

# Inductorless, Low Noise Step-Down DC/DC Converter Saves Space and Provides Efficient 1.5V Output

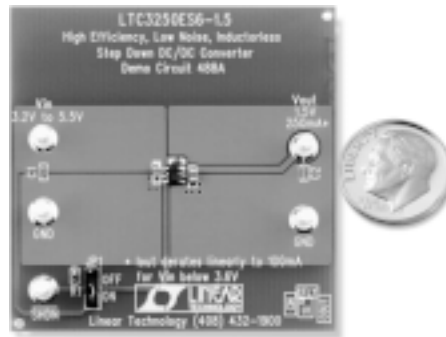
by Bill Walter

## Introduction

Linear Technology's new LTC3250-1.5 switched capacitor step-down DC/DC converter squeezes into the tightest spaces while providing up to 250mA of output current at 1.5V from a single 3.1V to 5.5V supply. To keep the converter footprint small, the LTC3250 operates at high frequency, allowing the use of tiny low cost ceramic capacitors—no inductors are required. The LTC3250 is available in a tiny 6-pin ThinSOT package making it possible to build a complete converter in an area of less than  $0.04\text{in}^2$ , as shown on the board in Figure 1.

The LTC3250 uses a 2-to-1 switched capacitor fractional conversion mode to achieve a 50% efficiency improvement over that of a linear regulator. A single input and output capacitor, and an external flying capacitor are all that is needed for operation.

The LTC3250 also features Burst Mode operation, which allows the LTC3250 to achieve high efficiency even at light loads. An output current sense circuit is used to detect when the required output current drops below about 30mA. When this occurs, LTC3250 delivers a minimum amount of charge for one cycle then goes into a low current state until the output drops enough to require an-



**Figure 1.** The LTC3250 is available in a tiny 6-pin ThinSOT package making it possible to fit a complete converter in less than  $0.04\text{in}^2$ .


other burst of charge. This bursting on and off of the charge pump persists until the load current rises above 30mA at which point constant frequency operation resumes. During Burst Mode operation the current transferred to the output is limited by internal circuitry, thus providing a nearly fixed output ripple of about  $10\text{mV}_{\text{P-P}}$ .

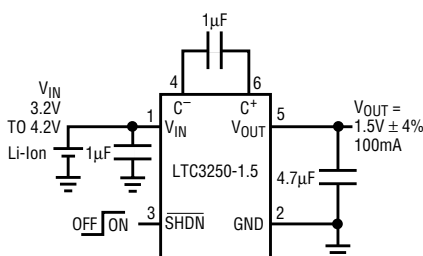
The LTC3250's constant frequency architecture not only provides a low noise regulated output, but also has lower input noise than conventional switched capacitor charge pump regulators. Regulation is achieved by sensing the output voltage and regulating the amount of charge transferred per cycle. This method of regulation provides much lower input and output ripple than that of conventional switched capacitor charge pumps. Charge transfer in the LTC3250 occurs at a constant 1.5MHz frequency making it easy to filter input and output noise. Conventional switched capacitor charge pumps, such as those that use only a Burst Mode architecture to regulate, are much more difficult to filter because they operate over a range of frequencies that can cover several orders of magnitude.

The LTC3250 has built-in short-circuit current limiting as well as over temperature protection. During a short-circuit condition the part automatically limits the output current to approximately 500mA. The LTC3250 shuts down and stops all charge transfer when the IC temperature exceeds approximately  $160^\circ\text{C}$ . Under normal operating conditions, the part should not go into thermal shutdown but the function is included to protect the IC from excessively high ambient temperatures, or from excessive power dissipation inside the IC (i.e., over-current or short circuit). The charge transfer will reactivate once the junction temperature drops back to approximately  $150^\circ\text{C}$ . The LTC3250 can cycle in and out of thermal shutdown indefinitely, without latch-up or damage, until the fault condition is removed.

The  $\overline{\text{SHDN}}$  pin is used to implement both low current shutdown and soft-start. Forcing the  $\overline{\text{SHDN}}$  pin low puts the LTC3250 into shutdown mode. Shutdown mode disables all control circuitry and forces the output into a high impedance state, leaving only a few nanoamps of supply current. The soft-start feature limits inrush currents required to charge the output capacitor, thereby minimizing input supply transients caused by the power on phase of the IC. The soft-start is implemented whenever the IC is brought out of shutdown.

## Conclusion

The LTC3250-1.5 is well suited for medium to low power step-down applications with tight board space and low noise requirements. It is an especially good match for single cell Li-Ion and multicell NiMH/NiCd battery powered applications. 



**Figure 2.** Schematic of the Li-Ion to 1.5V converter shown in Figure 1