

LED Lighting Depends On Drivers

LED lighting will drastically reduce energy expenditures, significantly reduce greenhouse gases, and provide increasingly sophisticated lighting options—but only with driver technology.

FIGURES INDICATE THAT widespread use of LED lighting by 2027 could save the equivalent electricity of that produced annually by 44 large electrical power plants, worth \$30 billion based on today's electricity prices. One fifth of global electricity is used in lighting, producing 1.9 billion tons of carbon dioxide (CO₂) annually. To put that into context, that's 70% of the world's passenger vehicle CO₂ output and 6% of global greenhouse gas emissions, so the potential for energy savings is immense.¹

LED lights and drivers continue to be among our most rapidly developing technologies with new innovations emerging on an ever-rolling production line (see "LEDs: In The Beginning," at electronicdesign.com). White LED efficiency has already increased by a factor of 10 since 2000. By 2020, the U.S. Department of Energy (DoE) estimates that commercial LED lighting efficiency will be as high as 258 lumens per watt, or two and a half times as efficient as today's fluorescent lamps, resulting in 90% energy savings. By then, the cost of LEDs will fall by 80% and global penetration will be 60%. In fact, the DoE believes that no other lighting technology offers the United States so much potential to save energy and enhance the quality of its building environments.

Shops, offices, factories, warehouses, art galleries, schools, and museums are just some on a long list of private and public spaces offering a massive potential market for the new technology. A significant proportion of that market will be retrofit rather than newly built, as 80% of the buildings that will be in use in 2050 have already been constructed.

LED lights are nothing without an LED driver. However, not many people are aware of drivers and how vital they are in providing the variable and highly adaptable range of lighting

designs now offered. LED drivers are the interface between the fittings and the mains power supply. Every lighting solution requires a unique driver design, and rapidly evolving driver technology is providing ever more comprehensive options to provide energy savings, definition, ambience, or old-fashioned wow factor.

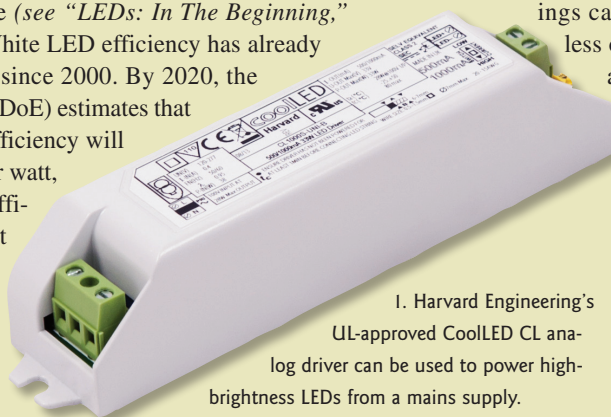
WHAT'S NOT TO LIKE?

The initial cost of installing LED lighting is higher than traditional technologies, but energy and maintenance cost savings cancel that out very quickly. They cost less over the life of the system and provide a better, brighter quality of light. Also, exchanging incandescent bulbs for LEDs can reduce a building's carbon footprint from lighting by 85%.

LEDs have an average lifespan of over 100,000 hours, or 11 years of continuous operation or 22 years at half power. That's more than 10 times longer than any other light source on the market. LED lifetimes are rated differently from those of conventional lights, which go out when the filament breaks. An LED's typical lifetime is defined as the average number of hours until light falls to 70% of initial brightness. By dimming over time in contrast to the abrupt failure of traditional bulbs, operators can replace the fitting before the lights go out, which is an advantage in safety-critical environments.

LEDs emit more light per watt than traditional light bulbs, which is where the energy savings come in. In addition, their efficiency is not affected by shape and size, unlike fluorescent light bulbs or tubes. Conventional light bulbs waste most of their energy as heat. For example, an incandescent bulb gives off 90% of its energy as heat, and a compact fluorescent bulb wastes 80% as heat. LEDs remain cool. This obviously leads to additional savings in air conditioning. Furthermore, LEDs give off light in a specific direction and are up to eight times more efficient than incandescent and fluorescent bulbs, which waste energy by emitting light in all directions.

LEDs light up very quickly and can easily be dimmed either by pulse-width modulation or by lowering the forward current. In addition, they don't use lead or mercury, so they're kinder to the environment. And since they don't have any glass com-



1. Harvard Engineering's UL-approved CoolLED CL analog driver can be used to power high-brightness LEDs from a mains supply.



ANTONY CORRIE is the vice president of Harvard Engineering Americas. He joined Harvard to set up its Americas division in August 2012. Previously, he was regional vice president for Southern California at Future Electronics, where he grew sales to more than \$100 million annually and managed 50 people.

ponents, they aren't vulnerable to vibration or breakage like conventional bulbs. LEDs are therefore well suited for use in areas like sports facilities and high-crime locations.

THE HEART OF THE LED

LEDs offer huge benefits. But to ensure optimum energy efficiency, reliability, and durability, they need the support of dedicated control gear. LED drivers play an important role in the overall design of lighting by regulating the power output. The main task of an LED driver is a constant light output, meaning a steady power supply to the LEDs, despite possible power variations (*Fig. 1*).

With LED drivers, users can choose between different power supply options, ranging from simple to sophisticated, to achieve maximum energy efficiency. Users also gain a variety of configuration options and adjustable soft start or emergency light functions. LEDs are ideal for applications using occupancy sensors, time-based switching, or switched daylight harvesting, which involves turning off half of the lights when a certain ambient light level is detected. The LED driver determines the quality of control performance.

Ultimately, efficiency and durability are tied not only to the LEDs themselves but also to the drivers that operate them. At their simplest, these drivers take the input current and input voltage and then reconfigure them for use by an LED. In that sense, they are a lot like the ballasts that have been used for decades in fluorescent lights.

Drivers are key in enabling market growth for LEDs in several ways. Innovations in design are allowing products to do more with less by improving the overall efficiency. Yet there is a misconception that driver technology is static and standardized. The reality is that there is no such thing as a "universal" LED driver. Every application requires a unique driver design, and the quality of the driver has a significant effect on the performance of the LED.

A range of factors determines the type of LED driver required, including the type and quality of LEDs being installed, whether they will be placed individually or in series strings, whether there are size limitations, and, ultimately, the main design goal of the installation.

Today's drivers come in two versions, constant current and constant voltage, with a number of variations. In simple terms, constant current drivers are used to power individual bulbs or multiple bulbs connected in series. Constant voltage drivers are best for applications where the user requires flexibility with the number of luminaires connected in parallel to one power supply. As lamps are added, the current will increase to the maximum limit.

DIMMING

With the overall design goal in mind, another important lighting concept is the availability of dimming functions. With

dimnable drivers, LEDs can be used to create a certain ambience or to highlight certain features. In addition, dimmable drivers allow for further energy savings to be achieved as they work on the premise that the human eye struggles to distinguish between LED lights that are on at 100% and those that are on at 90%.

It is a common mistake to think that dimming lights will result in a loss of light. The opposite is actually true. Although the driver efficiency will reduce a little as the LEDs are dimmed, overall significant energy will be saved. Also, dimming lights to half power can greatly extend the lifespan of LEDs, decreasing maintenance costs.

LEDs usually can be dimmed between 100% and 5%, or even lower, and are controlled by a phase dimmer switch, Digital Addressable Lighting Interface (DALI) controller, or 0-10V controller. DALI is widely recognized as the leading intelligent dimming protocol for LEDs. DALI drivers enable users to program their LED installations using digital signals to send control information to each light. Users then can set different lighting and ambient levels for displays, maximizing their investment.

Analog 0-10V drivers offer a less costly and more basic dimming solution to the DALI digital protocol. They can be easily programmed with a simple passive controller or a fixed or variable resistor. These controls use voltage input to manage the intensity of the light. For example, lights would be on at 100% at 10 V. At 5 V, lights would be powered at 50%. At 0 V, lights would be off.

Two main dimming protocols typically use a phase control dimmer switch: triac (leading edge) and trailing edge. Triac is the cheapest and most common method of dimming, but it generates an undesirable amount of electromagnetic interference (EMI). Trailing edge dimming is more expensive than triac but produces much less EMI.



2. BMW installed LED lighting in its Rome showroom to save energy and more dramatically show off its cars.

THE RESULTS ARE CLEAR

LED lighting gives off a better, brighter quality of light. When it's used with the right kind of driver, it also can provide a highly adaptable and flexible lighting environment using an array of color temperatures and profiles (*see*

"LEDs Kick Off A New Lighting Era At Manchester United" at electronicdesign.com). An expert lighting consultant is as important as a good builder.

In the workplace, good lighting can have a positive influence on health, improving absenteeism. It decreases eye strain, headaches, nausea, and neck pain. On the factory floor, better lighting improves performance. Increasing light levels from 300 lux to 2000 lux improves productivity by 8%, increases task performance by 16%, and reduces rejects by 29%. It also makes a positive contribution to safety, reducing accident rates by 52%.²

In retail, clever lighting choices can subtly influence consumer buying decisions, and LED lighting provides

the flexibility to highlight products and save energy where less light is needed. Leading U.K. retailer Next plc recently announced the rollout of 110,000 LED luminaires across its stores. Luxury car manufacturer BMW is also in the fast lane, having already installed LED solutions in a number of showrooms including its prestigious premises in Rome, Italy (*Fig. 2*).

Well known for its high-end exclusive models, BMW wanted to update its lighting not only to be energy efficient, but also to provide a fresh and highly creative approach to showcasing its cars. A combination of Harvard Engineering's dimmable CoolLED drivers, Projection Lighting's AlphaLED Gyro Cube, and Xicato's LED modules proved to be the perfect solution.

These drivers can control the voltage within each light to provide diverse lighting levels in different areas of the showroom, while keeping the overall appearance of the lighting consistent. This means that BMW is able to dim the level in the general showroom to 600 lux, while maintaining light over the cars at a higher level of 800 to 900 lux, creating a visual and inspirational dynamic highly relevant to the luxury brand. The result? Diverse but sophisticated lighting levels that highlight the star quality of BMW's prestigious cars.

The LEDs installed in the showroom have provided BMW with a number of other advantages too. Due to their long lifespan and high efficiency, the LEDs offer a very low-maintenance solution that will last a number of years. They have also cut energy usage and CO₂ emissions substantially—proof that bespoke LED solutions can deliver significant results.

With immense energy savings, green gains, and a new and ever expanding palette of controllable lights now at our disposal, it is no exaggeration to say that LED lighting is poised to take over from traditional lighting. Infinitely scalable, extremely reliable, and improving all the time, LEDs are quickly becoming the new standard, and companies signing up to it will truly reap the rewards of this lighting revolution. **ED**

REFERENCES

1. "Lighting The Clean Revolution," The Climate Group, http://thecleanrevolution.org/_assets/files/LED_report_web1.pdf
2. "Lighting In The Workplace," http://www.iar.unicamp.br/lab/luz/Id/Arquitetural/Handbooks/lighting_in_the_workplace.pdf