Charge Pump Powers White LEDs

by Steven Martin

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.

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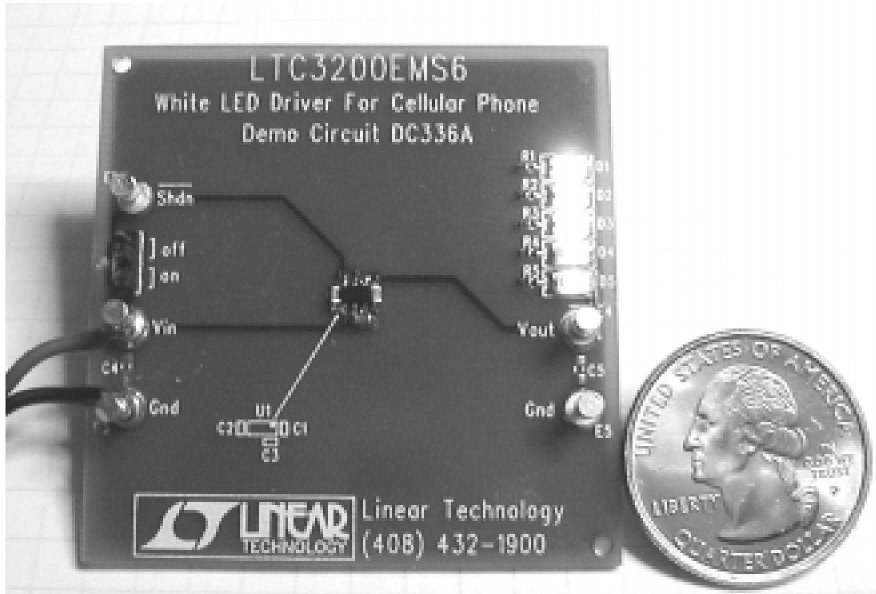

Figure 1. LTC3200 evaluation circuit

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.

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.

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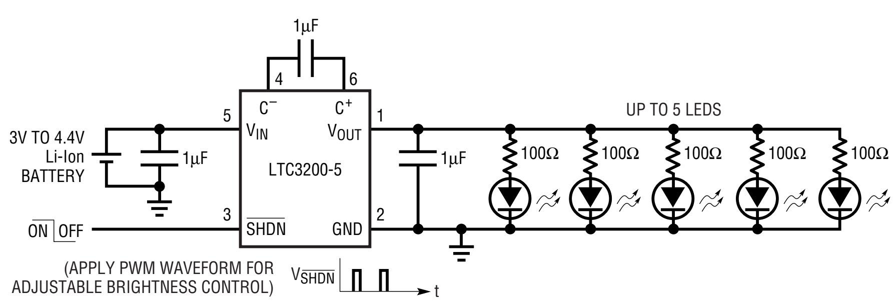

Figure 2. Li-Ion battery-powered 5V white or blue LED driver

LTC3200, continued from page 29

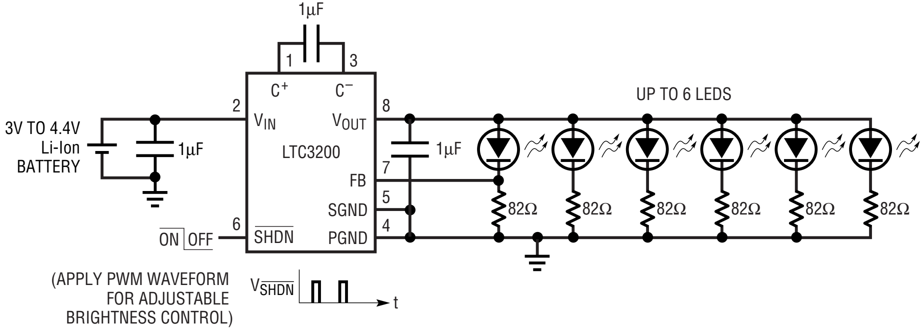

Figure 3. White or blue LED driver with LED current control

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 $\overline{\text{SHDN}}$ 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.