

Flicker In LED Luminaires

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The goal of this white paper is help you understand the possible effects of flicker on customers and how the type of LED Power Supply used can affect the level of flicker produced by LED luminaires.

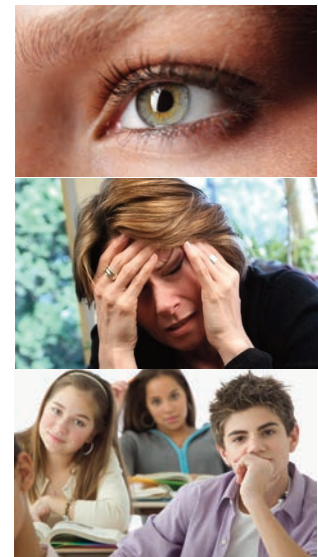
Why Does Flicker Matter?

When flicker is perceived by the average observer it can be interpreted simply as annoying and/or distracting. For at-risk observers, such as those sensitive to light, individuals with Autism, and those with photosensitive epilepsy, especially children, flicker under certain conditions may trigger health issues within these populations which include migraines, eyestrain, seizures, and impaired visual performance.

The presence of flicker in LED lighting applications is dependent on the light modulation characteristics of the LED Power Supply, the ambient light conditions, the sensitivity of the individuals using the space, and the tasks performed.

Flicker Definition

The U.S. Department of Energy (DOE) defines flicker as a “variation of light output over time,” and states that “all light sources flicker to some degree.”



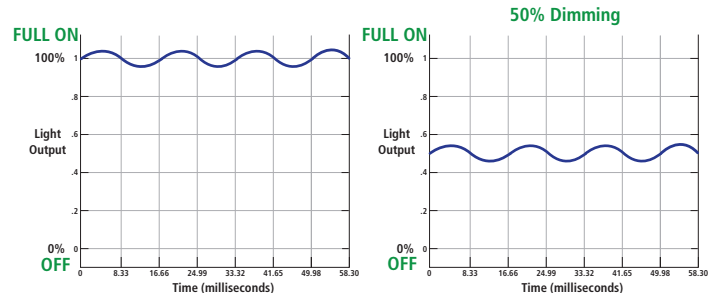
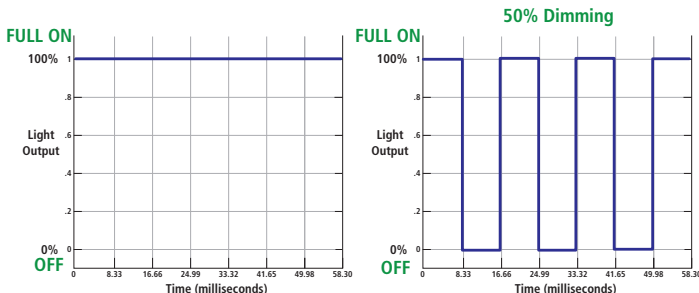
Flicker and LED Power Supplies

There are two types of LED Power Supplies to choose from when specifying LED lighting systems. It is important to understand the technology underlying each type and how it effects the amount of flicker generated in a space.



Pulse Width Modulation (PWM) LED Power Supplies dim the light by rapidly switching the current on and off to the LEDs. The ratio of time on to time off determines the perceived brightness of the LED. PWM LED Power Supplies may not exhibit objectionable flicker when current is at 100%, but when dimmed, flicker may become apparent.

Constant Current Reduction (CCR) LED Power Supplies dim the light by reducing the amount of current delivered to the LED. The LED does not turn on and off. CCR LED Power Supplies may exhibit a ripple on the output current signal.



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Download the LRC ASSIST Study

4 Ways to Check for Flicker in LED Power Supplies

The Lighting Research Center's (LRC) ASSIST Program outlines four ways to check for flicker in LED power supplies.

1. Use a **Waveform Analyzer** to observe the exact wave shape of the electrical signal from the LED Power Supply to the LED array.
2. Spin a **Flicker Checker Wheel** to observe the pattern that emerges from different LED Power Supplies, especially when dimmed.

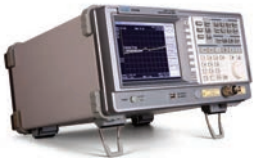
Choppy distinct patterns = High degree of Flicker present



Smooth concentric circles = Minimal Flicker present

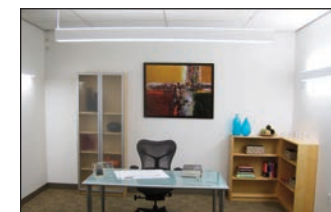
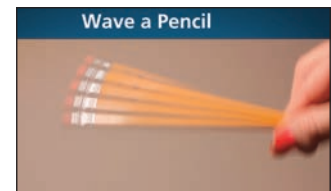


3. **Wave an object** under the light source to see if multiple images are produced by each cycle.
4. The best tool is to ask for a **mock-up of the space** with all sources and dimmers to experience the luminaire firsthand.



Waveform Analyzer

The Flicker Checker wheel was created over 40 years ago to check for magnetic ballasts in the ceiling. It was not developed to determine Flicker associated with LED luminaires but it's a commonly used tool.

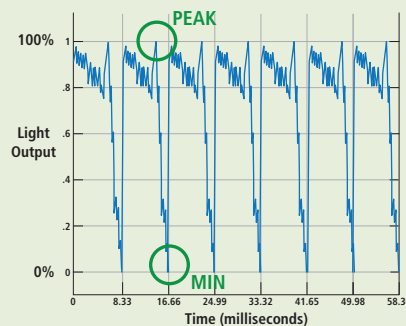


4 Ways to Measure the Level of Flicker

The LRC has identified four ways to measure the level of flicker present in an LED lighting system. These are illustrated on the waveform graphs below. This data can be used to compare the level of flicker in different LED lighting systems.

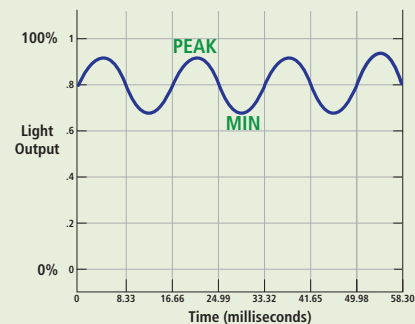
1. The peak light output vs. the minimum light output in a cycle

PWM



PWM dims by having the LED 100% on during part of the cycle and 0% on for other part

CCR

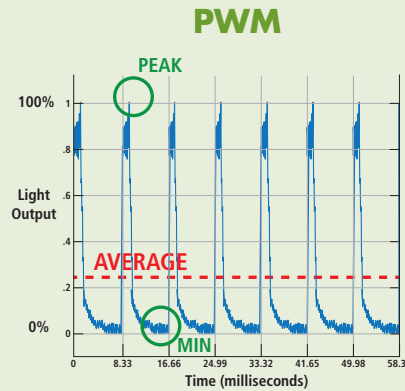


CCR reduces the light output without turning the LED 100% on or 100% off

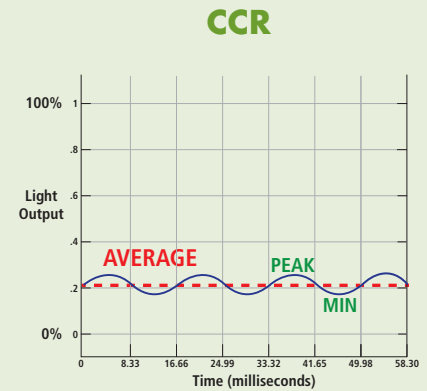
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2. The average light output in a cycle

Flicker decreases when the difference between Peak and Minimum is reduced.

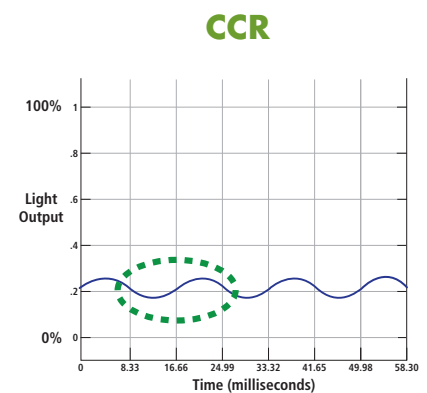
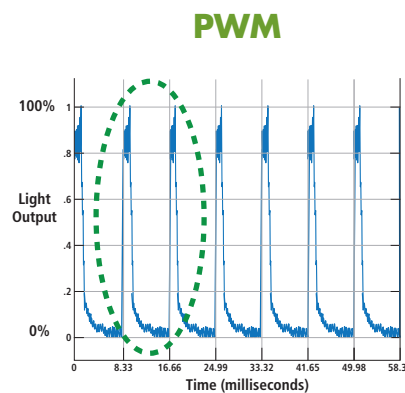


Waveform illustrating 100% Flicker at 25% dimming

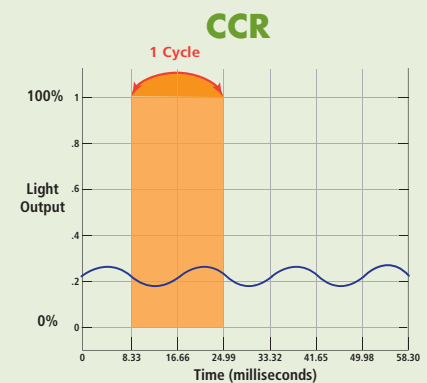
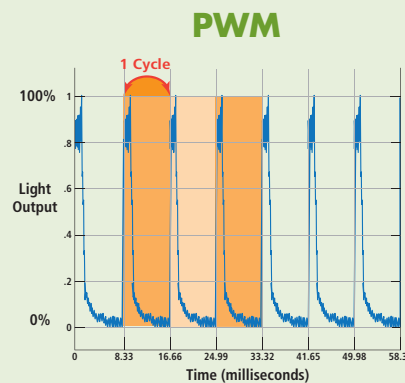


Waveform illustrating the power supply running at 20% current

3. The shape of the light output during a cycle



4. Frequency



Summary

1. The U.S. DOE states that "National Standards do not currently exist to determine the acceptable level of flicker in a space, especially when dimmed."
2. Flicker generally becomes apparent when LED luminaires are dimmed. Be sure to check for performance at dimmed levels.
3. Ask your manufacturer what LED power supply they use to understand how it might affect the level of flicker in specifications.
4. PWM LED power supplies turn LEDs on and off each cycle. They may not show flicker at 100%. Be sure to approve the dimming method to avoid flicker.
5. CCR LED power supplies provide a constant level of current to the LED even when dimmed. This type of supply is less likely to cause objectionable flicker.
6. For more information contact your local Finelite agent to arrange a mock-up.