What to Consider

When Selecting an LED Driver

INVENTRONICS

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Optimal solid-state lighting designs requires careful consideration of the LED driver. The driver is a critical element that provides power to the LED's while also adding a degree of protection from the AC mains. There are many factors that influence the selection of the driver from electrical characteristics, to controls and added features. The information provided is intended to help educate and guide users through the selection process.

The initial considerations are based on the electrical ratings and performance. The first decision is if the design requires constant current (CC) or constant voltage (CV). Many solid-state lighting designs drive the LEDs (which are diodes) with a controlled current; using a constant current driver (Figure 1). This is often the simplest design approach as there is little external circuitry required. There are however, applications that favor a constant voltage driver that regulates the output voltage; using a constant voltage driver (Figure 2). These applications include simple light strips or more sophisticated distributed architectures where the current is regulated downstream at the LEDs.

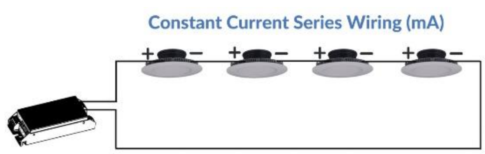

Figure 1: Example of a series wiring using a constant current driver.

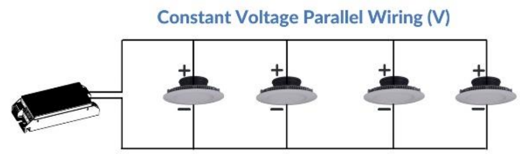

Figure 2: Example of a parallel wiring using a constant voltage driver.

The next consideration is the power level, which is based on the voltage and current requirements. The driver should have margin to accommodate best design practice for situations; such as cold start when the forward voltage of the LED is increased, requiring more power than typical. Once the power level is determined, the proper output current and voltage model can be selected. A programmable driver greatly simplifies the task by allowing the user to specify the voltage range and current. The advantage is that individual designs can be optimized, and multiple designs can be accommodated with a single programmable driver facilitating sourcing and qualification tasks.

Following the consideration of electrical parameters, mechanical considerations can be made. A key element to the design is where the driver is located in the luminaire design. LED drivers can be found in a variety of shapes including linear, low profile and round to name just a few (Figure 3). The dimensions of the form factor can be checked to ensure fit. The package may require consideration for overall thermal management or for ease of installation. Cabling or connectors can be considered based on the luminaire design and if installation will happen in the field or factory floor.

Figure 3: Examples of different LED driver form factors

With the electrical and mechanical factors considered the next step is attention to approvals. The most significant approvals are safety related and guided by regional standards (Figure 4). The designer must identify the applicable standards for the regions the products will be sold. In Europe the approvals most often sought are by ENEC, while the United States looks for nationally recognized test labs (NRTLs) testing to UL standards. The China market looks for CCC, India for BIS, Japan for PSE, etc. Safety approvals and marking alone is a complex consideration which the LED driver manufacturer can assist with.
Beyond the safety standards there may be additional market-based guidelines to consider. Meeting these standards may promote interoperability or eligibility for certain credits. Examples of this include DALI issued through the Digital Illumination Interface Alliance (DiiA) or the Design Lights Consortium (DLC).

Agency	Location
UL	North America
FCC	North America
CE	Europe
ENEC	Europe
CB	Worldwide
CCC	China
PSE	Japan
KC	Korea

Figure 4: Examples of certifications and the region they are associated with.

Lifetime of the driver is greatly influenced by environmental factors (Figure 5). The application setting, and luminaire design will determine the environmental needs and surge protection levels of the LED driver. If the expectation is for the driver to be used in an unconditioned environment, then temperature range and consideration of ingress protection (IP) is very important. In these cases, drivers with encapsulation are frequently selected. The encapsulation ("potting") helps transfer heat externally to reduce any local hotspots and provide a level of protection against ingress and vibration. For indoor applications these choices may be less critical as the environment is controlled, however, care must still be taken. The luminaire design will greatly influence the local ambient the driver may see, which can be elevated if system thermal design (Figure 6) is not considered carefully. Common mode (CM) and Differential mode (DM) surge protection is an additional environmental related consideration. The greater the rated surge levels (such as 6kV DM and 10kV CM) the greater the ability for the driver to absorb or divert energy associated with electrical mains disturbances.

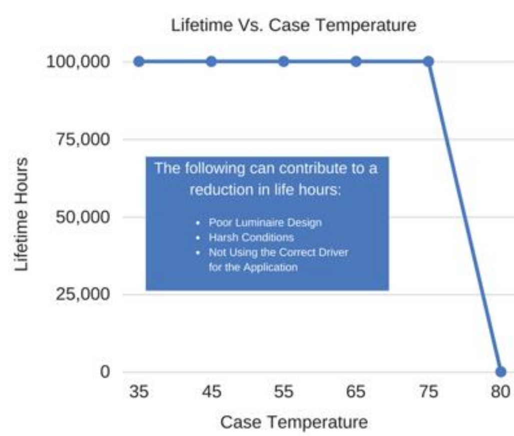

Figure 5: Example of Driver Lifetime vs. Case Temperature

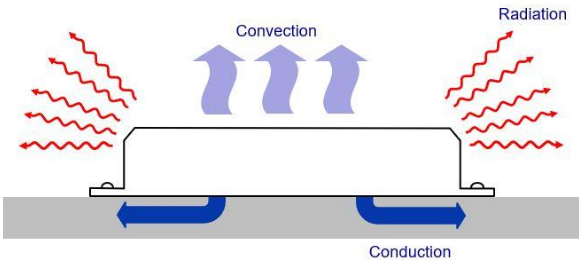

Figure 6: Example of thermal design and the way heat dissipates

The final selection of consideration is dimming, controls and features. Although the clear majority of applications are constant current, the capability to dim the luminaire is a common requirement in lighting design. However, the dimming control method can vary. The most common method is 0-10V but you might also see need for pulse width modulated (PWM), timers or 0-5V depending on the applications. In addition to commonly used dimming schemes, there is a rapid emergence in designing smart or connected lighting which may use a variety of wired or wireless protocols such as Zigbee or Bluetooth. Additional driver features can simplify designs or add capabilities. One example is an auxiliary output voltage (Figure 7) which can simplify the use of controls without the need for an additional AC (power supply) connection (potential point of failure) by connecting and controlling from the output or low voltage side of the driver. Other features include external temperature sensing, output lumen compensation and Dim to Off which all can add value and differentiation to your luminaire.

Figure 7: Example of LED drivers with auxiliary constant voltage supply

The following table summarizes the selection criteria:

Category	Consideration	Importance
Electrical	Constant Current or Constant Voltage	Control method to LEDs
	Output Power	Insure proper operation and best performance
	Output current, voltage	Matching driver to light engine
	Programmable	Flexibility in setting current
Mechanical	Shape	Fit luminaire design
	Cables or Connectors	Ease of installation
Standards	Safety	Requirement for markets
	Market Based	Interoperability of credits
Environmental	Applications	Determine ingress protection
	Temperature	Range of temperature
	Surge Ratings	Protection for mains anomalies
Controls	Dimming	Control of light levels
	Connected Lighting	Enable smart lighting
Features	Dim to Off	Output side turn off
	Output Lumen Compensation	Compensate for aging LEDs
	External Temperature Control	Luminaire protection

The selection of the LED driver is critical to any solid-state luminaire design. LED drivers are complex electrical systems themselves, so great care must be taken to ensure proper selection for a successful deign. And last but not least: In addition to the driver product characterization, it is important to work with partners who distinguish themselves through technical knowledge, sales support and a commitment to innovation that demonstrates they can support the OEM through the process from concept to production. It is well recognized globally, that Inventronics stands out when it comes to reachability, response time to questions, and the provided quality of the support.

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Peter Resca is the technical marketing director for Inventronics and is responsible for identifying and developing the company's broad portfolio of LED drivers and Lighting Controls. Based in Boston, MA Resca manages the Global product offering for Inventronics, a leading manufacturer of LED drivers for the solid-state lighting market. He has a BSEE from Worcester Polytechnic Institute and an MBA from the University of Massachusetts. He began his career designing power electronics and has more than 20 years' experience in power and lighting with roles leading Engineering Development, Sales, Operations and Marketing.

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