1.2MHz, 2A, Monolithic Boost Regulator Delivers High Power in Small Spaces

by Kevin Ohlson

Introduction

Even as cell phones, computers and PDAs shrink, they require an increasing number of power supply voltages. The challenge, of course, is how to squeeze more voltage converter circuits into less space—without sacrificing power or efficiency. Boost converters, in particular, are becoming more prevalent, as main supply voltages are lowered to accommodate core logic circuits, while many components require a higher supply voltage. The LTC3426 boost converter meets the challenge with converter-shrinking features, including a low $R_{DS(ON)}$ monolithic switch, internal compensation and a 3mm × 3mm × 1mm ThinSOT package. The LTC3426 operates at high frequency and therefore works with small, low cost inductors and tiny ceramic capacitors.

The LTC3426 incorporates a constant frequency current mode architecture, which is low noise and provides fast transient response. With a minimum peak current level of 2A, the LTC3426 delivers up to 900mA of output current. Figure 1 shows the converters output current capability at 5V as a function of V_{IN} with peak inductor current at 2A. An input supply range of 1.6V to 4.3V makes the LTC3426 ideal for local supplies ranging from 2.5V to 5V. Efficiencies above 90% are made possible by its low 0.11Ω (typ.) $R_{DS(ON)}$ internal switch.

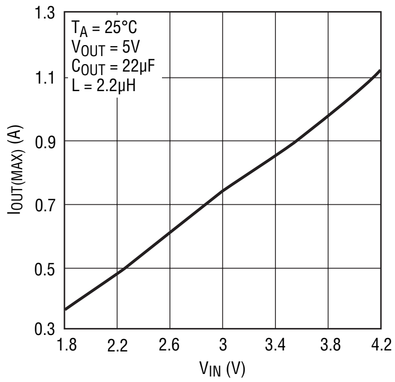

Figure 1. High current outputs are attainable with minimum 2A switch limit.

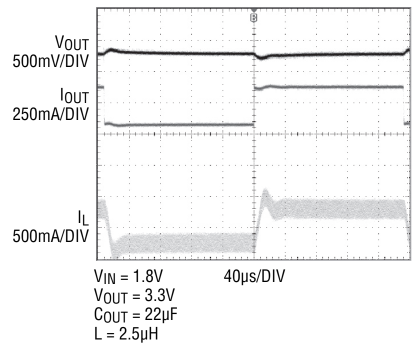

Figure 2. Fast transient response to load step of 250mA to 500mA

There is no need for an external compensation network because the LTC3426 has a built-in loop compensation network. This reduces size, lowers overall cost and greatly simplifies the design process. Figure 2 shows the V_{OUT} response to a 250mA-to-500mA load step in a 1.8V to 3.3V application.

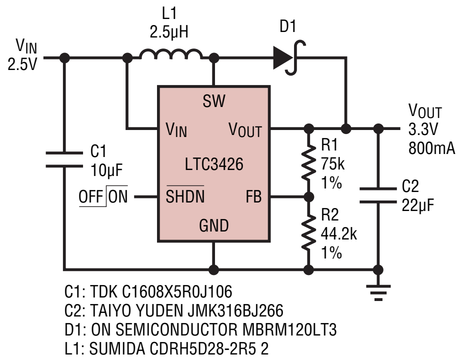

Figure 3. Application circuit for 3.3V output delivers 800mA

The Shutdown input can be driven with standard CMOS logic above either V_{IN} or V_{OUT} (up to 6V maximum). Quiescent current in shutdown is less than 1µA. A simple resistive pull-up to V_{IN} configures the LTC3426 for continuous operation when V_{IN} is present.

3.3V Output 800mA Converter

Some applications require local 3.3V supplies which are utilized periodically yet are required to deliver high currents. The LTC3426 is an ideal solution which requires minimal board space and, when in shutdown, draws less than 1µA quiescent current. Figure 3 shows a circuit which delivers up to 800mA at 3.3V from a 2.5V input. This circuit also works with V_{IN} down to 1.8V with 750mA output. The output voltage is easily programmed by changing the feedback ratio of R1 and R2 according to the formula:

$$V_{OUT} = 1.22V \bullet \left(1 + \frac{R1}{R2}\right)$$

Lithium-Ion 5V Boost Converter

Some portable applications still require a 5V supply. Figure 4 shows a circuit which operates from a single Lithium-Ion battery and delivers at

continued on page 32

DESIGN IDEAS

at around 42V to protect the internal power devices.

Layout Considerations

Proper layout is important to achieve the best performance. Paths that carry high switching current should be kept short and wide to minimize the parasitic inductance. In the boost regulator, the switching loop includes the internal power switch, the Schottky diode (internal or external), and the output capacitor. In the negative output regulator, the switching loop includes the internal power switch, the flying capacitor between the SW2 and D2 pins, and the internal Schottky diode.

Connect the output capacitors of the AV_{DD} and LED switchers directly to the PGND14 pin before returning to the ground plane. Connect the output capacitor of the V_{ON} switcher to the PGND23 pin before returning to the ground plane. Also connect the bottom feedback resistors to the AGND pin. Connect the PGND14, PGND23 and AGND pins to the top layer ground pad underneath the exposed copper ground on the backside of the IC. The exposed copper helps to reduce thermal resistance. Multiple vias into ground layers can be placed on the ground pad directly underneath the part to conduct the heat away from the part.

LTC3426, continued from page 22

least 750mA from a V_{IN} as low as 3V. When fully charged to 4.2V, over 1A can be supplied. The photograph of a demonstration board in Figure 5 shows just how small the board area is for this application, 10mm × 12mm. Tiny ceramic bypass capacitors and surface mount inductors keep the design small.

Figure 6 shows efficiency exceeding 90% and remaining greater than 85% over a load range from 10mA to 900mA with a fully charged battery.

Component Selection

The LTC3426 requires just a few external components to accomodate various V_{IN} and V_{OUT} combinations. Selecting the proper inductor is important to optimize converter performance and efficiency. An inductor with low DCR increases efficiency and reduces self-heating. Since the inductor conducts the DC output current plus half the peak-to-peak switching current, select an inductor with a minimum DC rating of 2A. To minimize V_{OUT} ripple, use low ESR X5R ceramic capacitors. The average Schottky diode forward current is equal to the DC output current therefore the diode average current should be greater than 1A. A low forward voltage Schottky diode reduces power loss in the converter circuit.

Conclusion

The addition of the LTC3426 to Linear Technology's high performance boost converter family allows the designer to deliver high current levels with minimal board space. An on chip switch and internal loop compensation reduces component count to provide an inexpensive solution for spot regulation applications.

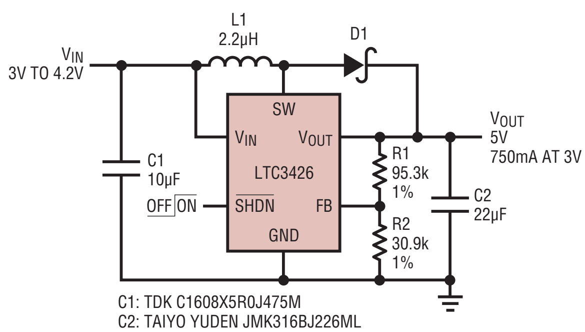

Figure 4. Compact application circuit for V_{OUT} at 5V

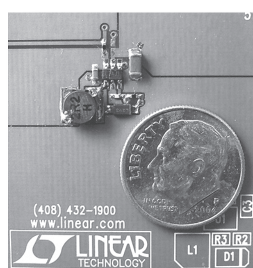

Figure 5. Photograph of demo board of circuit in Figure 4—board area is 10mm × 12mm

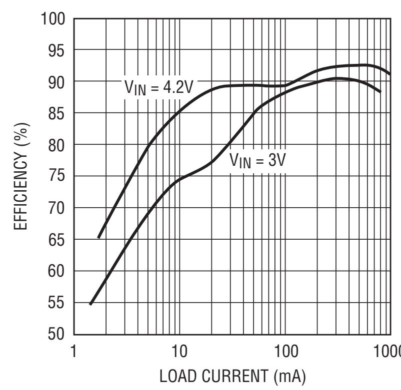

Figure 6. Up to 92% efficiency in Lithium-Ion battery to 5V output applications

LTC4302, continued from page 26

further eases the burden of heavy capacitive loads by providing strong pull-up currents during rising edges to reduce the rise time. Thanks to these two features, the LTC4302 enables the implementation of much larger 2-wire bus systems than are possible with a simple unbuffered multiplexer.

Impedance Analyzer, continued from page 30

assume that either the inductance is well damped, or it is shunted by large value capacitances.

Notes

1. This subject is treated in some detail in the LTC1647 data sheet, Figures 9, 10, and 11 inclusive.
2. An hp 5210A Frequency Meter or any common counter gives adequate accuracy for most measurements.