TIP 322: Development of a Predictive Reliability Test Method for Solid-State Luminaires, Light Engines, and Integral Lamps

Context

Lighting accounts for between 20 and 30 percent of electric energy use in the United States. The widespread use of LED lighting systems has the potential to reduce lighting energy use by 50 percent. For LED lighting systems to be accepted by the market however, they must be reliable and meet customer expectations and manufacturers' claims.

LED products are made up of many different components including LEDs, drivers, circuit boards, optics, thermal management devices, and other elements that are important to the overall reliability of the product.

Presently, the LED lighting industry lacks a standardized test method that can determine the accurate life of a complete LED system, such as an integral lamp, light engine, or luminaire.

Description

The project built on work that the Lighting Research Center (LRC) conducted previously to develop a cost-effective, accelerated life test method that can predict the whole system life of LED luminaires, light engines, and integral lamps at any given environment temperature and system use pattern. This project allowed the LRC to expand its work to a wider range of LED luminaire and lamp types, further validate the testing method developed, and move the method forward toward broad industry adoption and standardization.

The study developed a test method to predict LED system life in any application by testing the whole LED system, including on-off power cycling with sufficient dwell time, and considering both failure types, catastrophic and parametric. In addition, chromaticity (color) shift of products were measured and tabulated.

Benefits

Some LED lighting manufacturers claim extremely long product lifetimes such as 100,000 to 200,000 hours, even though components such as drivers are likely to fail within 50,000 hours. Additionally, the failure rate is accelerated by high operating temperatures. A standardized test method is needed, to predict the lifetime of LED lighting products and their components at various operating temperatures Therefore, a well-validated and robust test method that will truly estimate the life of a complete LED system will help the solid-state lighting industry.

This project was designed to help build customer confidence in LED product life and reliability, and speed market acceptance of this technology. This may result in significant annual energy savings and reduction in peak electric demand for BPA service territories.

Accomplishments

The study completed in this project supports a proposed industry standard for timely and cost-effective testing of LED luminaires for life and color shift. This method will allow manufactures to reliably determine the expected life of a solid-state lighting product with about 4 months of testing.

Deliverables

Project deliverables include:

- List of LED lighting products (e.g., luminaires, light engines) selected for testing during the project
- Schematic drawing of testing set-up and apparatus and list of equipment being used for testing
- Copy of all data collected during the project in electronic format
- Report of testing results and project findings
- Recommended testing method/protocol based on testing results with supporting documentation for movement forward through the technical committee process
- Final project report

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Project Start Date: October 1, 2014

Project End Date: September 30, 2016

Funding

Total Project Cost: $709,000

For More Information Contact:

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Links

Estimating LED Life
http://www.lrc.rpi.edu/programs/solidstate/LEDLife.asp

Participating Organizations

Lighting Research Center, Rensselaer Polytechnic Institute
ASSIST (Alliance for Solid State Illumination Systems and Technologies

Conclusions:

The results of this study show a shorter time, less than 3000 hours, test procedure can be developed to accurately predict LED system life in any application by knowing the LED temperature and the switching cycle. Using the life-test method described in this study will yield time to failure due to catastrophic and parametric failures. The shorter of the two failure modes is the system lifetime.

When systems employ feedback control to limit temperature rise or prevent lumen depreciation, the proposed test method may not yield desired results. Other methods must be investigated to handle such systems.

The proposed test procedure is useful for determining the lifetime of LED products more accurately than the current industry practice. Even though it may not catch all failure modes, it would certainly encourage failure modes typically found in LED fixtures used in most indoor applications. Adopting this procedure would help users gain more confidence of the lifetime numbers reported by product manufacturers and would help create more accurate payback analysis calculations that are commonly practiced in the lighting industry when making decisions to replace existing lighting products.

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