DESIGN NOTES

High Power Desktop LCD Backlight Controller Supports Wide Dimming Ratios While Maximizing Lamp Lifetime – Design Note 264

Rich Philpott

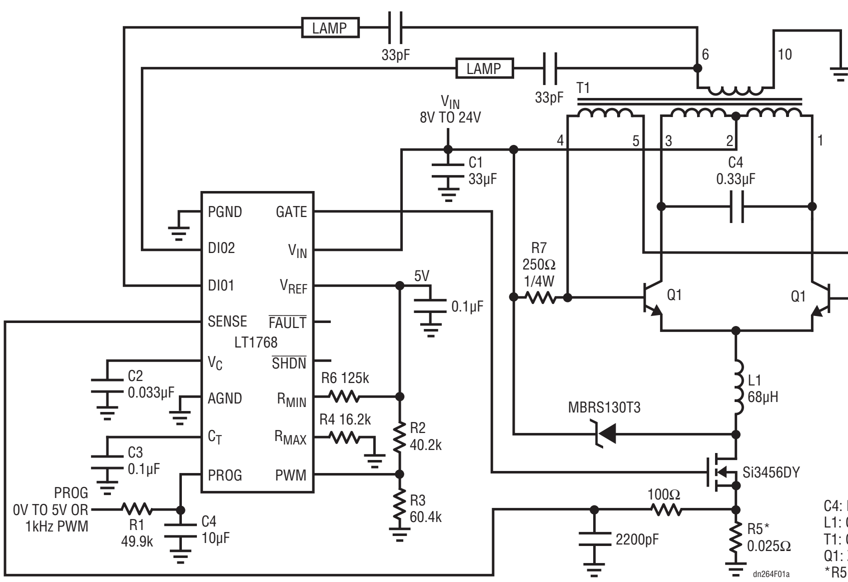
Introduction

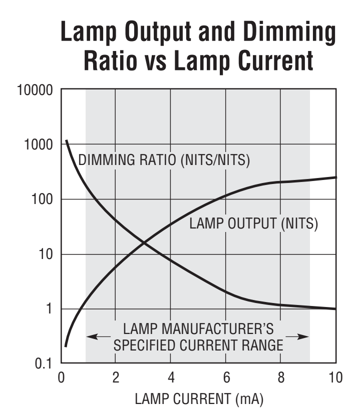
Liquid crystal displays (LCDs), long standard in laptop computers and handheld instruments, are gaining in popularity as desktop computer displays. Larger displays require multiple high power cold cathode fluorescent lamps (CCFLs). The lamps must have a dimming range and life expectancy comparable to those of previous generations of desktop displays. To achieve maximum lamp lifetime and dimming range while maintaining efficiency, CCFL drive should be sinusoidal, contain zero DC component, and not exceed the CCFL manufacturer's current ratings. Providing a low crest-factor sinusoidal CCFL drive also maximizes current-to-light conversion efficiency, reduces display flicker and minimizes EMI and RFI emissions. The LT®1768 high power CCFL controller, with its unique Multimode Dimming, provides the necessary drive to enable a wide dimming range, while maximizing lamp lifetime.

LT1768 Dual CCFL Backlight Inverter

The circuit in Figure 1 is a dual, grounded-lamp backlight inverter that operates from an input of 9V to 24V, delivers current from 0mA to 9mA per CCFL and has a dimming ratio greater than 100:1. The LT1768 in the circuit is a 350kHz fixed frequency, current mode, pulse width modulator that provides the lamp-current control function.

The CCFL current is controlled by a DC voltage on the PROG pin of the LT1768. This voltage feeds the LT1768's Multimode Dimming block, which converts it to a current and feeds it to the V_C pin. As the V_C pin voltage rises, the LT1768's GATE pin is pulse-width modulated at 350kHz. The pulse width modulation produces an average current in inductor L1 proportional to the voltage on the V_C pin. The CCFL's are driven by





C4: PANASONIC ECHU	(914) 374-2474
L1: COILTRONICS UP4-680	(561) 752-5000
T1: COILTRONICS CTX110607 (2 IN PARALLEL)	
Q1: ZETEX ZDT1048	(631) 543-7100
*R5 CAN BE METAL PCB TRACE	

Figure 1. 14W CCFL Supply Produces a 100:1 Dimming Ratio While Maintaining Minimum and Maximum Lamp-Current Specifications

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the Royer-class converter comprised of T1, C4 and Q1. The Royer converter produces a 90% efficient, zero DC component, 60kHz sinusoidal waveform based on the average current in L1. Sinusoidal currents from both CCFLs are returned to the LT1768 through the DIO1/DIO2 pins. A fraction of the CCFL current pulls against the V_C pin closing the loop. A single capacitor on the V_C pin provides loop compensation and CCFL current averaging, which results in constant CCFL current regardless of line and load conditions. Varying the value of the V_C current source via the Multimode Dimming block varies the CCFL current and resultant light intensity.

Multimode Dimming

Previous solutions used intensity control schemes that were limited to either linear or PWM control. Linear control schemes provide the highest efficiency circuits but either limit dimming range or violate lamp specifications to achieve wide dimming ratios. PWM control schemes offer wide dimming range but produce high crest-factor waveforms detrimental to CCFL life and waste power at higher currents. The LT1768's patented Multimode Dimming combines the best of both control schemes to extend CCFL life while providing the widest possible dimming range.

The circuit in Figure 1 accepts either a 0V to 5V DC voltage, or a 0V to 5V, 1kHz PWM waveform and converts to a DC voltage. The filtered input voltage is sent to the LT1768 PROG pin, which controls lamp intensity by placing the LT1768 into one of five distinct modes of operation. Referring to Figure 2, which mode is in use is determined by the voltages on the PROG and PWM pins and by the currents that flow out of the R_{MAX} and R_{MIN} pins.

Off mode (V_{PROG} < 0.5V) sets the CCFL current to zero.

Minimum current mode (0.5V < V_{PROG} < 1.0V) sets the CCFL current to a precise minimum level set by the R_{MIN} resistor. This mode determines the minimum lamp current and intensity.

Maximum current mode (V_{PROG} > 4V) sets the CCFL current to a precise maximum level set by the R_{MAX} resistor. Setting the CCFL current in this mode to the manufacturers maximum rating achieves maximum intensity and ensures no degradation in the lamp lifetime.

In linear mode (V_{PWM} < V_{PROG} < 4V), CCFL current is controlled linearly with the voltage on the PROG pin.

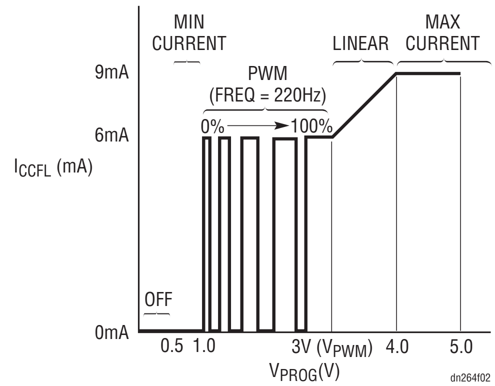

Figure 2. Lamp Current vs PROG Voltage

Linear mode provides the best current-to-light conversion and highest efficiency.

In PWM mode (1V < V_{PROG} < V_{PWM}), the CCFL current is modulated between the minimum CCFL current and the value for CCFL current in linear mode with V_{PROG} = V_{PWM}. The PWM frequency is set by a single capacitor on the C_T pin. The PWM duty cycle is set by the voltage on the PROG pin with 1V equal to 0%, and 100% (linear mode) equal to V_{PWM}. The LT1768's PWM mode enables wide dimming ratios while reducing the high crest factor found in PWM-only dimming solutions.

When combined, these five modes of operation allow the creation of a DC-controlled CCFL current profile that can be tailored to enable the widest possible dimming ratio while maximizing CCFL lifetime.

LT1768 Fault Modes

The LT1768 also has fault detection to ensure that lamp current and Royer transformer ratings are not exceeded under fault conditions. If one CCFL lamp is open, the LT1768 activates a fault flag and adjusts the current in the remaining so that it never exceeds the maximum current set by the R_{MAX} resistor. If both lamps are open circuit, the LT1768 shuts down the Royer section to avoid any hazardous high voltage conditions.

Additional Features

The LT1768 also provides a temperature-compensated 5V reference, an undervoltage lockout feature, thermal shutdown and a logic-compatible shutdown pin that reduces supply current when activated. The LT1768 is available in a 16-pin SSOP package.

Data Sheet Download

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Linear Technology Corporation
1630 McCarthy Blvd., Milpitas, CA 95035-7417
(408) 432-1900 • FAX: (408) 434-0507 • www.linear.com