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Q: How can todayâ€™s LEDs be improved to provide better performance while at the same time lowering energy consumption?

By Brian Witzen, Sr. Field Technical Manager Sharp Microelectronics of the Americas

In commercial buildings, lighting accounts for a substantial portion of the energy budget and total energy cost. These costs can be greatly reduced through power-saving LED technologies and advanced lighting control systems. While incandescent lamps typically produce 12â€“15 lumens/W and fluorescents at least 50 lm/W, specifications currently reach up to 100 lm/W with white LEDs.

The Environmental Protection Agency (EPA) and Department of Energy (DOE) have recognized the importance of reducing lighting energy use with the inclusion of lighting systems into ENERGY STARÂ®.

New LED technologies decrease energy consumption and hazardous materials, while enhancing performance, light quality and operating life. LEDs havegreatly improved over a short time, and can be applied to more applications that previously would have utilized incandescent or halogen lights. As an example, SharpÂ®â€™s new MegaZenigata family of LEDs provides a direct replacement for typical 75W and 150W lamps while consuming only 15W and 25W of energy, respectively. Immediate energy savings can be realized in commercial spaces such as hotels, restaurants and office buildings.

The operating life of LEDs can exceed 50,000 hours, with light output gradually dimming over time versus the abrupt burnout of incandescent or flickering of fluorescent. The majority of LED failure mechanisms are caused by excessive or long-term high temperature. Elevated LED junction temperatures can cause a reduction in light output, degradation of chromaticity, performance, and reliability. To avoid this, the MegaZenigata uses a ceramic substrate containing an array of over 100 individual LED. The array strategy results in less current and heating of each die and provides excellent high-temperature properties. While typical LEDs can have a reduction in light output as high as 25% at operating temperatures, the MegaZenigatasgenerallyhave temperature-related losses at less than 10%.

In addition to lower energy consumption, Sharp has improved the quality of light output. Using a combination of red and green phosphors (instead of standard yellow phosphor used in many white LEDs),Sharp's MegaZenigata produces typical color rendering index (CRI) values of 94. This provides for more natural colors, especially deep reds, in indoor environments than the cool white 150W equivalent compact fluorescents.

The potential color bin inconsistencies of fluorescent fixtures between manufacturers â€“ or even batches â€“ are readily apparent in a typical office environment. Sharp's state-of-the-art manufacturing process produces high light output quality, consistency and uniformity. The resulting smaller color bins nearly eliminate noticeable color differences when similar luminaires are placed close together. Also, placement of multiple LED die in a unique circular pattern allows for even light distribution. This can simplify the development of optics needed to direct the light in a luminaire.

Advanced lighting control systems like dimmers, automated on/off control, occupancy sensors, ambient light sensors, communication systems between fixtures and control panels, and energy usage measurement systems can further reduce energy consumption. Large areas can now be dimmed to night-light levels, yet instantly return to full brightness when occupied. When used in conjunction with occupancy sensors, lighting energy can be focused rather than being wasted in unoccupied areas.

In many buildings, these benefits are not utilized due to the cost of installing the required controls and dedicated wiring. Wireless lighting control systems offer the benefits of advanced lighting control systems with added flexibility, reliability, ease of installation, and elimination of dedicated wiring. Various wireless standards have been introduced to make the implementation of advanced control systems possible, such as 802.15.4, Zigbee, Z-Wave, EnOcean, ISA-100.11a, WirelessHART, INSTEON, and others.

Continuous improvements in LEDs, along with the use of advanced lighting control systems, are making lighting more occupant-friendly and energy efficient, all while reducing negative environmental impact.

By Michael Day, Product Marketing Engineer for Analog Power, Texas Instruments

The answer to this question is best separated into two parts:Â power supply efficiency and power supply quality.Â For battery powered applications, a higher efficiency power supply results in longer battery life.Â This doesnâ€™t affect an LEDâ€™s actual lifetime, but it does extend the applicationâ€™s run-time.Â Increased efficiency in higher power, non-portable applications indirectly extends LED lifetime by allowing the LEDs to operate at lower temperatures.

A generally accepted rule of thumb is that each 10Â°C increase in junction temperature reduces lifetime by a factor of two.Â Power supply efficiency is critical for maintaining long lifetime in applications such as an LED incandescent light replacement.Â Higher efficiency can be achieved by the use of lower Rdson FETs and lower reference voltages.Â A lower reference voltage results lower voltage drop and power dissipation in the driverâ€™s current sense resistor.Â ICs like the TPS61165 that are specifically designed to power LEDs use relatively low references, 200mV in this case.Â IC designed to generate a standard voltage output may have an 800mV to 1300mV reference voltage.

Few realize that power supply quality affects and LED?s lifetime.Â Poor control of startup currents, transient currents, and even forward current in steady state conditions negatively affects.Â A properly designed softstart circuit prevents current overshoot at turnon.Â The LED driver should also be designed to handle line transients without resulting in excessive increases in LED current.Â The LED driver should also provide the required LED current without excessive current ripple. Many designers save cost by minimizing the LED driverâ€™s output capacitance.Â The resulting increase in ripple current does not affect LED brightness, but it does reduce lifetime.Â LED brightness is proportional to the average current.Â LED lifetime is indirectly proportional to RMS current.Â An LED driver that generates a 1 A DC drive current with no AC ripple results in the same brightness as a driver with a 1 A DC offset and 1 A peak to peak ripple.Â Both waveforms drive the LED with an average current of 1 A, so LED brightness is identical.Â However, the RMS currents are 1 A and 1.22 A respectively, so the waveform with the AC ripple results in reduced LED lifetime.

Julian Carey, Director of Marketing, Intematix

LEDs are closer than ever to mass adoption in the general lighting market. Bans on incandescents and limited consumer preference for compact fluorescents have not only enabled, but necessitated a better solution that will reduce energy consumption without sacrificing light quality. New LED bulbs on the market illustrate the possibilities, but improvements must be made.

LEDs are an undeniably efficient technology, and rapidly becoming even more so. Conventional high-performing LED systems emit 100 lumens per watt, a considerable leap compared to the 70 lumen per watt benchmark reached in 2005. Despite this advantage, their bluish directional light is only ideal for limited applications: headlights, spotlights and flashlights. So the LED industry is now challenged to create a light people want to use, not merely to become more efficient.

To date, performance improvements tend to sacrifice efficiency. For example, diffusers added to reduce glare and create diffuse light average a 10 percent efficacy loss. Improving the color rendering index also results in lost efficacy and increased expense. As such, the industry turns to power supplies and external optics to improve the lighting system and adjust for the shortcomings of the LED component.

At Intematix, we focus on an often overlooked LED component to improve the system: phosphors and phosphor components. This luminescent chemical powder coated on blue LED chips dictates the color emitted and has a crucial impact on both efficacy and brightness by converting more blue light into useable white light.

Still, to improve brightness, lifetime and efficacy of LEDs, we need to move beyond the pieces of the system and reexamine the system itself. By moving the phosphor â€” the arbiter of quality and color â€” from the chip to a new location in the optical train, Intematix has found a way to achieve these often-conflicting goals. With the understanding that remote phosphor technology provides the system level change necessary to make this move forward, we launched our ChromaLitâ„¢ Collection in January.

Instead of applying phosphor directly to the chip, we apply it to a substrate such as polycarbonate. The resulting ChromaLit component, customizable in shape and color, then becomes the light source when activated by blue light of an average wavelength. In the case of a white light source, about 10 percent of the visible light is created by the blue LED, while the remaining 90 percent is emitted by the excited phosphors.

With this architecture, not only are we seeing unprecedented design freedom, but also 30 percent higher system efficacy. ChromaLit eliminates glare and delivers more light where you want it, without sending it through various optics. With a properly designed mixing chamber, white light that would have been absorbed back into a blue chip is effectively extracted. Also, moving the phosphor conversion process away from the LED energy source reduces system temperature and creates savings elsewhere: a smaller heatsink, fewer LEDs and increased brightness. Finally, reduced heat exposure to the phosphor increases reliability and longevity.

In reliability testing, we determined the lifetime of a ChromaLit system is longer than conventional LED systems. By reducing degradation of the phosphor and leaving the blue chip uncoated, each component outlasts the lifespan of the two combined. At this point, connectors and power supplies may have failures before ChromaLit or LEDs.

LEDs play a crucial role in the present and future of solid-state lighting. In order to improve current technology, we need to look at LEDs in a new light. At Intematix, we think that new light should be the highest quality and most efficient light possible. The key to getting us there is in the phosphor.