ALG
Advanced Lighting Guidelines
algonline.org

ALG CONNECTIONS
NOVEMBER 2014

# Understanding LED Systems

*By Barb Hamilton*

*No one in the lighting industry is debating that LEDs as a light source are unique, exciting, and here to stay. For the first time in decades we need a new vocabulary and knowledge base to properly apply this source in our work and for the benefit of customers. This is one of a series of overviews meant to build an understanding of LED technology and what we need to know to confidently discuss and successfully apply this electrifying technology.*

In order to discuss the broader application and dimming of LED systems, we need to first understand two things: 1) the electronic components that make up an LED system, and 2) driver types. It is how an LED system functions and how these components differ from those more familiar technologies (incandescent or fluorescent) that influence the compatibility of an LED lamp/luminaire and a given controller.

**There are several terms used to describe the electronics that control power to the LED array. The three important components are:**

- **LED driver** – A regulator, it regulates and limits power, delivering a constant current to the LED array, much like a ballast in fluorescent fixtures. The driver may be combined with the power supply in a single unit.
- **Power supply** – The supplier of constant power, it converts incoming line voltage to a voltage usable for the driver. This typically means converting the incoming 120-240V AC power to low-voltage DC power. The power supply may be combined with the LED driver in the same unit.
- **Controller/Control circuitry** – Term reserved for electronics that switch, dim, or provide the mixing of colors in multicolored LED systems.

In Figure 1 these electronic components are identified within the larger LED system. This diagram labels individual pieces of the entire LED system, helping to point out where familiar parts and properties apply in the overall system.

A major variation between applying incumbent and LED systems is that there are few standard LED array configurations or drivers, as is the case with fluorescent systems. This means that the standardized lamp/ballast combinations that have evolved for fluorescent technologies are not common for LED array/driver combinations.

## DRIVER TYPES

LEDs must be driven at a constant voltage or constant current. In recent years, 350mA, 700mA and 1A constant current LED drivers were the most common and were available in different power and LED array voltage capacities. But as LEDs have evolved, so have individualized drivers that provide specific performance.

LED driver topologies also vary by system configuration. Some drivers are designed for a single specific LED device or can be a general design for a variety of common LED packages.

ABOUT
ALG Connections

*Through a series of abstracts and synopses, ALG Connections informs readers on timely topics such as research, conference reviews, industry trends and technology updates.*

*ALG Online is one of the design guides offered by New Buildings Institute (NBI) through its Advanced Buildings® suite of tools and resources.*

*Visit us for more information about New Buildings Institute at newbuildings.org, ALG Online at algonline.org and Advanced Buildings at advancedbuildings.net.*

Successful applications will therefore depend on inquiries into a luminaire's default/alternate driver options and their compatibility with the intended control system..

The simplest LED driver consists of a **current-limiting resistor** in series with the LED array string. No active current regulation takes place, leaving the system vulnerable to uncontrolled operation and reduced lifetime. Efficiencies can also vary widely.

**Linear LED drivers** control current through the LED array by actively varying the resistance of a transistor in line with the array. As these are also resistive systems, the power dissipated by the transistor is wasted as heat and must be handled properly in the thermal design of the driver circuit.

Resistor and linear driver systems operate without generating electromagnetic interference and are considered inexpensive, but they are generally are less efficient than switching drivers.

**Switching LED drivers** are inductive systems that switch power to the LED array at high frequencies. At full power, current in the array is constant (with a small ripple). The use of inductive magnetics allows for accurate current regulation and very high efficiencies, but increases the possibility of electromagnetic interference that can cause problems with other electronic devices.

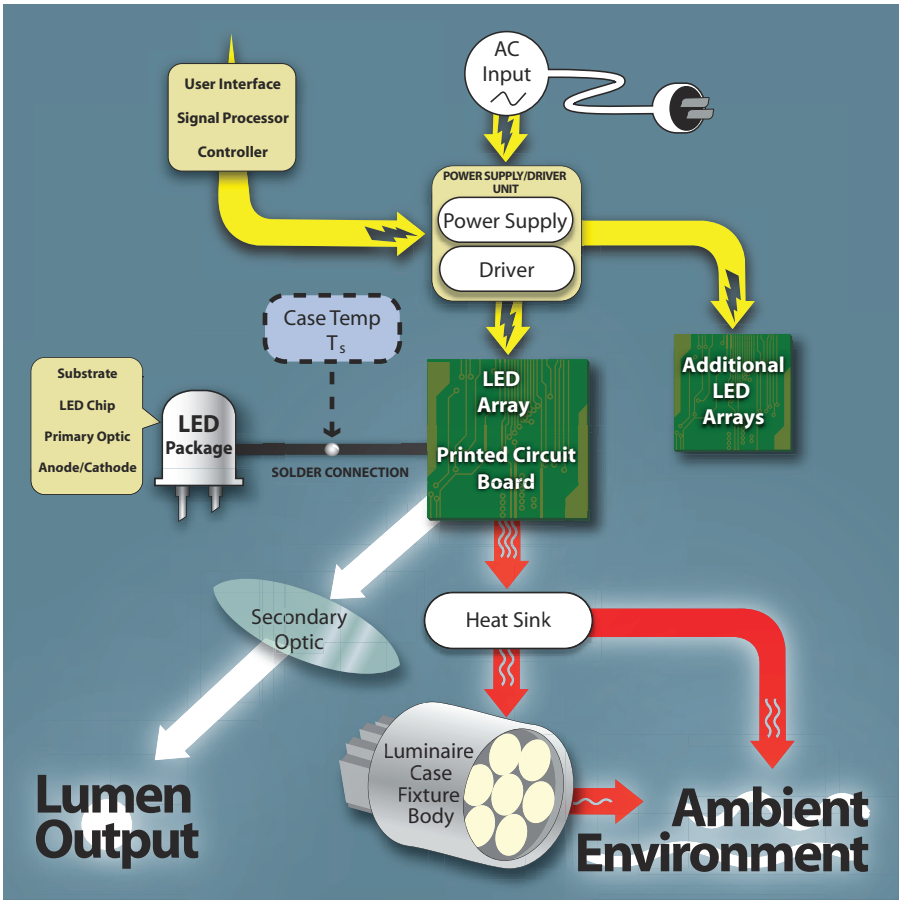


Figure 1: Illustration of an LED system. An LED Lamp/Luminaire can be considered a conversion of electrical energy (energy input) into light energy and heat (energy output). Courtesy of *ALG Online.*

For more information on LEDs and other lighting technologies and information, visit: Advanced Lighting Guidelines (ALGOnline.org).

*Barb Hamilton is a lighting consultant for New Buildings Institute. Her experience includes lighting design, product sales and marketing and several educational functions. Barb supports NBI's involvement in commercial lighting including development of the Advanced Lighting Guidelines online resource (known as ALG Online) and working to move advanced lighting practices and products into the market.*

*Special thanks to Northwest Energy Efficiency Alliance for their support in developing these* ALG Connections *pieces on LED technology.*