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International Commission on Illumination
Commission Internationale de l'Eclairage
Internationale Beleuchtungskommission

PROCEEDINGS of CIE Expert Symposium on the CIE S 025 LED Lamps, LED Luminaires and LED Modules Test Standard

26 November 2015

Braunschweig, Germany

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CIE x041:2016

UDC: 628.9 Descriptor: Lighting. Illuminating engineering
535.24 Descriptor: Photometry

THE INTERNATIONAL COMMISSION ON ILLUMINATION

The International Commission on Illumination (CIE) is an organization devoted to international co-operation and exchange of information among its member countries on all matters relating to the art and science of lighting. Its membership consists of the National Committees in about 40 countries.

The objectives of the CIE are:

1. To provide an international forum for the discussion of all matters relating to the science, technology and art in the fields of light and lighting and for the interchange of information in these fields between countries.
2. To develop basic standards and procedures of metrology in the fields of light and lighting.
3. To provide guidance in the application of principles and procedures in the development of international and national standards in the fields of light and lighting.
4. To prepare and publish standards, reports and other publications concerned with all matters relating to the science, technology and art in the fields of light and lighting.
5. To maintain liaison and technical interaction with other international organizations concerned with matters related to the science, technology, standardization and art in the fields of light and lighting.

The work of the CIE is carried out by Technical Committees, organized in seven Divisions. This work covers subjects ranging from fundamental matters to all types of lighting applications. The standards and technical reports developed by these international Divisions of the CIE are accepted throughout the world.
A plenary session is held every four years at which the work of the Divisions and Technical Committees is reported and reviewed, and plans are made for the future. The CIE is recognized as the authority on all aspects of light and lighting. As such it occupies an important position among international organizations.

LA COMMISSION INTERNATIONALE DE L'ECLAIRAGE

La Commission Internationale de l'Eclairage (CIE) est une organisation qui se donne pour but la coopération internationale et l'échange d'informations entre les Pays membres sur toutes les questions relatives à l'art et à la science de l'éclairage. Elle est composée de Comités Nationaux représentant environ 40 pays.

Les objectifs de la CIE sont :

1. De constituer un centre d'étude international pour toute matière relevant de la science, de la technologie et de l'art de la lumière et de l'éclairage et pour l'échange entre pays d'informations dans ces domaines.
2. D'élaborer des normes et des méthodes de base pour la métrologie dans les domaines de la lumière et de l'éclairage.
3. De donner des directives pour l'application des principes et des méthodes d'élaboration de normes internationales et nationales dans les domaines de la lumière et de l'éclairage.
4. De préparer et publier des normes, rapports et autres textes, concernant toutes matières relatives à la science, la technologie et l'art dans les domaines de la lumière et de l'éclairage.
5. De maintenir une liaison et une collaboration technique avec les autres organisations internationales concernées par des sujets relatifs à la science, la technologie, la normalisation et l'art dans les domaines de la lumière et de l'éclairage.

Les travaux de la CIE sont effectués par Comités Techniques, organisés en sept Divisions. Les sujets d'études s'étendent des questions fondamentales, à tous les types d'applications de l'éclairage. Les normes et les rapports techniques élaborés par ces Divisions Internationales de la CIE sont reconnus dans le monde entier.
Tous les quatre ans, une Session plénière passe en revue le travail des Divisions et des Comités Techniques, en fait rapport et établit les projets de travaux pour l'avenir. La CIE est reconnue comme la plus haute autorité en ce qui concerne tous les aspects de la lumière et de l'éclairage. Elle occupe comme telle une position importante parmi les organisations internationales.

DIE INTERNATIONALE BELEUCHTUNGSKOMMISSION

Die Internationale Beleuchtungskommission (CIE) ist eine Organisation, die sich der internationalen Zusammenarbeit und dem Austausch von Informationen zwischen ihren Mitgliedsländern bezüglich der Kunst und Wissenschaft der Lichttechnik widmet. Die Mitgliedschaft besteht aus den nationalen Komitees in rund 40 Ländern.

Die Ziele der CIE sind:

1. Ein internationales Forum für Diskussionen aller Fragen auf dem Gebiet der Wissenschaft, Technik und Kunst der Lichttechnik und für den Informationsaustausch auf diesen Gebieten zwischen den einzelnen Ländern zu sein.
2. Grundnormen und Verfahren der Messtechnik auf dem Gebiet der Lichttechnik zu entwickeln.
3. Richtlinien für die Anwendung von Prinzipien und Vorgängen in der Entwicklung internationaler und nationaler Normen auf dem Gebiet der Lichttechnik zu erstellen.
4. Normen, Berichte und andere Publikationen zu erstellen und zu veröffentlichen, die alle Fragen auf dem Gebiet der Wissenschaft, Technik und Kunst der Lichttechnik betreffen.
5. Liaison und technische Zusammenarbeit mit anderen internationalen Organisationen zu unterhalten, die mit Fragen der Wissenschaft, Technik, Normung und Kunst auf dem Gebiet der Lichttechnik zu tun haben.

Die Arbeit der CIE wird durch Technische Komitees geleistet, die in sieben Divisionen organisiert sind. Diese Arbeit betrifft Gebiete mit grundlegendem Inhalt bis zu allen Arten der Lichtanwendung. Die Normen und Technischen Berichte, die von diesen international zusammengesetzten Divisionen ausgearbeitet werden, sind auf der ganzen Welt anerkannt.
Alle vier Jahre findet eine Session statt, in der die Arbeiten der Divisionen berichtet und überprüft werden, sowie neue Pläne für die Zukunft ausgearbeitet werden. Die CIE wird als höchste Autorität für alle Aspekte des Lichtes und der Beleuchtung angesehen. Auf diese Weise unterhält sie eine bedeutende Stellung unter den internationalen Organisationen.

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COMMISSION INTERNATIONALE DE L'ECLAIRAGE
CIE Central Bureau
Babenbergerstrasse 9, A-1010 Vienna, AUSTRIA
Tel: +43(1)714 31 87
e-mail: ciecb@cie.co.at
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CIE Central Bureau
Babenbergerstrasse 9
A-1010 Vienna, AUSTRIA
Tel: +43(1)714 31 87
e-mail: ciecb@cie.co.at

www.cie.co.at

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The following table provides an overview of the papers presented at the symposium. They are published in the proccedings in consecutive order of presentation.

The authors are responsible for the contents of their papers.

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MULTIPLE TRANSFER STANDARD FOR CHARACTERISATION OF SPHERE TEST SETUPS

Sperling, A.[1], Pendsa, S.[1], Taddeo, M.[1], Revtova, E.[2], Renoux, D.[3], Blattner, P.[4], Poikonen, T.[5], Jordan, W.[6]
[1] Physikalisch-Technisch Bundesanstalt, Braunschweig, GERMANY, [2] VSL B.V., Delft, NETHERLANDS, [3] Laboratoire national de métrologie et d'essais, Trappes, FRANCE, [4] Eidgenössisches Institut für Metrologie METAS, Bern, Switzerland, [5] Aalto-korkeakoulusäätiö, Espoo, FINLAND, [6] OSRAM GmbH, Augsburg, GERMANY
armin.sperling@ptb.de

Abstract

The new international CIE standard CIE S 025/E:2015 "*Test methods for LED Lamps, LED Luminaires and LED Modules*" [1], which is also published with nearly the same content as European standard EN 13032-4 "*Light and lighting – Measurement and presentation of photometric data of lamps and luminaires – Part4: LED lamps, modules and luminaires*" [2], is a standard for test laboratories to define environmental and operational conditions for test measurements of LED sources. Different to other international test standards used before, this standard now commits test laboratories to evaluate uncertainty contributions for measurements and to assign uncertainty budgets to their measurement results. To support test laboratories in the characterization of their test setups which used for varying SSL products, a Multiple Transfer Standard (MTS) was developed to identify typical sources of errors and to improve the determination of uncertainty components.

Introduction

Some information about the most important uncertainty components that must be considered, and how measurement uncertainties can be assigned, are given in the annexes of the new CIE standard. In many cases, where test setups are calibrated with source standards having properties very close to the devices under test (DUT) many uncertainty contributions related to imperfect measurement setups cancel out. However, there are a lot of measuring tasks where a calibration close to a standard is not possible. Therefore, some test laboratories might run into trouble when following the given instructions, as considerable knowledge about the current status and the sensitivity of their test setups with respect to the characteristics and behaviour of the device under test (DUT) is needed. One reason is possibly the restricted information about electrical, spectral, angular dependent and frequency dependent properties of the DUT itself, which a test laboratory might have. But also not properly behaving measurement setups and the typical change of the respective sensitivities of the measurement setups with time are critical and must be checked on a regular basis. However, a rigorous check of e.g. a sphere setup is very time consuming and needs a lot of supplementary measurements to be carried out by skilled personal with additional characterised and/or calibrated measurement devices.

One possible supporting approach for test laboratories to enable the implementation of the standard CIE S 025 is followed by collaborators of the European project on "Metrology for Efficient and Safe Innovative Lighting" (MESaIL). In this project it was decided to build a special Multiple Transfer Standard (MTS), which can be used to characterise source measurement setups like integrating sphere setups or goniophotometers and which can be used by test laboratories to assign meaningful uncertainty budgets to their measurements.

Basic concept

The basic concept of this approach is the development of a source standard which can be operated stable and reproducible under various spectral, geometrical and temporal operating modes. By calibrating this MTS for each mode of operation, the source standard is able to transfer photometric units under multiple conditions (see Fig. 1). This feature of the MTS can

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then be used to determine source-dependent calibration factors of not properly behaving measurement setups. The properties of the modes can be chosen such that they provide the best opportunity to characterize various measurement setups including integrating spheres and goniophotometers used for testing.

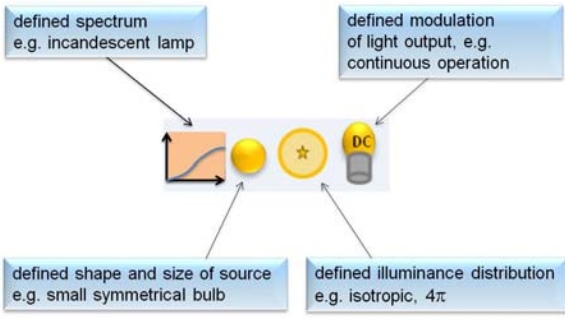

Figure 1a – Defined properties of a classical source based transfer standard

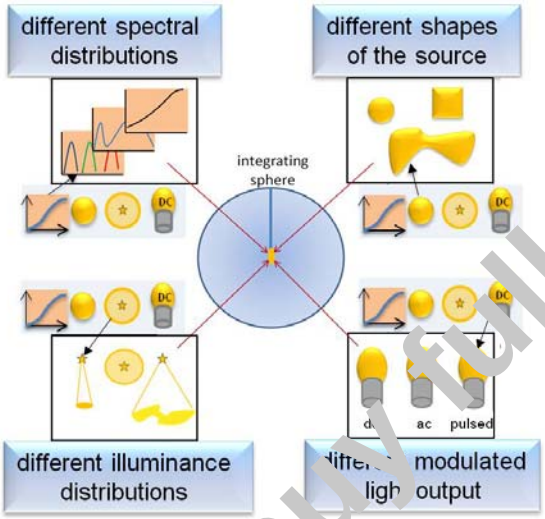

Figure 1b – Variable properties of the new Multiple Transfer Standard (MTS)

To show in case of sphere measurements whether or not a test setup is able to measure the luminous flux of a variety of different LED-based sources correctly and with the expected uncertainties, the MTS is equipped with sets of calibrated coloured and white LEDs (see Fig. 2).

Figure 2 – Picture of the bare Multiple Transfer Standard equipped with different coloured, warm white and cold white LEDs

The LEDs are mounted on specially designed printed circuit boards (PCBs). The PCBs are in excellent thermal contact to a cubical-shaped heat sink which is thermally stabilised via heat pipes. Each of the five PCBs is equipped with a microcontroller and all necessary electronic circuits to allow for an undisturbed independent self-contained operation of every single LED, and it also measures the PCB temperature. The measured PCB temperature is send to a controller board installed in the cylindrical part of the MTS which controls the heat sink temperature and which is also responsible for the wireless data transfer to an external computer which is used for data acquisition and programming. Due to the wireless data transfer, the MTS requires only a simple E27 socket for its connection to a power supply. Hence, it can be directly installed into an integrating sphere. According to CIE S 025 the sphere should have a diameter of at least 1,3 m.

If a perfectly behaving sphere setup is calibrated properly, it would be able to reproduce the known calibration values of every installed LED of the MTS – independent of colour, illuminance distribution and modulation. But a real sphere setup will show differences

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