3.3V converter delivers 3W from Li-ion battery

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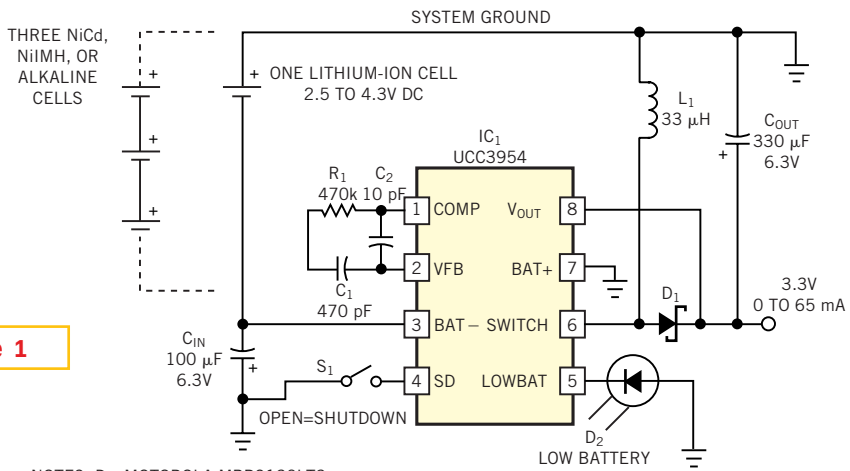
Lithium-ion batteries are rapidly gaining popularity in portable applications because of their superior energy density, low self-discharge rate, and high cell voltage. When you use one Li-ion battery to power a 3.3V dc/dc converter; however, you encounter a problem, because the battery voltage can be higher or lower than 3.3V. When fully charged, a Li-ion cell has approximately 4.2V output; when fully discharged, the voltage is approximately 2.5V. Therefore, you cannot use a simple buck or boost topology with a single inductor to generate a regulated 3.3V output. Some designs boost the voltage to approximately 4.3V and then use a low-dropout regulator to produce the 3.3V. This approach is inefficient, and efficiency is a crucial consideration in battery-powered applications. The circuit in **Figure 1** offers a solution to the problem.

The circuit works by referencing the

positive terminal of the battery to system ground and using a flyback topology with a single low-cost inductor to generate 3.3V, with respect to system ground. IC_1, a UCC3954, is a fixed-frequency, 200- kHz voltage-mode PWM converter that includes an internal 0.15V MOSFET switch. Gate drive for the FET comes from bootstrapping off the 3.3V output. The converter works efficiently over a load of 0 to 650 mA. Note that the input and output filter capacitors should be low-ESR tantalums or OSCONs. Output ripple is lower than 1% at maximum load. The inductor value is not critical; 33 mH is a good compromise between size and efficiency.

The compensation components (R_1, C_1, and C_2) ensure stability and provide good transient response over a wide load. For applications in which no sudden changes in load current occur, you can use a simpler, dominant-pole compensation method. In this case, you can omit R_1 and C_1 and increase C_2 to 0.039 µF. The UCC3954 includes a low-battery-warning output and a shutdown input. The low-battery warning is a current-limited, open-drain output that turns on when the battery voltage approaches the shutdown threshold of the IC. You can use it to turn on an LED or to drive an input to a µP to provide an alert that power will soon be lost.

To enable IC_1, you should pull the shutdown input up to output ground. When this input is left open, it pulls down to the battery (–) potential, and IC_1's quiescent current reduces to less than 1 mA. To prevent overdischarging the Li-ion battery, IC_1 automatically turns off when the input voltage drops to less than 2.5V, and the quiescent current reduces to 30 mA. Although IC_1 is designed for use with single-cell Li-ion batteries, you could also power the converter using three nickel-based rechargeables or three alkaline cells in series. As with any high-frequency converter, layout and grounding critical to proper operation. Keep all connections as short as possible, and use a ground plane. (DI #2263).



NOTES: D_1=MOTOROLA MBRS130LT3.
L_1=COILCRAFT DO3316P-333.
C_{IN}=AVX TPSE337M006R0100.
C_{OUT}=AVX TPSD107M010R0065.

Figure 1

This 3.3V dc/dc converter takes full advantage of the benefits of an Li-ion battery and works over the battery's full range of 4.2 to 2.5V.

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