How the West Was Won

BY JAMES BRODRICK

In recent years, the lack of standards for solid-state lighting has been likened to the Wild West. Variations in testing methods and even terminology from one manufacturer to another have caused confusion and frustration, as lighting designers and specifiers struggle to compare new solid-state lighting sources to traditional sources. While many lighting standards already exist, solid-state lighting is fundamentally different from traditional sources and requires new standards to accommodate the technical differences. A host of new test methods and standards are slated for release in 2008 and will chart a course for more consistent understanding of LED lumen output, lifetime and other performance characteristics. These first LED standards not only represent critical steps toward settling the Wild West, they also reflect an extraordinary cooperative effort among standards-setting organizations.

ON THE SAME PAGE

The effort to put new standards in place began several years ago when multiple organizations began to work individually or in small groups to create needed standards. **Table 1** provides a snapshot of key standards related to solid-state lighting. To foster greater coordination and collaboration among efforts, the U.S. Department of Energy (DOE) hosted a series of workshops. The first of these workshops was held in March 2006 and attended by representatives from the Illuminating Engineering Society of North America (IES), American National Standards Institute (ANSI), National Institute of Standards and Technology (NIST), National Electrical Manufacturers Association (NEMA), Underwriters Laboratories (UL), International Electrotechnical Commission (IEC), International Commission on Illumination (CIE) and Canadian Standards Association (CSA). At this first workshop, attendees discussed needs and priorities, and chose the DOE solid-state lighting Energy Star timeline as their development goal. At the most recent workshop, held in November 2007, attendees provided updates on progress and input on potential additional standards needed.

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In February 2008, ANSI released **C78.377-2008**, "Specifications for the Chromaticity of Solid-State Lighting Products," which specifies recommended chromaticity (color) ranges for white LEDs with various correlated color temperatures (CCTs). The standard is available free as an electronic download at *www.nema.org/stds/ANSI-ANSLG-C78-377.cfm#download*. Hard copies can be purchased from the ANSI and NEMA websites.

There are two IES standards of note. **LM-79**, "Approved Method for the Electrical and Photometric Testing of Solid-State Lighting Devices," specifies a standard test method for measuring the photometric properties of solid-state lighting devices, allowing calculation of luminaire efficacy. LM-79 is now available. **LM-80**, "Approved Method for Measuring Lumen Depreciation of LED Light Sources," specifies procedures for estimating LED lumen maintenance, an important element of estimating solid-state lighting lifetime.

Among other things, LM-79 specifies a standard test method for measuring parameters that allow calculation of luminaire efficacy, considered the most reliable way to measure LED luminaire performance. Luminaire efficacy (net light output from the luminaire divided by the input power and measured in lumens per watt) measures luminaire performance as a whole,

ANSI Performance and Measurement Standards	
C78.377-2008 *Specifications for the Chromaticity of Solid-State Lighting Products*	Specifies the recommended chromaticity (color) ranges for white light LEDs with various target correlated color temperatures (CCTs) and ensures accurate communication of chromaticities to consumers
C82.77-2002 *Harmonic Emission Limits – Related Power Quality Requirements for Lighting*	Specifies the maximum allowable harmonic emission of solid-state lighting power supplies
C82.SSL1 *Power Supply*	Will specify operational characteristics of electrical safety of solid-state lighting power supplies and drivers
IESNA Performance and Measurement Standards	
TM-16-05 *Technical Memorandum on Light Emitting Diode (LED) Sources and Systems*	Provides a general description of LED devices and systems and answers common questions about the use of LEDs
RP-16 *Nomenclature and Definitions for Illuminating Engineering Addendum a*	Will provide industry standard definitions of lighting terms, including all lighting technologies, and is currently being updated to include definitions of solid-state lighting terms
LM-79 *Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products*	Will specify procedures for measuring total luminous flux, electrical power, (allowing calculation of luminaire efficacy), and chromaticity of solid-state lighting luminaires and replacement lamp products
LM-80 *Approved Method for Measuring Lumen Depreciation of LED Light Sources*	Will specify procedures for determining lumen depreciation of LED arrays and modules (but not luminaires) related to effective useful life of the product

☐ Released ☐ In process

Note: This list is not comprehensive, as other existing and future industry standards, recommended practices, and regulatory requirements apply to specific solid-state lighting products. Information available as of April 4, 2008.

Table 1.

rather than relying on traditional methods that separate lamp ratings and fixture efficiency. This is a new paradigm for the lighting industry, and LM-79 helps establish a foundation for accurate comparisons of luminaire performance, not only for solid-state lighting but for all sources.

LM-80 is a test procedure for estimating the lumen depreciation of LED arrays and modules used in solid-state lighting luminaires. Unlike traditional filament-based lighting sources, LEDs don't die, they just fade away—a characteristic called lumen depreciation. While many things must be considered in estimating the useful life of a solid-state lighting system, including the potential for failure of any critical component within the system, the measurement of useful light produced from the LEDs is central to those estimates.

LM-80 sets two baselines: users will be able to select (based on the application) a product with a useful life of L_{70} (how long the product is expected to produce 70 percent or more of initial light output) or L_{50} (how long the product is expected to produce 50 percent or more of initial light output). LM-80 will provide essential initial guidance for estimating the useful life of LEDs within a product; future refinements to LM-80 are likely to include consideration of other factors that affect the life and reliability of solid-state lighting products.

LM-79 and LM-80 are key supporting standards for the new Energy Star criteria for solid-state lighting, issued by DOE in September 2007. The first Energy Star-qualified products are expected on the market in late 2008, and these products must be tested using LM-79 and LM-80. To learn more about the Energy Star qualification process, visit *www.netl.doe.gov/ssl/energy_star.html*.

MORE STANDARDS

There have been significant developments on additional standards for solid-state lighting.

- **IESNA RP-16**, "Nomenclature and Definitions for Illuminating Engineering; Addendum a," will provide industry standard definitions for terminology related to solid-state lighting. This addendum has completed its public review period.
- **ANSI C82-SSL1**, "Power Supply," will specify operational characteristics of electrical safety for power supplies and drivers for solid-state lighting products.
- **UL 8750**, "LED Safety," will specify minimum safety requirements for solid-state lighting components, including LEDs and LED arrays, power supplies and control circuitry. LED safety is currently specified through UL's "Outline of Investigation" (also numbered 8750), which contains the pertinent parts of other applicable UL standards that apply to LED lighting products. The outline will be used until the full LED-specific document is completed. UL customers can obtain the outline for free (with login) at: *www.ulstandards.com*. Others can purchase the outline at *www.comm-2000.com*.

To learn more about standards and test procedures in development, see *www.netl.doe.gov/ssl/usingLeds/measurement-series-standards.htm*.

MINIMIZING CONFUSION

The release of C78.377-2008 and the imminent LM-79 and LM-80 are the first tangible results of an accelerated, collaborative standards development process. These standards also represent the first of a growing body of information that will help support solid-state lighting development and innovation, and market adoption and growth.

The standards will help to remove the guesswork—for lighting manufacturers as well as designers and specifiers—about product characteristics, performance and comparisons. Setting standards, however, is just a start. Implementation will take time, but in the meantime, DOE and standards organizations will continue to augment that growing body of solid-state lighting standards, making it easier to select the best product for an application.

James Brodrick is the lighting program manager for the U.S. Department of Energy, Building Technologies Program. The Department's national strategy to guide high-efficiency, high-performance solid-state lighting products from laboratory to market draws on key partnerships with the lighting industry, research community, standards organizations, energy-efficiency programs, utilities and many other voices for efficiency.

research MATTERS

BY CORI JACKSON AND RON RUNKLES

In response to the addition of the Digital Addressable Lighting Interface (DALI) ballast protocol to the international fluorescent ballast standard, representatives from the National Electrical Manufacturers Association (NEMA) Lighting Controls, Ballast, Luminaire and Wiring Device Sections began development of an additional DALI protocol to incorporate lighting control devices such as wall switches, scene switches, occupancy sensors and photo sensors.

The proposed control interface is designed to be minimal in scope, yet robust enough to allow for full interoperability of DALI devices manufactured by various companies. This universal standardization of DALI control devices, along with the existing DALI ballast standard, will facilitate the design and implementation of complete, dynamic DALI lighting systems composed of products from multiple manufacturers.

The new NEMA DALI protocol is an open-source, digital protocol which provides controls manufacturers with the basic requirements for designing DALI-compliant control devices. As an expanded DALI protocol, the new standard allows for a substantial increase in available commands, allowing for acceptance of future lighting control devices, such as those that may be associated with solid-state lighting. Ballast commands will remain unchanged in the new protocol, while controls commands will utilize a 3-byte structure. The expansion of the protocol beyond its current 2-byte format also eliminates addressing and communication conflicts among DALI devices, allowing for a maximum of 64 ballasts and 64 controls devices on a single DALI system.

PROTOCOL IMPROVEMENTS

The original, ballast-only protocol has certain inherent disadvantages that the new NEMA DALI protocol seeks to overcome. The original standard does not support interoperability of controls and sensors, and there is no provision for their basic functionality or additional manufacturer-specific commands. Moreover, it does not provide for message collision protection but depends on a single master control. The new NEMA DALI protocol overcomes these disadvantages through the use of a 3-byte command structure which allows for collision detection, priority timeslots and basic control-device functionality.

The NEMA DALI protocol will assure that all control devices communicate at a basic level. The inclusion of an XML file, with a common set of parameters, will define interoperability of all future NEMA devices. An embedded XML file will define the functionality of a DALI control device. The XML file will contain all required device functionality, any optional functionality, as well as any manufacturer-specific functionality. As the basic building block of interoperability, it will