LINEAR TECHNOLOGY DESIGN NOTES

High Power CCFL Backlight Inverter for Desktop LCD Displays

Design Note 164

Jim Williams

Large LCD (liquid crystal display) displays designed to replace CRTs (cathode ray tubes) in desktop computer applications are becoming available. The LCD's reduced size and power requirements allow much smaller product size, a highly desirable feature.

CRT replacement requires a 10W to 20W inverter to drive the CCFL (cold cathode fluorescent lamp) that illuminates the LCD. Additionally, the inverter must provide the wide dimming range associated with CRTs, and it must have safety features to prevent catastrophic failures.

Figure 1's circuit meets these requirements. It is a modified, high power variant of an approach employed in laptop computer displays[1]. T1, Q1, Q2 and associated components form a current fed, resonant Royer converter that produces high voltage at T1's secondary. Current flows

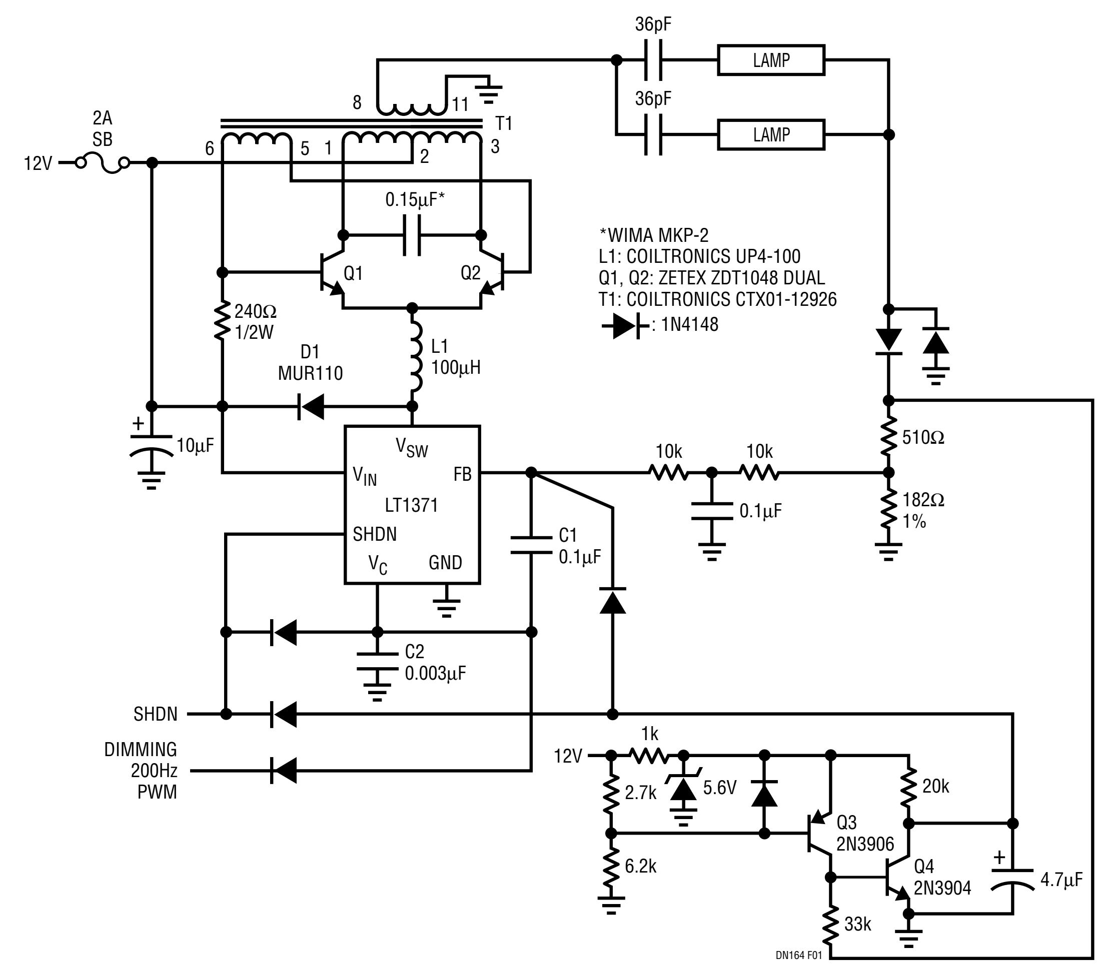

Figure 1. 12W CCFL Backlight Inverter for Desktop Displays Provides Wide Range Dimming and Safety Features

through the CCFL tubes and is summed, rectified and filtered, providing a feedback signal to the LT®1371 switching regulator. The LT1371 delivers switched mode power to the L1–D1 node, closing a control loop around the Royer converter. The 182Ω resistor provides current-to-voltage conversion, setting the lamp current operating point. The loop stabilizes lamp current against variations in time, supply, temperature and lamp characteristics. The LT1371's frequency compensation is set by C1 and C2. The compensation responds quickly enough to permit the 200Hz PWM input to control dimming over a 30:1 range with no degradation in loop regulation. Applicable waveforms appear in Figure 2.

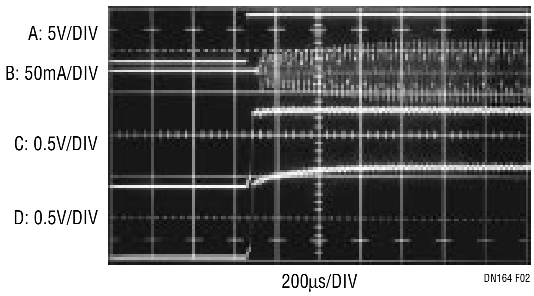

Figure 2. Fast Loop Response Maintains Regulation at 200Hz PWM Rate. Waveforms Include PWM Command (A), Lamp Current (B), LT1371 Feedback (C) and Error Amplifier V_C (D) Pins. Loop Settling Occurs in 500µs

Q3 and Q4 shut down the circuit if lamp current ceases (open or shorted lamps or leads, T1 failure or similar malfunction). Normally, Q4's collector is held near ground by the lamp-current-derived base biasing. If lamp current ceases, Q4's collector voltage increases, overdriving the feedback node and shutting down the circuit. Q3 prevents unwanted shutdown during power supply turn-on by driving Q4's base until supply voltage is above about 7V.

Figure 3 shows the shutdown circuit reacting to the loss of lamp feedback. When lamp feedback ceases, the voltage across the 182Ω current sense resistor drops to zero (visible between Figure 3's 2nd and 3rd vertical graticule lines, trace A). The LT1371 responds to this open-loop condition by driving the Royer converter to full power (Q1's collector is trace B). Simultaneously, Q4's collector (trace C) ramps up, overdriving the LT1371's feedback node in about 50ms. The LT1371 stops switching, shutting off the Royer converter drive. The circuit remains in this state until the failure has been rectified.

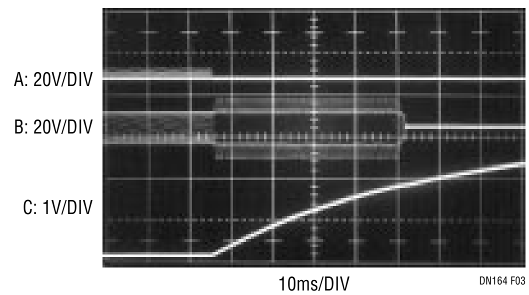

Figure 3. Safety Feature Reacts to Lamp Feedback Loss by Shutting Down Power. Lamp Current Dropout (Trace A) Allows Monitoring Circuit to Ramp Up (Trace C), Shutting Off Drive (Trace B)

This circuit's combination of features provides a safe, simple and reliable high power CCFL lamp drive. Efficiency is in the 85% to 90% range. The closed-loop operation ensures maximum lamp life while permitting extended dimming range. The safety feature prevents excessive heating in the event of malfunction and the use of off-the-shelf components allows ease of implementation.

1. See LTC Application Note 65, *A Fourth Generation of LCD Backlight Technology.*

For literature on our Switching Regulators, call **1-800-4-LINEAR**. For applications help, call (408) 432-1900, Ext. 2360

Linear Technology Corporation
1630 McCarthy Blvd., Milpitas, CA 95035-7417• (408) 432-1900
FAX: (408) 434-0507•TELEX: 499-3977 • www.linear-tech.com

dn164f LT/TP 0997 340K • PRINTED IN THE USA