PS: _5211/2018
(ICS:29.140.99)

PAKISTAN STANDARD

LED MODULES FOR GENERAL LIGHTING (SAFETY SPECIFICATIONS)

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LED MODULES FOR GENERAL LIGHTING (SAFETY SPECIFICATIONS)

0. FOREWORD

0.1 This Pakistan Standard was adopted by the authority of the Board of Directors for Pakistan Standards and Quality Control Authority after approval by the Technical Committee for Electric Lamps (TC-2) had been approved and endorsed by the Electrotechnical National Standards Committee on 31 January 2018.

0.2 This Pakistan Standard was prepared on the basis of IEC: 62031 since IEC Standard have been established in 2012, and amendment I was issued in October2012, and amendment II September 2014 hence it is deemed necessary to revise the Pakistan standard to keep abreast with the latest technology.

0.3 This Pakistan Standard is formulated on the basis of IEC 62031 "LED Modules for General lighting (Safety specifications)" along with amendment I and amendment II and some modifications for local conditions i.e. voltage range modified 80% to 106% and also ambient air temperature modified as $-10\ ^{0}C$ to $50^{0}C$.

0.4 Provision of Surge Protecting Device (SPD) is also to be part of this Standard.

0.5 Annexure O is prepared and attached for local requirements

0.6 This standard is subject to periodical review in order to keep pace with the development in industry. Any suggestions for improvement shall be recorded and placed before the revising committee in due course.

0.7 This standard is intended chiefly to cover the technical provisions relating to this standard and it does not include all the necessary provisions of a Contract.

CONTENTS

LED MODULES FOR GENERAL LIGHTING – SAFETY SPECIFICATIONS

1 Scope

This Pakistan Standard specifies general and safety requirements for light-emitting diode (LED) modules:

* LED modules without integral control gear for operation under constant voltage, constant current or constant power;
* self-ballasted LED modules for use on d.c. supplies up to 250 V or a.c. supplies up to 1 000 V at 50 Hz or 60 Hz.

NOTE 1 The safety requirements for separate control gear are specified in IEC 61347-2-13. The performance requirements for separate control gear are specified in IEC 62384.

NOTE 2 Requirements for LED modules with integrated control gear and equipped with a lamp cap (self-ballasted lamp), intended for mains voltage general lighting service retrofit applications (thereby replacing existing lamps with identical lamp caps) are specified in IEC 60968 (an amendment to the present edition or a new edition with extended scope is in preparation).

Requirements for LED modules with integrated control gear and equipped with a lamp cap (self-ballasted lamp), intended for non-mains voltage general lighting service retrofit applications (thereby replacing existing lamps with identical lamp caps) are under consideration.

NOTE 3 Where in the requirements of this standard both types of LED modules, with and without integral control gear, are addressed, the word “modules” is used instead. Where only the expression “LED module(s)” is used, it is understood to refer to the type without integral control gear.

NOTE 4 This standard includes photobiological safety.

2 Normative references

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

PS:IEC 60417*, Graphical symbols for use on equipment.* Available at http://www.graphical-symbols.info/equipment

PS:IEC:60598-1*, Luminaires, Part 1: General requirements and tests*

PS:IEC 60838-2-2*, Miscellaneous lampholders – Part 2-2: Particular requirements – Connectors for LED modules*

PS:IEC:61347 -1:2007, *Lamp controlgear – Part 1: General and safety requirements*

PS:IEC:61347 -2-13:2006, *Lamp controlgear – Part 2-13: Particular requirements for d.c. or a.c. supplied electronic controlgear for LED modules*

PS:IEC TR 62778, *Application of IEC 62471 for the assessment of blue light hazard to light sources and luminaires*

PS:ISO 4046-4:2002, *Paper, board, pulp and related terms – Vocabulary – Part 4: Paper and board grades and converted products*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

For expressions and terms in the field of LEDs and LED modules, refer to PS:IEC TS 62504, which is currently in development.

3.1
light-emitting diode
LED
solid state device embodying a p-n junction, emitting optical radiation when excited by an electric current

[IEV 845-04-40]

3.2
LED module
unit supplied as a light source. In addition to one or more LEDs, it may contain further components, e.g. optical, mechanical, electrical and electronic, but excluding the control gear.

3.3
self-ballasted LED module
LED module, designed for connection to the supply voltage

NOTE If the self-ballasted LED module is equipped with a lamp cap, it is regarded to be a self-ballasted lamp.

3.4
integral LED module
LED module, generally designed to form a non-replaceable part of a luminaire

3.5
integral self-ballasted LED module
self-ballasted LED module, generally designed to form a non-replaceable part of a luminaire

3.6
built-in LED module
LED module, generally designed to form a replaceable part built into a luminaire, a box, an enclosure or the like and not intended to be mounted outside a luminaire, etc. without special precautions

3.7
built-in self-ballasted LED module
self-ballasted LED module, generally designed to form a replaceable part built into a luminaire, a box, an enclosure or the like and not intended to be mounted outside a luminaire, etc. without special precautions

3.8
independent LED module
LED module, so designed that it can be mounted or placed separately from a luminaire, an additional box or enclosure or the like. The independent LED module provides all the necessary protection with regard to safety according to its classification and marking.

NOTE The control gear must not necessarily be integrated in the module.

3.9
independent self-ballasted LED module
self-ballasted LED module, so designed that it can be mounted or placed separately from a luminaire, an additional box or enclosure or the like. The independent LED module provides all the necessary protection with regard to safety according to its classification and marking.

NOTE The control gear may be integrated in the module.

3.10
rated maximum temperature
t_c
highest permissible temperature which may occur on the outer surface of the LED module (at the indicated position, if marked) under normal operating conditions and at the rated voltage/current/power or the maximum of the rated voltage/current/power range

3.11
heat transfer temperature
t_d
temperature occurring on a representative part of the LED module (or any heat-conducting foil or paste applied as for insertion if delivered with the LED module) (at the indicated position if marked) intended for the passing of heat to the lampholder or to other parts of the luminaire under normal operating conditions and at the rated voltage/current/power or the maximum of the rated voltage/current/power range

NOTE A measurement method is under consideration.

3.12
heat output to the luminaire
P_d
power to be transferred to the luminaire by means of heat-conduction in order to keep t_c

NOTE 1 P_d is below the rated power of an LED module.

NOTE 2 For LED modules which do not need heat-conduction to the luminaire for keeping t_c, P_d is equal to zero.

NOTE 3 A measurement method is under consideration.

3.13
ultraviolet hazard efficacy of luminous radiation
$K_{S,v}$
quotient of an ultraviolet hazard quantity to the corresponding photometric quantity

NOTE 1 Ultraviolet hazard efficacy of luminous radiation is expressed in mW/klm.

NOTE 2 The ultraviolet hazard efficacy of luminous radiation is obtained by weighting the spectral power distribution of the lamp or LED module with the UV hazard function $S_{UV}(\lambda)$. Information about the relevant UV hazard function is given in PS:IEC 62471. It only relates to possible hazards regarding UV exposure of human beings. It does not deal with the possible influence of optical radiation on materials, such as mechanical damage or discoloration.

4 General requirements

4.1 Modules shall be so designed and constructed that in normal use (see manufacturer's instruction) they operate without danger to the user or surroundings.

4.2 For LED modules, all electrical measurements, unless otherwise specified, shall be carried out at voltage limits (min/max), current limits (min/max) or power limits (min/max) and minimum frequency, in a draught-free room at the temperature limits of the allowed range specified by the manufacturer. Unless the manufacturer indicates the most critical combination, all combinations (min/max) of voltage/current/power and temperature shall be tested.

4.3 For self-ballasted LED modules, the electrical measurements shall be carried out at the tolerance limit values of the marked supply voltage.

4.4 Integral modules not having their own enclosure shall be treated as integral components of luminaires as defined in PS:IEC: 60598-1, Clause 0.5. They shall be tested assembled in the luminaire, and as far as applicable with the present standard.

4.5 In addition, independent modules shall comply with the requirements of IEC 60598-1, including marking requirements of that standard such as IP classification and mechanical stress.

4.6 If the module is a factory sealed unit, it shall not be opened for any tests. In the case of doubt based on the inspection of the module and the examination of the circuit diagram, and in agreement with the manufacturer or responsible vendor, such specially prepared modules shall be submitted for testing so that a fault condition can be simulated.

5 General test requirements

5.1 Tests according to this standard shall be type tests.

NOTE The requirements and tolerances permitted by this standard are related to testing of a type-test sample submitted by the manufacturer for that purpose. Compliance of the type-test sample does not ensure compliance of the whole production of a manufacturer with this safety standard.

Conformity of production is the responsibility of the manufacturer and may need routine tests and quality assurance in addition to type testing.

5.2 Unless otherwise specified, the tests shall be carried out at an ambient temperature of -10 °C to 50 °C.

5.3 Unless otherwise specified, the type test shall be carried out on one sample consisting of one or more items submitted for the purpose of the type test.

In general, all tests shall be carried out on each type of module or, where a range of similar modules is involved, for each wattage in the range or on a representative selection from the range, as agreed with the manufacturer.

5.4 If the light output has detectably changed, the module shall not be used for further tests.

NOTE Usually, a value of 50 % indicates irreversible changes in the module.

5.5 For SELV-operated LED modules, the requirements of PS:IEC:61347 -2-13, Annex I, apply additionally.

General conditions for tests are given in Annex A.

6 Classification

Modules are classified, according to the method of installation, as:

– built-in;
– independent;
– integral.

For integral modules, the NOTE to 1.2.1 in PS:IEC:60598-1 applies.

7 Marking

7.1 Mandatory marking for built-in or independent modules

a) Mark of origin (trade mark, manufacturer's name or name of the responsible vendor/supplier).

b) Model number or type reference of the manufacturer.

c)

1) If the LED module requires a stable voltage(s), the rated supply voltage or voltage range, both together with the supply frequency shall be marked. Marking of the rated supply current(s) is voluntary.

2) If the LED module requires a stable current, the rated supply current(s) or current range, both together with the supply frequency shall be marked. Marking of the rated supply voltage(s) is voluntary.

d) Nominal power.

e) Indication of position and purpose of the connections where it is necessary for safety. In case of connecting wires, a clear indication shall be given in a wiring diagram.

f) Value of t_c. If this relates to a certain place on the LED module, this place shall be indicated or specified in the manufacturer's literature.

g) If the assessment of blue light hazard according to PS:IEC TR 62778 results in assignment to risk group 0 or risk group 1, no marking for photobiological safety is required. If the assessment of blue light hazard according to PS:IEC TR 62778 results in a threshold illuminance value E_{thr}, marking with the E_{thr}, is required.

h) Built-in modules shall be marked with the symbol according to Figure 1 in order to separate them from independent modules. The mark shall be located on the packaging or on the LED module itself.

Source: IEC 60417-6053 (2011-05)

Figure 1 – Symbol for built-in LED modules

i) The heat transfer temperature t_d (if the LED module is provided with a cap enabling the insertion and the withdrawal without the use of tools and reliant on heat-conduction to the luminaire).

j) The power for heat-conduction P_d (if the LED module is provided with a cap enabling the insertion and the withdrawal without the use of tools and reliant on heat-conduction to the luminaire). If P_d is not known exactly, the rated power of the LED module may be taken instead.

k) Working voltage at which the insulation is designed.

7.2 Location of marking

Items a), b), c) and f) of 7.1 shall be marked on the module.

Items d), e), g), h), i) and j) shall be marked legibly on the LED module or on the LED module data sheet. Item k) should be in the manufacturer's literature.

For integral modules, no marking is required, but the information given in 7.1 a) to g) shall be provided in the technical literature of the manufacturer.

7.3 Durability and legibility of marking

Marking shall be durable and legible.

For items a), b), c) and f) of 7.1, compliance is checked by inspection and by trying to remove the marking by rubbing the area lightly by hand for 15 s with a piece of smooth cloth, dampened with water.

The marking shall be legible after the test.

For items d) to j) of 7.1, compliance is checked by inspection.

8 Terminals

For screw terminals, the requirements of PS:IEC:60598-1, Section 14, shall be used, if applicable.

For screwless terminals, the requirements of PS:IEC:60598-1, Section 15, shall be used, if applicable.

For connectors, the requirements of PS: IEC 60838-2-2 shall be used, if applicable.

9 Provisions for protective earthing

The requirements of PS:IEC:61347-1, Clause 9, apply.

10 Protection against accidental contact with live parts

The requirements of PS:IEC:61347-1, Clause 10, apply.

11 Moisture resistance and insulation

The requirements of PS:IEC:61347-1, Clause 11, apply.

12 Electric strength

The requirements of PS:IEC:61347-1, Clause 12, apply.

13 Fault conditions

13.1 General

The module shall not impair safety when operated under fault conditions that may occur during the intended use. The requirements of PS:IEC:61347-1, Clause 14, apply. Additionally, the following test shall be carried out.

13.2 Overpower condition

The test shall be started at an ambient temperature as specified in Annex A.

The LED module shall be switched on and the power monitored (at the input side). The voltage or the current shall be increased until 150 % of the rated power is reached. The test shall be continued until the LED module is thermally stabilised. A stable condition is reached, if the temperature does not change by more than 5 K in 1 h. The temperature shall be measured in the t_c point. The LED module shall withstand the overpower condition for at least 15 min, the time period of which can lie within the stabilisation period if the temperature change is ≤ 5 K.

If the module contains an automatic protective device or circuit which limits the power, it is subjected to a 15 min operation at this limit. If the device or circuit effectively limits the power over this period, the module has passed the test, provided the compliance (4.1 and last paragraph of 13.2) is fulfilled.

After finalising the overpower mode, the module is operated under normal conditions until thermally being stable.

A module fails safe if no fire, smoke or flammable gas is produced and if the 15 min overpower condition has been withstood. To check whether molten material might present a safety hazard, a tissue paper, as specified in 4.187 of PS:ISO 4046-4, spread below the module shall not ignite.

14 Conformity testing during manufacture

See Annex C.

15 Construction

Wood, cotton, silk, paper and similar fibrous material shall not be used as insulation.

Compliance is checked by inspection.

16 Creepage distances and clearances

The requirements of PS:IEC:61347-1 apply except for conductive accessible parts where PS:1601-1 is applicable.

17 Screws, current-carrying parts and connections

The requirements of PS:IEC:61347-1, Clause 17, apply.

18 Resistance to heat, fire and tracking

The requirements of PS:IEC:61347-1, Clause 18, apply.

19 Resistance to corrosion

The requirements of PS:IEC:61347-1, Clause 19, apply.

20 Information for luminaire design

Information is given in Annex D.

21 Heat management

21.1 General

Clause 21 is applicable for exchangeable modules. It is not applicable for non-exchangeable modules. Exchangeability is safeguarded by means of a cap or base and a lampholder. Precondition is that a heat conducting thermal interface to the luminaire is needed for keeping the temperature below the rated maximum temperature t_c.

21.2 Heat-conducting foil and paste

For the purpose of heat-transfer from the LED module to the luminaire, the use of a heat-conducting foil can be necessary. Any heat-conducting foil shall be delivered within the LED module packaging.

Heat-conducting paste shall not be used (under consideration).

21.3 Heat protection (under consideration)

LED modules shall be equipped with a device that cuts the power off or reduces it when t_c is exceeded.

21.4 Construction

The heat-conduction from the LED module to the luminaire, the electrical connection and the mechanical holding in the cap/holder system should be separate unless the contrary is proven safe (under consideration).

22 Photobiological safety

22.1 UV radiation

The ultraviolet hazard efficacy of luminous radiation of an LED module shall not exceed 2 mW/klm.

Compliance is checked by measurement of the spectral power distribution and subsequent calculation of the ultraviolet hazard efficacy of luminous radiation.

LED modules not relying on the conversion of UV radiation are expected to not exceed the maximum allowed ultraviolet hazard efficacy of luminous radiation. They do not require measurement.

22.2 Blue light hazard

The blue light hazard shall be assessed according to PS:IEC TR 62778, which shall be regarded as normative when testing LED modules to this standard.

NOTE Clause C.2 of IEC TR 62778 gives a method to classify LED modules where full spectral data is not available.

22.3 Infrared radiation

LED modules are expected to not reach a level of infrared radiation where marking or other safety measurements are required. They do not require measurement.

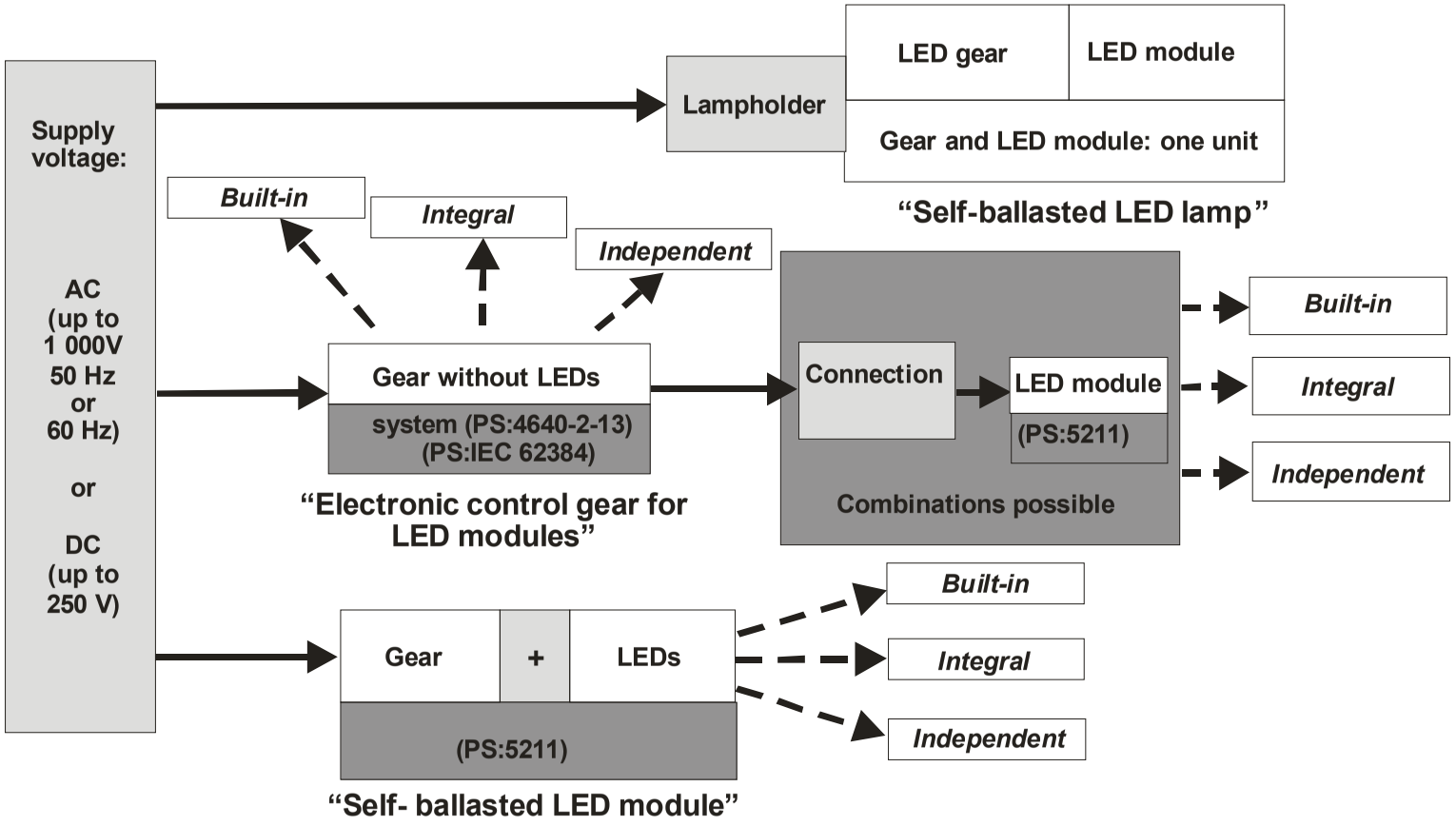
Annex A
(normative)

Tests

Refer to PS:4640-1, Annex H, Clauses H.1, H.2, H.4, H.7, and to Subclause H.11.2. In H.1.3, ignore the first paragraph. In all clauses, replace “lamp”, “(lamp) control gear” or “ballast” by “LED module”.

Annex B
(informative)

Overview of systems composed of LED modules and control gear



IEC 2316/07

Figure B.1 – Overview of systems composed of LED modules and control gear

Annex C
(informative)

Conformity testing during manufacture

This test is carried out at 100 % of production. It is combined with the measurement of input power at rated voltage/current. The luminous flux of no module should be significantly lower than that of the rest of the production.

NOTE Very low values of the luminous flux indicate internal losses that may be safety relevant, like current bridges.

For independent and built-in modules, PS:IEC: 60598-1, Annex Q, is applicable, but without polarity check.

Annex D
(informative)

Information for luminaire design

D.1 General

This annex applies for LED modules that:

- have a cap/base enabling the insertion and the withdrawal of the LED module with or without the use of tools,
- do not have a heat management on board and rather rely on heat-conduction to the luminaire for safe operation.

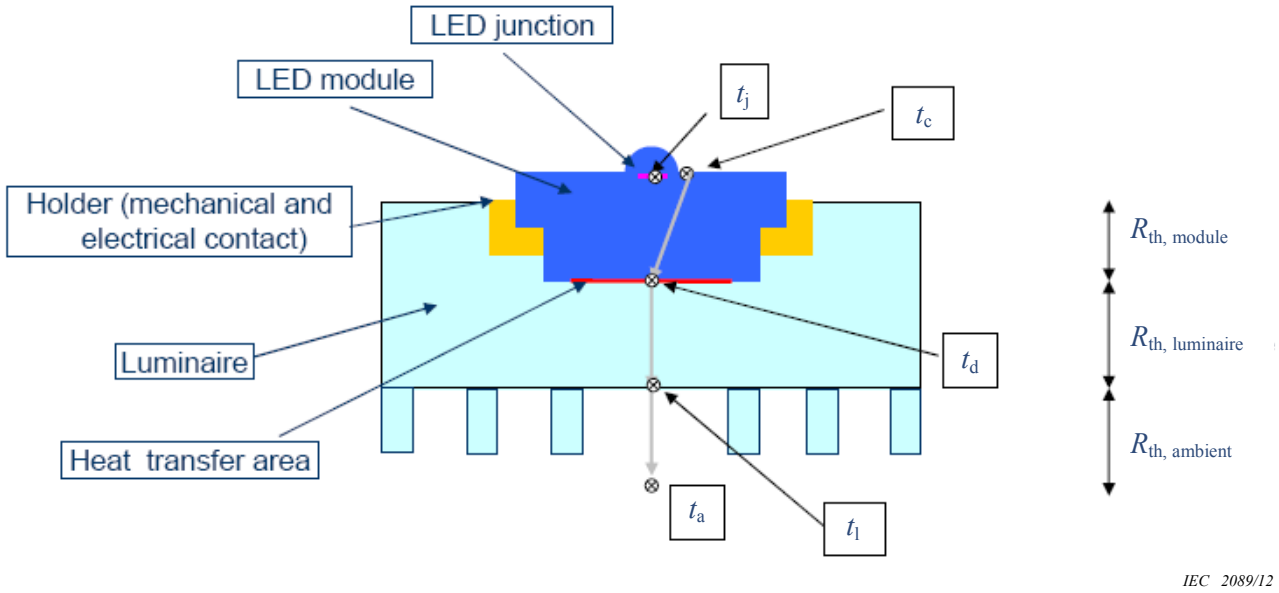
This annex covers only those provisions that are related to the thermal needs specific for these LED modules.

NOTE Because of their non-interchangeability, integral LED modules are excluded. Because independent LED modules are luminaire-like, not needing protection or else from a luminaire neither using a lampholder, they provide for their own heat management and are excluded. Only built-in LED modules remain within the scope of this annex.

For safe operation of these LED modules, it is essential to observe the recommendations of this annex.

D.2 Design freedom

A diagrammatic cross section of an LED module fixed by means of a lampholder to a luminaire with the locations for temperature measurements (t_a, t_c, t_d, t_j and t_l) and thermal resistances ($R_{th,\ module}$, $R_{th,\ luminaire}$ and $R_{th,\ ambient}$) is given with Figure D.1.



Key:

t_a rated maximum ambient temperature of the luminaire as defined in IEC 60598-1

t_c rated maximum temperature

t_d minimum heat transfer temperature

t_j junction temperature (shown for illustration only)

t_l temperature on the surface of the luminaire (shown for illustration only)

$R_{th,\ module}$ thermal resistance between t_c point and t_d point

$R_{th,\ luminaire}$ thermal resistance between t_d point and t_l point

$R_{th,\ ambient}$ thermal resistance between t_l and ambient

Figure D.1 – Diagrammatic cross section of an LED module (blue) fixed by means of a lampholder (yellow) to a luminaire (light blue, with symbolised cooling fins)

The thermal resistances shown in Figure D.1 can be added to a thermal resistance of the system:

$$R_{th,\ module} + R_{th,\ luminaire} + R_{th,\ ambient} = R_{th,\ system} \quad (D.1)$$

Any thermal resistance can be calculated from the temperature difference and the heat flow, e. g.:

$$R_{th,\ system} = (t_c - t_a) / P_d \quad (D.2)$$

$$R_{th,\ module} = (t_c - t_d) / P_d \quad (D.3)$$

The design freedom of the luminaire is given by the sum of $R_{th,\ luminaire} + R_{th,\ ambient}$. It can be calculated as follows:

$$R_{th,\ luminaire} + R_{th,\ ambient} = (t_d - t_a) / P_d \quad (D.4)$$

D.3 Testing in the luminaire

The knowledge of t_d and P_d as provided by the LED module manufacturer, of the geometry and the surface properties of the cap and of the t_a of the luminaire to be designed, will allow for designing a luminaire that will most probably keep the t_c of the LED module. However, testing in the luminaire if the luminaires does so will still be necessary.

Details of the test procedure are under consideration.

D.4 Blue light hazard assessment

D.4.1 LED modules of risk group 0 and risk group 1

If assessment according to PS:IEC TR 62778 leads to risk group 0 or risk group 1 classification of an LED module with respect to blue light hazard, any luminaire incorporating one or more of these LED modules should also be classified as of the same risk group with respect to blue light hazard, regardless of optics and viewing distance.

However, it should be left to the discretion of the luminaire manufacturer to apply PS:IEC TR 62778 directly to the luminaire, which could lead to a lower risk group classification.

D.4.2 LED modules with a threshold illuminance E_{thr}

If assessment according to PS:IEC TR 62778 leads to the classification of an LED module as having a threshold illuminance E_{thr}, any luminaire incorporating one or more of these LED modules should be regarded classified as having the same threshold illuminance E_{thr}. The viewing distance where this threshold illuminance is reached should be calculated according to 7.1 of PS:IEC TR 62778 from the luminous flux distribution measurement of the luminaire.

However, it should be left to the discretion of the luminaire manufacturer to apply PS:IEC TR 62778 directly to the luminaire, which could lead to a threshold illuminance E_{thr} greater than that of the LED module.

NOTE If, apart from the light source and its components, luminaires incorporate passive optical components such as lenses and reflectors, these will not change E_{thr}.

Annexure O

1. Efficiency

a. LED Bulbs 80 lumens/ watt

b. LED Tube Lights/ 80 lumens/ watt

c. LED Flood Lights up to 50 and above 50

d. LED Street Lights up to 50 and above 50

e. LED Down Light/panels 60 lumens/ watt

2. SPD Surge Protection Devices

Provision of Surge Protecting Device (SPD) is also recommended accordingly.

3. Power Factor >0.5