Single-Wire Camera LED Charge Pump Allows Multiple Output Current Levels With Single-Resistor Programmability

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Introduction

The number of features in cell phones continues to grow, even as the phones themselves physically shrink, driving a need for space saving circuits to control these features. The LTC3218 is such a device. It can drive a white LED with multiple current levels, requiring only three 0603 ceramic capacitors and one 0402 resistor. Its low profile, 3mm × 2mm, DFN package allows for an application circuit footprint of less than 30mm^2, making it an ideal driver for a cell phone camera flash. Additionally, due to its single-wire, high side current sensing design, only one high current trace is required to run to the anode of the LED. The cathode of the LED can be grounded locally, eliminating the need for a separate return trace. The LTC3218 can operate from a single-cell Li-Ion battery, with an input voltage range of 2.9V to 4.5V.

The LTC3218 generates the regulated output voltage needed to maintain the desired LED current. By remaining in the current regulated, 1x mode for as much of the battery voltage range as possible, efficiency is maximized. The LTC3218 steps up to 2x mode only when needed. Figure 1 shows the efficiency of the LTC3218 for various current levels.

To protect the LED from experiencing high currents for long periods of time, the LTC3218 features a built-in timer. This timer shuts down the part if it has been enabled in flash-mode (ENF = HIGH) for more than 2 seconds. The timer is reset by bringing the part into shutdown and re-enabling it.

Multiple Current Ratios

LED drivers often use external resistors to program LED current. The LED current is related to the programming resistor current through a fixed ratio. By employing multiple current ratios, the LTC3218 can be programmed for

Table 1. Output current modes for all ENT and ENF settings

ENF	ENT	I_{LED}
LOW	LOW	SHUTDOWN
LOW	HIGH	$1029/R_{SETT}$
HIGH	LOW	$2965/R_{SETF}$
HIGH	HIGH	$3993/R_{SETF}$

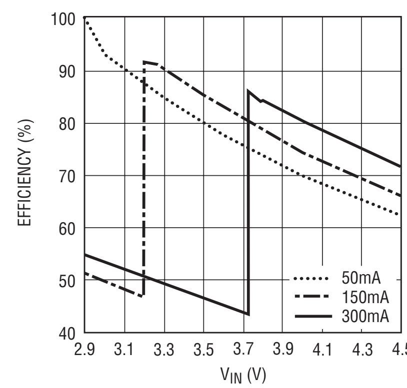

Figure 1. Efficiency vs V_{IN} for various LED currents

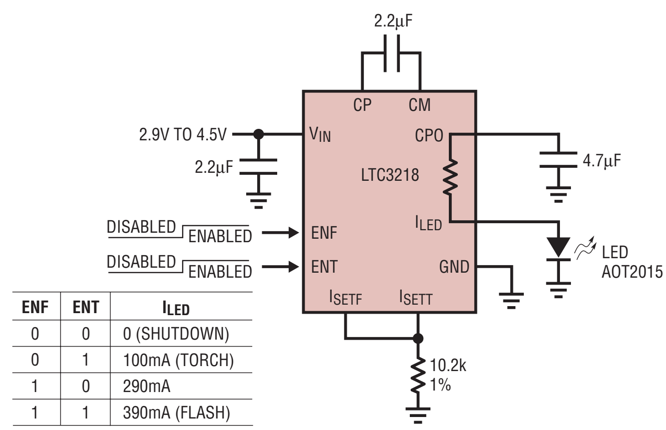

Figure 2. Typical application, using a single resistor to program LED currents

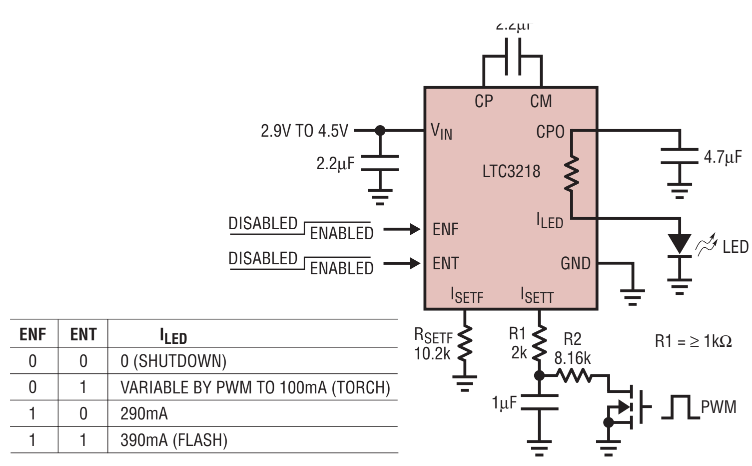

Figure 3. LED driver uses pulse-width modulation to implement dimming and brightness control

three different current levels using a single programming resistor. The current ratios are selected using the ENT and ENF pins. Table 1 shows the three different current ratios, and the ENT/ENF settings required to select them. R_{SETT} refers to the resistor connected between the I_{SETT} pin and GND, and R_{SETF} refers to the resistor connected between the I_{SETF} pin and GND. In the case where single-resistor programming is desired, the I_{SETT} and I_{SETF} pins can be shorted together and connected to a resistor to GND. Figure 2 shows an example of this configuration, along with the resulting output current levels.

Dimming and Brightness Control

Figure 3 shows how the LTC3218 can be configured to control LED brightness with just a few external components. By pulse-width modulating the gate of M1, the reference current in resistor R1 can be varied. The maximum LED current is determined by:

$$I_{LED(MAX)} = \frac{850 \bullet 1.21V}{R_{SETT}}$$

where R_{SETT} = R1 + R2 and the on-resistance of M1 is small compared to R_{SETT}. Resistor R1 should be greater than 1kΩ to provide adequate isolation between the 1µF capacitor and the internal servo-amplifier.

Conclusion

Due to its small size and low external parts count, the LTC3218 is ideally suited for compact, camera LED applications. Features such as its single resistor programmability, multiple current ratios and 2-second flash timeout make the part simple to use, without the need for complicated control algorithms. Its low shutdown current and high efficiency make it perfect for situations where battery power is at a premium.

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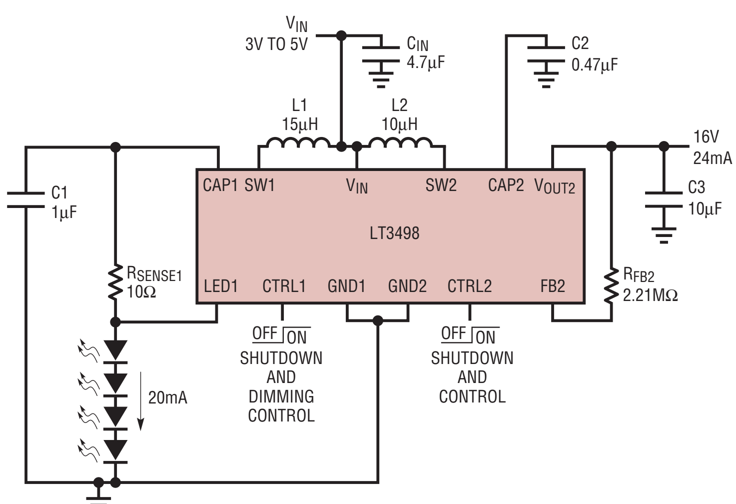
turned on when the part is enabled. When the part is in shutdown, the PMOS switch turns off, allowing the V_{OUT2} node to go to ground. This type of disconnect function is often required for OLED applications.

Li-Ion Powered Driver for Four White LEDs and OLED display

Figure 9 highlights the LT3498's simplicity and versatility. From a single 3mm × 2mm DFN, this circuit is capable of driving four LEDs in series, with 20mA of constant current as well as an OLED display. The efficiency for the LED driver in Figure 9 is shown in Figure 10. As shown above in Figure 1, the circuit can operate from a single Li-Ion battery (down to 3V) or 5V wall adapter and drive up to six LEDs in series at 20mA and an OLED display at 16V, 24mA out.

Conclusion

The LT3498 is a dual output boost converter that is capable of driving up to 6 white LEDs and an OLED display from a single-cell Li-Ion input. The device features 32V internal power switches, 32V internal Schottky diodes, independent DC or PWM dimming control, open LED protection, OLED output disconnect and internal compensation. The LT3498 offers a highly integrated, space-saving solution for a wide range of applications including space-constrained and noise-sensitive portable applications such as cellular phones, MP3 players and digital cameras.



C_{IN}, C2: X5R OR X7R WITH SUFFICIENT VOLTAGE RATING
C1: TAIYO YUDEN GMK212BJ105KG
C3: TAIYO YUDEN TMK316BJ106ML
L1: MURATA LQH32CN150K53
L2: MURATA LQH32CN100K53

Figure 9. Li-Ion to four white LEDs and an OLED display

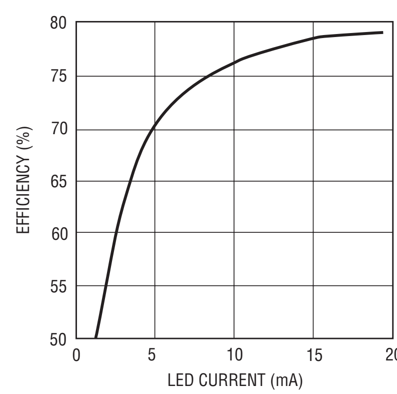


Figure 10. Efficiency of the LED driver in Figure 9