ENERGY STAR® Lamps Version 2.1 Draft 1 Meeting

February 3, 2017
1 pm – 3 pm EST

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Daniel Rogers, LC, ICF

EPA

Webinar Details

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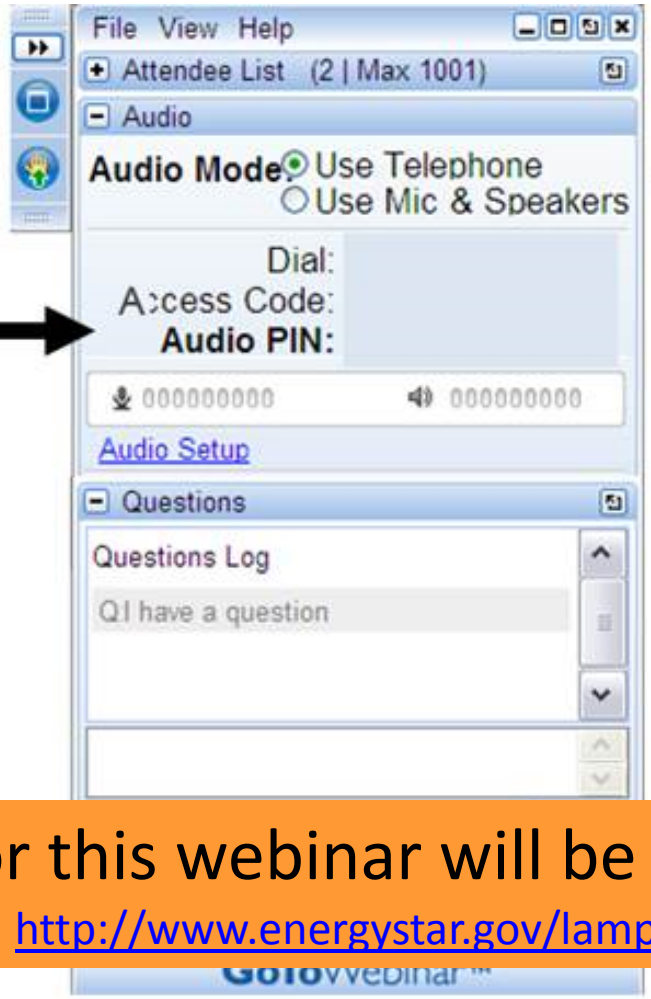

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Slides for this webinar will be posted at
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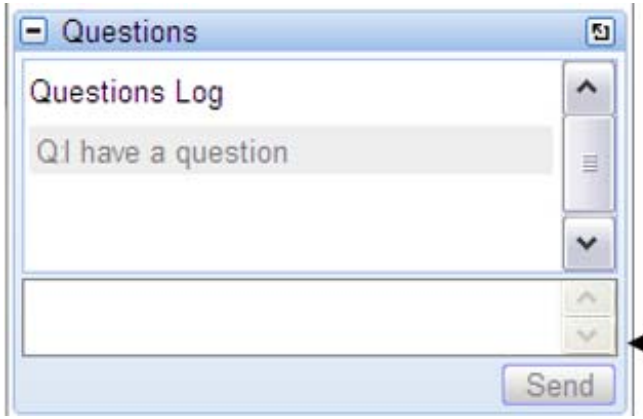
Asking a Question



You can type in questions at any time

Moderators

Taylor Jantz-Sell

ENERGY STAR Lighting Program Manager

U.S. Environmental Protection Agency

Daniel Rogers

ICF Lighting Technical Lead for ENERGY STAR Product Development

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Today's Agenda

- Introduction
- Part 1 (1:00 PM)
  - Goals
  - Specification Development Process
  - Draft 1 Changes
  - Discussion
- Part 2 (2:00 PM)
  - ENERGY STAR Method of Measurement of Light Source Flicker
  - Discussion
- Next Steps

Goals of this Point Revision

1. 15,000-hour minimum lifetime proposed for all LED lamp types
2. LED package as an allowable variation for family groupings
3. New test method proposed for reporting three key light source flicker metrics

Proposed changes for version 2.1 will not require products certified under V2.0 to be retested or recertified.

Lamps V2.1 Spec Development To Date

Event	Date
Draft Released	January 26, 2017
Draft Meeting	February 3, 2017
Deadline for Written Comments	February 23, 2017

Draft 1 Changes

Future Specification Revisions

Definitions

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SSL Lumen Maintenance Performance Data

Methods of Measurement and Reference Documents

Luminous Efficacy

Light Output

Correlated Color Temperature

Color Rendering

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Audible Noise

Section 3.1: Considerations for Future Revisions

- Industry test methods in development
  - IEC/TS 62861 Ed. 1: Guide to Principal Component Reliability Testing for LED Light Sources and LED Luminaires
  - NEMA SSL7B: Performance-related dimming standard
  - ANSI C82.15-201x: LED Driver Robustness

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Section 4: Definitions

- ***New:*** Filament Style Lamp
  - An LED lamp containing thin rods that are formed by multiple LED dies connected in series on a common longitudinal substrate and are configured to emulate a traditional incandescent filament (also referred to as “vintage style LED lamps”).
- ***Revised:*** Rated Lumen Maintenance Life
  - Updated reference (from LM-80-08 to TM-21-11)
- ***Removed:*** Stroboscopic Effect & Temporal Light Artifacts (*not used in specification*)

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Section 7.1: Product Variations

- **Any configuration included in a family grouping that shares the same model number** is representative of the performance of all configurations
- **Any sampled configuration that fails to meet the requirements during verification testing will result in a failed determination for all product configurations** sharing the same model number.

Section 7.1: Product Variations

- **Envelope Shape and Lamp Neck Variations:**
  - All variations must meet the applicable dimensional requirements for the shape and base type combination.
  - ***Dimensions of all variations must be verified to the appropriate ANSI standard.***
- **LED Package as an Allowable Variation:**
  - Allows flexibility to use a variety of LEDs without complete product retesting.

Lamp Attribute	Allowable Variation	Additional Test Data Required For Each Variant[3]
LED Package	To be eligible for sharing test data variations in the LED package, including same or next generation LED package or changing LED package model (same supplier or different) variations shall have: 1. Rated thermal resistance (Rth) between the measured junction temperature (Tj) and the package case temperature (Tc) ≤ the LED of the representative model; and 2. Luminous efficacy ≥ the representative model; and 3. Measured light output ≥ the representative model; and 4. The same nominal correlated color temperature as the representative model; and 5. Ra and R9 ≥ the representative model; and 6. TM-21 projected lumen maintenance that supports the rated life of the representative model. Increased lifetime claims require complete end product level testing. This variation may also include a reduction in the number of packages or a change to the optic as long as the product meets all applicable performance metrics. In all cases there should be no fundamental changes to the lamp or driver (e.g. the addition or deletion of driver capabilities). Changing from high-power to low power packages and vice versa, as well as changing from surface-mount to Chip-on-board (COB) LED packages and vice versa require complete end product level testing.	An LM-80 report is required for the new LEDs. Complete LM-79 testing on 10 units with the new LED packages is required. The performance metrics to be evaluated are (as applicable): • Luminous Efficacy • Light Output • Center Beam Intensity • Luminous Intensity Distribution • Correlated Color Temperature • Color Rendering Index (Ra and R9) • Color Angular Uniformity • Dimming and Flicker testing • Audible Noise

Section 7.2: Solid-State Lumen Maintenance Performance Data

- "ENERGY STAR Requirements for the Use of LM-80 Data" will replace the existing Lumen Maintenance Guidance.

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Section 8: Methods of Measurement and Reference Documents

- Updated placeholder references to final DOE test methods:
  - 10 CFR Part 430 Appendix W to Subpart B (CFL)
  - 10 CFR Part 430 Appendix BB to Subpart B (SSL)
- New Methods of Measurement
  - Addendum A to IES LM-80-08
  - Addendum B to IES TM-21-11
  - IES LM-80-15

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Section 9.1: Luminous Efficacy
Section 9.2: Light Output
Section 9.6: Correlated Color Temperature
Section 9.7: Color Rendering

- Placeholder DOE language replaced by:
  - 10 CFR Part 429 and 430 Appendix W to Subpart B (CFL)
  - 10 CFR Part 429 and 430 Appendix BB to Subpart B (SSL)

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Section 9.8: Color Maintenance

- New Methods of Measurement as applicable to this section:
  - Addendum A to IES LM-80-08
  - IES LM-80-15
- Placeholder DOE language replaced:
  - 10 CFR Part 430 Appendix BB to Subpart B

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Section 10.1: Lumen Maintenance (SSL)

- New Methods of Measurement as applicable to this section:
  - Addendum A to IES LM-80-08
  - IES LM-80-15
  - Addendum B to IES TM-21-11 (*will be added*)
- Early Interim Certification requirements include LM-80 test reports covered by IES LM-80-08 **or LM-80-15**
- Placeholder DOE language replaced:
  - 10 CFR Part 430 Appendix BB to Subpart B

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Section 10.2: Rated Life

- 15,000-hour rated life requirement for all LED lamps
  - Aligns the minimum lifetime of directional lamps with the current requirement for omnidirectional and decorative LED lamps

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Section 10.3: Rapid Cycle Stress Test

- Updated CFR reference:
  - 10 CFR Part 429 and 430 Appendix W to Subpart B

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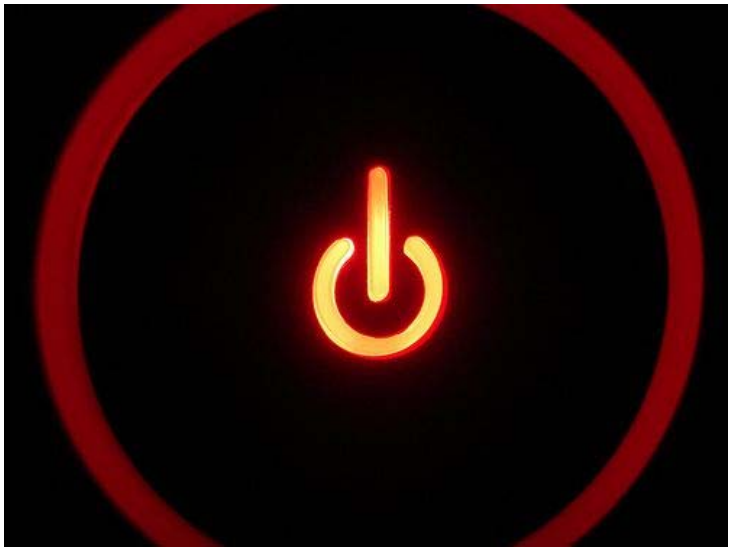
Section 11.2: Power Factor
Section 11.4: Start Time
Section 11.7: Standby Power Consumption

- Placeholder DOE language replaced:
  - 10 CFR Part 429 and 430 Appendix W to Subpart B (CFL)
  - 10 CFR Part 429 and 430 Appendix BB to Subpart B (SSL)

Section 11.7: Standby Power Consumption: All Lamps

- Laboratory test results shall detail off-state power consumption **to *at least*** the tenth of a watt.



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Section 12.4: Flicker: All Lamps Marketed as Dimmable

- The following flicker-related metrics shall be reported:
  - Percent Flicker;
  - Flicker Index; and
  - ASSIST Flicker Perception Metric (MP).
  - Lamp light output periodic frequency.
- ENERGY STAR Method of Measurement for Light Source Flicker (*new*)
- The reported values of Percent Flicker, Flicker Index, and ASSIST Flicker Perception Metric shall be the highest value measured.
- ENERGY STAR webinars and 2016 Partner Meeting presentation

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Section 12.5: Audible Noise: All Lamps Marketed as Dimmable

- Previous wording was confusing
  - "Lamp shall not emit noise above 24 dBA at 1 meter or less."
- NEW WORDING – No real change
  - "Lamp shall not emit noise above 24 dBA."
- Clarified that measurement shall be taken within one meter of the lamp.

Written Comments

In addition to making verbal comments during today's meeting, stakeholders are encouraged to submit formal written comments regarding this draft to:

lighting@energystar.gov

Please use subject line

"ENERGY STAR Lamps V2.1 Draft 1 Comments"

Comment Deadline
February 23, 2017

Discussion Time

- Questions?

ENERGY STAR Method of Measurement for Light Source Flicker

February 3, 2017
2 pm – 3 pm EST

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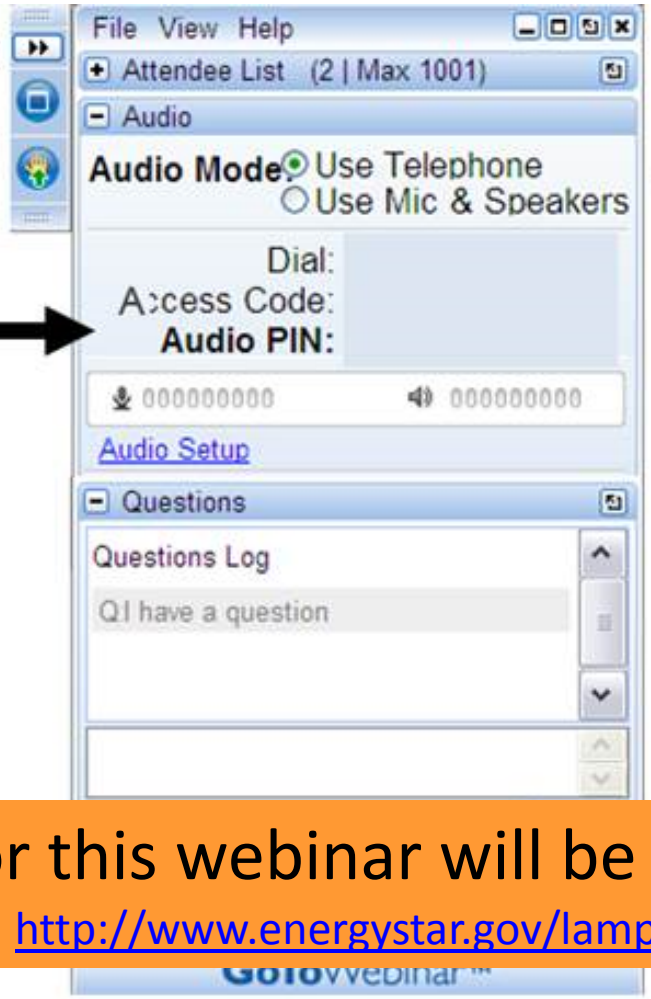

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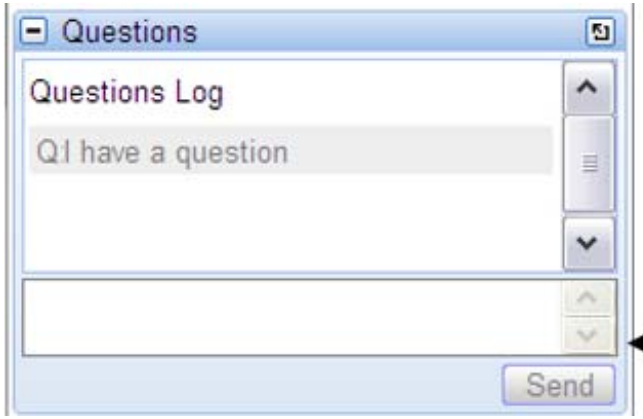

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Section 12.4: Flicker: All Lamps Marketed as Dimmable

- The following flicker-related metrics shall be reported:
  - Percent Flicker;
  - Flicker Index; and
  - ASSIST Flicker Perception Metric (MP).
  - Lamp light output periodic frequency.
- ENERGY STAR Method of Measurement for Light Source Flicker (*new*) adapted from current ENERGY STAR recommended practice
- The reported values of Percent Flicker, Flicker Index, and ASSIST Flicker Perception Metric shall be the highest value measured.

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- Test procedure for Light Source Flicker can be performed concurrently with the ENERGY STAR Light Output on a Dimmer testing

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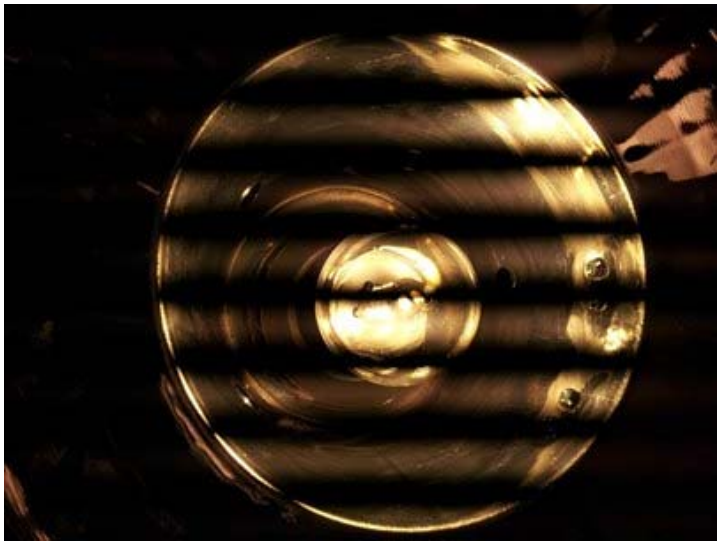
Applicability

- May eventually apply to all products covered in the scope of the Lamps, Luminaires, and Ceiling Fans specifications that are marketed as dimmable.



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- *(New)* **Fundamental Frequency:** The lowest frequency component of a periodic waveform.
- *(New)* **Minimum Control Position:** The setting on the dimmer or control device intended to achieve the minimum light output during operation. (*new*)
- *(Revised)* **Minimum Light Output:** The minimum light output (MinLO) refers to the light output of the UUT when operating with a dimmer in the circuit. For the purposes of this testing:
  - If no minimum dimming level is claimed, MinLO shall be set at 20% of MaxLO.
  - If minimum dimming level claimed: MinLO shall be set at the claimed percentage of MaxLO.

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- *(New)* **ASSIST** *recommends*…Recommended Metric for Assessing the Direct Perception of Light Source Flicker, Volume 11, Issue 3 (ASSIST 2015).

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Waveform Capture Equipment

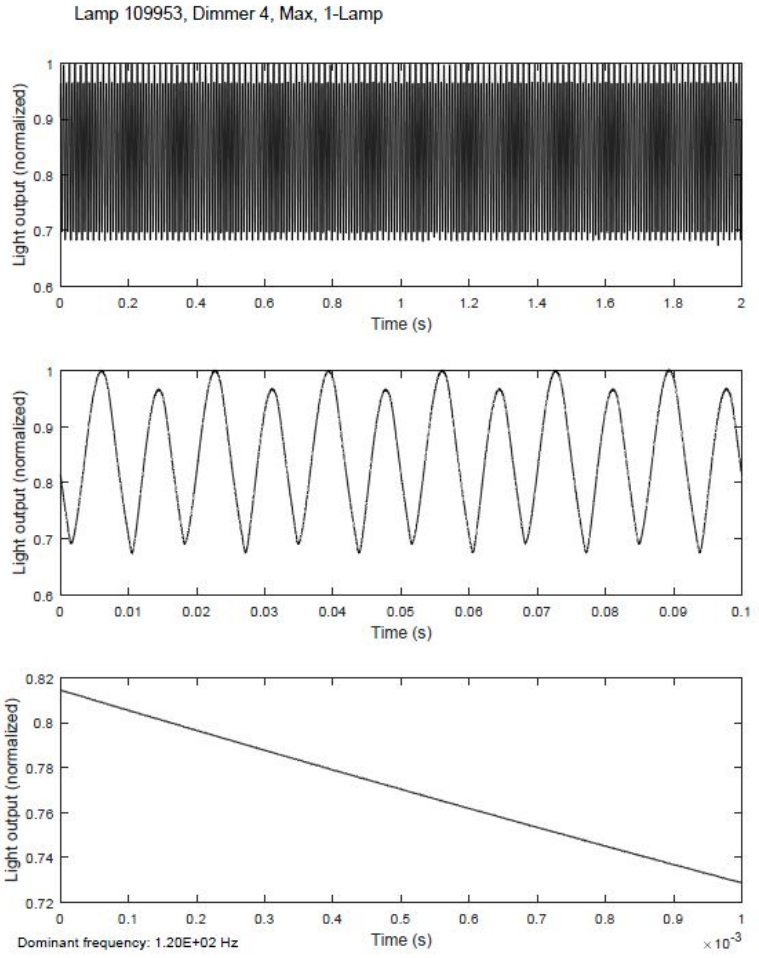
- Waveform digitizer (e.g., oscilloscope) requirements:

Characteristic	For Percent Flicker and Flicker Index	For ASSIST Flicker Metric (MP)
Temporal bandwidth (-3 dB rolloff freq)	0 to ≥ 1 MHz	0 to ≥ 500 Hz
Dynamic range of waveform amplitude	≥ 100:1 (40 dB)	≥ 1000:1 (60 dB)
Sampling rate	≥ 5 MSa/s	≥ 10 kSa/s
Record length	0.1 s (≥ 500 kSa)	2 s (≥20 kSa)

Note – At least 12-bit analog-to-digital conversion (ADC) is likely required to meet the dynamic range requirements for calculating the ASSIST Flicker Metric (M_P).

Waveform Capture Equipment

1. Appropriate photodetection, amplification and signal conditioning are needed.
2. Photodetector shall be corrected to closely fit the CIE spectral luminous efficiency curve (Vλ).
3. A photodetector amplifier, typically a transimpedance amplifier (current-to-voltage), is required.
4. An anti-aliasing filter is required.



Flicker Metric = 0.09, Flicker Index = 0.052, Percent flicker (LP) = 19.6%, Percent flicker (FBW) = 19.4%

Stray Light

1. Ensure that the light measured comes only from the UUT and is representative of the total light output of the product.
2. When the UUT is not powered, the detector output should read zero to within noise and resolution limits.

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Photometric Measurements

1. The UUT, photodetector, and enclosure (if applicable) shall remain stationary and have no vibrations or movement.
2. Ensure that the waveform digitizer receives the appropriate voltage range from the photodetector/amplifier.
3. Ensure that the photodetector receives light only produced by the UUT.
4. Check dark reading and adjust offsets as needed to ensure that the recorded zero-level (dc) is accurate

Measurement Sampling

1. Two light output waveforms per measurement sample:
   a. One at the full bandwidth of 0 to 1 MHz for a duration of 0.1 seconds (to calculate Flicker Index and Percent Flicker)
   b. Another at a reduced bandwidth of 0 to 500 Hz for a duration of 2 seconds (to calculate the ASSIST Flicker Metric)
2. At least 10 measurement samples shall be collected per UUT operating condition.
3. The time interval between each repeated sample shall be greater than 5 seconds.
4. The reported values of Percent Flicker, Flicker Index, and ASSIST Flicker Metric shall be the highest value measured.

Measurement Sampling

The following data shall be collected at each measurement point:

1. Waveform amplitude values for each of the 10 measurement samples for both the full-bandwidth and reduced-bandwidth measurements (at least 20 recorded waveforms)
2. Sampling rates of the full-bandwidth and reduced-bandwidth waveforms
3. Measurement bandwidths
4. Ambient temperature
5. Input voltage (rms), current (rms), and power

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Test Procedure for Light Source Flicker

Steps 1-6: measuring light source flicker at BLO:

1. Install the UUT in the test environment without a dimmer in the circuit.
2. Set power supply to rated voltage and frequency of the UUT.
3. Apply rated voltage/frequency to the UUT.
4. Allow the UUT to stabilize per IES LM-66-14 or LM-79-08.
5. Record light output, electrical parameters, and waveform readings.
6. Percent Flicker, Flicker Index, and ASSIST Flicker Metric (M_p) may be calculated now or at any later time from the saved waveforms. These measurements correspond to the BLO condition.

Test Procedure for Light Source Flicker

Steps 7-12: measuring light source flicker at MaxLO:

7. Install dimmer into the test circuit.
8. Apply rated voltage/frequency to the dimmer or control device.
9. Adjust dimmer to the maximum control position.
10. Allow UUT to stabilize (until 3 consecutive measurements are no more than 0.5% apart).
11. Record light output, electrical parameters, and waveform readings per sections 6.4.B and 6.4.C from measurement equipment.
12. Percent Flicker, Flicker Index, and ASSIST Flicker Metric (M_P) may be calculated now or at any later time from the saved waveforms. These measurements correspond to the MaxLO condition.

Test Procedure for Light Source Flicker

Steps 7-12: measuring light source flicker at MaxLO:

- A test setup that includes transfer switches to quickly install a dimmer into the test circuit as well as means to enable hot switching between dimmers may be utilized *to reduce stabilization times*.
- A test setup that includes means to measure light source flicker at maximum light output (MaxLO) for all five dimmers, and then measure light source flicker at minimum light output (MinLO) for all five dimmers may be utilized *to further reduce stabilization times by incurring only one max-to-min stabilization cycle*.
- To accommodate dimmer/UUT combinations that do not reach the required stabilization criterion, if the UUT has been stabilized for measurements previously (e.g., during BLO measurements) and the stabilization time was recorded, the UUT may be considered stabilized after operating for this period of time.

Test Procedure for Light Source Flicker

Steps 13-15: measuring light source flicker at MinLO:

13. Adjust dimmer so that the light output is the lower of:
    a. (20% of the MaxLO) ± 5%.
    b. (The minimum dimming level claimed as percentage of the MaxLO) ± 5%.
14. Allow the UUT to stabilize.
15. Verify that the UUT light output is still within the range as determined in step 13.
    a. If not, repeat steps 13 and 14.
    b. If within range, record light output, electrical parameters, and waveform readings. Calculate Percent Flicker, Flicker Index, and ASSIST Flicker Metric (MP) ; these measurements correspond to the MinLO condition.

Repeat steps 7-15 for each dimmer to be tested.

Test Procedure for Light Source Flicker

Steps 13-15: measuring light source flicker at MinLO:

If the minimum light output is:

- Greater than 20% of the MaxLO, measurements shall be taken at the minimum light output and the UUT/dimmer combination shall be identified as *not meeting the ENERGY STAR minimum light output requirement*.
- Greater than the claimed minimum dimming level, measurements shall be taken at the minimum light output and the UUT/dimmer combination should be identified as *not meeting the manufacturer performance claims*.

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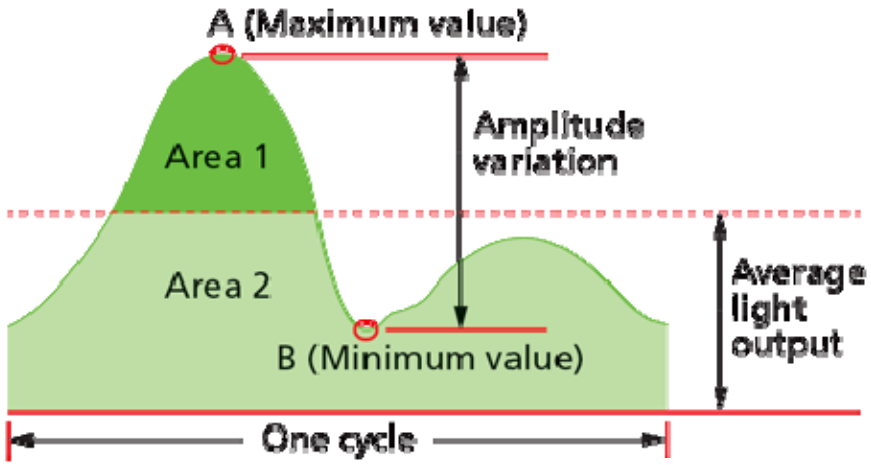
Percent Flicker

Percent flicker is calculated according to equation 1.

$$\text{Percent flicker} = \frac{\max(\Phi(n)) - \min(\Phi(n))}{(\max(\Phi(n)) + \min(\Phi(n)))}(100\%)$$

Equation 1

Where Φ(n) is the digitally sampled waveform. The functions max() and min() return the maximum value and minimum value of the waveform, respectively.



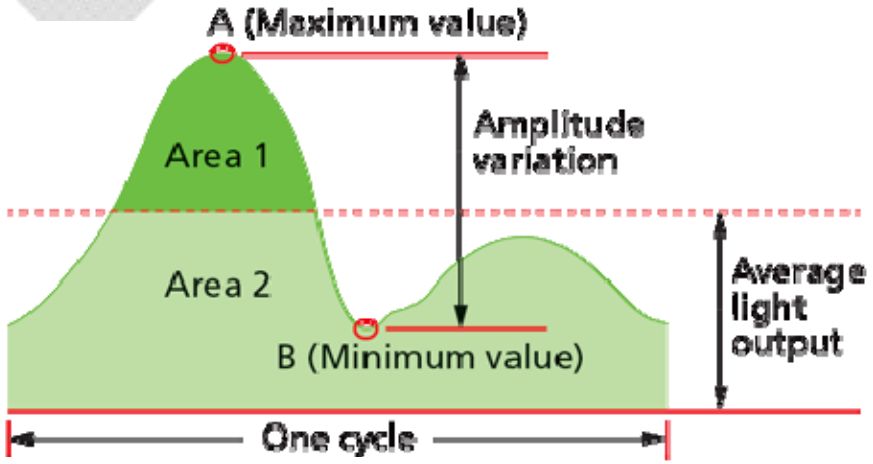
Flicker Index

Flicker Index is calculated according to equation 2.

$$\text{Flicker Index} = \frac{\sum_i \max[(\Phi_i - \overline{\Phi}), 0]}{\sum_i \Phi_i}$$

Equation 2

Where $\overline{\Phi}$ is the average or dc value of the waveform: $\overline{\Phi} = (\sum_i \Phi_i)/N$, where N is the total number of sample values in the waveform, and i is the index of each value. The max() function returns the maximum value of the two comma-separated arguments. A graphical representation of Flicker Index is shown below.



$$\text{Flicker index} = \frac{\text{Area 1}}{\text{Area 1} + \text{Area 2}}$$

ASSIST Flicker Metric

http://www.lrc.rpi.edu/programs/solidstate/assist/pdf/AR-FlickerMetric.pdf

Appendix B – Example of implementation of the Flicker Perception Metric Calculation as a Matlab® Function

Appendix C - Example of a Matlab® Script to Calculate and Display the Components of the Flicker Perception Metric

A copy and paste version of this code is available for download from:
http://www.lrc.rpi.edu/programs/solidstate/assist/recommends/flicker.asp

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Test Report

A. Manufacturer's name and product identification for the UUT and dimmers tested
B. Name and location of testing facility
C. Test date
D. Lamp base orientation (if applicable)
E. Input voltage (V)
F. Input voltage frequency (Hz)
G. Fundamental frequency (lowest frequency component), Percent Flicker, Flicker Index, and ASSIST Flicker Metric (MP) at BLO
H. Electrical measurements, light output reading, Percent Flicker, Flicker Index, and ASSIST Flicker Metric (MP) at MaxLO for each dimmer tested
I. Electrical measurements, light output reading, Percent Flicker, Flicker Index, and ASSIST Flicker Metric (MP) at MinLO for each dimmer tested
J. Stabilization time and stabilization method used
K. Digitized photometric waveform data of the full-bandwidth and reduced-bandwidth measurements that resulted in the highest values of Flicker Index and ASSIST Flicker Metric, respectively, as well as an image of the full-bandwidth photometric amplitude waveform plotted over a 100 ms time interval.

Flicker Measurement Training

- Date TBA
- Lighting Research Center, Troy, NY

Discussion Time

- Questions?

Written Comments

In addition to making verbal comments during today's meeting, stakeholders are encouraged to submit formal written comments regarding the ENERGY STAR Method of Measurement for Light Source Flicker to:

lighting@energystar.gov

Please use subject line

"ENERGY STAR Flicker Method of Measurement Comments"

Comment Deadline
February 23, 2017