A Look At Gaming Lighting from a Thin & Cool Perspective

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Durel Corporation

Gaming industry lighting is undergoing dramatic changes. Durel Corporation (Chandler, AZ), a fully integrated, high-volume manufacturer of electro-luminescent (EL) lamps and drivers, has been the #1 choice for worldwide applications such as cellular phones, watches, consumer electronics and automotive instrument clusters since 1988. Durel is now introducing specialized EL products into the casino/signage market, providing a complete systems-solution approach to backlighting gaming machines and signage applications. Durel's leading EL technology has been specially modified for these applications.

EL Benefits Durel electroluminescent lamps provide a high quality, thin, cool, and flexible alternative to traditional lighting systems. Unlike other lighting technologies, EL distributes light evenly over the entire surface, eliminating hot spots that degrade graphical details. Space is saved because the lamp package is less than 0.025" thick. Plus, energy-efficient EL is a cool alternative to conventional hot bulbs. Durel lamps are delivered preassembled with wiring and standard connectors already in place, making installations quick and simple.

Gaming/Topper Applications Durel's newest product offerings are gaming machine lamps, manufactured for a variety of toppers, slot glass and gaming machine billboards. Durel's gaming/topper applications can be attached to the back of the graphic glass with flat c-channel clamps or adhesives, making these bright, space-savings lamps an attractive alternative to large fluorescent bulb cases.

Traditionally, toppers designed to attract the eye to new machines are unlit, or if lit, are thick and bulky. Durel's EL technology provides two-sided illuminated signs that are thin, lightweight, and can be easily moved from machine to machine by unplugging two wires and moving the lamp and driver. (To install a Durel EL topper, simply feed the cord down through the candle into the slot machine and plug it into the power supply (the driver). The driver is then simply plugged into a 110Vac/60Hz electric outlet.)

Power Supply Durel's EL drivers use patented technology to achieve extended life and luminance. Within a machine bank, a single unit can operate multiple lamps up to a maximum total lighted area of 20ft2. The drivers will formally be introduced into the marketplace in September, 2002.

Performance In addition to other features and benefits, EL lamps eliminate catastrophic failure. Over time, the luminance level of EL lamps gradually decline until they reach their minimum preferred luminance level ("Time to Half Luminance"), at which time new lamps can be installed. Replacement is safe, simple and fast. To achieve greatest performance, Durel's EL system is set at a specific luminance level and target life depending on the application. The drivers are programmed to increase voltage as the EL lamp's luminance declines, which will extend its Time to Half Luminance (THL) between 2,000 and 8,000 hours, depending on the starting luminance level. This facilitates scheduled maintenance at four- or six-month intervals, or with changes of the graphics package.

See Durel at the Global Gaming Show Exhibition, September 17-19, 2002, Las Vegas, NV. Booth #358 For more information about Durel's products, please contact Mona Fechter at 480-917-6260 Fax: 480-917-6049, email: mfechter@durel.com or visit our website at www.durel.com.

Durel Corporation is a joint venture between 3M Corporation, located in Minnesota, and Rogers Corporation, located in Connecticut. The company's product lines include coated phosphors, inks, custom electroluminescent lamps, EL drivers, design engineering applications, and consulting services.

Introduction to Electroluminescent Lamps

Electroluminescent (EL) lamps are essentially capacitors with one transparent electrode and a special phosphor material in the dielectric. When a strong AC voltage is applied, the phosphor glows.

The required AC voltage is typically not present in most systems and must be generated from a low voltage DC source. In the past this was done with a self-oscillating transformer circuit. These circuits are large, expensive, and they often produce audible noise. Durel solved these problems by developing a switch-mode inductor-based circuit integrated into a single chip. A family of chip inverters based on this type of circuit now exists.

Basic Circuit Operation

The chip inverter powers the EL lamp by repeatedly charging an inductor with current from a DC source and discharging into the capacitance of the EL lamp (Figure 1). With each cycle the voltage on the lamp is increased. After many cycles when the lamp voltage is sufficient the lamp is discharged and the polarity of the inductive charging is reversed. By this means a symmetric low frequency alternating voltage is developed at the lamp's input.

The inverter circuitry is divided into several parts: off-chip circuitry, on-chip logic and control, and on-chip high voltage output circuitry. The output circuitry handles the power through the inductor and delivers the high voltage to the lamp. The on-chip logic and control generates the lamp operating frequency (LF) as well as the inductor switching frequency (HF) and duty cycle (D). These signals are combined and buffered to drive the high voltage output circuitry. The off-chip circuitry provides a degree of flexibility so that HF and LF can be adjusted to accommodate various lamp sizes, system voltages, and brightness levels. Since a primary objective of these chips is to save space, off-chip components were kept to a minimum.

Charge Pumping Modes

Pulsed current mode

This is the preferred mode of operation. The current in the inductor is completely discharged into the lamp (load) at the end of each HF cycle. The inductor always starts with zero current at the beginning of each HF cycle. This mode requires sufficient time (td) to allow the inductor (L) to fully discharge into the capacitive lamp load (Z).

Continuous current mode

In this mode a new inductor charging cycle is started while current in the inductor is still

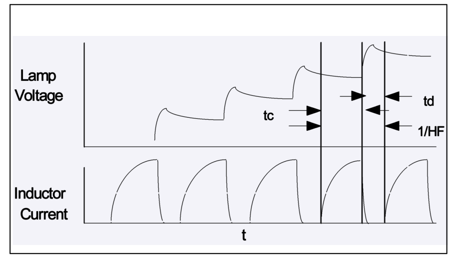

Figure 2: Pulsed Current Mode

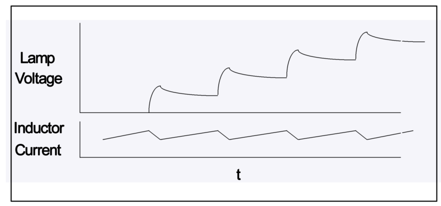

Figure 3: Continuous Current Mode

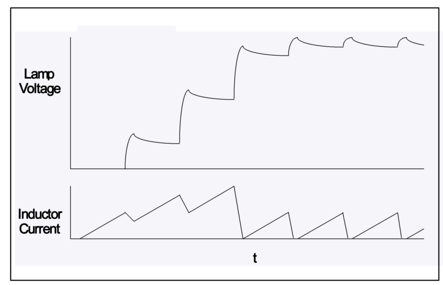

Figure 4: Mixed Mode

flowing into the lamp. Inductor current fluctuates but never reaches zero. Switching losses are higher and preventing inductor saturation becomes more difficult but higher power densities are possible.

Mixed mode

When lamp voltage is zero at the start of a lamp charging cycle it takes longer to discharge the inductor. There is not enough time to fully discharge the inductor so current builds from one HF cycle to the next. As voltage on the lamp builds, the inductor discharges more quickly so that inductor current starts to decline from cycle to cycle to the point where it reaches zero at the end of each HF cycle. It starts charging the lamp in continuous mode but finishes in pulsed mode. The lamp voltage builds much faster in the first phase, then flattens out in the pulsed phase.

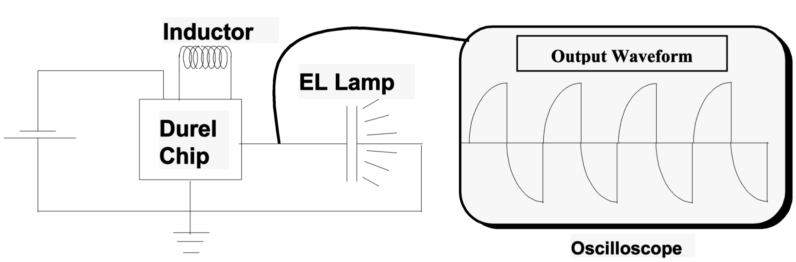

Figure 1: Inverter Operation Diagram