

Step-Up/Step-Down Charge Pump DC/DC Converter Provides up to 150mA in a Tiny 2mm × 2mm DFN Package

by Julian Zhu

Introduction

A wide variety of handheld and portable applications are powered by Li-Ion batteries or AA cells. The wide input voltage range of a single Li-Ion battery (2.7V–4.2V) or 2 AA cells (1.8V–3.0V) requires a DC/DC converter that can step-up or step-down the input voltage to provide a fixed output voltage such as 3.3V or 2.5V. The new LTC3240 step-up/step-down DC/DC converter is ideally suited for such applications and can provide up to 150mA in a tiny 6-lead 2mm × 2mm DFN package.

For input voltages greater than the regulated output voltage the LTC3240 operates as a low dropout regulator. When the input voltage decreases to within about 150mV of the regulated output voltage, the LTC3240 automatically switches to step-up

mode. In step-up mode, the LTC3240 operates as a constant frequency (1.2MHz) voltage doubling charge pump. The LTC3240 requires only three tiny external ceramic capacitors for an ultra small application footprint as shown in Figure 1.

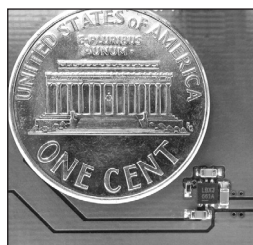


Figure 1. LTC3240-3.3 step-up/step-down converter capable of delivering current up to 150mA

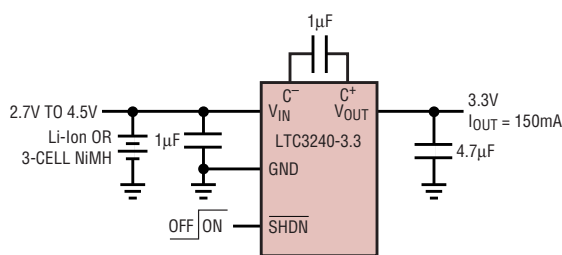


Figure 2. The regulated 3.3V from battery voltage

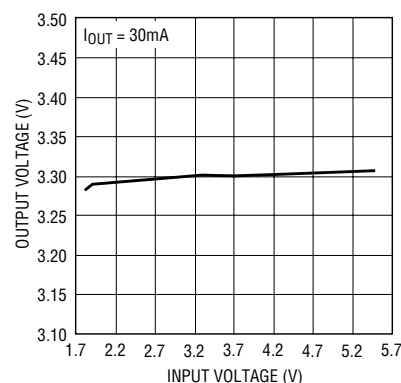


Figure 3. Output voltage vs input voltage (full range)

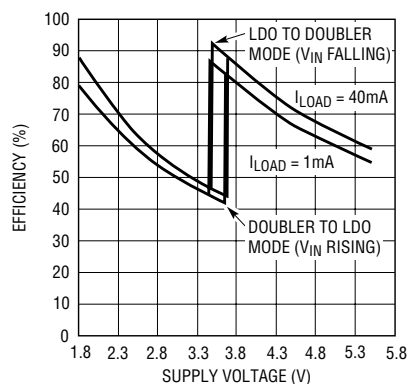


Figure 4. Efficiency vs input voltage (LTC3240-3.3)

The LTC3240 features low no load operating current (65µA typical) and ultra low shutdown current (<1µA). Built-in soft-start circuitry prevents excessive inrush current during start-up. The thermal-shutdown and current-limit circuitry allow the parts to survive a continuous output short-circuit.

Application for Li-Ion or Three AA Battery Input to 3.3V Out

A typical application circuit for LTC3240-3.3 is shown in Figure 2. The input can be a single Li-Ion battery or three AA cells. Figure 3 shows the output voltage variation for the entire input voltage range at a load current of 30mA.

A new or recharged battery starts out at its highest terminal voltage. As the battery discharges, its terminal voltage continues to drop until the next recharge. The LTC3240 optimizes the output efficiency by continuing to operate in the step-down (LDO mode) for most of the battery life. When the battery voltage gets low enough it automatically switches into charge-pump mode to squeeze out maximum energy from the battery before its next

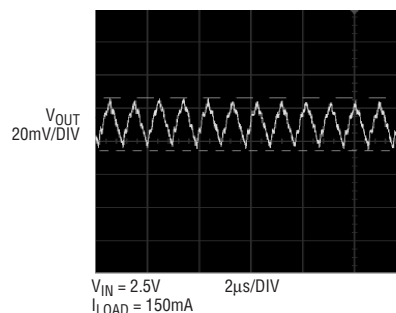


Figure 5. Output voltage ripple (LTC3240-3.3)


recharge cycle. Figure 4 shows the efficiency of LTC3240-3.3 as a function of input voltage.

In step-up (charge pump) mode, the LTC3240 uses a unique architecture to optimize the charge transferred to the output in each clock cycle, thus minimizing the output ripple. The part only needs a 4.7 μ F, 0603 size ceramic capacitor to obtain a 32mV maximum

ripple voltage (<1% for 3.3V output) at 150mA (See Figure 5).

To extend battery life at light loads, in charge pump mode, the part operates in high efficiency Burst Mode operation. In this case, the LTC3240 delivers a minimum amount of charge for a few cycles, and then enters a low current state until the output drops low enough to require another burst of charge.

Conclusion

The LTC3240 step-up/step-down charge pump DC/DC converter provides fixed regulated output voltage with currents up to 150mA from a wide input voltage range in a small 6-lead 2mm \times 2mm DFN package. It is ideally suited for efficient DC/DC conversion in space-constrained applications such as battery-powered handheld electronics. 


LT3486, continued from page 11

as 70V while both providing both overvoltage protection and remaining below the 42V maximum switch voltage. The charge pump Schottky diodes and capacitors double the effective output voltage for a given duty cycle while the LT3486 LED driver continues to regulate the 100mA constant LED current. The LEDs in Figure 7 have higher forward voltage than those in Figure 1 at 100mA,

resulting in a total string voltage as high as 40V. If more LEDs are needed, the string voltage can be stacked up to 70V before hitting the overvoltage protection level, but the peak switch current limit cannot be exceeded. As the string voltage and LED current goes up, the minimum input voltage also rises. Figure 8 shows the typical peak switch current limit dropping as duty cycle increases. In addition to

the peak inductor current, the voltage doubler also adds additional charge pump capacitor current.

Conclusion

The LT3486 is a dual 1.3A LED string driver with 1000:1 PWM dimming capability. Its 3% LED current accuracy, low sense voltage, low shutdown current, overvoltage protection and wide input voltage range make it ideal for high power LCD panels in a variety of applications including automotive displays and notebook computers. The simple 5:1 analog dimming ratio and more precise 1000:1 PWM dimming ratio provide the displays with enough brightness control for daylight and nighttime use while retaining their color characteristics across brightness levels. 

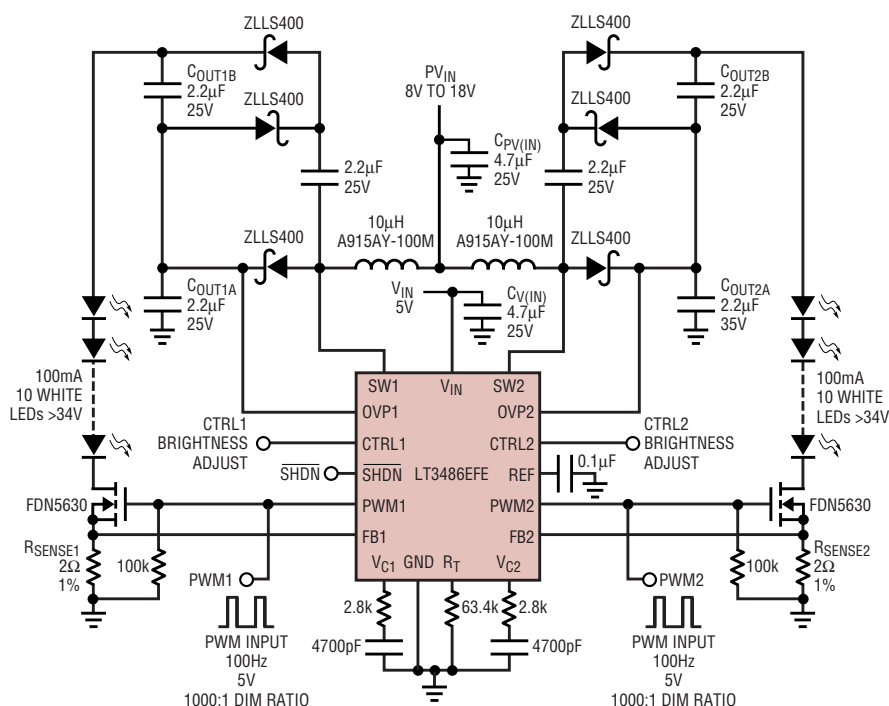


Figure 7. LED driver uses 8V–18V input to drive two strings of ten 100mA LEDs (40V max per string) with 1000:1 PWM dimming

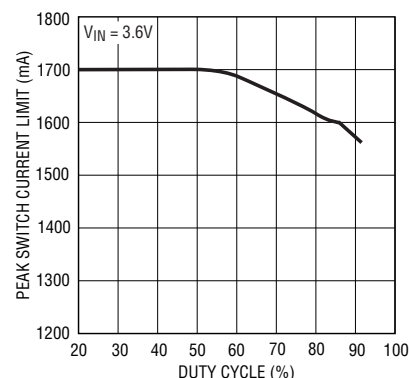


Figure 8. Typical peak switch current limit drops as duty cycle increases above 50%

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