LINEAR TECHNOLOGY

DESIGN NOTES

Tiny, Efficient High Power LED Camera Flash Solutions for Cell Phone Applications – Design Note 1009

Keith Szolusha

Introduction

Cell phones and PDAs are approaching the limit for small form factors, but their feature sets are growing with new functions such as built-in cameras and even video cameras. The initial in-phone cameras were basic, low resolution devices with little in the way of usable flash capability. However, cell phone camera resolutions have improved and sophisticated flash technology is expected to keep pace.

There are two flash technologies used in digital still cameras. The first uses a Xenon flash lamp to provide a very short, high lumen flash with excellent spectral characteristics. LTC offers Xenon photoflash solutions that are simple, compact and efficient (see Design Note 345).

The second flash technology uses LEDs. LED solutions hold the upper hand when simplicity and space is at a premium and they are the only choice when 'torch' or video-mode lighting is required. LED flash units fit into spaces where even the smallest Xenon photoflash cannot. Until recently, LEDs could not compete with Xenon solutions in light output and spectral performance, relegating them to the realm of low resolution (sub 1 megapixel) cameras. However, recent (>10×) performance improvements have made LEDs an attractive solution for the now popular 1 megapixel and higher cell phone cameras.

Linear Technology offers many simple and extremely compact solutions for driving the latest high-light-output LEDs, including Lumileds Luxeon Flash LEDs. These LEDs are up to 12 times brighter than conventional LEDs (http:/www.lumileds.com/solutions/solution.cfm?id=9).

Constant Current LED Drivers

Switcher-based DC/DC converters are small and efficient, so they are prime candidates for LED driver solutions. The problem with a traditional switcher is that it is designed to produce a regulated voltage for varying load currents. LEDs must be driven with *constant current* to generate predictable light output. Using a typical switcher for constant current involves adding an op amp and additional circuitry, which are undesirable in space-constrained applications.

Four new devices solve this problem. The LTC®3216 charge pump, the LTC3453 buck-boost, and the LT®1618 and LT3479 boost regulators all incorporate the required circuitry to generate a constant current output while maintaining high efficiency operation.

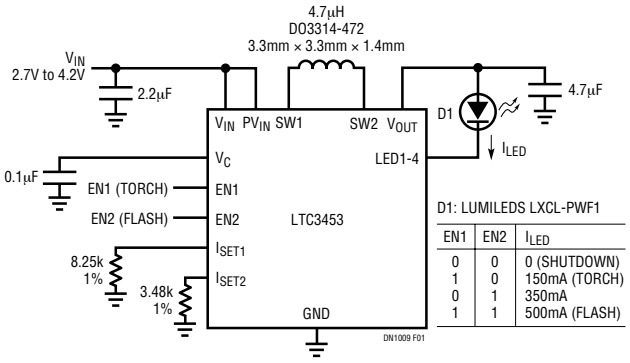


Figure 1. High Performance LED Flash Driver Yields Greater than 90% Efficiency. The LTC3453 Buck-Boost Delivers 500mA to the LXCL-PWF1 LED Flash with Only Six Tiny External Components

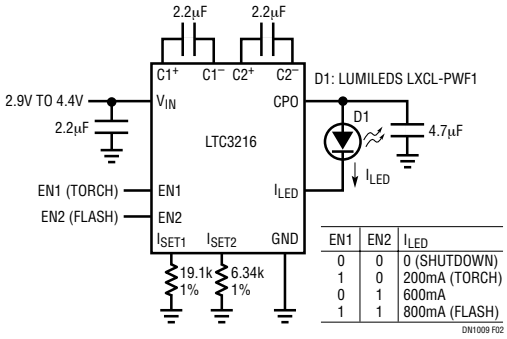


Figure 2. This LXCL-PWF1 Luxeon Flash Driver is Extremely Small. It Requires Only an LTC3216 Low Noise High Efficiency Charge Pump in a Small DFN Package, Along with Four 0603 Capacitors and Two 0402 Resistors

Buck-Boost for LXCL-PWF1

Although constant-current solutions do not directly regulate or monitor the output voltage of the LED driver circuit, the level of the output voltage relative to the input voltage is a key determinant of the type of part required. A buck or boost regulator does not have the ability, when converted to constant-current, to properly regulate the LED current if the forward voltage of the LED is not respectively below or above the input voltage. The wide input voltage range of a lithium-ion battery requires that a converter be able to both step-up and step-down the voltage when the forward voltage of the LED is within the range of the battery's discharge profile in order to achieve steady state regulation of the LED current.

The LTC3453 buck-boost LED driver (Figure 1) does this very efficiently with its four internal switches. This tiny solution only requires one, small and low profile inductor (3.3mm × 3.3mm × 1.4mm) and provides 90% LED efficiency. The even smaller LTC3216 charge-pump LED driver (Figure 2) takes a different approach to the same problem. By operating in 1×, 1.5× or 2× mode, it provides constant current to the PWF1 LED with either a step-up or step-down in voltage. The external components are only four small ceramic capacitors and two smaller resistors. The LTC3453 can provide up to 500mA LED flash current and the LTC3216 can provide 800mA LED flash current to the PWF1.

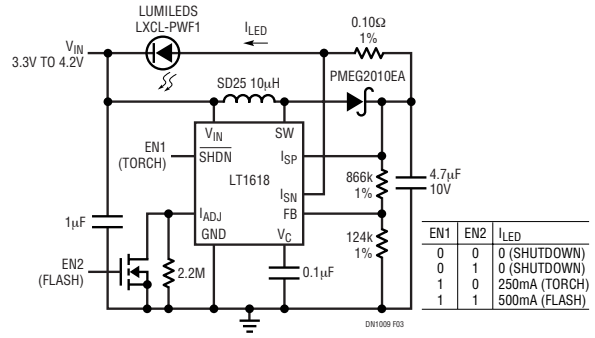
The LT1618 constant-current, constant-voltage converter (Figure 3) has a unique current sense amplifier with the ability to sample current from the input or output. By returning the LED from the output to the input, this boost converter is given buck-boost capability with up to 500mA LED flash current. The LT1618 solution provides effective performance for cost sensitive applications.

LXCL-PWF2 Boost Driver

To provide significantly more light output, the Lumileds LXCL-PWF2 Luxeon Flash LED stacks two PWF1s in series on a single die. This effectively provides twice the light of the PWF1 at the same LED current, but doubles the forward voltage.

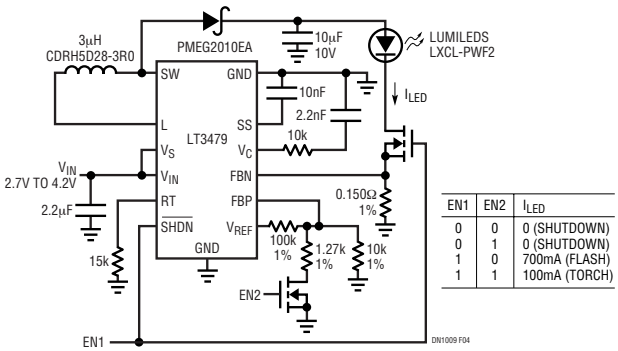
The higher forward voltage of the LXCL-PWF2 is always above the battery range, so a step-up (boost) solution is sufficient. The LT3479 can provide up to 700mA current flash to the PWF2 (Figure 4). The LT1618 can flash 350mA through the PWF2 when configured as a boost only. With the ability to externally reduce the error amplifier's reference voltage, the LT3479 drives the LED current directly through a sense resistor tied to the feedback pin without compromising efficiency.

An output disconnect MOSFET is required to turn off the LED. Boost regulators inherently provide a direct path from the input to the output even when the low side switch is shutdown. Since LEDs emit light even with very small forward current, a complete disconnect in the path to ground is required. By placing the FET in series with the LED, instead of between FB and GND, the LED current and feedback voltage are not compromised, maintaining excellent regulation.



EN1	EN2	I_{LED}
0	0	0 (SHUTDOWN)
0	1	0 (SHUTDOWN)
1	0	250mA (TORCH)
1	1	500mA (FLASH)

Figure 3. The LT1618 Constant-Current, Constant-Voltage Boost Regulator can Be Configured to Give a Low Parts Count Buck-Boost Solution for LXCL-PWF1 Luxeon Flash at 500mA



EN1	EN2	I_{LED}
0	0	0 (SHUTDOWN)
0	1	0 (SHUTDOWN)
1	0	700mA (FLASH)
1	1	100mA (TORCH)

Figure 4. The LT3479 Boost Regulator Delivers 700mA Constant-Current to the LXCL-PWF2 High Voltage Luxeon Flash with 85% Efficiency and Output Disconnect

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call (408) 432-1900, Ext. 2759

Linear Technology Corporation
1630 McCarthy Blvd., Milpitas, CA 95035-7417
(408) 432-1900 • FAX: (408) 434-0507 • www.linear.com

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