Introduction

Most of today’s portable equipment uses a liquid crystal display to convey information to its user. Until recently, those displays have been monochrome and have used a low voltage light emitting diode (LED) such as red or green for backlighting. With the advent of color liquid crystal displays, a white backlight source is needed. Recently, a revolution in LED technology has lead to the long-coveted white LED. However, white LEDs, which are actually blue LEDs with a special phosphor in the lens, operate at a considerably higher voltage than red or green LEDs. White LEDs can require anywhere from 3.5V to 3.9V to operate at 15mA. In battery powered systems, it’s impractical to drive the LEDs directly from the battery and still control the LED current. To properly control the LED current a somewhat larger voltage is needed, where the excess is used for control.

Figure 1 shows the LTC3200-5 constant frequency voltage doubler used to drive five white LEDs. Figure 2 is the schematic diagram of this circuit. The LTC3200-5 produces a regulated 5V output from an input as low as 3V. Switching at 2MHz, the constant frequency operation of the charge pump is ideal for low noise environments such as cellular telephones or internet communication devices.

Figure 1. LTC3200 evaluation circuit

Since it produces a regulated 5V output, the additional voltage dropped across the resistors controls the LED current. The resistors also provide ballasting to ensure that the LEDs run at similar currents despite moderate differences in forward voltage.

Figure 3 shows how the adjustable LTC3200 can be used to control the LED current directly by controlling the voltage on the ballast resistors. The LTC3200 regulates the anodes of the LEDs until the FB pin comes to balance at 1.268V. The feedback LED’s current is precisely controlled and the remaining LEDs are moderately well controlled by virtue of their similarity and the 1.268V ballast voltage. Since the current is more precisely controlled, up to six LEDs can be powered by the adjustable LTC3200.
Because of the voltage slew control, clamps or snubbers on the MOSFET drains are not required and switch ringing is greatly reduced. Figure 3 shows the noise at the outputs. The output noise is a very low 200 mV P-P.

The SHDN pin provides the supply with undervoltage lockout, ensuring that the input is up and running before the converter is allowed to start. In addition, the GCL pin prevents excessive gate voltage on the MOSFET and protects against the MOSFETs turning on without sufficient gate voltage. The CS pin provides the feedback for pulse-by-pulse current control and slew control. A large signal on CS, indicative of a fault, also shuts the MOSFETs off.

Converter efficiency is improved by use of a bootstrap winding that powers the part when the converter is up and running. Efficiency at the low noise setting is approximately 77%.

**Conclusion**

The LT1683 provides a unique way to produce an efficient, ultralow noise supply. Novel control circuitry quiets the switcher, allowing a new supply solution for sensitive electronic systems. The use of external MOSFET switches allows the voltage and current ratings of the supply to be tailored to the application.

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In either constant voltage or current controlled applications of the LTC3200, the LED brightness can be controlled by applying a PWM signal (approximately 100Hz) to the SHDN pin. Varying the pulse width from 4% to 100% gives the LEDs a linear appearance of brightness control from full-on to full-off.

**Conclusion**

In the tiny 6-pin SOT or 8-pin MSOP packages, the LTC3200 family of charge pumps provides a simple solution for powering white LEDs. Its small size, low external parts count and low noise, constant frequency operation is ideally suited for both communications and other portable products.