UNITRODE
Design Note

Lamp Ignitor Circuit

by Ron Fiorello

Both Fluorescent and HID lamps are becoming increasingly more popular due to their luminous efficiency and quality of the light output. These types of lamps, although they have many advantages over incandescent lamps, have more demanding starting requirements. This design note briefly describes a few different types of possible ignitor circuits and is not meant to be a complete description of all the possible circuit configurations.

Fluorescent Lamp Ignitor Circuit

The ignitor circuit shown in Figure 1 is typically used to start conventional Fluorescent lamps powered by an electronic ballast. Capacitor C

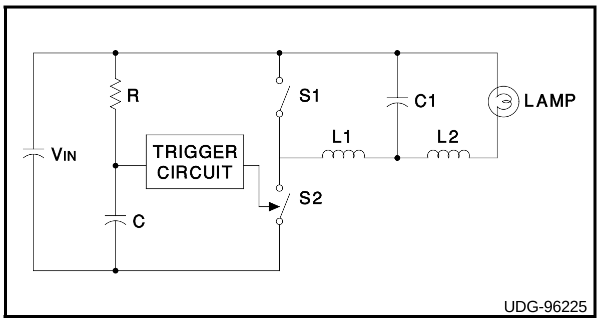

Figure 1.

charges upon application of the input voltage causing the trigger circuit to close switch S2 (where S1 and S2 are typically the power switches in a half bridge converter). This allows the series resonant circuit consisting of L1 and C1 to provide the high voltage (typically 500V) to ignite the lamp. Once the lamp has been lit, the trigger circuit is disabled. The trigger element is usually some type of semiconductor switch such as a DIAC.

Parallel Ignitor Circuit

The circuit in Figure 2 is a simple parallel ignitor circuit for a gas discharge lamp. The trigger cir-

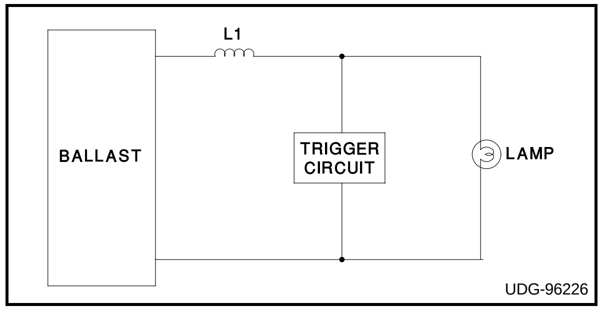

Figure 2.

cuit, which is usually part of the lamp, will repetitively trigger in order to generate the necessary voltage pulses to ignite the lamp. The pulses are due to the storage of energy in the inductor when the switch S1 turns on. The obvious advantage of this circuit is its simplicity since it consists of only two elements, an inductor and switch. Although a simple bimetal switch could be used, the disadvantage of the circuit is that the switch would need to be located in or near the lamp.

Series Ignitor Circuit for HID Lamp

The circuit in Figure 3 is typically used to ignite gas discharge lamps. The trigger circuit drives

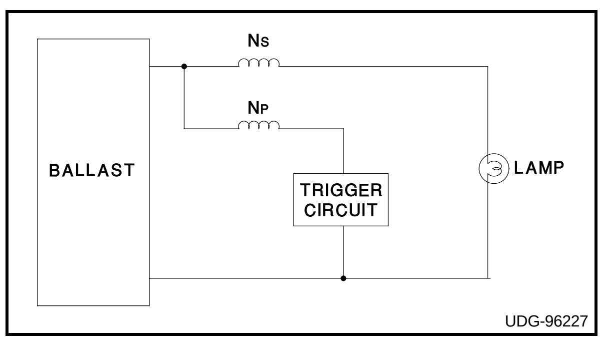

Figure 3.

the primary of a pulse transformer inducing a high voltage on the lamp electrodes. The main advantage of this series ignitor circuit is that the ballast is not exposed to the high voltage transients generated from the ignitor. The main disadvantage, which is true for most ignitor circuits, is that it should be located as close as possible to the lamp in order to minimize the parasitic effects of wiring. This effect could have significant impact on the rise time of the voltage pulse delivered to the lamp, increasing the chances of a no light condition. Methods for reducing the interwinding capacitance of the transformer must be used in order to reduce this parasitic element. The necessary voltages required to ignite HID lamps vary from lamp to lamp and manufacturer to manufacturer, but are usually between 5kV and 25kV for short arc lamp and 20kV to 50kV for long arc lamps.

The circuit in Figure 4 shows a HID ballast output stage driving a full bridge power stage for an AC lamp. Upon application of power to the output

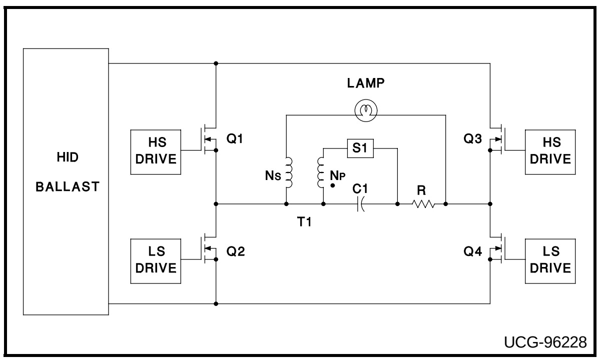

Figure 4.

stage of the ballast, before the lamp is lit, Q1 and Q4 are turned on and held on until such time that lamp ignition has occurred. It is sometimes necessary to hold Q1 and Q4 on even after ignition occurs until the arc discharge is fully established. During this time, C1 is allowed to charge up to predetermined level set by the threshold voltage of the switch S1. S1 must be capable of switching significant current in a short period of time (typically hundreds of amps in a fraction of a microsecond). This high current capability is necessary to get the arc discharge to form properly on the tips of the electrodes of the lamp. Once the arc discharge has occurred, the ignitor circuit is rendered inactive because the lamp impedance will drop drastically and the capacitor voltage will never reach the threshold level of the switch.

Assume, for instance, that the threshold voltage of S1 is 400V. C1 will be allowed to charge up to 400V before an ignition pulse occurs. This assumes that the open circuit output voltage of the ballast is limited to 600V before ignition of the lamp. The energy stored in the capacitor is $(1/2)CV^2$. Assuming a lossless switch for S1, all energy stored in C1 is then dumped into the transformer primary winding inductance. The primary inductance required to support this energy can be determined using the above assumption from:

$$(1/2) \bullet C1V^2 = (1/2) \bullet L_P I^2$$

The turns ratio from primary to secondary of T1 can be found based on the ignition voltage of the lamp. If the pulse transformer were ideal then all of the energy stored in the capacitor would be transferred to the lamp electrodes. We know, however, that this is not the case. Depending on the winding method used for the transformer, there can be significant energy lost to the interwinding capacitance. Because of this, it is necessary to take precautions to minimize this element. Usually a turns ratio 25% to 50% higher then that calculated is required to generate the necessary voltage on the secondary since it will not be possible to eliminate this capacitance entirely.

Care must be taken in choosing the secondary ignitor inductance since it is in series with the lamp and is being excited with an AC voltage. Too large an inductance will reduce the excitation voltage to the lamp. Luckily the excitation frequency of this voltage is typically between 200Hz and 1000Hz so the AC impedance can be kept to a minimum with a fairly large inductance value. The secondary inductance also provides some beneficial filtering of the current seen by the lamp. This filtering helps reduce the chance of acoustic resonances being excited in the arc tube by the switching frequency current ripple of the ballast. These resonances can cause problems with the lamp optics as well as lead to destruction of the lamp if left unchecked. Because of this, AC HID lamps are typically driven with a low frequency square wave current.

References

[1] Waymouth "Electrical Discharge Lamps" MIT Press

[2] Murdoch "Illumination Engineering from Edison's Lamp to the Laser" Visions Communication

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