IS 16105 : 2012

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भारतीय मानक

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Indian Standard

METHOD OF MEASUREMENT OF LUMEN MAINTENANCE OF SOLID STATE LIGHT (LED) SOURCES

ICS 29.140.99

B U R E A U O F I N D I A N S T A N D A R D S
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NEW DELHI 110002

February 2012 **Price Group 2**

Electric Lamps and Their Auxiliaries Sectional Committee, ETD 23

FOREWORD

This Indian Standard 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 describes the procedures by which LED light sources can be operated under controlled conditions to obtain optimally comparable data on changes in light output during the life of the lamp. This standard has used the term ‘sources’ which refers to packages, arrays and modules only.

This standard establishes procedures for the measurement of lumen maintenance. Performance of LED light sources is typically affected by variables such as operating cycle, conditions imposed by auxiliary equipment and fixtures, ambient temperature, airflow and orientation. Test conditions and programmes shall be designed to give comparable results when adopted by various laboratories. The recommendations of this approved method have been made with this objective.

Like all light sources, the light output from LEDs slowly decreases in output over time. Unlike traditional light sources, LEDs do not tend to fail catastrophically. Therefore, over time, lumen maintenance can result in lower light output than intended in the standard or required by codes, standard practices or regulations. LEDs may also undergo gradual shifts in the emitted spectra over time that may result in unacceptable appearance or colour rendering. These changes may affect the lumen maintenance due to changes in the lumen output resulting from a varying spectral power distribution.

It is important to know the light output efficacy and lumen maintenance as well as the life of these light sources. The term ‘lifetime’ is often used to describe end-of-life criteria such as when lumen maintenance falls below a defined threshold.

This standard is based on IES-LM-80-2008 ‘IES approved method for measuring lumen maintenance of LED light sources’, issued by Illuminating Engineering Society of North America.

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

METHOD OF MEASUREMENT OF LUMEN MAINTENANCE OF SOLID STATE LIGHT (LED) SOURCES

1 SCOPE

This standard covers the method of measurement of lumen maintenance of LED packages, arrays and modules only.

This test method is primarily intended to permit reliable comparison of test results among laboratories by establishing uniform test methods. It addresses the measurement of lumen maintenance testing for LED light sources designed and certified to meet lighting industry standards.

Performance of the light sources covered in this standard in a particular application may be different. The method described in this standard does not provide guidance or make any recommendation regarding predictive estimations or extrapolation for lumen maintenance beyond the limits of the lumen maintenance determined from actual measurements.

The method described in this standard covers the measurement of lumen maintenance of inorganic LED based packages, arrays and modules. It does not attempt to induce any failure modes other than the maintenance of lumen output.

This standard does not specify any failure modes other than the maintenance of lumen output.

NOTE — For information on the photometry of the LED light source (*see* IS 16106 : 2012 'Method of electrical and photometric measurements of solid-state lighting (LED) products').

2 REFERENCES

The standards listed below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed as follows:

IS No.	*Title*
1885 (Part 16/ Sec 1) : 1968	Electrotechnical vocabulary: Part 16 Lighting, Section 1 General aspects
2055 : 1962	Reference tables for platinum/ rhodium-platinum thermocouples
16101 : 2012	General lighting — LED and LED modules — Terms and definitions

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 16101, IS 1885 (Part 16/Sec 1) and the following shall apply.

3.1 Measurement Units — Electrical measurement units are the volt, the ampere, and the watt. Temperature, in degree Celsius, and unit of photometry is the lumen.

3.2 LED Light Source — LED package, array, or module that is operated *via* an auxiliary driver.

3.3 Lumen Maintenance — Lumen maintenance is the luminous flux output remaining output (typically expressed as a percentage of the maximum output) at any selected elapsed operating time. Lumen maintenance is the converse of lumen depreciation.

3.4 Lumen Maintenance Life — The elapsed operating time at which the specified percentage of lumen depreciation or lumen maintenance is reached expressed in hours. Operating time does not include elapsed time when the light source is cycled off or periodically shut down.

3.5 LED Light Source Failure — The failure to produce light. The failures, such as early failure to function due to manufacturing defects are reported but not included in the calculation of LED light source lumen maintenance.

3.6 Rated Lumen Maintenance Life (*L-p*) — The elapsed operating time over which the LED light source will maintain the percentage, *p*, of its initial light output for example:

a) L_{70} (hour) — Time to 70 percent lumen maintenance; and

b) L_{50} (hour) — Time to 50 percent lumen maintenance.

3.7 Case Temperature (T_s) — T_s is the temperature of the thermocouple attachment point on the LED light source package as defined by the manufacturer of the package.

4 AMBIENT AND PHYSICAL CONDITIONS

4.1 General

It is recommended laboratory practice that the storage and testing of LED sources should be undertaken in a relatively clean environment. Prior to operation, sources shall be cleaned to eliminate handling marks and the manufacturer's handling instructions must be observed, for example, electro static discharge, (ESD).

4.2 LED Unit Marking

Individual LED light sources shall be tracked during life testing. Units can be identified by markings applied directly to the units or by labels that can be attached units during transport and evaluation or to the life test rack position occupied by the unit during life test. The identification method selected shall take into account the effect of exposure to light, and heat. Suitable marking methods or materials include durable bar coding, ceramic ink marking, high temperature markers or any other method, which can be periodically renewed for the duration of the life testing.

4.3 Sample Selection

Sample selection of the LED light sources is important since the value of the test will depend upon the method of sampling, size of the sample, conditions of testing and other factors. Sample sources shall be selected to be sufficiently representative of the overall population being tested. Sampling shall be done as specified in respective standard. The sampling method and sample size used shall be reported.

4.4 Environmental Conditions

4.4.1 *Vibration*

Lamps shall not be subjected to excessive vibration or shock during life testing. This is less an issue for LEDs than other light sources.

4.4.2 *Temperature and Humidity*

Operation of the LED light sources between photometric measurements shall be at a minimum of three case temperatures, T_s, using the same drive current. The three case temperatures, T_s, shall be between 55°C and 85°C with a third temperature selected by the manufacturer. The case temperature and drive current selected by the manufacturer should represent their expectation for customers applications and should be within the recommended operating temperature range. Case temperatures shall be controlled within ± 2°C during life testing. The temperature of the surrounding air should be maintained to within ± 5°C of the case temperature during testing. The surrounding air temperature should be monitored within the test chamber. Humidity shall be maintained not exceeding 65 RH throughout the life test period.

4.4.3 *Airflow*

The airflow shall be minimized for proper light source starting and operation because of heat flow characteristics that differ due to variation in airflow. Because some air movement is necessary to avoid thermal stratification, care should be taken to minimize any drafts in the immediate vicinity of the devices under test.

4.4.4 *Operating Orientation and LED Unit Spacing*

The operating orientation of the LED light sources under test shall be as specified by the manufacturer. In general, orientation shall not affect LED light sources as they are solid-state but there may be effects from convection airflow due to heat-sinks and thermal management. The units shall be spaced to allow airflow around each test sample. This is facilitated by designing open life testing racks with minimal structural components to block airflow.

5 ELECTRICAL AND THERMAL CONDITIONS

5.1 Input Voltage and Current

Input voltage shall conform to the rated input voltage (rms) and frequency of the driver. When using direct current (d.c.), the ripple voltage shall not exceed 2 percent of the d.c. output voltage.

5.2 Line Voltage Wave Shape

The power supply shall have a voltage wave shape such that the total harmonic distortion does not exceed 3 percent of the fundamental.

5.3 Input Current Regulation

The input current shall be monitored and regulated to within ± 3 percent of the rated rms value during life testing and to ± 0.5 percent of the rated rms value during photometric measurements. The drive currents shall be maintained over the entire period of the operation of the LED light source. The current can be de-rated as a function of temperature in accordance with the manufacturer's recommendation. The intent is to test the LEDs at the same current as during realistic operation.

5.4 Auxiliary Equipment Including Drivers

For LED light source external drivers compliant with manufacturer's guidance shall be used.

5.5 Case Temperature

A thermocouple measurement system complying with IS 2055, shall be used to monitor the case temperature. The case temperature T_s, shall be monitored during life testing. T_s is measured directly on the component at the manufacturer designated case temperature measurement point which is the thermocouple attachment point on the LED unit. A heat sink meeting the recommendations of the manufacturer shall be used.

6 TEST AND MEASUREMENT PROCEDURES

6.1 Instrumentation

In life testing, accurate recording of elapsed operating time is critical. If used, an elapsed time meter shall be connected to the particular test positions and shall accumulate time only when the installed LED light sources are energized. In the event of a power failure to a position, monitoring devices shall not accumulate time. Video monitoring, current monitoring, or other means shall be used to determine elapsed operating time, if designed to provide sufficient temporal accuracy. All equipment calibration shall be in accordance with manufacturer specifications. Total elapsed time uncertainty should be within ± 0.5 percent.

6.2 Photometry Measurement

Photometric measurements shall be in conformance with the appropriate laboratory method for the LED light source under test. Luminous flux shall be measured at the drive current used during life testing. Ideally, the drive current should be initially set at the drive current used in determining the manufacturer's literature rating of luminous flux. Because the colour stability over life is an important parameter for many lighting applications, the chromaticity values shall be determined. It is strongly recommended that photometric and colorimetric values be determined from total spectral radiant flux measurements using a spectroradiometer.

6.3 Photometry Measurement Temperature

The ambient temperature during lumen and chromaticity measurements shall be set to 25 ± 2°C. The ambient temperature throughout the test duration shall be provided in the test report for each photometric measurement. The LED light source shall be required to cool to room temperature prior to measurement.

7 LUMEN MAINTENANCE TESTING METHOD FOR LED LIGHT SOURCES

7.1 Lumen Maintenance Testing Duration and Interval

At the ambient temperature specified in **4.4**, the unit shall be driven for at least 6 000 h with data collection at a minimum of every 1 000 h.

7.2 Operating Cycle

Unlike other sources where power cycling adversely affects lifetime and performance, LEDs can be 100 percent modulated at high rates with little effect on lifetime. However, the devices and modules shall be driven at constant current to remove any issues of modulation affecting results. Drive methods shall be reported.

7.3 Recording Failures

Checking for LED light source failures either by visual observation or automatic monitoring shall be done at a minimum of every measurement interval. Each failure shall be investigated to make certain that it is actually an LED light source failure and is not caused by improper functioning of the auxiliary equipment or electrical connections. Catastrophic LED light source failure shall be reported and included in the test report.

7.4 Chromaticity

The chromaticity shift shall be measured and reported over the course of the lumen maintenance test time by measuring chromaticity at each photometric test interval.

8 TEST REPORT

The test report shall list all pertinent data concerning conditions of testing, type of equipment, and types of LED light sources being tested. The following items shall be included in the test report:

a) Number of LED light sources tested;
b) Description of LED light sources;
c) Description of auxiliary equipment;
d) Operating cycle;
e) Ambient conditions including airflow, temperature and relative humidity;
f) Case temperature (test point temperature);
g) Drive current of the LED light source during lifetime test;
h) Initial luminous flux and forward voltage at photometric measurement current;
j) Lumen maintenance data for each individual LED light source along with median value, standard deviation, minimum and maximum

lumen maintenance value for all of the LED light sources;

k) Observation of LED light source failures including the failure conditions and time of failure;

m) LED light source monitoring interval;

n) Photometric measurement uncertainty; and

p) Chromaticity shift reported over the measurement time.

A table format shall be used to present test results data for each test.

Bureau of Indian Standards

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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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Amendments Issued Since Publication

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