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The challenge of standards and norms for SSL with Led Sytems-best practices

Stelian MATEI
Prof. dr. eng. – Electromagnetica SA, Semiconductor Lighting Centre
Email : stelian.matei@electromagnetica.ro

Abstract
Solid-state lighting differs fundamentally from traditional lighting technologies in terms of materials, drivers, system architecture, controls, and photometric properties. A multitude of new standards, norms and test procedures is needed to accommodate these technical differences. Standards for SSL systems are necessary, in general, because:

- enable products or components to work interchangeably or together;
- provide assurance that the product can deliver a certain level of performance; and
- provide the tools (symbols, terminology, methodology, etc) that make it easier for designers, manufacturers and users to communicate.

Despite continual improvements in the field of semiconductor lighting, the absence of a consistent standardization may possibly obstruct the LED's success in the lighting community. Since performance measurements are not yet reliable and consistent, there is great concerned that solid-state technology will only be chosen for applications where the advantages are obvious and the higher cost can clearly be justified. This paper presents a point of view of how the LED luminaire manufacturers and designers should cope with this challenge to ensure that all performance data reflects how light apparatus will perform in real-world applications.

Key words : lighting, LED technology

1. Introduction

An LED luminaire is in many ways more complex than a traditional lighting fixture. It is a system that includes a light-emitting source, heat transfer equipment, electrical control, optical conditioning, mechanical support, and protection, as well as aesthetic design elements (Fig.1). In that many system components and operating conditions require tighter control to provide optimum performance. With this new functional light source there is a need to ensure performance claims for the luminaire are made in a consistent way. The criteria should be designed to ensure that those performance claims can be matched against traceable data, to ensure that the performance data relate to the luminaire during operation and not just to the performance of the LED. Also because the LEDs themselves are expected to have long life, all of these other components, adhesives, and other materials must be equally long-lived, or, to the extent that they will not limit the system lifetime.

With the new types of light emitting diodes (LEDs) as introduced for general illumination there are increasing needs for accurate measurements of various optical parameters of LED luminaires.

Luminaire design data for traceability

There are many process variables during luminaires manufacturing process. Experience, track record and a traceability system are a vital part of providing a user or specifier with confidence and a route to tracking any issues. There are also many different types of environments luminaires will be required to operate (Fig 2). For example humidity can be higher in certain applications and can cause rapid degradation of materials used within the luminaire. Temperature can also be higher in certain applications and can cause rapid degradation of materials used within the luminaire. The luminaire manufacturer should work with the material suppliers and qualify any new materials if the application requires operating in high humidity and/or high temperature conditions.

Today LED luminaire design criteria are based upon compliance with existing lighting industry reference standards and test procedures, as well as new or revised standards and test procedures developed by lighting industry organizations. Some of the requirements as for example correlated color temperature (CCT), luminaire efficacy, zonal lumen density, and minimum light output are listed below.

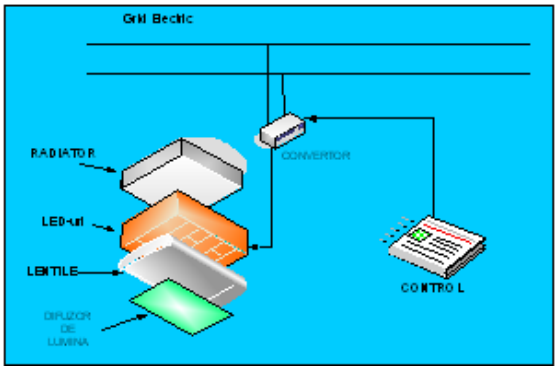

Figure 1 Solid state light with LED system

Figure 2 LED Luminaire-floodlight

Table 1. LED Luminaire requirements

Correlated Color Temperature (CCT)	The luminaire must have one of the following designated CCTs and fall within the 7-step chromaticity 2700 K, 3000 K, 3500 K, 4000 K, 4500 K, 5000 K, 5700 K, 6500 K
Color Spatial Uniformity	The variation of chromaticity in different directions (i.e., with a change in viewing angle) shall be within 0.004 from the weighted average point on the CIE 1976 (u',v') diagram.
Color Maintenance	The change of chromaticity over the lifetime of the product shall bewithin0.007 on the CIE 1976 (u',v') diagram.

Color Rendering Index (CRI)	Indoor luminaires shall have a minimum CRI of 75.
Off-state Power	Luminaires shall not draw power in the off state. Luminaires with integral occupancy, motion, photo-controls or individually addressable fixtures with external control and intelligence are exempt from this requirement. The power draw for such luminaires shall not exceed 0.5 watts when in the off state.
Warranty	The manufacturer must provide a warranty for luminaires, covering repair or replacement of defective electrical parts (including light source and power supplies) for a minimum of three (3) years from the date of purchase.
Thermal Management	Luminaire manufacturers shall adhere to device manufacturer guidelines, certification programs, and test procedures for thermal management.
Lumen Maintenance of LED Light Sources (L70)	LED package(s)/module(s)/array(s) used in qualified luminaires shall deliver at least 70% of initial lumens, when installed in-situ, for the minimum number of hours specified below: Residential Indoor: 25,000 hours Residential Outdoor: 35,000 hours All Commercial: 35,000 hours
Power Factor	Residential ≥ 0.70, Commercial ≥0.90
Minimum Operating Temperature	Power Supply shall have a minimum operating temperature of -20°C or below when used in luminaires intended for outdoor applications.
Maximum Measured Power Supply Case or Manufacturer Designated Temperature. Measurement Point (TMPPS)Temperature	Not to exceed the power supply manufacturer maximum recommended case temperature or TMP when measured during in-situ operation. This performance characteristic is separate and distinct from thermal requirements established by UL which governs safety rather than longevity of the power supply. All LED luminaires are expected to meet this requirement, including linear, suspended, close-to-ceiling, IC, ICAT and Non-IC recessed canisters, etc. as well as those luminaires that may be exempt from UL1598.
Output Operating Frequency	This performance characteristic addresses problems with visible flicker due to low frequency operation and applies to steady-state as well as dimmed operation. Dimming operation shall meet the requirement at all light output levels.(≥ 120Hz)
Electromagnetic and Radio Frequency Interference	Power supplies designated by the manufacturer for commercial and residential applications must meet EC requirements for consumer use (EN 61000, IEC 555).
Mechanical integrity	IPxx rating to suit the application, heat-sinking that will not become compromised with time and or lack of maintenance, vibration resistance, specifically so that the heat-sink does not become detached from the LED PCB, bonding mechanisms are suitable for the life of the lamp or luminaire
Noise	Power supply shall have a Class A sound rating.
Transient Protection	Power supply shall comply with IEEEC.62.41-1991, Class A operation. The line transient shall consist of seven strikes of a 100 kHz ring wave, 2.5 kV level, for both common mode and differential mode.
Incompatibility with Controls and Application Exceptions	Included documentation must clearly state any known incompatibility with photo-controls, dimmers or timing devices.
Reduced Air Leakage	Luminaires intended for installation in insulated ceilings shall be IC rated and be leak tested. The luminaire must include a label certifying “airtight” or similar designation to show air leakage less

	than specs.
Maximum Allowable Luminaire Aperture	The manufacturer should stipulate Luminaire aperture in order to satisfy end user application
Minimum Light Output	Min luminous flux as guaranteed by manufacturer
Zonal Lumen Density Requirement	Luminaire shall deliver a minimum of 75% of total lumens (initial) within the 0-60° zone (bilaterally symmetrical).
Minimum Luminaire Efficacy	Value of the luminaire efficacy in lm/W (E.g.: 24 lm/W or 35 lm/W)

LED luminaires standards

Standards for SSL systems fall into three basic categories:

- Communication standards define the basic terms, symbols and other communication tools used in the SSL industry. Glossaries, graphic symbols, metric units are typical subjects for communication standards.
- Design standards establish dimensions, tolerances or other physical characteristics of products. They ensure that SSL products meet criteria that enable interfacing and inter-changeability. „
- Performance standards provide a voluntary method of rating products. Light intensity, current/power rating, efficacy and efficiency analysis, and methods of testing for light intensity and light degradation are typical performance standards.

Despite continual improvements in the field of semiconductor lighting, the absence of a consistent standardization may possibly obstruct the LED's success in the lighting community. Some of the standards applicable to LED luminaires are listed as below.

Table 2 LED Luminaire applicable standards

Product type	Safety Standard	Performance Standard
Self-ballasted LED-lamps for general lighting services >50V - Safety specifications	IEC 62560 Edition 1 Publication expected 2010	IEC 62612/PAS Publicly Available Specification
Control gear for LED modules	IEC 61347-2-13 Published 2006	IEC 62384 Published 2006
LED Modules for general lighting - Safety specifications	IEC 62031 Edition 1 Publication 2008	IEC 62031 Published 2012
LED Luminaires	IEC 60598-1	IEC 62722

LED's and LED modules	IEC TS 62504 Terms and Definitions for LED's and LED modules in general lighting
CIE Technical Committees	TC2-46 CIE/ISO standards on LED intensity measurements
	TC2-50 Measurement of the optical properties of LED clusters and arrays
	TC2-58 Measurement of LED radiance and luminance
	TC2-63 Optical measurement of High-Power LEDs
	TC2-64 High speed testing methods for LEDs

Therefore for SSL luminaires is not a specific Standard as IEC 60598 it is the only standard referring generally to luminaires. Additional normative and standards applicable to LED luminaire and system components are also listed in the standard. The International Standard IEC 62031 is making distinction between various types of LEDs and also different structures in order to fulfill with luminaire's standard requirements (Fig.3). Unfortunately is still unclear how LED modules may conform with IEC 60598 requirements yet not referring specifically to this kind of light source or system. Consequently when applicable to LED this standard is referring to IEC 62031 in the same manner as a plug in/replaceable lamp ignoring the fact that most for street lights, assembly of LED module, the lens/optics, and even the control gear is the luminaire. Very often the LEDs or module cannot be removed from the fixture to be tested as a bare lamp. Even when this is possible the production of LEDs results in a wide range.

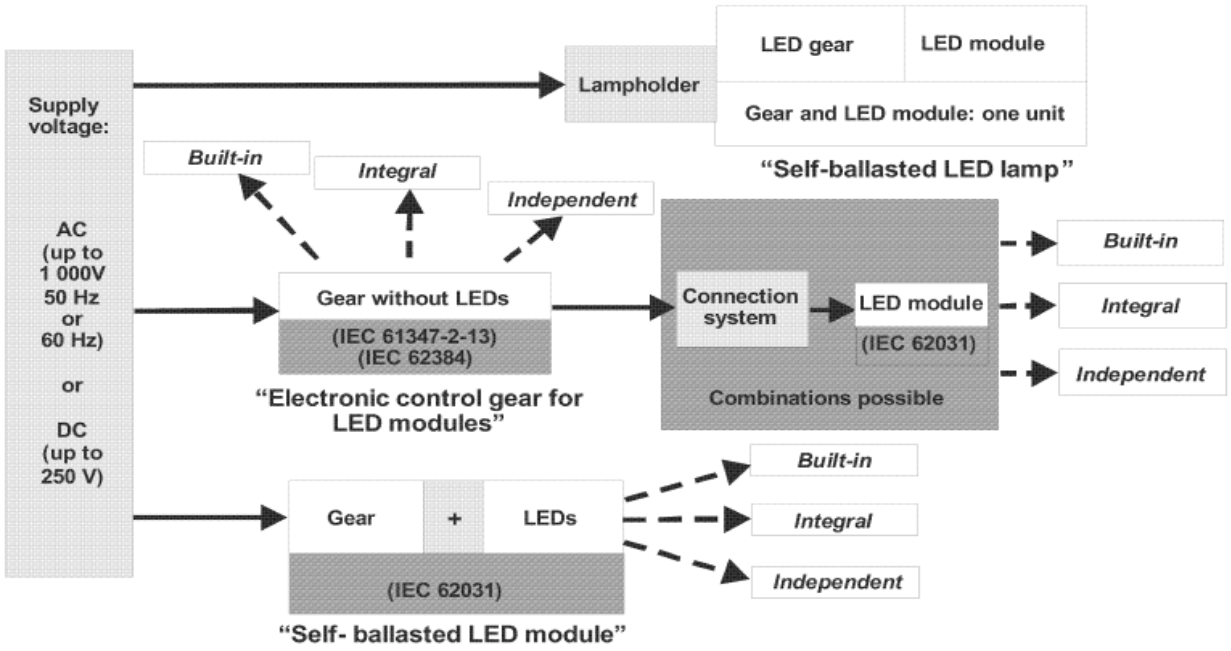

Figure 3 IEC 62031- LED module

For luminaires and lighting components, European harmonization of national approval marks has been achieved through introduction of the ENEC mark. It is important however, because it indicates that the product is suitable for use throughout Europe and that all of the most onerous special national conditions of test standards have been complied with.

When designing an exterior lighting installation it must be ensured that the lighting columns are not only strong enough to support the weight of the equipment attached to them but are also strong enough to withstand the more significant loading effect from wind pressure against the project area of the complete structure. In Europe document EN40 is used to check suitability, allowing the structure to be verified against statistical data for a geographical area and thereby ensuring that the column can withstand the wind conditions. The calculation process takes into account variables such as the height of the site above local ground level, the height above sea level, the distance from the coastline and the degree of shelter provided by local obstructions and features as all of these.

2. Conclusions

Lighting considerations are an important part of designing an environmentally sound structure. The use of Light Emitting Diode (LED) luminaires can provide certification points in a number of key areas. They are very capable of being used to make excellent general lighting sources that can replace many of the traditional lighting technologies in use today. In addition to these major advantages, LEDs also have a number of other favorable attributes as discussed earlier. However, in order to benefit from all of these great characteristics, one must first develop a luminaire which takes into account the need for LEDs to be cooled. First and foremost, it will be properly designed lighting systems that will allow LEDs to reach their potential. The bottom line for LED lighting systems is that they have the potential to save a substantial amount of energy cost for lighting over the lifetime of a project. In addition to the energy savings, the long lives of LEDs in well-designed systems will result in substantial savings in both labor and material costs for maintenance