Boost Converter Drives 1A White LEDs

by Keith Szolusha

White LEDs are brighter and more powerful than ever. High-power white LEDs, because of their extreme luminous density and ultra-compact size, are replacing conventional bulbs in flashlights, headlamps, streetlights, and many automotive applications—anywhere a conventional bulb might be found. Some new white LEDs, such as Lumileds' Luxeon™ series, improve on conventional bulbs in several characteristics, including greater luminescence, improved response time, and increased durability with decreased size and cost.

The challenge in using white LEDs in portable applications is powering them with the wide input voltage range that batteries present, such as 3.3V to 4.2V from a lithium-ion. LEDs require constant current to maintain constant luminosity. The battery-LED DC/DC converter must both step up and step down the source voltage to a 3.0V to 3.6V LED forward voltage range at a constant LED current such as 1A.

The LT3436EFE 800kHz boost converter in Figure 1 provides 1A driving current for the Luxeon III series white LED LXHL-PW09 from a lithium-ion battery. The Luxeon III white LED has a forward voltage range from 3.0V to 3.6V. By tying the LED from the output of the boost converter back to the input, as opposed to ground, the boost converter is capable of both stepping-up and stepping-down its input voltage to the LED. The effective output voltage of the converter is a boosted voltage of V_{IN} plus V_{LED} as shown in the schematic.

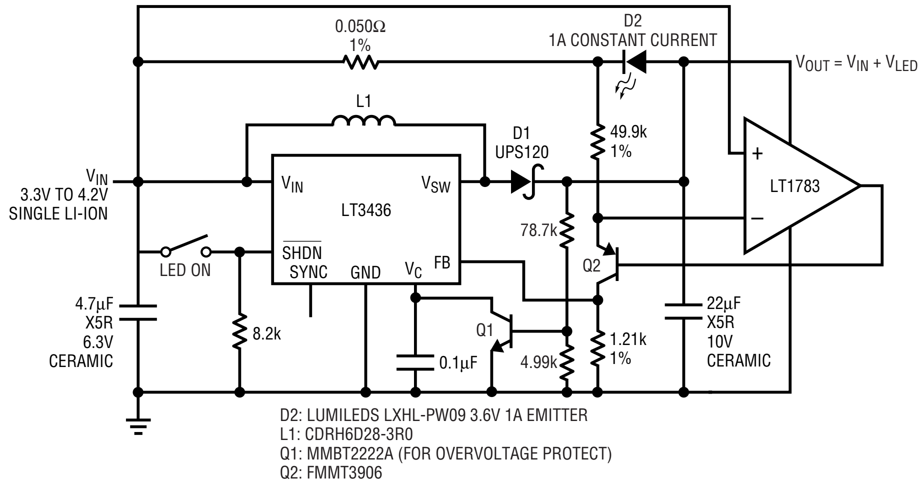

Figure 1. LT3436EFE boost converter drives Luxeon III 1A 3.6V white LED with 70% efficiency.

The LT1783 1.25MHz SOT-23 rail-to-rail op amp provides the current-sense capability and regulates the diode current to 1A when the LED ON switch is closed. When the switch is open, the LT3436 consumes only 6µA in shutdown.

Luxeon is a trademark of Lumileds Lighting.

LTC3416, continued from page 31

1.8V/4A Converter Tracks a 2.5V I/O Supply

Figure 1 shows a 1.8V step-down DC/DC converter tracking an I/O supply voltage of 2.5V. This circuit operates from an input voltage of 3.3V and provides a regulated 1.8V output at up to 4A of load current. Efficiency is as high as 90% and is shown in Figure 2.

The switching frequency for this circuit is set at 2MHz by a single external resistor, R_{OSC}. Operating at a frequency this high allows the use of a lower valued and physically smaller inductor. During start-up, the output of the LTC3416 coincidentally tracks the I/O supply voltage. Once the I/O supply voltage exceeds 1.8V, tracking is disabled and the LTC3416 regulates its output voltage to 1.8V. Figure 3 shows the relationship between the output voltage waveform of the LTC3416 and the I/O supply voltage during start-up.

Ceramic capacitors offer low cost and low ESR, but many switching regulators have difficulty operating with them because the extremely low ESR can lead to loop instability. The phase margin of the control loop can drop to inadequate levels without the aid of the zero that is normally generated from the higher ESR of tantalum capacitors. The LTC3416, however, includes OPTI-LOOP compensation, which allows it to operate properly with ceramic input and output capacitors. The LTC3416 allows loop stability to be achieved over a wide range of loads and output capacitors with proper selection of the compensation components on the I_{TH} pin.

Conclusion

The LTC3416 with its tracking ability is well suited to applications involving microcontroller-based circuits with dual supply architectures. It's high switching frequency and internal low $R_{DS(ON)}$ power switches allow the LTC3416 to provide a small solution size with high efficiency for systems with power supply sequencing requirements.