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

by Mohammed H. Jafri

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 30mm², 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.

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

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.

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

<table>
<thead>
<tr>
<th>ENF</th>
<th>ENT</th>
<th>$I_{LED}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>LOW</td>
<td>SHUTDOWN</td>
</tr>
<tr>
<td>LOW</td>
<td>HIGH</td>
<td>1029/R_SETT</td>
</tr>
<tr>
<td>HIGH</td>
<td>LOW</td>
<td>2965/R_SETTF</td>
</tr>
<tr>
<td>HIGH</td>
<td>HIGH</td>
<td>3993/R_SETF</td>
</tr>
</tbody>
</table>

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. \( R_{\text{SETT}} \) refers to the resistor connected between the I\(_\text{SETT} \) pin and GND, and \( R_{\text{SETF}} \) refers to the resistor connected between the I\(_\text{SETF} \) pin and GND. In the case where single-resistor programming is desired, the I\(_\text{SETT} \) and I\(_\text{SETF} \) 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:

\[
I_{\text{LED(max)}} = \frac{850 \cdot 1.21V}{R_{\text{SETT}}}
\]

where \( R_{\text{SETT}} = R1 + R2 \) and the on-resistance of M1 is small compared to \( R_{\text{SETT}} \). 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.