 

LED WATCH

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FIGHTING FLICKER

There is still no testing standard, but flicker is on the industry's radar

Thanks in part to the rapid emergence of LED lighting, the phenomenon of flicker has been getting increased attention. All conventional light sources modulate luminous flux to some degree, usually as a consequence of drawing power from AC sources. But whereas conventional light sources have somewhat delayed responses to changes in electrical current—which serves to "cushion" them to some degree against flickering—the LED and its driver respond instantly to such changes, which can result in stark fluctuations in light output. And while these fluctuations may not be noticeable to everyone, they can still result in health and task performance problems.

Understanding and countering flicker is essential to the success of high-efficiency lighting technology. That's why the U.S. Department of Energy (DOE) Solid-State Lighting Program conducts flicker research and is supporting a number of industry committees (CIE 1-83: Visual Aspects of Time-Modulated Lighting Systems; CIE 2-89: Measurement of Temporal Light Modulation of Light Sources and Lighting Systems; and the IES Testing Procedures Committee) that are developing flicker standards for measurement, acceptability and metrics. A wide variety of technical resources on flicker can be found at *www.energy.gov/eere/ssl/flicker*.

A LACK OF STANDARDS

Although specifying the right product for a given application and risk sensitivity requires the ability to quantitatively characterize flicker, there's currently no standardized test procedure for measuring photometric flicker from light sources, and manufacturers rarely report flicker characteristics. Ideally, a test-and-measurement procedure would facilitate the capture of light-source intensity or luminance over time and describe how to characterize periodic waveform characteristics using one or more metrics, and how to identify aperiodic characteristics. (Fortunately, the CIE and IES groups are close to finalizing test-measurement procedures.) In 2015, an IEEE group published a recommended practice for evaluating flicker risks, which served as an excellent starting point, and Energy Star and California's Title 20 are requiring the reporting of flicker performance and/or considering the adoption of flicker criteria. NEMA has also weighed in with recommendations of metrics and criteria. However, flicker metrics and criteria for different applications are not yet firmly established. Some manufacturers appear to be giving flicker increased design priority, as evidenced by the improved performance of new product generations.

The periodic waveform that usually characterizes flicker can be principally described by four parameters: its amplitude modulation (i.e., the difference between its maximum and minimum levels over a periodic cycle); its root mean square (rms) average value over a periodic cycle (also called the DC component); its shape or duty cycle (the ratio between the pulse duration and the period of a rectangular waveform); and its periodic frequency (i.e., the number of recurring cycles per second). The most commonly used metrics for quantifying flicker are Percent Flicker, Flicker Index and Fundamental Flicker Frequency, although meters today also have the capability of measuring and reporting other flicker metrics, such as Stroboscopic Visibility Measure.

FLICKER METERS

The growing awareness of flicker has led to a profusion of handheld flicker meters that have come on the market to help users determine in the field if flicker is occurring and, if so, whether the level is acceptable for the application in question. These handheld meters range from simple smartphone applications to scientific-grade meters. DOE recently conducted a study of handheld flicker meters to determine how they perform and to identify any issues. The study was a follow-up to a 2016 DOE study that compared three benchtop laboratory meters against a reference system. The benchtop meters from that study all measured light-intensity waveforms and calculated essential flicker-performance characteristics and metrics similarly, both to each other and to the reference system. Some differences in performance were found when the light-intensity waveforms had significant high-frequency content greater than the dominant 120 Hz found in many products (especially when the light sources used in the study were dimmed), and when meter limitations prevented proper configuration.

The new DOE study compared the performance of eight handheld meters capable of measuring flicker in the field to a reference benchtop meter chosen based on its performance in the earlier study. A set of 12 light sources was selected for this study, based on their being typical of a specific architectural lighting product, exhibiting a specific waveform characteristic, and/or because they had previously been tested and were available for reuse in this study.

The study found that handheld flicker meters today are capable of providing performance nearing that of a benchtop meter in a controlled environment. Even free applications available for smart devices can provide a measurement that could be used as an indicator that a flicker problem may exist. However, the accuracy of the smartphone-based application tested should be followed up by more-precise flicker measuring equipment. Although the study uncovered some limitations and anomalies, these have been addressed either in product literature, on the device or software itself, or through firmware/software updates.

DEVIATION OF PERCENT FLICKER FOR HANDHELD METERS, RELATIVE TO REFERENCE METER MEASUREMENT

Percent Flicker	Viso (App)	Viso	AsenseTek	Fauser	UPRtek	Everfine	GL Optic	Gigahertz Optik
Mean Deviation (all measurements)	17.31	0.20	1.27	3.14	2.34	19.10	0.75	0.68
Mean Deviation (max levels)	10.69	0.25	1.76	4.06	2.53	10.31	0.54	0.72
Mean Deviation (dimmed levels)	33.20	0.00	0.61	1.91	2.08	30.82	1.03	0.64

DEVIATION OF FLICKER INDEX FOR HANDHELD METERS RELATIVE TO REFERENCE METER MEASUREMENT

Flicker Index	Viso (App)	Viso	AsenseTek	Fauser	UPRtek	Everfine	GL Optic	Gigahertz Optik
Mean Deviation (all measurements)	0.100	0.017	0.024	N/A	0.016	0.163	0.023	0.008
Mean Deviation (max levels)	0.038	0.005	0.010	N/A	0.009	0.111	0.006	0.002
Mean Deviation (dimmed levels)	0.250	0.066	0.042	N/A	0.026	0.232	0.047	0.016

The tables above present meter performance as it relates to Percent Flicker and Flicker Index, as well as the performance at maximum and dimmed light output levels across all light sources tested. See the full report at https://www.energy.gov/eere/ssl/flicker for exact product model numbers and description of laboratory testing, as well as explanations on the limitations of some meters.

METER CONSIDERATIONS

The test meters have qualities that vary in utility, depending on the intended use of the meter. It's important to be aware of meter limitations that prohibit certain measurements from being reliable; e.g., some of the meters began to fail to detect flicker at much lower frequencies compared to other meters. It's also important to consider whether there's a need for other types of field measurement, such as light levels or spectral content. Various meters tested have capabilities beyond the measurement of flicker, which makes them useful for other field measurements and evaluations.

How the meter will be used is also important. Some meters, for example, have sensors on the same side as the screen, others on the top edge, and others on detachable heads that allow measurements to occur remotely from the controller/body. One meter needs to be tethered to a computer in order to function. Knowing how testing will be done in the field is helpful in identifying whether a given meter would be a better option for the intended tasks.

How the data will be used after the measurement is taken, and whether recordings of light-intensity waveform data would be useful, are other aspects to consider. The waveform data, for example, may be used for calculating metrics that the meter does not automatically report, or for calculating metrics that are developed in the future. And some meters generate reports that may be useful for recordkeeping or delivering to clients.

As flicker continues to be an important factor in the selection and use of lighting products, future generations of flicker meters will enable design professionals and users in the field to adequately characterize lighting from a product or in a space and determine whether the level of flicker is acceptable for the given application.

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