Increasing Home Efficiency with High Brightness LEDs

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There are a multitude of reasons to outfit homes with High Brightness Light Emitting Diodes (HBLEDs). They save significant amounts of energy. They are safer for the environment because they contain no mercury, as fluorescents do. They reduce maintenance costs because their lifespan is the longest. They also increase safety because they don't instantaneously fail; instead, they gradually degrade.

High power LEDs are driven at high current on the order of 350 – 1000 mA. With the latest technology, they can produce 40 to 80 lumens per watt and come in 1 – 3 watt packages. The major manufacturers, according to the US Department of Energy website, are Cree, Philips and Osram.

LED technology has been improving steadily since the turn of the millennium. Their light output (in lumens/watt) surpassed all other sources of light about 2 years ago. This, combined with the large energy savings, is spurring a revolution in home lighting.

After presenting a comparison of HBLEDs with the major and popular light sources, incandescent and fluorescent, we present an example home application circuit.

Comparison Of Light Sources

Well-informed customers will seek out ways of using HBLEDs as often as possible. In a table of comparison (Table 1), it is clear that the brightest solutions are HBLED.

	HBLED	Incandescent	Fluorescent	Compact Fluorescent
Efficacy	22%	0.7 - 2.6%	8 - 15%	9%
Color Tint vs. Current	Little	Change	No	No
Light Angle	Focused	Reflector	Reflector	Reflector
Lifespan (hours)	50 k	1 k – 2 k	30 k	10 k
Vibration/Shock	Solid-state	Fragile	Fragile	Fragile
Dimension	Very small	Bulky	Bulky	Compact
Mercury	No	No	Yes	Yes
Failure Mode	Decay	Burn out	Burn out	Burn out
Driver Circuit	Need a power supply	Simply connect to ac	Need a ballast	Need a ballast

Table 1: Comparison Of Different Light Sources

Let's take a closer look at the table. The efficacy of the light source is similar to the efficiency. How much of the energy going into the lamp is turned into light as opposed to heat? Higher numbers are preferred and HBLED provides them. If the driving current fluctuates, incandescents are the most likely to show a change in color tint.

The major benefit for both fluorescent and HBLED over incandescent is in lifespan. This is one of the main reasons that incandescents are being phased out of circulation in many countries. It follows that HBLEDs can pull ahead of fluorescents in popularity because they are solid-state (made of silicon and not fragile), very small and contain no hazardous chemicals (no need for special environmental disposal).

HBLED Lighting Design Goals

To switch to HBLEDs, customers are demanding high quality. They want designs with a power factor of at least 0.90 and an efficiency of 80% or better. In dc applications, the maximum input voltage tops out around 40 V. In ac applications, there might be 120 V or 240 V (maximum 277 V) inputs. The HBLEDs must be driven by pulse-width modulators running at frequencies in excess of 120 Hz to minimize any visible distraction. Sometimes that frequency needs to be variable. In addition to these design constraints, both isolated and non-isolated designs are used, depending on the engineer and the application. A final complexity that might be considered, when necessary, is a dimming circuit.

As can be seen, there isn't one blanket solution. There are also other factors within the design to take into consideration. Each solution is specifically defined by LED quantity and the current running through them. Adjustments must also be made for variations in magnetic components as well as the chosen power components and output capacitors.

Application Circuit

The price of HBLEDs is approximately $1 to $2. Since they are used in strings for each solution, this frees the converter from being the design cost constraint.

The first controller to present is the ISL6721. It is a single-ended pulse-width modulating current mode controller. Its peak current mode control effectively handles power transients and provides inherent overcurrent protection. It has been configured as an actual T8 replacement circuit (replacing the traditional ballast circuit in a fluorescent lighting set-up) at a major contact manufacturer. The ISL6721 can also be configured as an incandescent light replacement. A non-isolated flyback solution is currently lighting a mall in Asia, using 10 HBLEDs, with a 10 W output, and an efficiency of 82%.

To truly be competitive in the home market, an HBLED lighting solution has to offer a dimmable option. A clever circuit can accomplish this. Remember that the LEDs are driven by pulse-width modulating controllers. This means that they are not "on"

constantly. The amount that they are powered is controlled and can be variable. Coincidentally, this is accomplished by the “controller”.

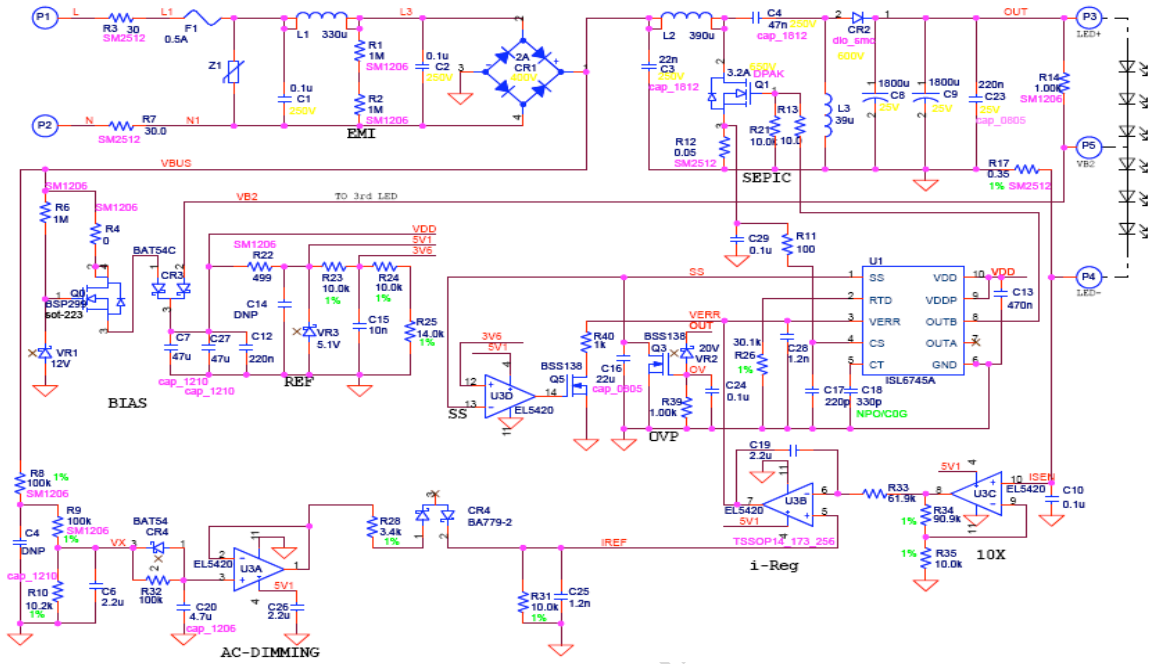

Fig. 1. 6-LED Adapter With Dimming For Down Lighting

Fig. 1 shows the complete schematic for a down lighting solution of a 6 LED adapter with dimming. The heart of the design (besides the HBLEDs, of course) is the ISL6745A controller. The components at the top right create a SEPIC controller driving the string of six HBLEDs. The surrounding amplifiers provide current regulation, short-circuit protection and overvoltage protection. On the bottom left is the ac-dimming circuit. The dimmer amplifier output is filtered before serving as the reference node on the current regulator to feed back into the loop.

The bias voltage, VDD, on the ISL6745A can range from 6.5 V to 20 V. The outputs are 12 V, 1 A low-side FED drivers to drive a low side FETs (like Q1 in this design), the gate of a high voltage driver IC or a gate drive transformer.

The ISL6745A is the most popular HBLED driver in Intersil’s portfolio. In addition to the uses highlighted in Fig. 1, it has adjustable switching frequency, adjustable soft start, over temperature protection, and precision adjustable "dead time." It is offered in a space-saving MSOP-10 package. As a hallmark of its flexibility, the ISL6745A can work isolated or non-isolated, as well as dimmable or non-dimmable.

Conclusion

HBLEDs are the greenest alternative for consumer lighting and technology has advanced enough to make them viable. Replacement solutions are available to replace both incandescent and fluorescent designs. Save power, increase lifespan, improve safety and increase reliability: use HBLEDs.

About The Author

Tamara grew up in the Midwest, finding her way West with an acceptance letter from Stanford University. After collecting 3 EE degrees (BS, MS, and PhD), she taught analog circuits and test development engineering as an assistant professor at San José State University. With 8 years of part-time experience in applications engineering, she joined industry full-time in August 2007 at Intersil Corporation as a principal applications engineer.