Circuit forms simple, low-cost, 1-kV driver

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High-voltage drivers have recently received much attention, because they play an important role in driving piezoelectric and electro-optical components, for example. Figure 1 shows a simple, low-cost, 1-kV driver. The circuit uses offline, current-mode-control techniques and a flyback switching-powe--supply design. IC_1, a UC3844, is the major control component, using a switching frequency of 100 kHz. The IC provides frequency modulation to reduce the switching frequency under light- and no-load conditions. The feedback voltage, which you derive from the output of the error amplifier, serves as the indicator for load conditions. Once the feedback voltage becomes lower than the green-mode threshold voltage, the switching frequency starts to decrease.

All the power losses are in direct proportion to switching frequency. These losses include the switching losses of the transistor, core losses in the transformer and inductors, and the power loss of the snubber. The frequency modulation in the PWM-controller IC reduces the power consumption in the supply under light- and no-load conditions. But the frequency modulation has no effect on the PWM operation under normal- and high-load conditions.

Pin 2 (the feedback pin) of the UC3844 sums the current-sense signal, the output-voltage feedback signal, and any added slope compensation. The feedback-control circuit uses a TL431 adjustable shunt regulator to detect the output signal. A PC817 passes the signal to the feedback pin of the UC3844. The TL431 acts as an open-loop error amplifier with a 2.5V temperature-compensated reference. When the output voltage is lower than the desired level, the feedback to the UC3844 automatically compensates the pulse-width modulation of the output triggering signal. Ceramic bypass capacitors (0.1 µF) from V_{CC} and V_{REF} to ground provide low-impedance paths for high-frequency transients. This design uses a Tomita (www.tomita-electric.com) EI25-2E6 core set to fabricate the transformer. To prevent core saturation, the gap is approximately 1 mm. The primary winding has 70 turns of 28-gauge wire. Both the secondary windings have 105 turns of 34-gauge wire. The primary and secondary auxiliary windings have five and six turns, respectively, of 34-gauge wire. The dc output voltage of the circuit in Figure 1 is 1 kV (fixed). You can adjust the output voltage in a 50V range by adjusting VR_1. Both load and line regulation are less than 1%, and power efficiency is 80% at full load.

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