

	<b>SURFACE VEHICLE RECOMMENDED PRACTICE</b>	<b>SAE</b> <b>J2938 FEB2012</b>
		Issued      2012-02
LED Light Sources Tests and Requirements Standard Part 2: LED Lumen and Color Maintenance Measurements		

## RATIONALE

### Rationale for choosing case temperature (Section 5.2.2)

LED lumen degradation and color change over time is a temperature dependent behavior. In general, the higher the junction temperature, the faster the lumen depreciation is. The highest or maximum junction temperature is determined and recommended by the LED manufacturer based on the technologies used in the LED package. For LED users, the way in which the LEDs are designed into the automotive lighting application is based on the maximum junction temperature. Instead of setting a universal case temperature ( $T_s$ ) to be tested, it is more practical for the LED producers and users, depending on LEDs and the applications, to choose a specific case temperature for a specific type of LED to be tested and reported. In the current practice, some LED manufacturers provide LED characteristics relating to case temperature, others refer to junction temperature. Because only case temperature can be directly measured, therefore it is recommended that the case temperature  $T_s$  is set, depending on the LED manufacturer's specification, either to a temperature such that the junction temperature is within 10 °C below the maximum junction temperature claimed by the LED producers. or if the manufacturer only specifies case temperature, then it can be tested within 10 °C below the maximum case temperature.

### Rationale for lumen and color maintenance testing duration (Section 5.5.4.1)

The exterior automotive lighting usage in the US for the life of the vehicle is referred to the reports UMTRI-2008-14 and UMTRI-2008-48 where a 95 percentile duty cycle was assumed which is more appropriate than average usage. In the reports, the annual usage of DRL is presented to be 382.0 h, and for the other (non-DRL) longest use lamps 107.1 h. Based on this information, the life of the vehicle lighting is estimated. If the LEDs used are expected to last the life of vehicle, the lumen maintenance test duration is recommended for 6000 h for DRL and 2000 h for other lamps.

## 1. SCOPE

This SAE Recommended Practice provides test procedures, requirements, and guidelines for the methods of the measurement of lumen maintenance of LED devices (packages, arrays and modules). This document 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.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2012 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

**TO PLACE A DOCUMENT ORDER:**    Tel:    877-606-7323 (inside USA and Canada)  
     Tel:    +1 724-776-4970 (outside USA)  
     Fax:    724-776-0790  
     Email: CustomerService@sae.org  
 SAE WEB ADDRESS:                        http://www.sae.org

**SAE values your input. To provide feedback  
 on this Technical Report, please visit  
[http://www.sae.org/technical/standards/J2938\\_201202](http://www.sae.org/technical/standards/J2938_201202)**

## 2. REFERENCES

### 2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

### 2.2 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

SAE J1889 LED Signal and Marking Lighting Devices

SAE J2650 Performance Requirements for Light Emitting Diode (LED) Road Illumination Device Systems

SAE J573 Miniature Lamp Bulbs

### 2.3 IES Publications

Available from IES, 120 Wall Street, 17<sup>th</sup> Floor, New York, NY 10005, Tel: 212-248-5000, [www.ies.org](http://www.ies.org).

IES LM-80-08 Measuring Lumen Maintenance of LED Light Sources

IES TM-21-11 Projecting Long Term Lumen Maintenance of LED Light Sources

### 2.4 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

UMTRI-2008-14 Rear-World Frequency of Use of Lighting Equipment

UMTRI-2008-48 LEDs and Power Consumption of Exterior Automotive Lighting: Implications for Gasoline and Electric Vehicles

## 3. DEFINITIONS

### 3.1 DUT

Device Under Test (LED package, arrays and modules)

### 3.2 LED LIGHT SOURCE (SAE J573)

A light source where the visible radiation is emitted from one or more LED's. An LED light source may or may not require an additional electronic control unit (gear) and may or may not require additional provisions for thermal management

### 3.3 LED PACKAGE (ANSI/IES RP-16-10)

An assembly of one or more LED dies that includes wire bond or other type of electrical connections, possibly with an optical element and thermal, mechanical, and electrical interfaces. Power source and ANSI standardized base are not incorporated into the device.

### 3.4 LED MODULE (ANSI/IES RP-16-10)

An assembly of LED packages (components), or dies on a printed circuit board or substrate, possibly with optical elements and additional thermal, mechanical, and electrical interfaces that are intended to connect to the load side of a LED driver. Power source and ANSI standard base are not incorporated into the device.

### 3.5 LUMEN MAINTENANCE (IES LM-80-08)

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

### 3.6 LUMEN MAINTENANCE LIFE (IES LM-80-08)

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 the elapsed time when the light source is cycled off or periodically shut down.

### 3.7 LED SOURCE FAILURE

The condition where a LED source fails to produce light.

### 3.8 CASE TEMPERATURE, $T_s$ (IES LM-80-08)

$T_s$  is the temperature of the thermocouple attachment point on the LED light source package as defined by the manufacturer of the package.

### 3.9 MAXIMUM JUNCTION TEMPERATURE, $T_{j, \max}$

$T_{j, \max}$  is the maximum junction temperature for operating LED's specified by the manufacturer of the LED package.

## 4. MARKINGS

### 4.1 Sample Marking

Individual DUTs shall be tracked during life and lumen maintenance testing. Samples can be identified by markings applied directly to the samples or by labels that can be attached to samples during transport and evaluation or to the life test rack position occupied by the sample during life test.

### 4.2 Sample Selection

Sample DUTs shall be selected to be sufficiently representative of the overall population being tested. The sampling method and sample size used shall be reported.

## 5. TESTS

### 5.1 General

Clean DUTs shall be used to limit handling marks or contaminations of the surface. The manufacturer's handling instructions must be observed, in regards to electro-static discharge, ESD.

### 5.2 Environmental Conditions

#### 5.2.1 Mechanical Static

The DUTs should be conducted under mechanically static conditions.

### 5.2.2 Temperature and Humidity

The DUT shall be tested at the case temperature  $T_s$  such that  $T_s$  is greater than  $T_{s,max}$  minus 10 °C, or  $T_j$  is greater than  $T_{j,max}$  minus 10 °C, whatever is appropriate according to the specification of the DUT (See Rationale).

Case temperatures shall be controlled to a tolerance of  $\pm 2$  °C during lumen maintenance testing. Humidity shall be maintained to less than 65 RH throughout the life and lumen maintenance test.

### 5.2.3 Airflow

Airflow shall be minimized for proper DUT 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.

### 5.2.4 Operating Orientation and DUT Spacing

The operating orientation of the DUT should be as specified by the manufacturer. In general, orientation will 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.

## 5.3 Electrical Conditions

### 5.3.1 Input Voltage and Current

Input voltage shall conform to the rated input (rms) voltage, the direct current( dc) and ripple voltage shall not exceed 2% of the required dc input voltage. The operating current of the DUT shall be the same current as in typical operation.

### 5.3.2 Input Current Regulation

The input current shall be monitored and regulated to within  $\pm 2$  % of the rated rms value during life testing and to  $\pm 0.5$  % of the rated rms value during photometric measurements. For low power LEDs in which the operating current is less than 100 mA, the tolerance of  $\pm 5$  % of the rated rms value during life testing is acceptable. 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 in typical operation.

### 5.3.3 Auxiliary Equipment Including Drivers

For LED light sources without integrated auxiliary equipment, external drivers compliant with manufacturer's guidance shall be used.

## 5.4 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 (e.g., thermocouple attachment point) on the LED unit. A heat sink meeting the recommendations of the manufacturer should be used.