DOE Spotlight, Technical Support Spur Industry to Address Flicker

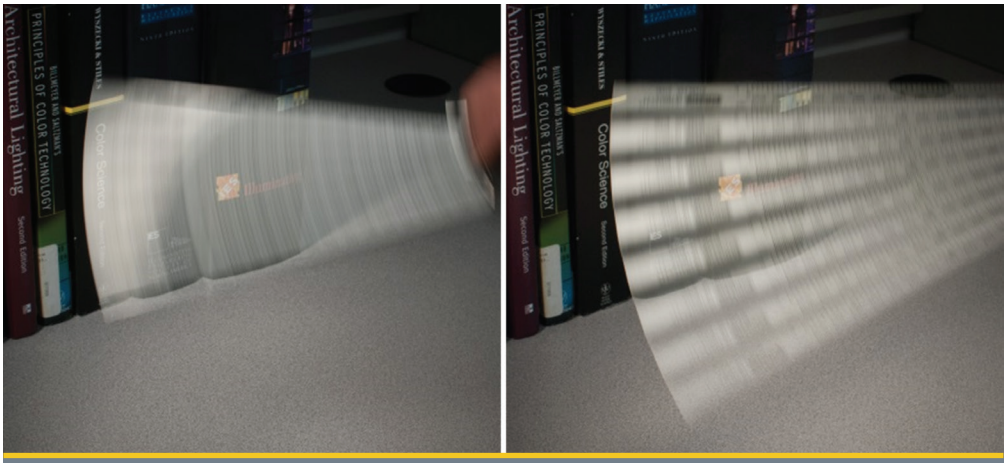
DOE and industry efforts drive development of guidance, standards, and tools.

All conventional light sources modulate luminous flux and intensity (i.e., they flicker) to some degree, whether it is perceptible or not. Thanks in part to U.S. Department of Energy (DOE) efforts, flicker is garnering increasing attention from lighting designers and specifiers, the standards and specification community, and, consequently, lighting manufacturers. More and more, an understanding of why flicker matters and how much it varies across commercially available products is becoming essential to proper lighting design. Specifying the right product for a given application and risk sensitivity requires the ability to quantitatively characterize flicker. At this time, however, there is no standardized test procedure for measuring photometric flicker from light sources, and manufacturers rarely report flicker characteristics.

While all AC-powered light sources flicker, flicker can be more pronounced in LEDs because, unlike other sources, LEDs have no persistence. This means that LEDs respond to a change in forward current with a near-instantaneous change in light output. But LEDs pose no inherent flicker hazard, and there are LED lighting products on the market that exhibit less flicker than their conventional counterparts. What primarily determines the degree of flicker in LEDs is the driver. However, it's more costly to make drivers that minimize flicker—and such drivers have to be larger in size, to accommodate the components that smooth out the light emission. For that reason, LED flicker is more likely to be a problem in lower-priced products, as well as in those products (such as MR16s) that have size constraints. In addition, the use of dimmers can exacerbate or cause flicker. The key is compatibility between the dimmer and the driver.

I'm very grateful for the work you and your organization are doing [regarding IEEE standards and DOE resources on flicker]—it will make a significant difference.

— Jason Hirsch, Imaging Scientist for the U.S. Air Force



The stroboscopic effect is just one of many potential consequences of flicker. The lamp used for the image on the left does not flicker, and thus the moving object is a smooth blur. Because it does flicker, the lamp used for the image on the right appears to create multiple instances of a moving object.

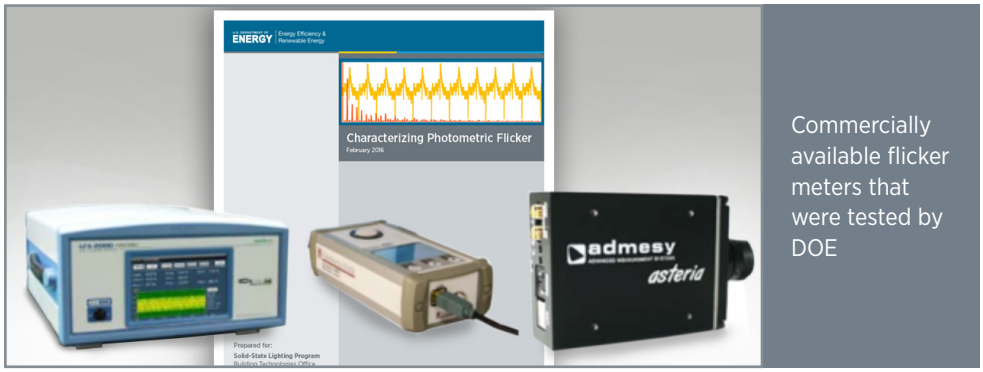
Building Awareness

In 2009, DOE technical experts noted significant flicker in a number of solid-state lighting (SSL) products and brought the issue to the forefront in the industry through a steady series of presentations and publications. Presentations at industry trade shows such as LIGHTFAIR® International as well as at annual DOE SSL Workshops identified key issues and

MARKET IMPACTS

of DOE/Industry Efforts to Address Flicker

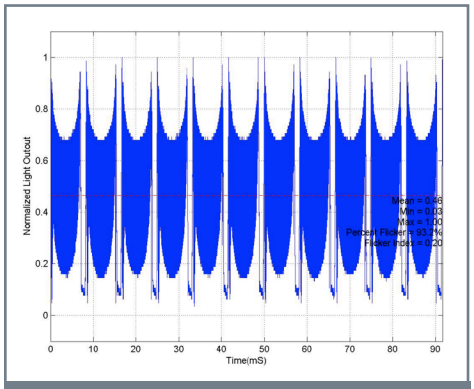
- IEEE 1789, "Recommended Practice for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers," is published in 2015.
- ENERGY STAR® and California's Title 20 require the reporting of flicker performance and/or are considering the adoption of flicker criteria.
- Improved flicker performance of new product generations suggests that some manufacturers are giving flicker increased design priority.
- IES Testing Procedures Committee (TCP) subcommittee is working on a method of measuring and quantifying temporal light artifacts.
- CIE Technical Committee 1-83: Visual Aspects of Time-Modulated Lighting Systems is considering development of standardized test and measurement procedures for flicker.
- Flicker meters are developed and made commercially available.



Commercially available flicker meters that were tested by DOE

helped build awareness. At the same time, CALiPER test reports, fact sheets, and *SSL Postings* provided additional information and analysis.

As a result, the Institute of Electrical and Electronics Engineers (IEEE) formed an industry standards committee to develop a recommended practice for evaluating flicker risks. Two members of DOE's SSL team served on that committee, with one of them serving as co-chair. The work of this committee resulted in the publication of IEEE 1789-2015, "Recommended Practice for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers," which provides guidance that can help manufacturers design drivers or select them for their products, to minimize possible flicker-associated health and productivity effects. The guidance also shows manufacturers how to test for flicker and how to report the results on their cut sheets, so that specifiers can use the recommendations without having to do any product testing themselves.



Graph showing flicker behavior of PAR 30 LED lamp tested by DOE

This new standard, in turn, prompted the emergence of commercial flicker meters for use in gauging conformance with IEEE 1789-2015 recommended practices, as well as commercial services such as UL's new "Verified Mark," which helps manufacturers indicate the flicker percentage of their LED lighting products. To support accurate flicker measurement, DOE tested a number of these commercially available flicker meters and reported on product performance to help specifiers determine the flicker behavior of lighting products, and to accelerate the development of standard test and measurement procedures. The report, *Characterizing Photometric Flicker*, was published in February 2016 and is available to inform the efforts of lighting and meter manufacturers, test laboratories, and standards and specifications bodies. It's also intended to help meter users understand and better select meters for their measurements, which in turn helps build the market for better flicker meters.

DOE continues to contribute expertise to solving flicker by participating in the IES Testing Procedures Committee (TPC) subcommittee working on a method of measuring and quantifying temporal light artifacts. The International Commission on Illumination (CIE) Technical Committee 1-83: Visual Aspects of Time-Modulated Lighting Systems is also considering the development of standardized test and measurement procedures for flicker. These accumulating efforts are paying off. ENERGY STAR® and California's Title 20 now require the reporting of flicker performance and/or are considering the adoption of flicker criteria, and some manufacturers appear to be giving flicker increased design priority, as evidenced by the improved performance of new product generations. ■

Metrics and Test Methods

To accelerate the development and implementation of needed metric and test methods for SSL products, DOE works closely with a network of standards-setting organizations, providing technical assistance, analysis, and support. Such support has been instrumental in the development of many standards that set the foundation for SSL product development and adoption, including:

- **IES LM-79-2008**, "Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products"
- **IES LM-80-2015**, "Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules"
- **IES TM-21-2011**, "Projecting Long Term Lumen Maintenance of LED Light Sources"
- **IES TM-30-2015**, "IES Method for Evaluating Light Source Color Rendition"
- **IEEE 1789-2015**, "IEEE Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers"
- **ANSI C78.377-2015**, "American National Standard for Electric Lamps—Specifications for the Chromaticity of Solid-State Lighting (SSL) Products"

In most cases, these standards reflect years of technical support and committee meetings to forge industry consensus.