

Using the UC3871 and UC3872 Resonant Fluorescent Lamp Drivers in Floating Lamp Applications

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The UC3871 and UC3872 family of resonant lamp drivers contain all of the necessary control circuitry to implement a highly efficient cold cathode fluorescent back-light driver. The grounded lamp circuit topology is discussed in detail in both U-141 and U-148. This design note describes how to modify the circuit to accommodate a floating lamp topology.

In many back-light systems, the physical spacing between the lamp and lamp wires with respect to the foil reflector and LCD frame can be tight. With tight spacing, distributed capacitance will form. High voltage capacitive coupling effects may result in uneven illumination across the tube and a slight degradation in efficiency. A floating lamp topology can reduce these effects. Figure 1 compares the AC voltage gradient of a grounded lamp and a floating lamp.

In the grounded lamp application, one end of the lamp has a high AC voltage while the other end of the lamp is connected to circuit ground. Although the current passing through the lamp is uniform, the voltage along the lamp (with respect to the ground plane) is not. The resulting electromagnetic field gradient causes a non-uniform phosphor glow as shown in Figure 1. At low currents, when the lamp is dimmed, the non-uniformity may be visible. This is known as the "thermometer effect". A floating lamp reduces the thermometer effect by cutting the voltage gradient in half.

To a lesser degree, a floating lamp will also improve circuit efficiency. Referring to Figure 1, the stray capacitance causes leakage currents from the lamp to circuit ground. Although the current through stray capacitance doesn't directly trans-

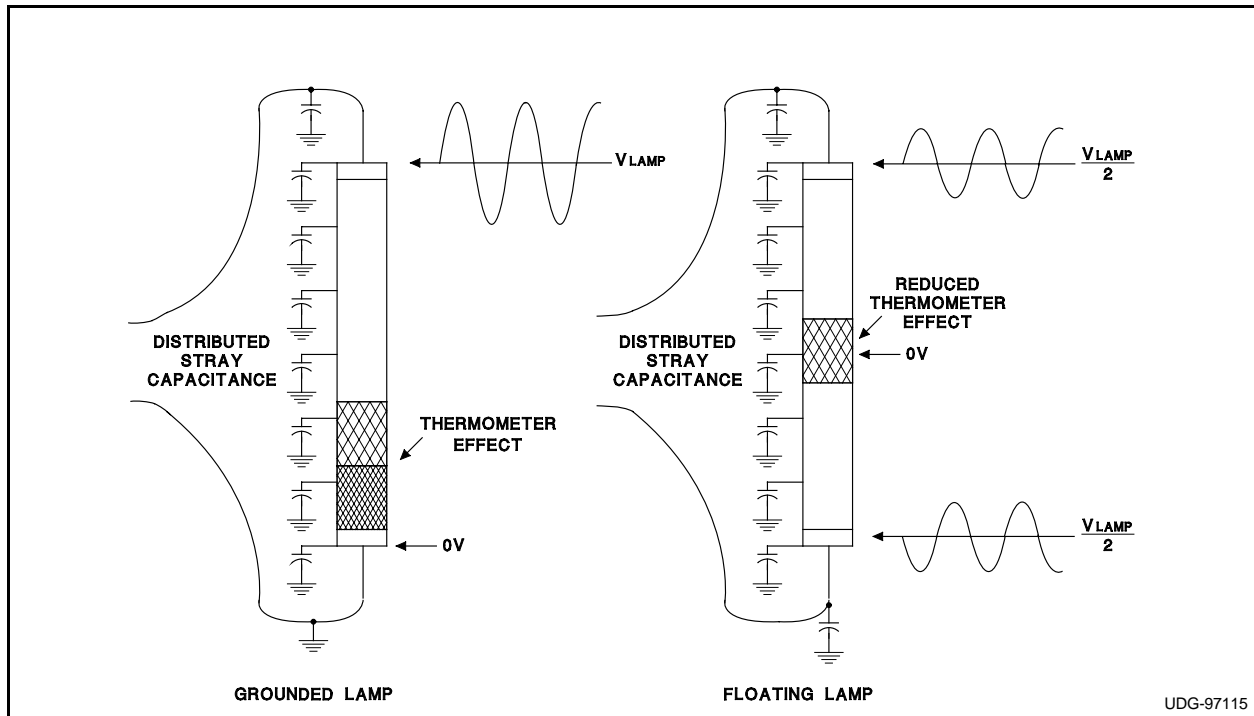


Figure 1.

late into losses, the extra current through the transformer and switching devices does. The floating topology cuts the average voltage along the lamp in half, this decreases the leakage current.

The UC3871 / 72 design can be converted to a floating lamp architecture as shown in Figure 2. A resistor added to the source of Q1 and Q2 is used to sense buck converter current. Buck current is proportional to the lamp current by the turns ratio of T1. A divider network connected between RSENSE, the inverting input of the error amplifier, and VREF is used to control lamp current. The non-inverting input of the error amplifier is internally derived off of VREF and should track within 0.5%. Resistors R1 and R3 should be chosen to have similar tolerances. When R2 is adjusted to zero ohms, lamp current is at a minimum. When R2 is adjusted to 2kΩ, lamp current is at a maximum. Several suppliers offer transformers for CCFL applications. A Coiltronics

CTX110605 transformer was used for the circuit in Figure 2.

Optional Open Lamp Detection with a Floating Lamp

During normal operation, the voltage at the output of the buck converter will appear as a full wave rectified sinusoid at the resonant frequency. If the lamp is opened, current that initially fed the lamp will begin to feed the resonant tank, increasing the tank voltage. The transformer voltage will then increase until the buck current and the losses in the tank reach equilibrium. This increase in secondary voltage may result in a break down of the transformer's insulation. Open lamp detection can reduce voltage stress on the CCFL transformer during an open lamp condition by decreasing the buck current feeding the resonant tank. In many designs, the tank voltage will not increase to destructive levels and open lamp detection is not necessary.

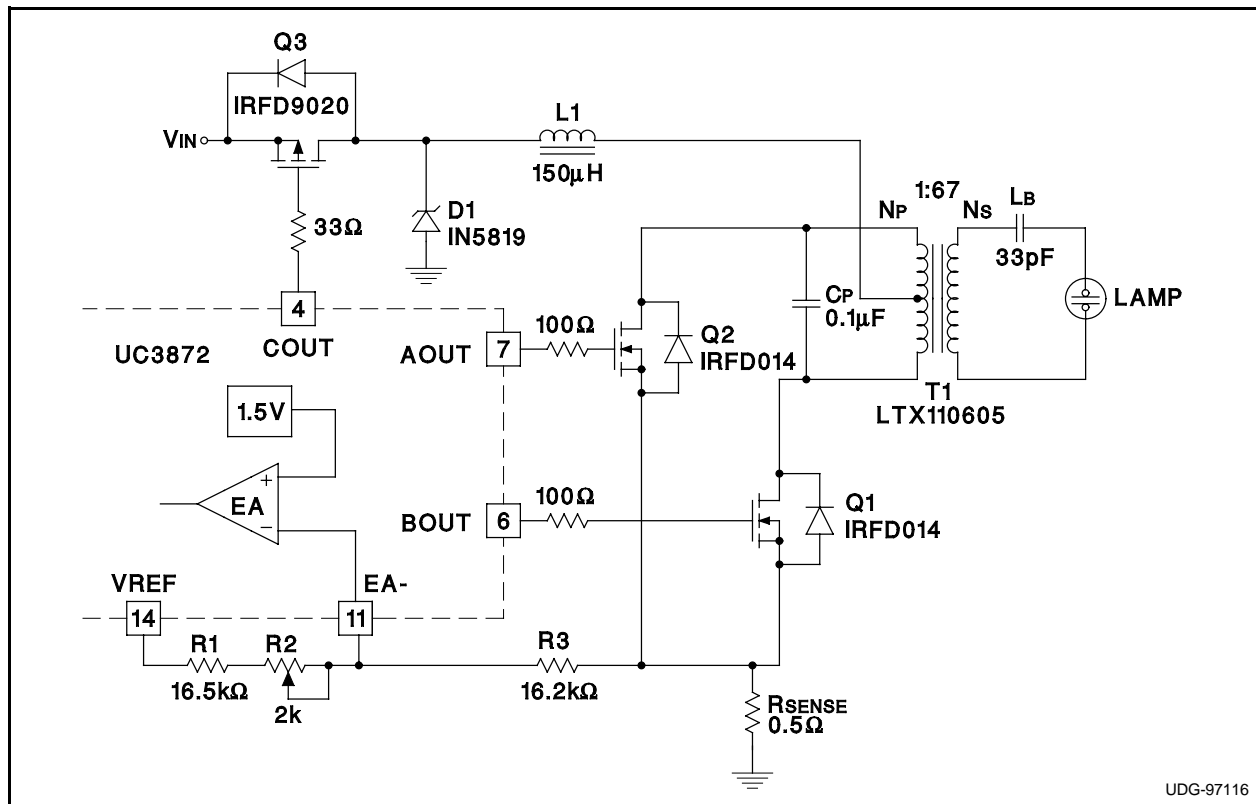


Figure 2. Floating Lamp with Primary Side Current Sense

The UC3871 / 72 open lamp detection circuitry will be invalidated by the floating lamp topology. Figure 3 shows a method for implementing open lamp detection with an open collector, quad comparator. If the buck output voltage increases above an acceptable level, comparator 1 will toggle high. A diode between the output and the positive input will latch the output high until power is cycled. A high output on comparator 1 will cause a low output on comparator 3, which is

connected to the output of the error amplifier. Pulling low will force a minimum duty cycle on the buck converter, decreasing the current feeding the tank, and the voltage on the transformer. Comparator 2 overrides the output of comparator 1 during soft start, allowing the tank voltage to ring up so the lamp can strike.

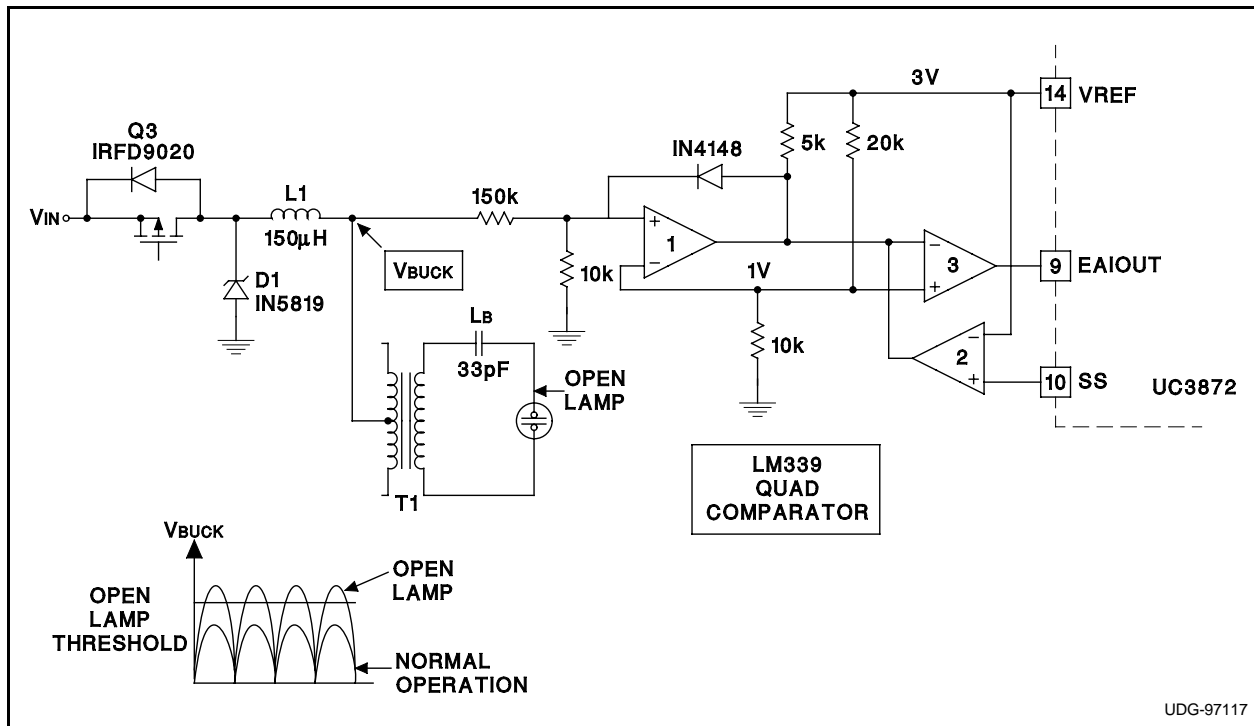


Figure 3. Optional Open Lamp Detection Circuit