LED Technology: Making the Transition from Incandescent Bulbs and Fluorescent Fixtures

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When a new technology comes along, the early adopters jump in with both feet, anxious to try it out regardless of the cost or difficulties involved. Others wait until either the cost comes down, the "glitches" are worked out, or both.

In the case of light emitting diodes, commonly referred to as LEDs, the story is the same. They've been around for many years, but for use as replacements for incandescent bulbs or fluorescent fixtures, the transition to solid state lighting (SSL) has been slow. Not only is cost an obstacle, but the technology poses quite a few challenges to both the designer and end user.

SSL has been gaining traction because while cost has been decreasing, levels of brightness have been increasing. With energy costs increasing and the "green" movement gaining momentum, visible LEDs are a natural enabling technology. They use a fraction of the amount of energy of an incandescent light bulb, and they don't contain mercury, which is present in the compact fluorescent light fixtures that are often used to replace incandescent light bulbs to save energy!

Many municipalities are jumping on the LED bandwagon to achieve the benefits of solid state technology. For instance, the City of Ann Arbor is changing over its entire street lighting to LEDs. California's Building Energy Efficiency Standards for Residential and Nonresidential Building's Title 24 residential lighting code will drive new energy efficient technologies as well. A Chineselanguage Commercial Time report noted that Taiwan plans to replace 460,000 traffic signal lights with LED lamps, and all incandescent light bulbs are expected to be eliminated by 2012.

Large retail chains in the U.S. are realizing the financial benefits of going with SSL while at the same time going green. Walmart is using LED lighting in its refrigerated case lighting, which was first launched back in 2005 at pilot locations in McKinney, Texas and Aurora, Colorado. Quoting from their website (http://walmartfacts.com/articles/4716.aspx)… "LEDs have a longer life span than fluorescent bulbs, produce less heat and use significantly less energy than typical grocery case lighting."

The chart below compares the lifetimes of LEDs and traditional lighting technologies:

Technology	Lifetime (hours)
Incandescent	3,000
Fluorescent	10,000
Visible LED	50,000 to 100,000

The easiest case for longer life comes when you compare LEDs with incandescent bulbs. It gets to be more of a challenge when you make the case for an LED against a fluorescent fixture, since the latter is already a very efficient source of light. And that explains the big push for compact fluorescent lights (CFL) replacing incandescent lights in homes. However, a CFL still contains mercury (not a good mix for land fills), and the LED is still more efficient with a far superior life time.

Once a lighting manufacturer is convinced to make the transition to SSL, many questions need to be answered. LEDs are driven by DC current, emit light uni-directionally, and care must be taken to ensure the junction temperature does not exceed the specified temperature. In other words, the design engineer can't just put a bunch of LEDs on an FR4 board and drive them at whatever current is available.

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In order to do it "right," the following minimum steps need to be taken:

First, you need to make sure you have the "right" color white. Companies such as OPTEK Technology have an "integrating sphere" where they will take a company's light fixture and take measurements of the light output and measure its color temperature (CCT) and brightness (TLF) in order to select the right visible LED components for the SSL design.

Secondly, you need to make sure you know how much light you need. While in the integrating sphere, OPTEK will measure the light output required. LEDs still have a high price tag when compared with a normal light bulb, so the key to success is often using fewer LEDs. Furthermore, the traditional lighting industry rates its light sources on the amount of energy the fixture consumes, and typically you also end up with a loss of 50% of the light output from the fixture itself. That's why it's critical to get real world measurements of the light output of the traditional fixture you're trying to convert. Then once you've made the conversion with an LED design, you go back to the lab and test using the LED design to see if you can duplicate the results. Companies such as OPTEK can provide that service. Below is some sample data of what would come out of the lab.

AMBER

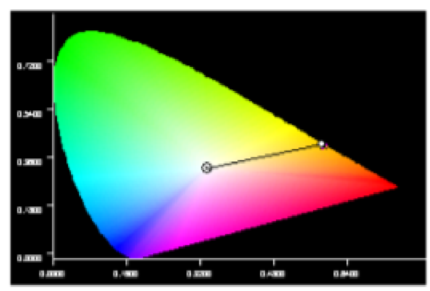
Total Luminous Flux Parameters

TLF	60.30 lm
Peak Wavelength	594.7 nm
Dominant Wavelength	591.0 nm
Center Wavelength	593.9 nm
Half Bandwidth	13.8 nm
Total Radiant Flux	1.2366e-001 W

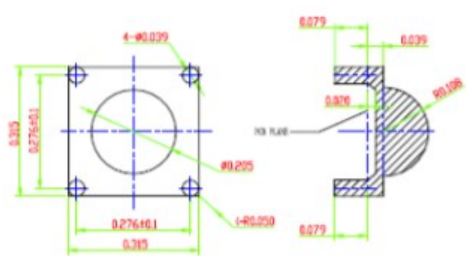
1931 Chromaticity Calculations

x: 0.5801
y: 0.4184

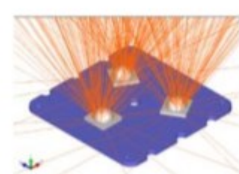
Forward Voltage = 2.90 V@ 1050 mA



As mentioned earlier, one nuance of LEDs is they emit light in one direction, whereas light bulbs and fluorescent tubes emit light in all directions. This is a key difference, but the fact that LEDs are uni-directional may not be a bad thing, since the existing light fixture may have lenses to direct the light from a bulb and now are not necessary. Regardless, it's a factor that the designer has to take into consideration. However, the designer might need help in custom lens design to ensure the LED lights the targeted area.



Another major consideration for the designer is heat. Traditional fixtures generate heat, and of course that is one of the major reasons they are so inefficient electricity is wasted generating that heat. On the other hand, LEDs don't require much electricity. However, in order to enjoy the benefits of long life, the design engineer must make sure



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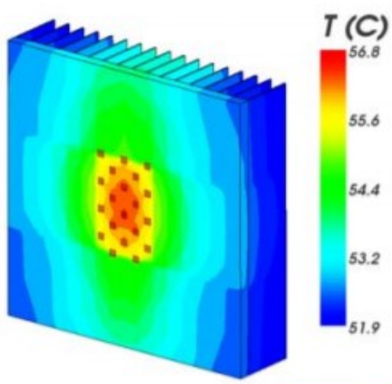
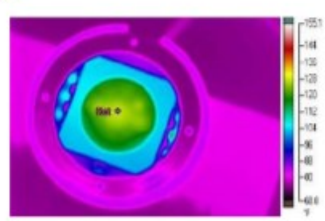
the junction temperature of the LED stays at or below the specification. Furthermore, the efficacy of the LED (lumen output at a given input current) is improved when the junction temperature remains low. Thus the designer needs to pay careful attention to thermal management, including what type of substrate material to use, how big the heat sink is and whether it requires active cooling or passive cooling. Since the thermal requirements of a solid state lighting product are so dissimilar to that of a fluorescent or incandescent product, it behooves the lighting manufacturer to work with someone with the tools and expertise.

OPTEK Technology has many tools available to the fixture manufacturer wanting to make the switch to solid state lighting. Starting with the substrate material, OPTEK will often suggest its OPTEK Technology LED Technology: Making the Transition Page 5 of 5 from Incandescent Bulbs and Fluorescent Fixtures own OPTOTHERM™, a copper clad aluminum substrate material that has been optimized for maximum thermal efficiency while maintaining high isolation voltage capability. Once the design is completed, OPTEK uses thermal modeling software to determine if heat is under control. And once prototypes are made, it uses a thermal imaging camera to look for hot spots on the VLED to check for actual junction temperature.

Visible LEDs have gained traction in the market place due to the potential benefits of long life and low energy requirements in general illumination applications. The key to success with solid state lighting is to take care in the application by partnering with a vendor who has the experience and tools to make the most of this exciting technology.





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