Introducing the LED Driver

Not only can they extend the useful life of your LEDs, drivers also aid in dimming and color changing

By Craig DiLouie, Lighting Controls Association

Light emitting diodes (LEDs) are low-voltage light sources that require a constant DC voltage or current to operate optimally. Because they operate on a low-voltage DC power supply, they easily adapt to different power supplies, have longer standby power, and are safer. Individual LEDs that are used for illumination require 2V to 4V of direct current (DC) power and several hundred milliamps of current. As LEDs are connected in series in an array, higher voltage is required.

In addition, the light source must be protected from line-voltage fluctuations during operation. Changes in voltage can produce a disproportionate change in current, which in turn can cause light output to vary, as LED light output is proportionate to current and is rated for a current range. If current exceeds the manufacturer recommendations, the LEDs can become brighter, but the increased heat can degrade their light output at a faster rate and shorten useful life. One definition of useful life for LEDs is the point at which light output declines by 30%.

Therefore, LEDs require a device that can convert incoming AC power to the proper DC voltage and regulate the current that flows through the LED during operation. An LED driver converts 120V (or other voltage) 60 Hz AC power to the low-voltage DC power required by the LEDs and protects them from line-voltage fluctuations. It's analogous to a ballast in a fluorescent or HID lighting system.

LED drivers may be constant voltage types (usually 10V, 12V, and 24V) or constant current types (350mA, 700mA, and 1A). Some operate specific LED devices or arrays, while others can operate most commonly available LEDs. They're usually compact enough to fit inside a junction box, include isolated Class 2 output for safe handling of the load, operate at high system efficiency, and offer remote operation of the power supply.

Photo courtesy of Advance Transformer Co.

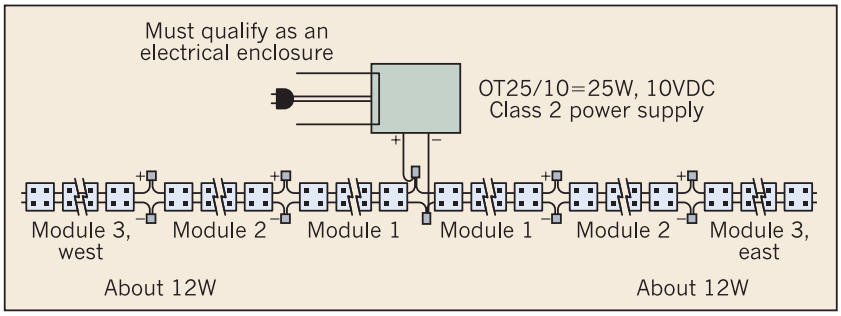
After an electrical fire destroyed the face of a Carl's Jr. fast-food franchise sign, the neon signage was replaced with new LED signage powered by LED drivers. Input watts dropped from 200W to 38W with the LED system, producing a payback in less than two years.

Dimming and color changing. Drivers can enable dimming and color-changing or sequencing of LEDs initiated by preset commands, occupant presence, or manual commands. Most LED drivers are compatible with commercially available 0V to 10V control devices and systems like occupancy sensors, photocells, wall box dimmers, remote controls, architectural and theatrical controls, and building and lighting automation systems. They can also work with devices governed by the DMX and digital addressable lighting interface (DALI) protocols and, in the future, may include wireless as a control option.

"With the use of fully electronic drivers, the possibilities are endless," says Al Marble, manager of sales and market development for Rosemont, Ill.-based Philips-Advance Transformer. "This area is only now being developed, but tighter integration of all electronic components is expected to reduce the use of discrete components in the field and simplify application."

Drivers with dimming capability can dim the LED light output over the full range from 100% to 0%. They do so by reducing the forward current or by using pulse width modulation (PWM) via digital control. More sophisticated

Figure courtesy of OSRAM Sylvania, Inc.



For these six back-light modules, the leads to the power supply should connect at the center of the chain so that three modules travel in one direction and three travel in the other direction.

methods exist, but most dimming drivers use PWM. With this method, the frequency could range from 100 modulations per second to hundreds of thousands of modulations per second. With that many modulations, the LED appears to be continuously lighted without flicker. A benefit of the PWM method is that it enables dimming with minimal color shift in the LED output. According to the Lighting Research Center, dimming causes LEDs to experience a shift in spectral power distribution similar to what happens in an incandescent lamp. However, if colored LEDs in an array are used to produce white light, the amount of shift, particularly with red and yellow LEDs, may produce an undesirable effect on the white light that is produced by the system.

Dimming doesn't result in a loss of efficiency. During dimming, LEDs still operate at the same voltage and current as during full light output. In addition, lamp life isn't affected by dimming, as is sometimes the case with frequently dimmed fluorescent lighting. Rather, dimming LEDs may lengthen their useful life because it can reduce operating temperatures inside the light source.

Drivers can also be used for color changing or sequencing by dimming a mix of colored LEDs in an array. The driver can also work with a color sequencer, which receives the 10V or 24V LED driver output and converts it into three-channel output—usually red, blue, and green—that can be mixed to create a wide range of colors. A sequencer can carry out a preset series of color changes at a speed determined by the specifier. It's also possible to control and program each LED individually by interfacing with a DMX digital controller, which makes it possible to dynamically dim up or down thousands of LEDs to create a seemingly infinite spectrum of colors.

Specification tips. Sameer Sodhi, product marketing manager for LED power supplies and controls at Osram Sylvania, points out that a common problem with LED system operation involves overloading the driver. LED drivers are rated for a maximum load that must be followed.

"One of the most common mistakes is to connect too many LED strings in series," he says. "Doing so may result in too low a voltage being available to the last string(s) in the chain" (Figure above).

Another common problem, he warns, is using the wrong voltage driver. "When a wrong voltage driver is used, the LEDs will either not light up or may operate at higher currents than intended," he says. "A prudent practice is to check the voltage rating of the LED load being used against the rated output voltage of the driver. For example, using a 12V driver on a 10V LED load could result in significantly shorter life of the module."

Sodhi also believes that one of the most important LED driver features to examine is the quality of the DC output voltage of the driver.

"To maximize the light output from

The Future Looks Bright for LEDs

Colored LEDs currently dominate the exit sign market. They're incorporated into an estimated 85% to 95% of all exit signs sold in the United States, and they're making inroads into the traffic signal market, with current penetration estimated at 30%. They show significant promise for automobile lighting, and are being sold in a variety of consumer products like flashlights and light wands. They're also penetrating mainstream commercial applications like task lights, accent lights, wall washing, signage, advertising, decorative and display lighting, cove lighting, wall sconces, outdoor / landscape / façade lighting, downlighting, and custom lighting.

the LEDs without overstressing them requires a constant DC current to be maintained through them," he says.

In addition, he cautions that remote mounting of the driver results in voltage drops and power losses on the DC wiring that must be properly accounted for.

Finally, Sodhi advises specifiers to be aware of ambient temperatures at the application. While LEDs have the ability to start at temperatures as low as −40°C, operating them at cold ambient temperatures can cause operating problems. "LEDs draw higher power at cold ambient temperatures, the opposite of what happens with fluorescent lamps, and this can lead to system malfunction," he warns. "For outdoor applications where the power supply is mounted remotely, the maximum LED load on the driver should be de-rated by 10% to 20% to avoid system conflicts during cold temperatures."

Marble points out that special attention should be paid to the environmental rating of the driver. Most drivers are "dry location only" in type and must be installed in a weatherproof electrical enclosure if used outdoors. Damp location type drivers should be used in signs or raceways where some moisture is expected, and wet location type drivers are typically supplied in a pre-assembled, sealed enclosure for mounting outdoors.

Marble also believes UL Class 2 ratings—required for LEDs in signage—can benefit general lighting applications.

"UL Class 2 mandates that the driver has voltage, current, and power below certain levels on the secondary," he says. UL Class 2 rated LED drivers provide electrical isolation from the AC line voltage, which allows for safe handling of the LEDs operating at low-level DC voltages.

"Off-the-shelf DC power supplies are typically designed for room temperature applications, such as IT or telecom," he adds. "Such power supplies may operate erratically or not at all under the rigors of a lighting application."

Finally, Marble advises that LEDs can suffer from heat-associated problems even during normal operation. "LEDs are occasionally and incorrectly believed to generate little or no heat," he says, pointing out that there can be substantial heat generated in higher-wattage LED fixtures. "Hopefully, the integrator/fixture manufacturer designed appropriate heat sinks for the system. Still, allowing ample heat dissipation in the installation by mounting to metal or allowing some ventilation if possible is good practice."

LEDs continue to break into new markets, proving there are few places they can't go. Whether they stay there will depend on how diligent installers are in applying the devices necessary to keep them working properly. EC&M

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