Developing System for Controlling Failure Rate of LED Light Fixture

Jeong-Jin Kang[1], Keehong Um[2+], SooyeupYoo[3], Gyoo-Seok Choi[4], Yong-Soon Im[5], Sang-Bong Park[6], Eunyoung Kang[7]

[1] Department of Information and Communication, Dong Seoul University, Seongnam, Korea
[2] Department of Information Technology, Hansei University, Gunpo, Korea
[3] R&D Center, Amotech Company, Seoul, Korea
[4] Department of Computer Science, Chungwoon University, Hongseong, Korea
[5] Department of Broadcasting, Kookje University, Pyeongtaek, Korea
[6] Department of Computer and Information Science, Semyung University, Jecheon, Korea
[7] Department of Information and Communication Engineering, Dongyang Mirae University, Seoul, Korea

jjkang@du.ac.kr, um@hansei.ac.kr, syoo01@paran.com, lionel@chungwoon.ac.kr, ysim@kookje.ac.kr, psbcom@semyung.ac.kr, eykang@dongyang.ac.kr

[+]Corresponding author. Tel: +82-2-031-5308; Fax: +82-2-031-5172
E-mail address: um@hansei.ac.kr

Abstract. For LED-based lighting systems, in contrast to the conventional systems, the lumen maintenance and lifetime should be understood. The sensor light fixture decreases due to many factors, being the heat is one of them. In this work, by controlling the current through the LED, we develop a controller to expand the life time of LED sensor luminaire. We can measure the maximum life span by controlling the amount of current flows. This study shows the method to measure the illumination of LED, controls the amount of current flows in order to maintain the level of illumination of LED output, extend the lifetime of LED, and guarantees the minimum illumination of LEDs.

Keywords: failure, bathtub curve, degradation factors, luminaire, thermal resistors

1 Introduction

Lifetime of a device is an estimate of how long it is expected to operate as intended, in a given environment. In general, lifetime (end of life) of LED is the time when the device no longer emits light [1]. Failure is the event of state or condition of not meeting a desirable or intended objective, pertaining to a specific unit of product or component. Failure of any part in a system may lead to a failure to the whole system. Composing a part in such a way not to harm the system is essential to operate the desired system. Depending on the situation, there are several cases in connecting parts

in series, parallel, and feedback, and the proper combination of them. For LED systems in our study, performance degradation of part could result in failure of the system. When designing lighting systems, in either conventional incandescent or gas-discharged lamps, the total illumination, the minimum level of brightness, expected lamp rate are to be considered. For an electronic system such as LED light, the performance of a global system composed of many components is typically characterized by an initial high failure rate in Fig.1 shows a “bathtub” curve describing the behavior, widely used in reliability engineering, describing a particular form of the hazard function which comprises three failure parts of early, random, and wear-out. Since it is high at the beginning and end of the product cycle, the failure rate over time takes the form of a “bathtub’ curve [2].

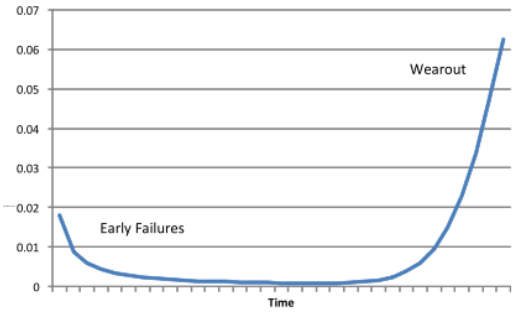

Fig. 1 . The “bathtub” curve illustrating failure behavior of LED system.

LEDs, as solid state light sources, are characterized by having long lifetimes in normal operating conditions. In contrast to the conventional lightening systems, such as incandescent lamp and fluorescent lamp, the efficiency is about 90 % in transforming electric energy into light energy. In LED lighting industry, two types of concepts for electrical efficiency LED lighting are expressed. It is important to recognize and understand the difference between both types. Energy efficiency pertains to the ratio of light to heat produced by the LED design [2, 3].

2 Degradation Factors

The changes in brightness or color coordinates are considered to be the most significant degradation factors. As the operation time passes, LEDs experience a gradual decrease in luminous flux in units of lumens, the SI derived unit of luminous flux, a measure of the total "amount" of visible light emitted by a source. LEDs have a well-deserved reputation for high-efficiency operation, not to mention high reliability. Properly specified and implemented, LEDs should and do satisfy virtually every lighting application. Still, there are times when actual device lifetimes fall short of the specified ideal [4]. Due to the continuous degradation in time, a failure criterion must be established in order to obtain a concrete evaluation of the LED failure. Fig. 2 shows the instant of time the flux reaches the failure criterion is then described as the failure time of the LED. As a rule, the failure criterion is decided by application in

operation. The lifetime of LEDs are considered to be expired if the luminance reaches about 50 % (L50) or 70% (L70) of the initial luminance [5].

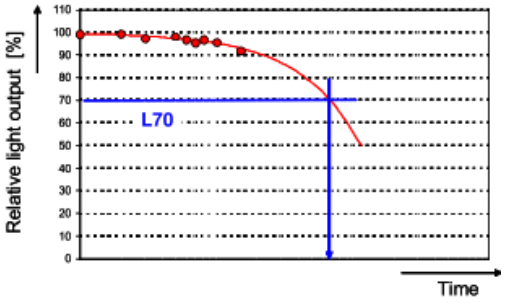

Fig. 2. Light output vs. time of LED system.

In 2006, Korean government announced 15/30 project to increase the distribution rate 30% of LED luminaire by 2015 with the replacement of LED in place of conventional lightening systems.

3 System Configurations of Thermal Resistors

In Fig. 3, a configuration of digital signal oscillator in the temperature gauge, as devices for measuring and recording temperature, is shown. It is composed of the current source, three resistors, and two capacitors. If the thermal resistance of temperature indicator is 50℃, the temperature of PN junction, dissipating a power of 1 watt, is 75℃. If the temperature of surrounding space is 85℃, the temperature of PN junction, dissipating a power of 1watt, is 135℃. For the temperature of 135℃ in the junction, the life time of LED sensor luminaire is expected to be about 30,000 hours [5].

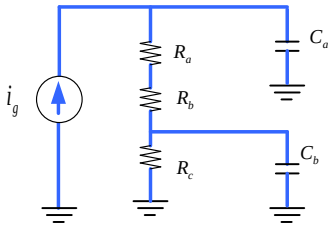

Fig. 3. Configuration of thermal resistors in the temperature gauge.

If we decrease the dissipating power from 1 watt to 0.6 wtts by decreasing current through the LED emitters, the temperature at the PN junction is equal to

$85 + (50 * 0.6) = 105℃$. The temperature tells the expected values of life time to be 50,000 hours. In other words, if the amount of current through the LED emitter is reduced by 40% and the temperature of PN junction is decreased, then the expected life time can be extended by 20,000 hours.

4 Conclusions

In this paper, we have designed a controller to manage the failure rate of LED light fixture. We took advantage of current through the LED in order that the temperature in the PN junction of LED kept constant value during a normal operation. By adjusting the current, the illumination of LED light system is controlled, the level of illumination of output from the LED is being kept to a constant level resulting in the extended lifetime.

Remark: This work is the modified version of presentation at the conference of ISA 2013(April 26-28, Cebu, Philippines).

References

1. Next Generation Lighting Industry Alliance with the U. S. Department of Energy : LED Luminaire lifetime Recommendations for Testing and Reporting, 2nd Ed. (2011)
2. http://www.lunaraccents.com/educational-electrical-efficiency-LED-lighting.html (2009)
3. Richard Stevenson: The LED's Dark Secret: Solid-state lighting won't supplant the lightbulb until it can overcome the mysterious malady known as droop. IEEE Spectrum (Aug.,2009)
4. http://www.digikey.com/us/en/techzone/lighting/resources/articles/ Understanding-and-Preventing-LED-Failure.html (2012)
5. Reliability and Lifetime of LEDs, Application Notes Catalog.osram-os.com (2008)