IS 16103-1 (2012): LED Modules for General Lighting, Part 1: Safety Requirements [ETD 23: Electric Lamps and their Auxiliaries]

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Indian Standard

LED MODULES FOR GENERAL LIGHTING

PART 1 SAFETY REQUIREMENTS

ICS 29.140.99

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Electric Lamps and Their Auxiliaries Sectional Committee, ETD 23

FOREWORD

This Indian Standard (Part 1) was adopted by the Bureau of Indian Standards, after the draft finalized by the Electric Lamps and Their Auxiliaries Sectional Committee had been approved by the Electrotechnical Division Council.

This standard specifies the general and safety requirements for LED modules for general lighting services.

The performance requirements have been covered in Part 2 of this standard.

This standard is published in two parts. The other part in the series is:

Part 2 Performance requirements

This standard for LED modules for general lighting applications acknowledges the need for relevant tests for this new source of electrical light, sometimes called 'solid state lighting'.

The provisions in this standard represent the technical knowledge of experts from the fields of the semiconductor industry and those of the traditional electrical light sources. Two types of LED modules namely with integral and external control gear are covered in this standard.

This standard is based on IEC 62031 : 2008 'LED modules for general lighting — Safety specifications' and 34A/1416/CDV, LED modules for general lighting safety specifications, issued by the International Electrotechnical Commission (IEC) with following modifications.

a) Schedule of type test and acceptance test has been incorporated, and
b) Referred to standards have been changed.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

LED MODULES FOR GENERAL LIGHTING

PART 1 SAFETY REQUIREMENTS

1 SCOPE

This standard (Part 1) specifies general and safety requirements for light-emitting diode (LED) modules:

a) LED modules without integral control gear for operation under constant voltage, constant current or constant power; and

b) 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.

The performance requirements are given in a separate standard IS 16103 (Part 2) : 2012 'LED modules for general lighting : Part 2 Performance requirements'.

NOTES

1 The safety requirements for separate control gear are specified in IS 15885 (Part 2/Sec 13) : 2012 'Lamp Controlgear: Part 2 Particular requirements, Section 13 d.c. or a.c. supplied electronic control gear for LED modules'.

2 The performance requirements for separate control gear are specified in IS 16104 : 2012 'd.c. or a.c. supplied electronic controlgear for LED modules — Performance requirements'.

3 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 IS 16102 (Part 1) : 2012 'Self-ballasted LED lamps for general lighting services: Part 1 Safety requirements'.

4 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.

5 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.

An overview of systems composed of LED modules and control gear is given in Annex B.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	*Title*
2500 (Part 1) : 2000	Sampling procedures for inspection by attributes: Part 1 Sampling schemes; indexed by acceptance quality limit (AQL) for lot-by-lot inspection (*third revision*)
4661 : 1999	Glossary of terms used in paper trade and industry
10322 (Part 1) : 2012	Luminaires: Part 1 General requirements and tests
15885 (Part 1) : 2011	Lamp controlgear: Part 1 Safety requirements
15885 (Part 2/ Sec 13) : 2012	Lamp controlgear: Part 2 Particular requirements, Section 13 d.c. or a.c. supplied electronic control gear for LED modules
16101 : 2012	Terms and definitions for LEDs and LED modules in general lighting
16104 : 2012	d.c. or a.c. supplied electronic control gear for LED modules — Performance requirements
16108 : 2012	Photobiological safety of lamps and lamp systems

3 TERMINOLOGY

For the purposes of this standard, the definitions given in 16101 and the following shall apply.

3.1 Light-Emitting Diode (LED) — Solid state device embodying a *p-n* junction emitting optical radiation when excited by an electric current.

3.2 LED Module — Unit supplied as a light source. In addition to one or more LEDs, it may contain further components, for example 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 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 under control.

NOTES

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

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

3 A measurement method is under consideration.

3.13 Acceptance Test — Tests carried out on samples taken from a lot for the acceptance of the lot.

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 **0.5** of IS 10322 (Part 1). 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 IS 10322 (Part 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 25 ± 2°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 percent indicates irreversible changes in the module.

5.5 For Safety Extra Low Voltage (SELV)

Operated LED modules, the requirements of Annex L in IS 15885 (Part 1) shall apply.

General conditions for tests are given in Annex A.

6 CLASSIFICATION

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

a) built-in;
b) independent; and
c) integral.

For integral modules, Note under **1.2.1** of IS 10322 (Part 1) shall apply.

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) Either the
   1) Power or power range;
   2) 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; and
   3) 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) For eye protection, see requirements of IS 16108.
h) Built-in modules shall be marked as given in Fig. 1 in order to separate them from independent modules. The mark shall be located on the packaging or on the module itself.

FIG. 1 SYMBOL FOR BUILT-IN MODULES

j) 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).
k) 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.

7.2 Location of Marking

Items **7.1** (a) to **7.1** (c) and **7.1** (f) shall be marked on the module.

Items **7.1** (d) to **7.1** (h) and **7.1** (k) shall be marked legible on the module or on the module data sheet.

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

7.3 Durability and Legibility of Marking

For items **7.1** (a) to **7.1** (c) and **7.1** (f), 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 **7.1** (d) to **7.1** (h) and **7.1** (k), compliance is checked by inspection.

7.4 BIS Certification Marking

The LED modules may also be marked with the Standard Mark.

7.4.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986

and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

8 TERMINALS

For screw terminals, the requirements of Section 14 of IS 10322 (Part 1) shall apply, if applicable.

For screwless terminals, the requirements of section 15 of IS 10322 (Part 1) shall apply, if applicable.

9 PROVISIONS FOR PROTECTIVE EARTHING

The requirements of **9** of IS 15885 (Part 1) shall apply.

10 PROTECTION AGAINST ACCIDENTAL CONTACT WITH LIVE PARTS

The requirements of **10** of IS 15885 (Part 1) shall apply.

11 MOISTURE RESISTANCE AND INSULATION

The requirements of **11** of IS 15885 (Part 1) shall apply.

12 ELECTRIC STRENGTH

The requirements of **12** of IS 15885 (Part 1) shall 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 **14** of IS 15885 (Part 1) shall apply.

Additionally, the test given in **13.2** shall be carried out.

13.2 Overpower Condition

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

The module shall be switched on and the power monitored (at the input side) and increased until 150 percent of the rated voltage, current or power is reached. The test shall be continued until the module is thermally stabilized. 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 module shall withstand the overpower condition for at least 15 min, the time period of which can lie within the stabilization 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 (*see* **4.1** and last paragraph of **13.2**) is fulfilled.

After finalizing 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 IS 4661, 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 section 11 of IS 10322 (Part 1) shall apply.

17 SCREWS, CURRENT-CARRYING PARTS AND CONNECTIONS

The requirements of **17** of IS 15885 (Part 1) shall apply.

18 RESISTANCE TO HEAT, FIRE AND TRACKING

The requirements of **18** of IS 15885 (Part 1) shall apply.

19 RESISTANCE TO CORROSION

The requirements of **19** of IS 15885 (Part 1) shall apply.

20 INFORMATION TO LUMINAIRE DESIGN

See Annex D.

21 HEAT MANAGEMENT

21.1 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).

21.2 Heat Protection

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

21.3 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 TESTS

22.1 Classification of Tests

22.1.1 *Type Tests*

The following shall constitute the type tests to be carried out on selected sample of LED module, sample being drawn preferably from regular production lot:

a) Marking (*see* **7**);
b) Terminals (*see* **8**);
c) Provisions for protective earthing (*see* **9**);
d) Protection against accidental contact with live parts (*see* **10**);
e) Moisture resistance and insulation (*see* **11**);
f) Electric strength (*see* **12**);
g) Fault conditions (*see* **13**);
h) Conformity testing during manufacture (*see* **14**);
j) Construction (*see* **15**);
k) Creepage distances and clearances (*see* **16**);
m) Screws, current-carrying parts and connections (*see* **17**);
n) Resistance to heat, fire and tracking (*see* **18**);
p) Resistance to corrosion (*see* **19**); and
q) Heat management (*see* **21**).

22.2 Acceptance Test

The sampling plan for acceptance tests shall be as specified in IS 2500 (Part 1). The following shall constitute as acceptance tests:

a) Marking (*see* **7**),
b) Terminals (*see* **8**),
c) Provisions for protective earthing (*see* **9),**
d) Protection against accidental contact with live parts (*see* **10**),
e) Moisture resistance (*see* **11),**
f) Electric strength (*see* **12**), and
g) Fault conditions (*see* **14**).

ANNEX A

(*Clauses* 5.5 *and* 13.2)

TESTS

A-1 Clauses **H-1**, **H-2**, **H-4**, **H-7**, and to sub-clause **H-11.2** of IS 15885 (Part 1) shall be applicable. However with regard to **H-1.3**, the first paragraph shall not be taken into account. In all clauses, the term LED module shall be used in place 'lamp', '(lamp) control gear' or 'ballast'.

ANNEX B
(*Clause* 1)

OVERVIEW OF SYSTEMS COMPOSED OF LED MODULES AND CONTROLGEAR

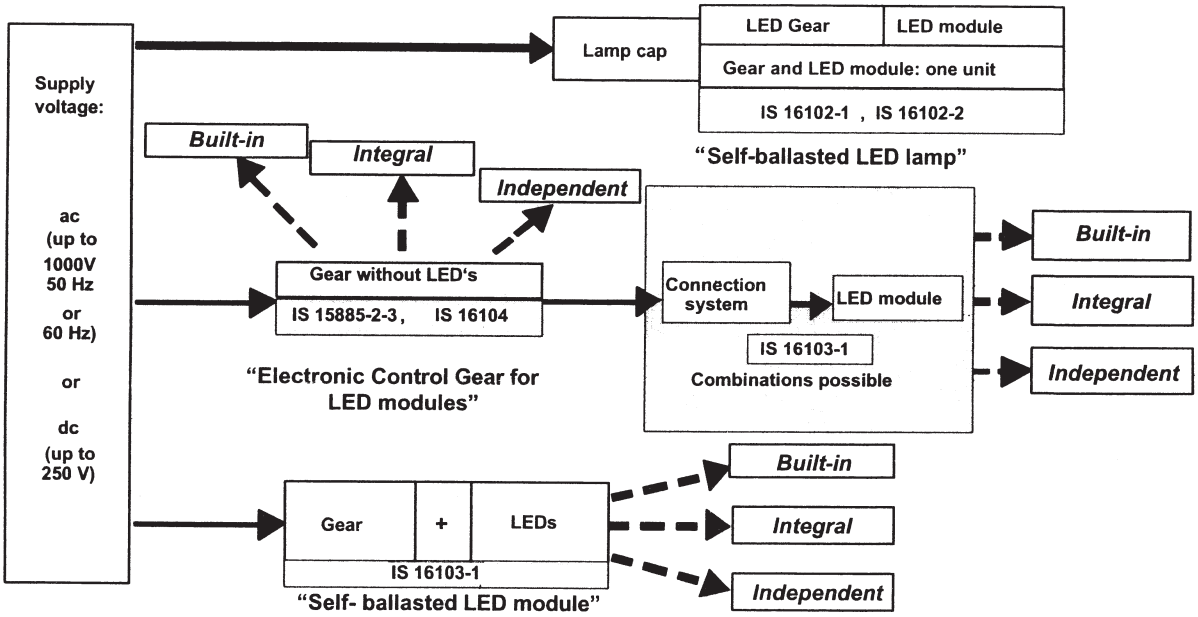


FIG. 2 OVERVIEW OF SYSTEMS COMPOSED OF LED MODULES AND CONTROLGEAR

ANNEX C
(*Clause* 14)

CONFORMITY TESTING DURING MANUFACTURE

C-1 The test is carried out on 100 percent 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.

For independent and built-in modules, Annex Q of IS 10322 (Part 1) is applicable, but without polarity check.

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

ANNEX D
(*Clause* 20)

INFORMATION FOR LUMINAIRE DESIGN

D-1 GENERAL

This Annex applies for LED modules that

a) have a cap/base enabling the insertion and the withdrawal of the LED module with or without the use of tools; and

b) 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 have to 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_1 and thermal resistances ($R_{th,\ module}$, $R_{th,\ luminaire}$, and $R_{th,\ ambient}$) is given in Fig. 3.

The thermal resistances shown in Fig. 3 can be added to a thermal resistance of the system:

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

Any thermal resistance can be calculated from the temperature difference and the heat flow, for example:

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

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

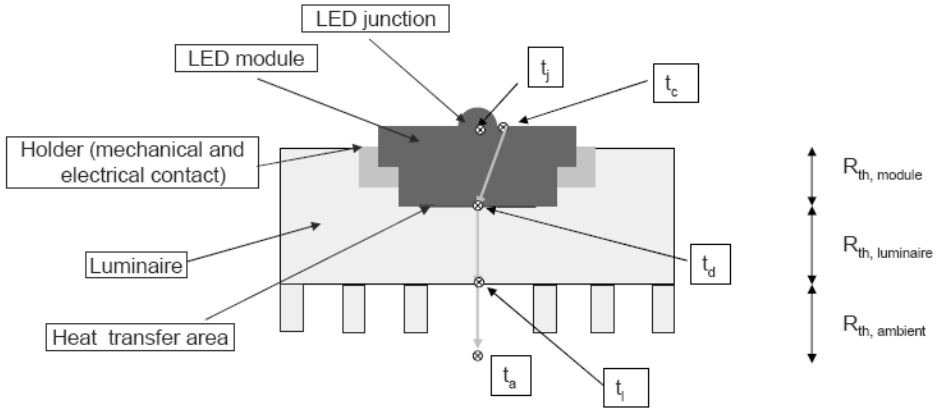
The design freedom of the luminaire is given by the sum of $R_{th,\ luminaire} + R_{th,\ ambient}$. It can be calculated as follows:

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

D-3 *IN-SITU* TESTING

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, *in-situ* testing if the luminaires does so will still be necessary.

Details of the test procedure are under consideration.



t_a — rated maximum ambient temperature of the luminaire as defined in IS 10322 (Part 1);
t_c — rated maximum temperature;
t_d — minimum heat transfer temperature;
t_j — junction temperature (shown for illustration only);
t_1 — 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; and
$R_{th,\ ambient}$ — thermal resistance between t_1 and ambient.

All dimensions in millimetres.

FIG. 3 DIAGRAMMATIC CROSS SECTION OF AN LED MODULE (BLUE) FIXED BY MEANS OF A LAMPHOLDER (YELLOW) TO A LUMINAIRE (LIGHT BLUE, WITH SYMBOLISED COOLING FINS)

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards : Monthly Additions'.

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