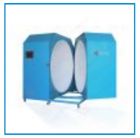


Constant Temperature Integrating Sphere

Product No: IS-*MT

Get a Quote

Your email address will not be published. Required fields are marked *

Name*
Company*
Email*
Cell/WhatsApp
Message*
Verify Code
Send

Description | Video

Product Categories

- Goniophotometer >
- Spectroradiometer >
- Integrating Sphere >
- LED Test Instruments >
- CFL Testing Instruments >
- Photometer and Colorimeter >
- EMI and EMC Test Systems >
- Electronic Ballast Tester >
- Electrical Safety Tester >
- Environmental Test Chamber >
- Plug and Switch Testing >
- AC and DC Power Supply >
- Object Color and Glossiness Test >
- Mask Produce and Test Machine >
- Electronic Components Test >

Related Technical Articles

Integrating sphere as an instrument for sphere integration

optical properties

What does an integrating sphere measure

How do you calibrate an integrating sphere

Related Successful Case

Costa Rica – Installation for constant temperature integrating sphere, IK level tester and IP waterproof test

India – Constant Temperature Integrating Sphere Spectroradiometer System LPCE-2(LMS-9000B) Installation and Training

Kenya – Lisun engineer Provide the installation and training for constant temperature integrating sphere system

Europe – Installation and training LED test instruments in Spain, UK and Germany

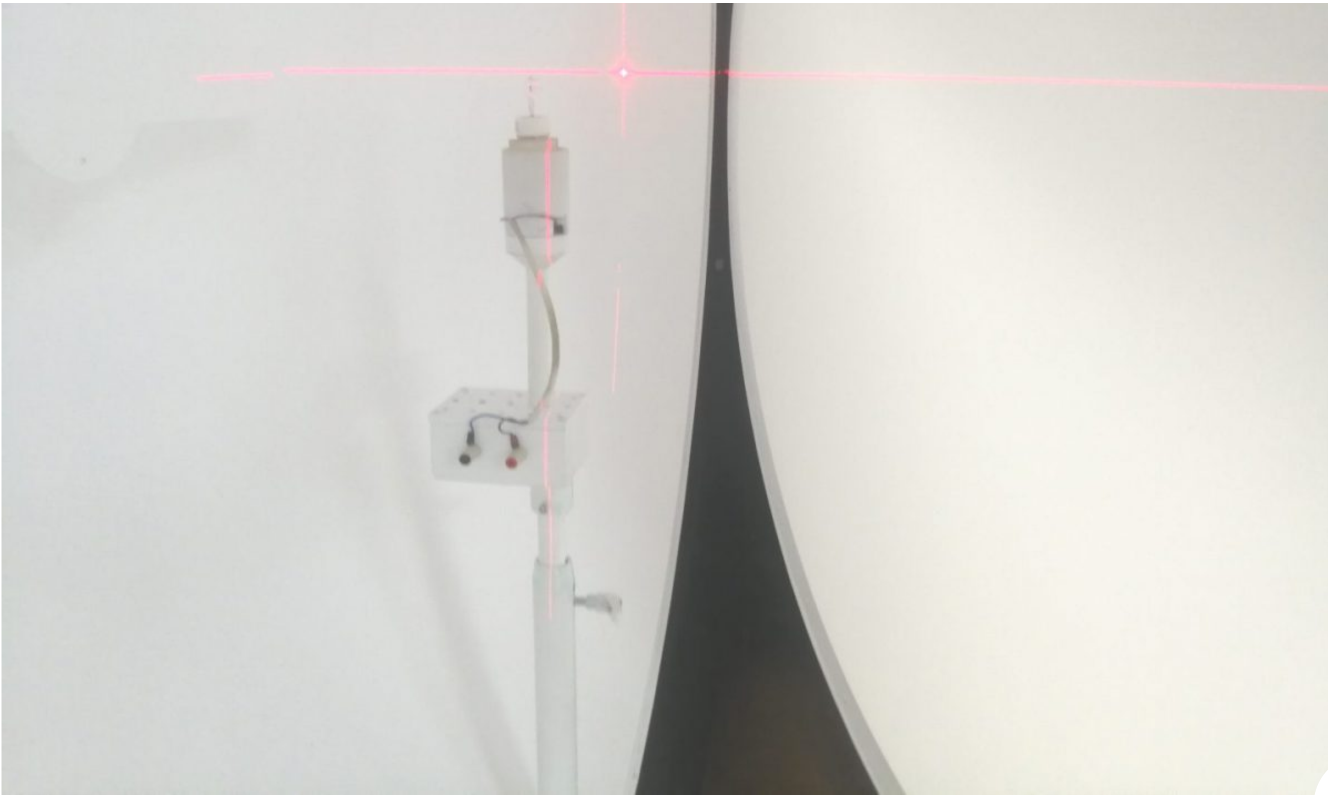
LISUN IS-*MT Constant Temperature Integrating Sphere is fully meet IES LM-82 Clause 4.4.

Specifications:

- Diameter: IS-0.3MT (0.3m), IS-0.5MT (0.5m), IS-1.0MT (1.0m), IS-1.5MT (1.5m), IS-1.75MT (Φ1.75m), IS-2.0MT (Φ2.0m). Other size can be designed according to your request.
- Painting material of integrating spheres is according to CIE Pub.No.84 (1989)
- The painting material is $BaSO_4$ coating: ρ (λ) ≥0.96 (450nm~800nm) and ρ (λ) ≥0.92 (380nm~450nm)
- Fine diffuse reflection: Reflectance ρ≈0.8 and accuracy of ρ (λ) <1.5%
- Build-in all functional lamp testing jigs: for E40/E27, T5/T8/T12 tubes and the testing holder base for LED and other luminaires. All samples under test can be installed both up and down directions in the sphere.
- Power cable, power terminal and auxiliary lamp position are built-in (Auxiliary lamp is optional).
- Power cable and socket are build-in. It is convenient to power on the lamp under test
- Two photo detector ports, one optical fiber port and temperature sensor hole are built-in
- Constant Temperature controlled range: 25℃-55℃ (refer to the environmental temperature with 25℃): Temperature Increasing tolerance: ±1℃ and Temperature Down tolerance: ±2℃
- Build-in cross laser can help to install the standard lamp and the lamp under test in the center of the integrating sphere

Tags : Constant Temperature Integrating Sphere , IS-*MT

1



Cross Laser for Integrating Sphere

Applications:

The integrating sphere works with a Spectroradiometer to do the photometry, colorimetry and radiometry parameters measurement:

• IS-0.3M/IS-0.5M is for LEDs, LED modules, mini LED bulbs & other small lamps. The flux testing range is 0.001 to 1,999 lm.

• IS-1.0MT is for CFL or LED bulbs. The flux testing range is 0.1 to 199,990 lm.

• IS-1.5MT/IS-1.75MT is for CFL, LED bulb and tube, fluorescent lamp, CCFL. The flux testing range is 0.1 to 1,999,900 lm.

• IS-2.0MT is for HID lamps or high power lamps. The flux testing range is 0.1 to 1,999,900 lm

Ni Jia

Related Products

LPCE-2(LMS-9000) High Precision Spectroradiometer Integrating Sphere System

LPCE-2(LMS-8000) LED Integrating Sphere Spectroradiometer System

LMS-9500C Scientific Grade CCD Spectroradiometer

LMS-9000C High Precision CCD Spectroradiometer

1

Illuminating
ENGINEERING SOCIETY

IES LM-82-12

Approved Method: Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature

IES Approved Method for the Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature

Publication of this Committee
report has been approved by IES.
Suggestions for revision should
be directed to IES.

Prepared by:
The Subcommittee on Solid State Light Sources
of the IES Testing Procedures Committee

IES LM-82-12

Approved by the IES Board of Directors,February 13, 2012 as a Transaction of the Illuminating Engineering Society of North America.

Published by the Illuminating Engineering Society of North America, 120 Wall Street, New York, New York 10005.

IES Standards and Guides are developed through committee consensus and produced by the IES Office in New York. Careful attention is given to style and accuracy. If any errors are noted in this document, please forward them to Rita Harrold, Director Educational and Technical Development, at the above address for verification and correction. The IES welcomes and urges feedback and comments.

ISBN # 978-0-87995-266-2

Printed in the United States of America.

DISCLAIMER

IES publications are developed through the consensus standards development process approved by the American National Standards Institute. This process brings together volunteers representing varied viewpoints and interests to achieve consensus on lighting recommendations. While the IES administers the process and establishes policies and procedures to promote fairness in the development of consensus, it makes no guaranty or warranty as to the accuracy or completeness of any information published herein.

The IES disclaims liability for any injury to persons or property or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of, or reliance on this document

In issuing and making this document available, the IES is not undertaking to render professional or other services for or on behalf of any person or entity. Nor is the IES undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

The IES has no power, nor does it undertake, to police or enforce compliance with the contents of this document. Nor does the IES list, certify, test or inspect products, designs, or installations for compliance with this document. Any certification or statement of compliance with the requirements of this document shall not be attributable to the IES and is solely the responsibility of the certifier or maker of the statement.

Prepared by the Subcommittee on Solid State Lighting of the IES Testing Procedures Committee

Solid-State Lighting Subcommittee
Cameron Miller, *Chair*
Jianzhong Jiao, *Technical Coordinator*

John Adinolfi*
Carl Andersen
Jim Anderson
Alex Baker*
Robert Berger
Rolf Bergman
Dennis Bradley*
Eric Bretschneider
David Chan*
Gigi Chan*
Xiaolu Chen*
Jason Chesley*
Pei-Ting Chou*
Zane Coleman*
Steven Coyne*
James Creveling*
Ku'uipo Curry
Ronald Daubach*
Marc Dyble*
Steven Ellersick*
David Ellis
David Grandin*
Michael Grather
Kei Haraguchi
Rudi Hechfellner*
Kyle Hemmi*
Sylvia Herman*
Tanya Hernandez*
Yoelit Hiebert*
James Hospodarsky
Bin Hou*
Fallight Hsu*
Shuming Hua*
Jeff Hulett
Po-Chieh Hung*
Andrew Jackson*
Je Jang*
David Jenkins
Hoon Sung Jung*
Jim Kahn*
Michael Kalkas*
Demetrios Karambelas
Hamid Kashani*
Philip Keebler*
Mihaly Kotrebai
Kevin Krueger
Rand Lee
Michael Lehman*
Richard Li*
Joseph Linquata*
Dave Lomas*
Jeremy Ludyjan*
Joseph Marella
Mark Mayer
Mark McClear*
Greg McKee
Ronald Naus*
David Neal*
Andy Nishida*
Yoshihiro Ohno*
Napoli Oza*
Saga Patel*
Emil Radkov
Sid Rane*
Eric Richman
Michael Riebling*
Ian Rosso*
Ronald Rykowski*
Gary Schaefer*
Mark Sapcoe
Jason Schutz
Keith Scott
Frank Shum*
Frank Solimine*
Lloyd Stafford*
Gregory Staples*
Gary Steinberg
Jacqueline Swiernik*
Ted Tomonaga*
Gary Trott*
Ralph Tuttle
Venkat Venkataramanan*
Joseph Welch*
Kurt Wilcox*
Jeremy Yon
William Young*
John Zhang

IESNA Testing Procedures Committee
Michael Grather, *Chair*

Carl Andersen
Lawrence Ayers*
Alex Baker*
Robert Berger
Randall Bergin*
Rolf Bergman
Eric Bretschneider
Daniel Brooks*
Kevin Broughton*
David Chan*
Pei-Ting Chou*
Richard Collins*
Ku'uipo Curry*
Russell Dahl*
Ronald Daubach*
David Ellis
Adam Foy*
Peter Franck*
Michael Grather
Richard Heinisch*
Kyle Hemmi*
Tanya Hernandez*
Robert Horan
James Hospodarsky
Shuming Hua*
Po-Chieh Hung*
Donald Husby**
Stephen Hutton*
Andrew Jackson
David Jenkins*
Jianzhong Jiao
Hoon Sung Jung
Michael Kalkas
Demetrios Karambelas
Hamid Kashani*
Ryan Kelley*
Mihaly Kotrebai
Kevin Krueger
Becky Kuebler*
John Lawton*
Lorence Leetzow*
Kelly Lerbs*
Robert Levin*
Ian Lewin
Richard Li*
Robert Low*
Joseph Marella
Philip McCarthy*
Greg McKee
C. Cameron Miller
Bruce Mosher
Waneta Newland
Yoshihiro Ohno*
Gerard Plank*
Emil Radkov
David Randolph
Eric Richman*
Michael Riebling*
Mark Sapcoe
Jason Schutz*
Andrew Smith*
Donald Smith*
Joong Kon Son*
Robert Speck**
Lloyd Stafford*
Gary Steinberg
Ralph Tuttle
Ken Wagner*
James Walker*
Heather Waugh*
Joseph Welch*
Kurt Wilcox*
Jeremy Yon*
John Zhang

*Advisory
**Honorary

Contents

IES Approved Method for the Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature

INTRODUCTION

The performance (e.g., luminous flux, life) of light emitting diodes (LEDs) depends strongly on the temperature at the LED junction, and this temperature can vary depending on how the LED is integrated into the luminaire and on the application environment. LED light engines and integrated LED lamps are used in many different types of luminaires including those for decorative lighting and non-directional applications.

Generally, LED performance, in terms of luminous flux, luminous efficacy, color, and life, is affected by the temperature at the LED junction. During operation, the LED junction temperature can reach as high as 150°C. At such temperature, the amount of thermal energy transferred to the ambient environment via radiation is very small. Therefore, conductive and convective thermal energy transfer techniques are employed to limit the LED junction temperature within the upper limit for the luminaire design. Active or passive heat sinks or combinations of these are typically used to effectively control the LED junction temperature to the luminaire design value.

When an LED light engine or integrated LED lamp is used in a luminaire, the thermal environment near the LED is altered by both the luminaire design and the application environment. By measuring the performance characteristics of an LED light engine or integrated LED lamp at various temperatures, the luminaire manufacturer can model the expected light output of a given luminaire design by measuring the operating temperature of the LED light engine or integrated LED lamp in the luminaire. For luminaires that cannot be measured as a complete system, modeling the light source portion for light output temperature dependence shall be an option.

1.0 SCOPE

The intent of this document is to establish consistent methods of testing and data presentation for ease of interpretation and comparison, which will assist luminaire manufacturers in selecting suitable LED light engines and integrated LED lamps for each luminaire product. This approved laboratory method defines the procedures to quantify the performance of LED light engines and integrated LED lamps as a function of temperature.

2.0 NORMATIVE REFERENCES

2.1 IES Testing Procedures Committee.

IES LM-79-2008 *Approved Method for the Electrical and Photometric Measurements of LED Light Sources*, New York: Illuminating Engineering Society of North America.

2.2 ANSI/IES Nomenclature Committee

ANSI/IES RP-16-2010, *Nomenclature and Definitions for Illuminating Engineering.*

3.0 DEFINITIONS

3.1 Measurement Units

Electrical measurement units are the volt, the ampere, and the watt. The thermal temperature measurement unit is degrees Celsius. The unit of photometric flux is the lumen. The unit of luminous intensity is the candela. The unit of correlated color temperature is the Kelvin.

3.2 LED Light Engine (ANSI/IES RP-16-2010)

An integrated assembly comprised of LED packages (components) or LED arrays (modules), LED driver, and other optical, thermal, mechanical and electrical components. The device is intended to connect directly to the branch circuit through a custom connector compatible with the LED luminaire for which it was designed and does not use an ANSI standard base.

3.3 LED Lamp, Integrated (ANSI/IES RP-16-2010)

An integrated assembly comprised of LED packages (components) or LED arrays (modules), LED driver, ANSI standard base and other optical, thermal, mechanical and electrical components. The device is intended to connect directly to the branch circuit through a corresponding ANSI standard lamp-holder (socket).

3.4 Unit Under Test (UUT)

The unit tested is an LED light engine as defined in **Section 3.2** or an LED lamp, integrated as defined in **Section 3.3**.

3.5 Heat Sink

A device attached to an LED assembly (package, array or module) to dissipate heat.

3.6 Thermal Chamber

A chamber used to maintain a local ambient temperature.

4.0 AMBIENT AND PHYSICAL TEST CONDITIONS

4.1 General

This approved method characterizes the UUT performance (e.g., lumen output) as a function of the temperature at manufacturer-specified temperature monitoring points. Manufacturer-specified temperature monitoring points shall be used for compliance with this test method. The performance of the UUT itself (e.g., lumen output) is determined as a function of temperature at the manufacturer-specified temperature monitoring points. These performance characteristics can then be estimated over the range of temperatures set by the maximum and minimum temperatures at which the UUT only was tested using a simple curve-fit to the measured values. Using this information, the performance of the UUT in a luminaire can be estimated by measuring the temperature of the manufacturer-specified temperature monitoring points while the UUT is operated in the luminaire at specified operation (e.g., in-situ) conditions and by comparing this to the performance curve derived from the UUT only measurements.

UUT driver electronics may be affected by the operating temperature. Proximity of the driver electronics to the heat-generating LEDs can result in higher driver component temperatures than are assignable due to general ambient temperature. Manufacturers of LED drivers may specify a maximum operating temperature and identify a temperature monitoring point(s). The driver temperature monitoring point(s) temperature is correlated with the temperature of the most temperature sensitive component(s) of the driver electronics. The driver temperature monitoring point(s) when provided shall be monitored during testing.

For the purpose of this document, the UUT manufacturer-specified temperature monitoring point(s) temperature is (are) denoted as T_b, and manufacturer-specified temperature monitoring point for the driver is denoted as T_d.

All components of the UUT shall be subject to the same environmental conditions, even though the elements of the assembly may not be mechanically connected (e.g., the driver, though electrically connected, is mechanically separated from LED modules).

4.2 Temperature Monitoring Point Measurement

The temperature monitoring point shall be identified by the requester or the UUT manufacturer. The requester shall identify and diagram a UUT temperature monitoring point, T_b, and a driver temperature monitoring point T_d if applicable.

A variety of temperature measuring devices may be used such as thermocouples or thermistors. If thermistors (temperature sensitive resistors) are used, they should be calibrated against a known standard.

The temperature measuring device shall be chosen such that it does not conduct a significant amount of thermal energy away from the UUT. The temperature measurement device shall have a calibration with an expanded uncertainty (k = 2) of less than 1° C. The temperature measuring device(s) shall be thermally and mechanically attached to the requester or manufacturer-specific test point(s) throughout the duration of the tests.

4.3 Seasoning

For the purposes of characterizing the UUT with respect to temperature, the UUT does not require seasoning.

4.4 Thermal Environment

There are several methods for controlling the temperature of the UUT. The difficulty is integrating the photometric measurement of the UUT while controlling the temperature of the UUT. One such method is placing the UUT into a temperature controlled integrating sphere. Additional methods include: a) mounting the UUT to a thermoelectric cooler (TEC), or b) mounting the UUT in a temperature chamber that only controls the local environment around the UUT. The most important aspect is to ensure that the method of controlling the UUT temperature has a heating equivalence similar to the application of the UUT. For example, if heat is applied at one end of the heat sink with a thermoelectric cooler, this may be equivalent to a temperature chamber using convection to control the UUT temperature.

Regardless of the temperature controlling method, the T_b of the UUT operating at the electrical conditions specified for the test shall be set to the specified temperature within a tolerance of ±2° C. For the initial photometric measurements (see **Section 6.1**) the ambient environment shall follow the procedures in **IES LM-79-08.**

Photometric detector(s) shall remain within their temperature tolerance range throughout planned testing, as detector thermal variation can introduce increased uncertainties.

4.5 Stabilization

Before all photometric measurements are taken at any given temperature, the UUT shall be operated long enough to reach stabilization and temperature equilibrium. The time required for stabilization depends on the UUT. It should be judged that stability is reached when the variation (maximum – minimum) of at least 3 readings of the light output and electrical power over a period of 30 min, taken 15 minutes apart, is less than 0.5 %, and the readings shall not be increasing or decreasing monotonically. The stabilization time used for each UUT shall be recorded.

5.0 ELECTRICAL TEST CONDITIONS

5.1 Electrical Settings

The UUT shall be operated at the rated voltage (AC or DC) according to the manufacturer's specification of the UUT for its normal use. If the UUT has dimming capability, measurements shall be performed at the maximum light output power condition. If the UUT has multiple modes of operation including variable CCT, measurements may be made for different modes of operation (and CCTs) if necessary, and such setting conditions shall be clearly documented in the test report.

5.2 Circuits

For UUTs requiring DC input power, a DC digital voltmeter or mulitmeter (DVM or DMM in voltage mode) and a DC digital ammeter (DMA) or current shunt/DVM (or DMM in current mode) combination shall be used. The DVM shall be connected across the electrical inputs of the UUT; the DMA or current shunt/DVM (or DMM in current mode) shall be connected in-line in the return lead of the circuit. Reported wattage is the product of the measured current and voltage. The voltage, current and wattage shall be documented in the test report.

For UUTs requiring AC input power, an AC digital power analyzer shall be connected between the AC power supply and the UUT. The voltage sensing leads shall be connected across the electrical power inputs of the UUT. Input power as well as input voltage and current shall be measured and reported.

5.3 Electrical Measurement Uncertainties

The uncertainties for DC voltage and DC current measurement shall be ≤ 0.2 %.

The expanded uncertainties for AC voltage and AC current measurements shall be ≤ 0.2 % for the range used. The expanded uncertainty for AC power measurement shall be ≤ 0.25 %. In addition AC measurement instruments shall measure accurately up to the 50th harmonic of the AC fundamental frequency.

6.0 TEST METHOD AND PROCEDURES

6.1 Room Temperature Measurement Using Absolute Photometry Measurement Methods

6.1.1 Room Temperature Initial Measurement

The UUT shall be first tested for electrical and photometric characteristics in accordance with the testing methods specified in **IES LM-79-08 Section 9.** Record electrical power P_i (W), total luminous flux Φ_i (lm), and optionally, chromaticity coordinates (x_i,y_i), (u'_i,v'_i), and correlated color temperature CCT_i (K). Record the UUT manufacturer-specified temperature monitoring point temperature(s), T_b as $T_{b,i}$, and the manufacturer-specified temperature monitoring point(s) for the driver, T_d as $T_{d,i}$.

6.1.2 Room Temperature Calibration Measurement

As the second step, the UUT shall be measured with a device that controls the temperature(s) T_b ($T_{b,i}$) of the UUT. Use the temperature controlling method (**Section 4.4**) to adjust the thermal environment so that T_b is the same as the room temperature initial measurement in **Section 6.1**. Record the value of T_b as $T_{b,0}$. While keeping T_b constant, measure the electrical power P_0, total luminous flux Φ_0 or luminous intensity I_0 at the defined spatial point, and optionally, chromaticity coordinates (x_0,y_0), (u'_0,v'_0), and correlated color temperature CCT_0 if recorded during the initial measurement.

The correction factors between the room temperature initial measurements and room temperature calibration measurements shall be determined as:

Electric power correction factor:

$$C_{power} = \frac{P_i}{P_0} \quad (1)$$

Luminous flux correction factor:

$$C_{flux} = \frac{\Phi_i}{\Phi_0} \quad (2a)$$

or

$$C_{flux} = \frac{\Phi_i}{I_0}. \quad (2b)$$

Chromaticity corrections:

$$\Delta_x = x_i - x_0 \text{ , } \Delta_y = y_i - y_0 \quad (3a)$$

or

$$\Delta_{u'} = u'_i - u'_0 \text{ , } \Delta_{v'} = v'_i - v'_0 \quad (3b)$$

$$\Delta_{CCT} = CCT_i - CCT_0 . \quad (4)$$

6.2 Measurement with Temperature Controlled Device

When the UUT is measured with a device that controls the temperature T_b of the UUT (see **Section 4.4**), the photometry measurement can be made either as flux integration or a directional measurement.

Flux Integration Measurement: A flux integrating device of any geometry of sufficient size to contain the UUT with a method to control the critical temperature values per **Section 4.4** may be used. Acceptable realizations include but are not limited to the following: a) a temperature controlling method coupled with an integrating sphere using a 2π or 4π configuration; and b) a temperature controlling method coupled to a pseudo-integrating device such as a tube lined with white reflecting material and a cosine corrected spectrometer head mounted on the bottom.

Directional Measurement: The measurement can be made at a single spatial point defined and selected by the initial measurement of luminous intensity, I (cd).

Note: for a narrow beam DUT (Device Under Test) the sensitivity of the angular beam properties with the change of temperature should be investigated.

In either of the above measurements, once the UUT with the temperature controlling method is coupled to the measurement system, they shall not be separated until the measurements are complete.

6.2.1 Measurement at Temperature $T_{b,0}$ + 25°C

Adjust the temperature controlling method so that T_b reaches no lower than T_b = $T_{b,0}$ + 25°C. Record this value as $T_{b,1}$. Measure the electrical power P_1, photometric and colorimetric properties, total luminous flux Φ_1 or luminous intensity I_1, and as optional, chromaticity coordinates (x_1,y_1), or (u'_1,v'_1), and correlated color temperature CCT_1.

Record the corrected results for the first elevated temperature T_b = $T_{b,1}$ as:

$$P = C_{power} P_1 \quad (5)$$

$$\Phi = C_{flux} \Phi_1 \quad (6a)$$

or

$$\Phi = C_{flux} I_1 . \quad (6b)$$

And as optional,

$$x = x_1 + \Delta_x \text{ , } y = y_1 + \Delta_y \quad (7a)$$

or

$$u' = u'_1 + \Delta_{u'} \text{ , } v' = v'_1 + \Delta_{v'} \quad (7b)$$

$$CCT = CCT_1 + \Delta_{CCT} . \quad (8)$$

6.2.2 Measurement at Temperature $T_{b,0} + \Delta T$

A temperature difference, ΔT, is selected or provided. ΔT may be a positive value or a negative value. Adjust the temperature controlling method so that T_b = $T_{b,0} + \Delta T$. Record this value as $T_{b,2}$. Measure the electrical power P_2, total luminous flux Φ_2 or intensity I_2, and optionally, chromaticity coordinates (x_2,y_2), or (u'_2,v'_2), and correlated color temperature CCT_2.

Record the corrected results for T_b = $T_{b,2}$ as:

$$P = C_{power} P_2 \quad (9)$$

$$\Phi = C_{flux} \Phi_2 \quad (10a)$$

or

$$\Phi = C_{flux} I_2 . \quad (10b)$$

And as optional,

$$x = x_2 + \Delta_x \text{ , } y = y_2 + \Delta_y \quad (11a)$$

or

$$u' = u'_2 + \Delta_{u'} \text{ , } v' = v'_2 + \Delta_{v'} \quad (11b)$$

$$CCT = CCT_2 + \Delta_{CCT} . \quad (12)$$

6.2.3 Measurement at Additional Temperatures

Additional measurements at other temperature other than $T_{b,0}$ + 25°C and $T_{b,0} + \Delta T$ can be performed with the same procedure in **Section 6.2**. Record the results calculated in a similar manner to **Section 6.2**.

7.0 REPORTING REQUIREMENTS

The following shall be included in the test report for each T_b at each setting condition:

a) Input power (W)
b) Input voltage (V)
c) Input current (A)
d) Luminous flux (lm)
e) Luminous efficacy (lm/W)
f) Chromaticity (x, y or u', v'), as optional
g) Correlated color temperature (K) as optional
h) Monitored driver temperature, T_d
i) Test date
j) Test facility
k) Test instrumentation
l) UUT description
m) Internal procedure reference

Table 1 shows the recommended table format for the test report.

Table 1. Recommended Table Format for the Test Report

Test date, facility, equipment, and operator			
UUT description (manufacturer, description, catalog number)			
If applicable, UUT driver description (manufacturer, description, catalog number, input and output parameters)			
Description of test method including testing configuration.			
Internal procedure reference			
	Initial Temperature	First Elevated Temperature (Initial + 25°C)	Second Elevated Temperature (per Test Requesters)
Measured temperature of T_b (or T_d)			
Input power (W)			
Input voltage (V)			
Input current (A)			
Luminous flux (lm)			
Luminous efficacy (lm/W)			
CIE chromaticity (x,y or u',v') (as optional)			
Correlated color temperature (K) (as optional)			
Uncertainties			

REFERENCES

1. Alliance for Solid-State Illumination Systems and Technologies (ASSIST). 2009. *ASSIST recommends...Recommendations for testing and evaluating white LED light engines and integrated LED lamps used in decorative lighting luminaires*. Vol. 4, Iss. 1, revised April 2009. Troy, NY: Lighting Research Center, Rensselaer Polytechnic Institute. Internet: http://www.lrc.rpi.edu/programs/solidstate/assist/pdf/AR-LEDLightEngine-revApril2009.pdf.

2. *Lighting Handbook, 10th Edition*, New York: Illuminating Engineering Society of North America, 2011.

3. ASTM Standard E230-03, *Standard Specification and Temperature-Electromotive Force (EMF) Tables for Standardized Thermocouples*, ASTM International, West Conshohocken, PA, www.astm.org.

120 Wall Street, 17th Floor
New York, NY 10005
www.ies.org

$25.00 Order # LM-82-12 ISBN# 978-0-87995-266-2