Greener lighting options: Optimizing today's CFL technology for better performance and looking towards a future filled with LEDs

It is widely recognized that incandescent lighting can't hold a candle to CFL (compact fluorescent lamp) technology when it comes to energy efficiency.

So there is growing pressure on CFL technology to better support the green lighting revolution.

Governments are already moving in the direction of requiring more efficient lighting sources. In the U.S., an initiative is underway to define a "SuperCFL Lamp" that exceeds current industry performance in a number of categories, including efficacy, lifetime, and control characteristics such as dimming.

The European Union is already setting tougher quality requirements for CFLs. These new EU performance standards can only be implemented with IC control. Phase 1 of the new regulations has been in place since September 2009. The next step up is scheduled for September 2013. Converting a 4 billion-units-per-year industry to meet the upcoming regulation is a major challenge. The countdown to 2013 has prompted many CFL vendors to choose an IC solution as an easy path towards reaching or even exceeding the quality and performance standards.

Today however, to a large degree, CFLs fall short of their promise – and the innate capabilities of the technology – because reliability issues diminish their useful life.

CFLs have a current range of 60-70 lumens per Watt (Lm/W) efficacy rating. Best of class lamps have reliability ratings that can extend lifetimes to up to 15.000 hours. But reliability is more often mediocre with many lamps failing in a few months, far short of the 4000 to 6000 hour lifetime that is often considered standard quality.

Today's average CFL is controlled by a collection of discrete components wired together and crammed in the bulky base that consumers often find unwieldy and inconvenient. Meanwhile, consumers must often contend with poor quality, experience far shorter life than claimed, and endure long start-up times.

The GreenChip™ IC: bringing smaller, more reliable, longer lifetime, high efficiency solutions

But there is a solution: The GreenChip™ IC can help. Integrating a dozen discrete components into a single IC reduces the wires and all while achieving a breakthrough in reliability. The CFL also becomes approximately 10% more efficient compared to average electronics based on discrete components. Improved quality also translates into longer lifetime – as much as 15,000 hours – and extended on/off switching cycles.

Lighting the way

NXP's GreenChip™ technology simplifies the process of designing and assembling lamps and the company's mass manufacturing capacity is capable of providing the CFL lighting market's needs.

NXP manufactures the first LED driver family to demonstrate lifetime performance that matches the lifetime of LEDs (in excess of 75 000 hours at 105 °C)

NXP's broad portfolio enables the entire range of new CFL or LED system architectures with functions such as radio communications, intelligence and flexible drives.

Another important advantage is that adding an IC opens the possibility for controlling the CFL so that it can be dimmed using standard wall plug dimmers. This feature enables CFL lamps to behave like incandescent lamps in terms of fast startup and deep dimming. The GreenChip™ enables best-in class dimming performance below the 10% threshold; CFL lamps that behave almost like incandescent lamps. Since CFL lifetime is limited by the number of switching cycles, better control also makes it possible to extend the CFL's useful life.

NXP Semiconductors has a wide range of high performance CFL lighting solutions that will lead to substantially higher performing CFLs. Utilizing its GreenChip™ technology – a technology that enables new levels of efficient power management --simplifies the lamp design and assembly process. The company's manufacturing capacity,65 million chips every day, is capable of providing the CFL lighting market's needs.

The coming LED revolution

Although CFL technology leads the lighting front of the green energy environment, its overall efficacy potential makes it almost certain that it cannot dominate the market indefinitely.

From an energy efficiency perspective, comparisons favor LED. With literally billions of lamps being lit all over the world on a daily basis, small differences can quickly add up to gigawatts. All lamp technologies are affected by manufacturing processes and as a result an efficacy range – which can be quite wide – is provided for each.

- CFL: 60 – 70 Lumens per Watt (Lm/W)
- LED: 5 – 130 Lm/W
- Metal halide: 65 – 100 Lm/W

The bright story of LED technology is told only in part by its outstanding and rapid evolution toward higher and higher efficacy ratings. For years it struggled to break past the 10% efficacy mark and, as a result, never made much of a dent in CFL dominance. Over that past few years, however, LED lamps have been increasing their efficacy steadily year after year. In 1995 LED efficacy was 20 Lm/W; in 2000, 55 Lm/W; in 2005 120 Lm/W; and in 2010 160 Lm/W. Some LEDs in production today are achieving 40 Lm/W and others still in the research phase reach the high end of the assigned range. Their useful life is rated at 40.000 hours and the best-in-class LEDs of today can be integrated into a lamp that generates 400 lumens.

Like any emerging technology, LEDs have a laundry list of issues to be resolved, the most important of which is heat dissipation. Despite its high lamp efficacy ratings, about 75% of the energy consumed by today's average LED lamp is converted to heat energy – and there is another difficulty. Whereas incandescent and CFL lamps radiate heat much like the sun (and therefore do not need heat sinks), LEDs dissipate heat through conduction (and do require heat sinks).

Moreover, the electronics is in the heat sink, which puts great temperature stress on the electronics. This makes it necessary to utilize an IC technology that can survive a typical ambient temperature in the

range of 100° to 120°C if lifetimes are to be extended. NXP has done exactly that with its High Voltage SOI technology that performs in an environment where standard CMOS technologies barely survive.

Because LEDs are so long lived, making a control IC that lasts as long as the light source itself is an issue for semiconductor manufacturers. NXP manufactures the first LED driver family to demonstrate lifetime performance that matches the lifetime of LEDs (in excess of 75 000 hours at 105 °C).

CFL and LED systems with a future

Control implies intelligence and communication skills, neither of which are embodied in the vast majority of CFLs manufactured today. But with integrated ICs, the next-generation CFL will have several new features including:

1. The ability to dim in lamp as well as turn it off/on
2. Shorter time to attain full lumen output
3. Extended useful lifetime
4. Safety features such as lamp failure protection and power down
5. Wireless communication with other devices as well as people

With ICs and a simple radio built in, CFL lamps can use a wireless protocol for control. This will make installation easier because a wall plug dimmer will not be required. Consumers can simply replace the lamp and use the remote control unit. And, importantly, no copper wiring is required to implement the switching function because ZigBee RF control is implemented.

The electronics that realize all these benefits are shown schematically in Figure 1.

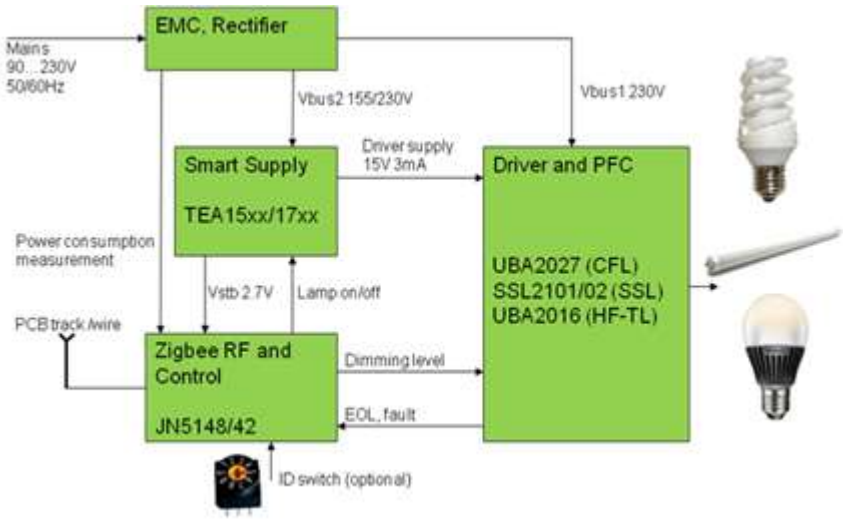

Figure 1. A smarter, more energy efficient CFL or LED lamp requires simple radio communications to monitor the outside world, a microcontroller to process data, and an adjustable lamp driver.

Within its broad portfolio of green energy ICs, NXP Semiconductors has products capable of supplying the new CFL or LED system architectures with radio communications, intelligence and flexible drives. These include the OL2380 2-way ISM-band transceiver and the UBA2028 dimmable 20W CFL driver IC.

Toward brighter, more energy efficient lighting

CFL and LED lighting technologies have the potential to drive down the amount of electricity used to illuminate homes, offices and factories. The greatest benefits from these technologies can only be achieved, however, through the utilization of IC control circuits. By fielding a broad range of ICs, using advanced semiconductor fabrication techniques and participating in aggressive research initiatives, NXP is proving itself to be the semiconductor partner of choice for the lighting industry.