	
Mineral-filled phenol-formaldehyde (PF)	*165*
Cellulose-filled phenol-formaldehyde (PF)	*140*
Urea-formaldehyde (UF)	*90*
Melamine	*100*
Glassfibre-reinforced polyester (GRP)	*130*
Other materials:	
Resin-bonded paper/fabric	*125*
Silicone rubber (where NOT used for electrical insulation)	*230*
Rubber (where NOT used for electrical insulation)	*70*
Wood, paper, textiles and the like	*90*

* *Reduced by 15 °C where insulation is stressed, e.g. clamped or flexed.*

** *Cable specifications usually quote different maximum temperatures but these are based on continuous operating temperatures rather than the test conditions given in this specification.*

*** *These temperatures are the maximum permitted under the artificial test conditions given in this test specification, for example draught-proof enclosure and test supply voltage above the rated value for the luminaire. It is important to note that, in some countries, the European installation Standards (HD 384) and the European Cable Standards (HD 21) specify a temperature of 70 °C to be the maximum that PVC fixed wiring can sustain in normal continuous operation.*

During any cycle of operation of the protector during the test, the surface temperature may be more than 135 °C provided that the length of time between the instant when the surface temperature first exceeds the limit and the instant of attainment of the maximum temperature indicated in table 12.6 does not exceed the time correspondingly indicated in that table.

Table 12.6 – Temperature overshoot time limitation

Maximum temperature of the mounting surface °C	*Maximum time for attainment of the maximum temperature from 135 °C* Min
over 180	*0*
between 175 and 180	*15*
between 170 and 175	*20*
between 165 and 170	*25*
between 160 and 165	*30*
between 155 and 160	*40*
between 150 and 155	*50*
between 145 and 150	*60*
between 140 and 145	*90*
between 135 and 140	*120*

After the test, the following applies:

The highest temperature of any part of the mounting surface shall not exceed 180 °C at any time during tests for thermal links and manual-reset thermal cut-outs, or 130 °C during tests for auto-reset thermal cut-outs.

For track-mounted luminaires, after the test no part of the track shall show symptoms of unsafe deterioration, for example cracks, scorches or deformation.

12.7 Thermal test in regard to fault conditions in lamp controlgear or electronic devices in plastic luminaires

The test applies only to luminaires with a thermoplastic housing not fitted with an extra mechanical temperature-independent device as per 4.15.2.

12.7.1 Test for luminaires without temperature sensing controls

The luminaire shall be tested under the conditions specified in items a), c), e), f) and h) of 12.4.1. In addition, the following also applies.

20 % of the lamp circuits in the luminaire, and not less than one lamp circuit, shall be subjected to abnormal conditions (see item a) of 12.5.1).

The circuits which have the most thermal influence on the fixation point and exposed parts shall be chosen and other lamp circuits shall be operated at rated voltage under normal conditions.

12.5 Thermal test (abnormal operation)

Under conditions representing abnormal service conditions (where applicable, but not representing a defect in the luminaire or misuse) parts of the luminaire and the mounting surface shall not exceed the temperatures given in table 12.3 and the wiring within the luminaire shall not become unsafe. (1)

NOTE – Symptoms of possible unsafe conditions include cracks, scorches and deformation.

During the test for compliance, the through wiring shall not be loaded.

Track-mounted luminaires shall not cause excessive heating of tracks on which they are mounted.

Compliance is checked by carrying out the test described in 12.5.1.

12.5.1 Test

Temperatures of parts listed in table 12.3 shall be measured in accordance with the following conditions.

a) The test shall be made if, during service, the luminaire could be in an abnormal condition as in cases 1), 2), 3) or 4) below, and if this condition would cause any part to be at a higher temperature than during normal operation (in which case a preliminary trial may be needed).

If more than one abnormal condition is possible, that condition shall be selected which most adversely affects the results of the tests.

The test is not applicable to fixed non-adjustable filament lamp luminaires except in case 3) below.

1) A possibly unsafe operating position arising other than from misuse; e.g. if by accident an adjustable luminaire is bent close to the supporting surface using a force not exceeding 30 N.

2) A possibly unsafe circuit condition arising other than from defective manufacture or misuse; for example a circuit condition occurring at the end of the service period of a lamp or of a starter (see annex C).

3) A possibly unsafe operation condition arising from the use of a GLS lamp in a filament lamp luminaire intended for a special lamp; e.g. if, temporarily, a special lamp is replaced by a GLS lamp of the same wattage.

4) A possible unsafe circuit condition arising from a short circuit in the secondary circuit (including the transformer itself) of a luminaire with transformer fitted for lamp voltage supply.

Test 2) is applicable only to tubular fluorescent and other discharge lamp luminaires.

Test 4) shall be made with a short-circuit in the lampholder. During test 4), the temperature rise due to heat emanating from the lamp to the mounting surface shall be checked by the test according to item 1), while the temperature rise due to heat emanating from the transformer shall be measured with the contacts of the lampholder being short-circuited.

Luminaires containing an electrical motor are operated with the rotor locked against rotation.

NOTE – In the case of the presence of one or more motors, the test should be made in accordance with the most critical condition (see annex C). (2)

The luminaire shall be tested under the conditions specified in Items a), c), e), f), and h) of 12.4.1. In addition the following shall apply.

For fluorescent lamp luminaires with an a.c. supplied electronic lamp control gear incorporating a filter coil, the filter coil shall be tested separately by applying a test voltage across the coil adjusted to give the nominal operating current. All other parts of the lamp control gear and the lamp shall be inoperative for this test.

NOTE – For the purpose of this test specially prepared lamp control gear is needed. (1)

Compliance is checked as follows:

a) The temperature of the mounting surface shall not exceed 130 °C when the lamp circuit(s), subjected to abnormal conditions, is (are) operated at 1,1 times rated voltage.

b) The values of the ambient temperature and the temperature measured at 1,1 times (the rated voltage or the maximum of the rated voltage range) are plotted on a graph (figure 9) and the best straight line obtained using linear regression is drawn through these points. The extrapolation of this straight line shall not reach a point representing a mounting surface temperature of 180 °C at a ballast or transformer winding temperature of less than 350 °C.

c) For track-mounted luminaires, no part of the track shall show symptoms of unsafe deterioration, for example cracks, scorches or deformation.

12.6.2 *Test for luminaires with temperature sensing controls external to the ballast or transformer and luminaires with temperature declared thermally protected ballasts symbol*  *with a marked value above 130 °C.*

The luminaire shall be set up for this test as described in 12.6.1.

The circuits subjected to the above conditions shall be operated with a slowly and steadily increasing current through the windings until the thermal cut-out operates. Time intervals and increments in current shall be such that thermal equilibrium between winding temperatures and mounting surface temperatures is achieved as far as is practicable.

During the test, the highest temperature of any part of the surface on which the luminaire is mounted shall be continuously measured. This completes the test for luminaires fitted with thermal links.

For luminaires fitted with manual-reset thermal cut-outs, the test shall be repeated three times, allowing a 30 min interval between tests. At the end of each 30 min interval, the cut-out shall be reset.

For luminaires fitted with auto-reset thermal cut-outs, the test shall be continued until a stable mounting surface temperature is achieved. The auto-reset thermal cut-out shall operate three times by switching the ballast off and on, under the given conditions.

NOTE – Associated transformers not tested with their own enclosure should be subjected to the test since these characteristics are not verified by the component standard.

Conformity is checked as follows:

During the test the temperature of any part of the mounting surface shall not exceed 135 °C and shall be not more than 110 °C when the protector recloses the circuit (with a resetting type protector) except that:

b) The test voltage shall be as follows.

Filament lamp luminaires: as specified in item d) of 12.4.1.

Tubular fluorescent and other discharge lamp luminaires: 1,1 times the rated voltage or the maximum of the rated voltage range.

For motors contained in luminaires: 1,1 times the rated voltage (or the maximum of the rated voltage range of the luminaire). (2)

During short-circuit according to test 4) between 0,9 and 1,1 times the rated supply voltage.

NOTE – If a luminaire contains both a filament lamp and a tubular fluorescent or other discharge lamp, or a motor, it may be necessary to provide it temporarily with two separate supplies. (2)

c) If the luminaire ceases to operate because of a defective part of the luminaire (including the lamp), the part should be replaced and the test continued. Measurements already made need not be repeated but the luminaire shall be stabilized before further measurements are made. If, however, a hazardous condition has arisen, or if any part becomes unserviceable as a type defect, then the luminaire is deemed to have failed the test.

If a protective device in the luminaire (for example a thermal or current cut-out of the one-shot or cycling type) operates during the test, the highest temperatures reached should be taken as the final temperatures.

d) If the luminaire incorporates a capacitor (other than a capacitor connected directly across the supply), this capacitor shall be short-circuited, notwithstanding the requirements of annex C, if the voltage across it under test conditions would exceed 1,25 times its rated voltage for self-healing capacitors or 1,3 times its rated voltage for non-self-healing capacitors.

e) Luminaires for metal halide lamps which according to the lamp specification can lead to ballast or transformer overheating are tested in accordance with 2b) of annex C.

The values given in table 12.3 shall not be exceeded.

12.5.2 Compliance

In the test of 12.5.1, none of the temperatures shall exceed the appropriate value given in table 12.3 (subject only to the concession of item a) below) when the luminaire is operated at its rated ambient temperature t_a. In cases where the temperature of the test enclosure differs from t_a, the difference shall be taken into account when applying the limits given in the table.

a) Temperatures shall not exceed the values shown in table 12.3 by more than 5 °C.

NOTE – The allowance of 5 °C is made to take into account the inevitable variability of temperature measurements in luminaires.

Table 12.5 – Maximum temperature of windings under abnormal operating conditions and at 110 % of rated voltage for lamp control gear marked "D6"

		Maximum temperature °C					
Constant S		***S4.5***	***S5***	***S6***	***S8***	***S11***	***S16***
For t_w =	*90*	*158*	*150*	*139*	*125*	*115*	*107*
	95	*165*	*157*	*145*	*131*	*121*	*112*
	100	*172*	*164*	*152*	*137*	*127*	*118*
	105	*179*	*171*	*158*	*144*	*132*	*123*
	110	*187*	*178*	*165*	*150*	*138*	*129*
	115	*194*	*185*	*171*	*156*	*144*	*134*
	120	*201*	*192*	*178*	*162*	*150*	*140*
	125	*208*	*199*	*184*	*168*	*155*	*145*
	130	*216*	*206*	*191*	*174*	*161*	*151*
	135	*223*	*213*	*198*	*180*	*167*	*156*
	140	*231*	*220*	*204*	*186*	*173*	*162*
	145	*238*	*227*	*211*	*193*	*179*	*168*
	150	*246*	*234*	*218*	*199*	*184*	*173*

NOTE – For lamp control gear subjected to an endurance test duration other than 30 or 60 days, equation (2) specified in the relevant IEC auxiliary standard should be used to calculate the maximum temperature which should correspond to the number of days equal to two-thirds of the theoretical endurance test.

(An explanation of the constant S and its use is given in the relevant IEC auxiliary standard.)

12.6 Thermal test (failed lamp controlgear conditions)

These tests apply only to luminaires marked with the ▽F *symbol and incorporating lamp control gear that either does not meet the spacing requirements of 4.16.1 or does not provide thermal protection in accordance with 4.16.2. Electronic lamp controlgear and small wound devices that may be incorporated into these components are exempt from the requirements of this clause.* ②

12.6.1 Test for luminaires without thermal cut-outs

The luminaire shall be tested under the conditions specified in items a), c), e), f) and h) of 12.4.1. In addition, the following also apply.

20 % of the lamp circuits in the luminaire, and not less than one lamp circuit, shall be subjected to abnormal conditions (see item a) of 12.5.1).

The circuits which have the most thermal influence on the mounting surface shall be chosen, and other lamp circuits shall be operated at rated voltage, or at the maximum of the rated voltage range under normal conditions.

Circuits subjected to abnormal conditions shall then be operated at 1,1 times the rated voltage, or the maximum of the rated voltage range.

Table 12.3 – Maximum temperatures under the test conditions of 12.5.2

Part	***Maximum temperature*** °C
Caps of single-capped fluorescent lamps	*As specified in the appropriate IEC lamp standard****
*Windings in ballasts or transformers with t_w marking**	*See tables 12.4 and 12.5*
Windings in transformers, motors etc., if the winding insulation system according to IEC 60085 is:	
– *of class A material***	*150*
– *of class E material***	*165*
– *of class B material***	*175*
– *of class F material***	*190*
– *of class H material***	*210*
Capacitor case:	
– *If t_c is not marked*	*60*
– *If t_c is marked*	*t_c + 10*
Mounting surface:	
– *Surface illuminated by the lamp (adjustable luminaires according to 12.5.1a) 1)*	*175*
– *Surface heated by the lamp (portable luminaires according to 4.12 of IEC 60598-2-4)*	*175*
– *Normally flammable surface (luminaires with (F) marking)*	*130*
– *Non-combustible surface (luminaires without (F) symbol)*	*Not measured*
Track (for track-mounted luminaires)	*As stated by the track manufacturer*
Mains socket-outlet-mounted-luminaires and plug-ballast/transformer case parts intended to be gripped by hand	*75*

* *Unless otherwise marked on the ballast, the maximum temperatures specified in the column S4.5 of table 12.4 or 12.5 apply.*

** *The material classification is in accordance with IEC 60085 and IEC series 60216.*

*** *Information regarding point(s) of measurement and temperature limits are given in IEC 61199, annex C.*

Table 12.4 – Maximum temperature of windings under abnormal operating conditions and at 110 % of rated voltage for lamp control gear

		Maximum temperature °C					
Constant S		***S4.5***	***S5***	***S6***	***S8***	***S11***	***S16***
For t_w =	*90*	*171*	*161*	*147*	*131*	*119*	*110*
	95	*178*	*168*	*154*	*138*	*125*	*115*
	100	*186*	*176*	*161*	*144*	*131*	*121*
	105	*194*	*183*	*168*	*150*	*137*	*126*
	110	*201*	*190*	*175*	*156*	*143*	*132*
	115	*209*	*198*	*181*	*163*	*149*	*137*
	120	*217*	*205*	*188*	*169*	*154*	*143*
	125	*224*	*212*	*195*	*175*	*160*	*149*
	130	*232*	*220*	*202*	*182*	*166*	*154*
	135	*240*	*227*	*209*	*188*	*172*	*160*
	140	*248*	*235*	*216*	*195*	*178*	*166*
	145	*256*	*242*	*223*	*201*	*184*	*171*
	150	*264*	*250*	*230*	*207*	*190*	*177*