94% Efficient, Low Noise, Step-Up DC/DC Converter in 2mm × 2mm DFN Package Offers Unrivaled Performance and Solution Size

by Bert Hepfinger

Introduction

As handheld electronic devices shrink, the need for compact, high efficiency power converter solutions grows. The new LTC3427 is a full featured, low noise, step-up converter that is ideal for space constrained applications. It integrates a fixed frequency, internally compensated, synchronous boost converter with output disconnect, inrush current limiting and soft start into a low profile 0.75mm × 2mm × 2mm DFN package. A switching frequency of 1.25MHz minimizes the solution footprint by allowing the use of tiny, low profile inductors and ceramic capacitors. The LTC3427's fixed frequency operation makes it ideal for noise sensitive applications where the wide frequency spectrum associated with multiple mode converters may be undesirable. It is possible to fit a complete LTC3427-based, 2-Alkaline cell to 3.3V/200mA, low noise, power converter with efficiencies as high as 94% into only 45mm^2 of board real estate.

Features

The LTC3427 operates from input voltages as low as 1.8V and provides output voltages ranging from 1.8V to 5.25V, making it suitable for generating 3.3V or 5V from either dual Alkaline/NiMH cells or a single Li-Ion battery. The fixed frequency operation allows tighter regulation at light loads and provides very low output voltage ripple, which eliminates the load variable noise harmonics found in some multi-mode converters. High efficiency is achieved by the integration of low gate charge internal switches rated at 0.525Ω for the N-channel and 0.575Ω for the P-channel (typical).

The LTC3427 also provides inrush current limiting soft-start. During start-up, the LTC3427 slowly ramps the peak inductor current from zero to a maximum value greater than 500mA over a period of 2.5ms. Current mode control with slope compensation insures excellent response to input line and output load transients. Internal compensation for the feedback loop further eliminates external components, helping to lower cost and simplify the design process. Anti-ringing circuitry reduces EMI when the part is operating in discontinuous mode. In shutdown, the part draws less than 1µA of quiescent current and disconnects the output from the supply, allowing the output to discharge to 0V.

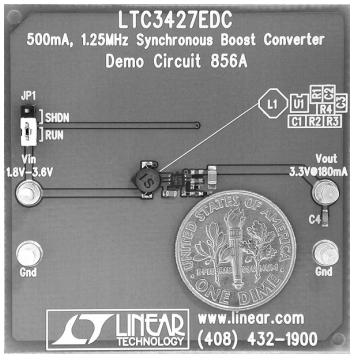

Figure 1. It is possible to fit an entire LTC3427-based boost converter into 45mm^2.

Two Alkaline Cell to 3.3V, 650mW Converter

The LTC3427 requires only a few external components to create a wide selection of low voltage, low power converter solutions. Figure 2 illustrates a 2-Alkaline cell to 3.3V converter with a maximum output current of 200mA. With careful board layout and the use of tiny input and output capacitors, it is possible to squeeze the entire converter into 45mm^2 of board space. X5R ceramic capacitors are recommended for V_{IN} and V_{OUT} bypassing.

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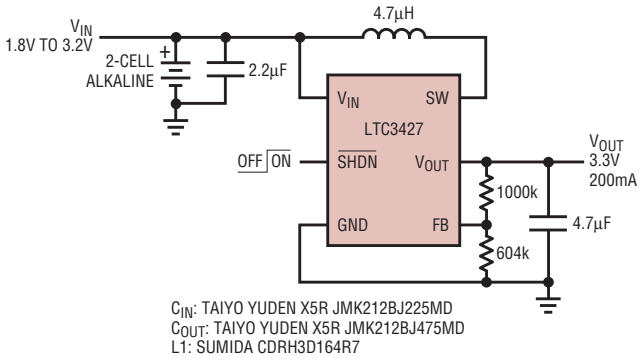

Figure 2. 2-Alkaline cell to 3.3V synchronous boost converter

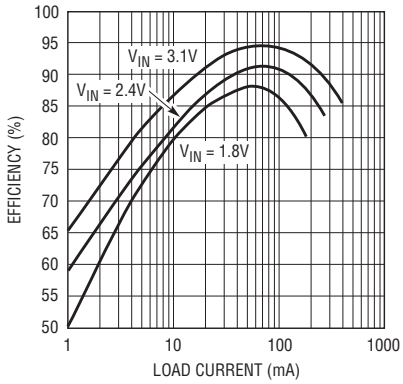

Figure 3. Efficiency vs load current for the converter in Figure 2

supplies while drawing as little as 1µA of quiescent current.

The ultralow supply current and low operating voltage are combined with excellent amplifier specifications—input offset voltage of 500µV maximum with a typical drift of only 1µV/°C, input bias current of 90pA maximum, open loop gain of 100,000 and the ability to drive 500pF capacitive loads—making the LT6003/LT6004/LT6005 amplifiers ideal when excellent performance is required in battery powered applications.

The single LT6003 is available in the 5-pin TSOT-23 and tiny 2mm × 2mm DFN packages. The dual LT6004 is available in the 8-pin MSOP and 3mm × 3mm DFN packages. The quad LT6005 is available in the 16-pin TSSOP and 5mm × 3mm DFN packages. These devices are specified over the commercial, industrial and automotive temperature ranges.

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Even though the total solution cost is low and the area required is small, efficiency is not sacrificed. Figure 3 shows that peak efficiencies for this converter of up to 94% are attainable from fully charged batteries. High efficiency is maintained over a wide output load range from 200mA down to a few mA due to the miserly quiescent current required to operate this converter. Figure 4 illustrates the effect of fixed frequency switching on the V_{OUT} ripple over a wide range of loads, which minimizes the spectrum of EMI for noise sensitive applications. These waveforms are for a 4.7µF output capacitor. The ripple can be reduced by increasing this value.

There is always a trade off between solution size and efficiency. For applications where board space concerns are more critical, substantial space savings can be achieved by the use of surface mount chip inductors. In a typical application with a load current of 50mA to 100mA, a sacrifice of 3%–4% in efficiency can yield a board space savings of 25%–30% by using tiny chip coils such as the Murata LQH2MC series.

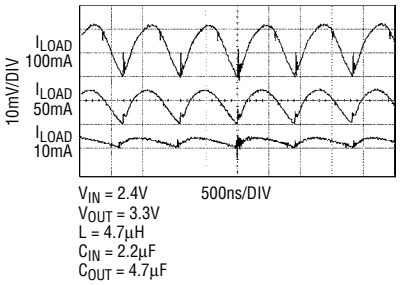

Figure 4. Low V_{OUT} ripple over a wide range of loads for the circuit of Figure 2

Lithium-Ion to 5V, 1W Converter

For 5V applications where board space is at a premium, Figure 5 illustrates a single lithium-ion battery to 5V converter with a maximum output current of 200mA. As in the previous example, with careful board layout and component selection, this converter solution should only occupy 45mm^2 of board space. Further significant board space savings are possible with the use of tiny chip inductors. As illustrated in Figure 6, peak efficiencies of up to 93% are attainable from a fully charged battery. Adding an optional low current Schottky diode across the synchronous rectifier (SW node to V_{OUT}) can increase efficiency by as much as 2%, though this negates the output disconnect feature.

Conclusion

The LTC3427 in the compact 2mm × 2mm DFN package is the industry's smallest, high efficiency, low noise, synchronous boost converter with true output disconnect and soft start. With few external components required, it is not necessary to sacrifice performance to achieve the smallest possible power converter solution. The LTC3427 is the ideal choice for low voltage, low power converter applications, especially those challenged with severe space constraints or noise sensitivity.

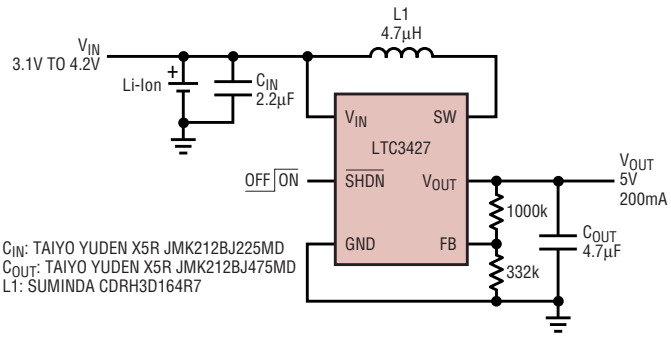

Figure 5. Single Li-ion cell to 5.0V synchronous boost converter

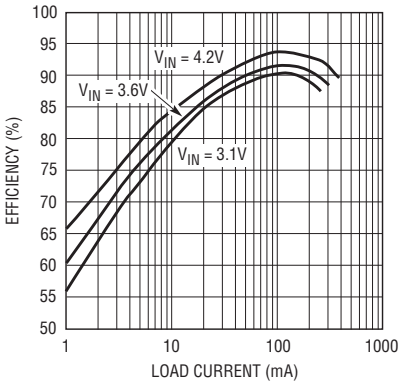

Figure 6. Efficiency vs load current for a single lithium ion cell to 5.0V converter