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ANALOG MODULES, INC.

Specialists in Analog and Laser Electronics

MODEL 8800V LASER CONTROLLER
APPLICATION NOTES

<u>Electronic Pulse Forming Networks</u>

Unlike conventional PFN's, the electronic PFN provides control over pulse width and amplitude without component changes. Such flexibility permits the user to adapt the PFN to a variety of applications from the electronic interface.

Referring to Figure 1, a relatively large capacitor bank is held at a constant voltage by the high voltage power supply (HVPS). A high side switch element, such as an isolated-gate, bipolar transistor (IGBT) is used between the capacitor bank and the lamp. When the switch closes, a current flows in the lamp equal to:

$$I_{LAMP} = (V_{CAP} / K_O)^2$$

where K_O = lamp impedance

This current continues to flow and produce light as long as the voltage is applied through the switch. From this it can be seen that energy per pulse is easily set with voltage and pulsewidth for a fixed k_O:

$$E_{PULSE} = \left(\frac{V^3_{CAP}}{K^2_O} \right) T_{PW}$$

This technique does not use an ideal current source and therefore has certain practical limitations.

1. Since the power supply only delivers the average power, the resulting peak power must come from the capacitor bank. Voltage on the capacitor will begin to droop at a rate proportional to the lamp current. A first order approximation of this droop is:

$$V_{DROOP} = \frac{I_{LAMP} \bullet T_{PW}}{C_{TOTAL}}$$

To minimize the effects on pulse shape, the total droop should be held to less than 10%.

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2. Due to the lamp dynamics, the actual current pulse rise time can be tens of microseconds. A typical rise time of 50 to 100μsec can be expected for a lamp k_O of 25 and a capacitor voltage of 800 volts. If the application is for short pulses, the current pulse waveshape will not be rectangular.

3. If there is a large inductance between the switch and lamp, energy is stored during the pulse and current must continue to flow after the switch is shut off. The catch diode shown at the switch output to ground provides the path for the fall time of the current pulse. This inductance may come from long lamp cables or series lamp trigger transformers. Inductive values greater than 20μhenries will affect the falling edge and tend to slow the fall time of the current pulse. This reduced fall time like that of the rise time previously discussed, is usually not even noticed unless pulse widths are small. In addition, the pulse shape is normally not critical as long as it is constant.

4. From the previous equation relating lamp current to lamp impedance, a very low k_O or short circuit could cause extremely high currents. Although the switch is protected by a current limit circuit, the resulting negative transient at turn off due to stored energy in any series inductance may exceed the device rating. For this reason, it is best to minimize the inductance between switch and lamp. It should be noted that inductance is not required for pulse shaping as in a conventional PFN.

One last consideration is that of the simmer voltage. Lamps typically simmer between 100 to 200V and are sometimes used in series. When calculating the required capacitor voltage based upon energy and k_O, the PFN voltage must be above simmer voltage. Otherwise the switch will not turn on during the commanded pulse.

Analog Modules, Inc. has developed a simple spreadsheet to assist the systems designer when selecting a power supply and electronic PFN. If you would like assistance with your design, please contact one of our power supply applications engineers at (407) 339-4355.

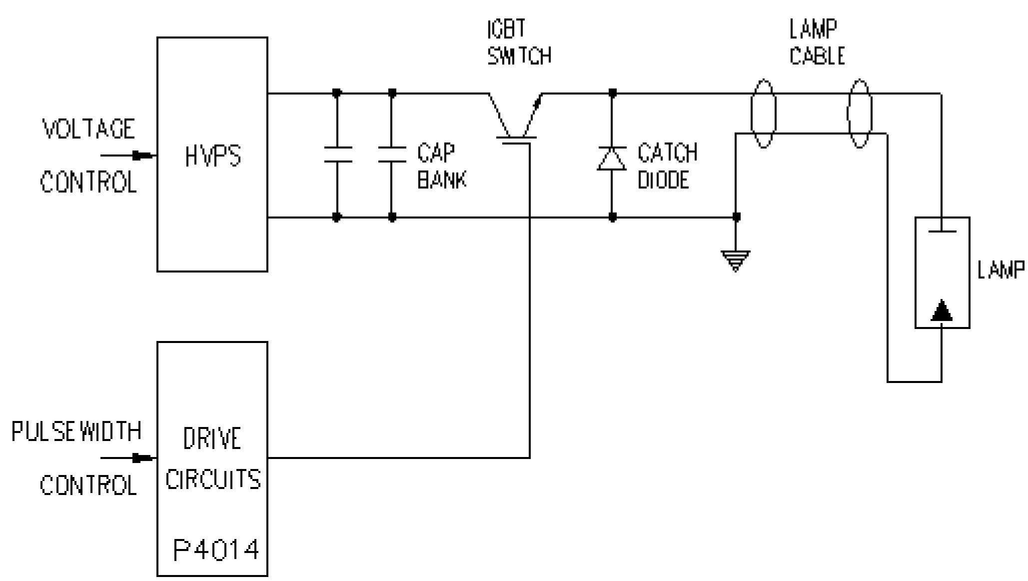
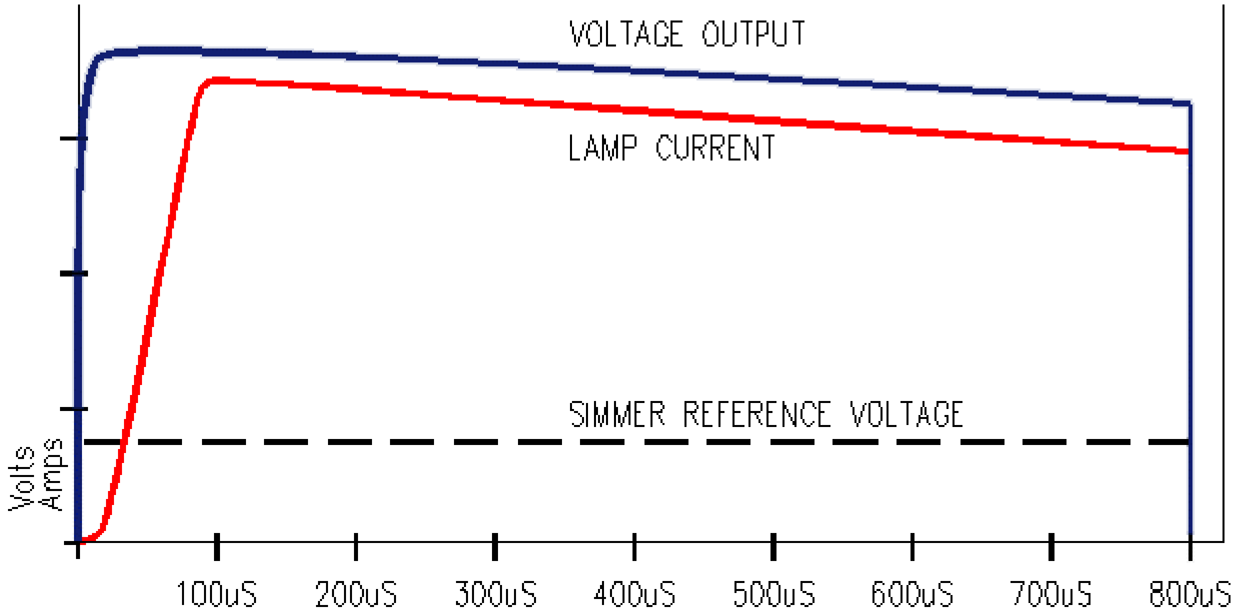


Figure 1. Circuit Diagram



Typical IBGT I/V Waveforms