Residential High Efficacy Lighting

JA10 Flicker – Fourier Transform

What is High Efficacy Lighting?

California's 2016 Title 24, Part 6 Building Energy Efficiency Standards (Energy Standards) for residential buildings require high efficacy lighting throughout new homes, additions, and alterations. The definition of a "high efficacy" luminaire has been expanded to include luminaires containing light sources that meet the new performance requirements outlined in Title 24, Part 6 Reference Joint Appendix JA8 (JA8), Qualification Requirements for High Efficacy Light Sources. One of these new performance requirements for light sources complying with JA8 is "reduced flicker operation," which is defined as amplitude modulation (Percent Flicker) of less than 30% for frequencies less than 200Hz, measured at both 100% and 20% light output.

The 2016 Energy Standards also include a new Joint Appendix, JA10, Test Method for Measuring Flicker of Lighting Systems and Reporting Requirements, that provides flicker testing and data reporting requirements for JA8 light sources.

Relevant Code Sections

Title 24, Part 6 Building Energy Efficiency Standards:

- Reference Joint Appendix JA8 (JA8) – Qualification Requirements for High Efficacy Light Sources
- Reference Joint Appendix JA10 (JA10) – Test Method for Measuring Flicker of Lighting Systems and Reporting Requirements

JA10 Data Filtering Requirements – Fourier Transform

JA10 describes a method of filtering the raw high frequency photometric data to isolate the percent flicker that occurs at frequencies below 200Hz in order to show compliance with the JA8 reduced flicker operation requirement.

JA10 also requires the data to be filtered below several other cut-off frequencies (40 Hz, 90 Hz, 400 Hz and 1,000 Hz) for reporting purposes. To get the raw data into the specified format for all five cut-off frequencies, the data must be filtered using a Fourier transform.

Manufacturers or their third-party certifiers may develop their own MATLAB command language, design their own Fourier analysis tool to perform the transform or use the sample MATLAB command language found in the Energy Code Ace JA10 Best Practices report.

WHY FILTER RAW FLICKER DATA?

The impacts of light flicker on people, including the detection of flicker and the negative physiological impacts of flicker, are a function of both the amount of light modulation (Percent Flicker), and the frequency at which it occurs. Flicker occurring at low frequencies can be much more noticeable and/or harmful than a comparable Percent Flicker occurring at very high frequencies. California's flicker testing and reporting protocols include a filtering process to identify the frequencies at which flicker is occurring.

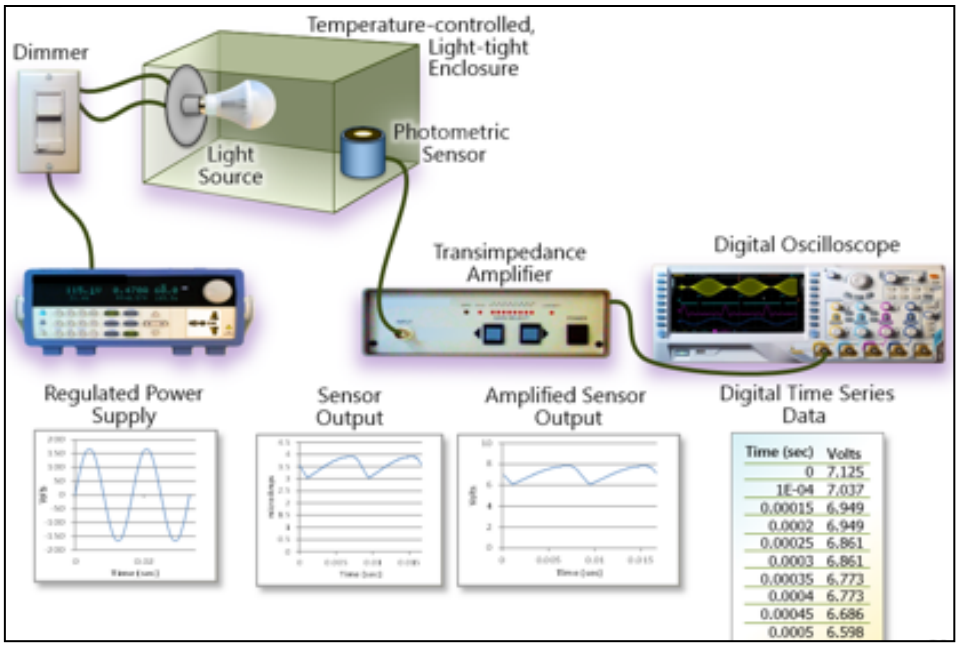
Filtering raw flicker data to isolate flicker occurring at low frequencies can result in a noticeable reduction in Percent Flicker measurements. If products are tested but the data are not filtered, the results may be misleading. The difference can be significant. A product that appears to have flicker levels above 30% based on its raw flicker data may have flicker levels below 30% after the data are filtered to a 200 Hz cut-off frequency. In fact, in testing supported by the California Investor-Owned Utilities, about 14% of products were measured to have >30% flicker when the data was not filtered, and <30% flicker once filtered below 200 Hz. On average, Percent Flicker values were found to be about 6% higher for unfiltered results as compared to filtered. *(Source: CA IOUs: LED Flicker Test Results and Repeatability Analysis)*

JA10 Reporting Requirements

JA10 requires equipment manufacturers of JA8 products or their designated representatives to upload the test data manually through the MAEDBS or by using the Data Certification Form (MS Excel 2010 or newer) as described in Table JA-10-1, Flicker Data to be Recorded and Submitted to the California Energy Commission, which is reproduced below. The manufacturer or its designated representative must retain the test data for a period of at least two years from the date of certification, and the test data must be made available to the Energy Commission upon request.

TABLE JA-10-1. FLICKER DATA TO BE RECORDED AND SUBMITTED TO THE CALIFORNIA ENERGY COMMISSION

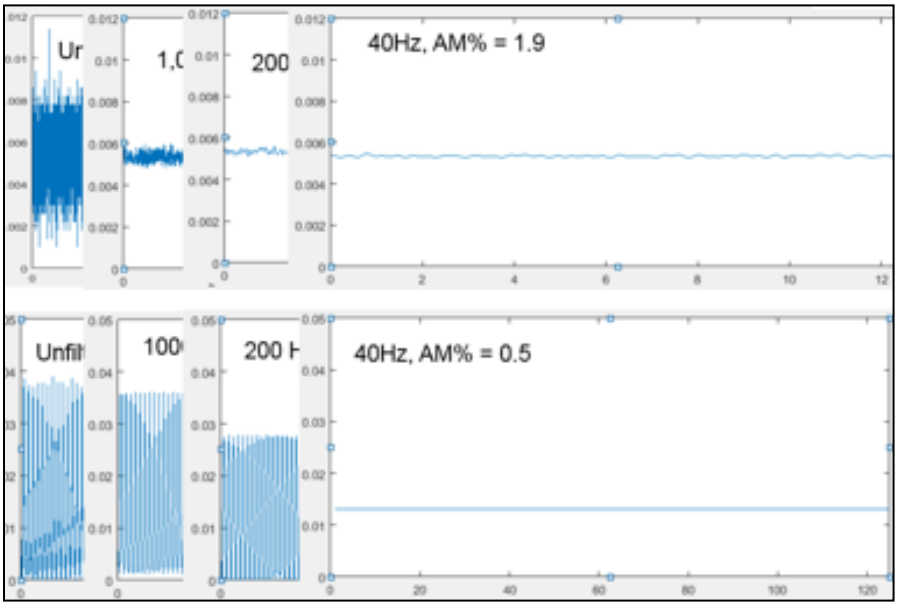
Data	Units/Format
Test Date	
Test Operator	Company Name, Contact Name, Address, Phone Number, e-mail address
Entity submitting results	Company Name, Contact Name, Address, Phone Number, e-mail address
	Manufacturer or Brand
Tested lighting system component: Dimmer	Dimmer type, Manufacturer or Brand, model number
Tested lighting system component: light source (lamp or light engine)	Light source type (lamp, light engine, etc), Manufacturer or Brand, model number
Tested lighting system component: Ballast or Driver	Ballast or Driver, Manufacturer or Brand, model number
Recording interval	seconds (no greater than 0.00005 seconds)
Equipment Measurement Period	seconds (no less than 1 second)
Fraction of rated light output integrated over measurement period at 100%, 20% and minimum fraction of light output.	Fraction of rated light output integrated over measurement period at 100%, 20% and minimum fraction of light output
Amplitude modulation unfiltered	calculated percent amplitude modulation unfiltered for each dimming level (100%, 20% and minimum fraction of light output)
Percent amplitude modulation with 1,000 Hz cut-off	calculated percent amplitude modulation, data filtered with a 1,000 Hz cut-off frequency for each dimming level: (100%, 20%, and minimum fraction of light output)
Percent amplitude modulation with 400 Hz cut-off	calculated percent amplitude modulation, data filtered with a 400 Hz cut-off frequency for each dimming level: (100%, 20%, and minimum fraction of light output)
Percent amplitude modulation with 200 Hz cut-off	calculated percent amplitude modulation, data filtered with a 200 Hz cut-off frequency for each dimming level: (100%, 20% and minimum fraction of light output)
Percent amplitude modulation with 90 Hz cut-off	calculated percent amplitude modulation, data filtered with a 90 Hz cut-off frequency for each dimming level: (100%, 20% and minimum fraction of light output)
Percent amplitude modulation with 40 Hz cut-off	calculated percent amplitude modulation, data filtered with a 40 Hz cut-off frequency for each dimming level: (100%, 20% and minimum fraction of light output)



Flicker Test Set Up

Certifying Products for Compliance

Compliance with JA8 and JA10 entails designing and marking products according to the regulations, testing regulated products using the required test methods, and certifying the product to the Energy Commission's Appliance Efficiency Database. Instructions for submitting Title 24 appliance data for high-efficacy light sources and the Date Certification Form can be found on the Energy Commission's website. Energy Code Ace offers resources and training to help guide you through the process. See the For More Information section on the next page for details.



Example of Filtered Waveform

For More Information

Primary Documents

- Energy Standards Section 100.1 – Definitions and Rules of Construction
  energycodeace.com/site/custom/public/reference-ace-2016/Documents/section1001definitionsandrulesofconstruction.htm
- Energy Standards Sections 110.9 – Mandatory Requirements for Lighting Control Devices and Systems, Ballasts, and Luminaries
  energycodeace.com/site/custom/public/reference-ace-2016/Documents/section1109mandatoryrequirementsforlightingcontroldevicesandsyst.htm
- Energy Standards Section 130.0 – Lighting Systems and Equipment and Electrical Power Distribution Systems
  energycodeace.com/site/custom/public/reference-ace-2016/Documents/section1300lightingsystemsandequipmentandelectricalpowerdistribu.htm
- Energy Standards Section 150.0(k) – Mandatory Features and Devices
  energycodeace.com/site/custom/public/reference-ace-2016/Documents/section1500mandatoryfeaturesanddevices.htm
- Energy Standards Joint Appendix JA1 – Glossary
  energycodeace.com/site/custom/public/reference-ace-2016/Documents/appendixja1glossary.htm
- Energy Standards Joint Appendix JA8 – Qualification Requirements for High Efficacy Light Sources
  energycodeace.com/site/custom/public/reference-ace-2016/Documents/appendixja8qualificationrequirementsforhighefficacylightsources.htm
- Energy Standards Joint Appendix JA10 – Test Method for Measuring Flicker of Lighting Systems and Reporting Requirements
  energycodeace.com/site/custom/public/reference-ace-2016/Documents/appendixja10testmethodformeasuringflickeroflightingsystemsandrep.htm
- 2016 Title 20 Appliance Efficiency Regulations:
  govt.westlaw.com/calregs/Browse/Home/California/CaliforniaCodeofRegulations?guid=I8F8F3BC0D44E11DEA95CA4428EC25FA0&originationContext=documenttoc&transitionType=Default&contextData=(sc.Default)
- Voluntary California Quality Light-Emitting Diode (LED) Lamp Specification
  energy.ca.gov/appliances/led_lamp_spec/

California Energy Commission Information & Services

- Energy Standards Hotline: 1-800-772-3300 (Free) or
  Title24@energy.ca.gov
- Online Resource Center:
  energy.ca.gov/title24/orc/
  – The Energy Commission's main web portal for Energy Standards, including information, documents, and historical information
- JA8 Compliance for Test Laboratories Fact Sheet:
  energy.ca.gov/2016publications/CEC-400-2016-018/CEC-400-2016-018-FS.pdf
- Instructions for Submitting High-Efficacy Light Sources for Title 24 Appliance Data:
  energy.ca.gov/appliances/database/forms_instructions_cert/Lighting_Products/2016%20JA8%20High%20Efficacy%20Lighting%20(JEFF).zip
- Modernized Appliance Efficiency Database (MAEDBS):
  https://cacertappliances.energy.ca.gov/Login.aspx

Additional Resources

- California Lighting Technology Center (CLTC) Guides:
  – Residential Lighting: What's New in the 2016 Title 24, Part 6 Code?
  cltc.ucdavis.edu/publication/2016-title-24-code-changes-residential
  – Residential Lighting: A guide to meeting or exceeding California's 2016 Building Energy Efficiency Standards
  cltc.ucdavis.edu/publication/residential-lighting-design-guide-2016-standards
- Energy Code Ace:
  EnergyCodeAce.com
  – An online "one-stop-shop" providing free resources and training to help appliance and building industry professionals decode and comply with Title 24, Part 6 and Title 20. The site is administered by California's investor-owned utilities.
  Of special interest:
  - Report: Sample MATLAB Fourier Low Pass Filter Routine
    energycodeace.com/download/17579/file_path/fieldList/Report.BP.JA10%20Sample%20MATLAB%20Command.zip
  - Fact Sheets
    energycodeace.com/content/resources-fact-sheets/
    – Residential Lighting 2016
    – Title 20 Certification Overview, Process and FAQs
    – Title 20 Lighting FAQs
    – Residential High Efficacy Lighting for Manufacturers
  - Title 20 On-Demand Video Training:
    energycodeace.com/content/title-20-training/

  Please register with the site and select an industry role for your profile in order to receive messages about all our free offerings!