An Approach to Reduce AC LED Flicker

by

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ABSTRACT

Since its first introduction to lighting industry in 2005, the alternating current (AC) light-emitting diode (LED) has experienced rapid development. Presently, there are three types of AC LED packages, including, anti-parallel connection, Wheatstone bridge, and Schottky barrier diode. Not needing a driver which converts AC to DC to power the LED is a distinct advantage AC LED has over direct current (DC) LED. The absence of a driver could mean potentially higher system efficiency, fewer failure components, smaller system envelope, and lower system cost. However, one of the main drawbacks for AC LED is light flicker. Because it is directly driven by AC line voltage, which oscillates at 60Hz (or 50Hz), the AC LED produces light flicker at twice the frequency of the AC line frequency (e.g. 120Hz in North America). According to past research studies, light flicker can cause negative health effects and also perception of light flicker is undesirable in lighting applications. Several solutions have been proposed to reduce light flicker, such as increased drive frequency and reduced modulation depth. These solutions can effectively reduce light flicker, but they introduce new problems to the light system, such as lower power factor and low power efficiency. In a lighting system, a good solution should reduce light flicker while maintaining high power factor and high power efficiency. The objective of this thesis is to find a solution that reduces light flicker by reducing modulation depth while maintaining high power factor and power efficiency.

In this study, an electrical circuit was designed to drive an AC LED in which one resistive branch and one capacitive branch are included. There is one load in each branch, and each load is composed of AC LED modules made of high-voltage LEDs. This circuit design produces balanced light output in each branch and the light output waveforms from the two branches are phase shifted. The combined light output produces lower modulation depth (percent flicker) and thus reduces perception of light flicker.

Initially, a theoretical analysis was carried out to predict how the percent flicker, power factor and power efficiency change as a function of phase shift. Based on the theoretical

analysis, three hypotheses were developed. The pilot study aided in exploring how the circuit parameters (such as resistance and capacitance) affect the phase shift, as well as the interactions among the circuit parameters. The results from the experiment showed that an optimal solution for this circuit design can be achieved. Additionally, an experiment with unbalanced light outputs in the two branches of the circuit showed that, a circuit can be designed to produce better solution (lower percent flicker, higher power factor and higher power efficiency). The possible reasons for this better performing system with unbalanced light outputs in the two branches are discussed.