Digitally Programmable Output Monolithic Buck Regulator with Built-In DAC and I²C Interface

by Earl Barber

Introduction

A small package and high efficiency make Linear Technology's new LTC3447 buck regulator an ideal choice for portable devices using lithium-ion batteries. The tiny 3mm × 3mm DFN package supplies up to 600mA of current over an I²C programmable output range of 0.69V to 2.05V. An internal 6-bit DAC gives the designer the flexibility needed to control the supply voltage for various modes of operation.

LTC3447 Features Include:

- ❑ Soft Start — Limits peak inductor current for a short period when the regulator is first enabled.
- ❑ Frequency Foldback — Reduces oscillator frequency when the regulated voltage is below the desired operating point. This allows time for the inductor current to discharge fully and prevent thermal runaway.
- ❑ Over Temperature Protection — Turns off internal switching FETs until the operating temperature returns to a normal level.
- ❑ Power Good Reporting — Reports when the regulated voltage is either under-voltage or over-voltage. This feature can be disabled via the I²C interface.
- ❑ Burst Mode Operation — Improves efficiency at light loads to improve battery life. When a light load is detected, the regulator enters a highly efficient mode whose quiescent current is 33µA.

Minimal Space

Figures 1 and 2 show the LTC3447 powered from a single Lithium-Ion battery. To minimize critical board real estate, only two ceramic capacitors, a single inductor, and a single resistor are required for operation. The LTC3447 regulator is internally compensated to further reduce the need for additional external components. Optional external resistors can be used when a start-up voltage other than 1.38V is desired. When using the optional start-up resistors, the regulated voltage can be set to a value outside of the normal DAC output range. Once the internal DAC is changed, the regulated output voltage remains between 0.69V and 2.05V.

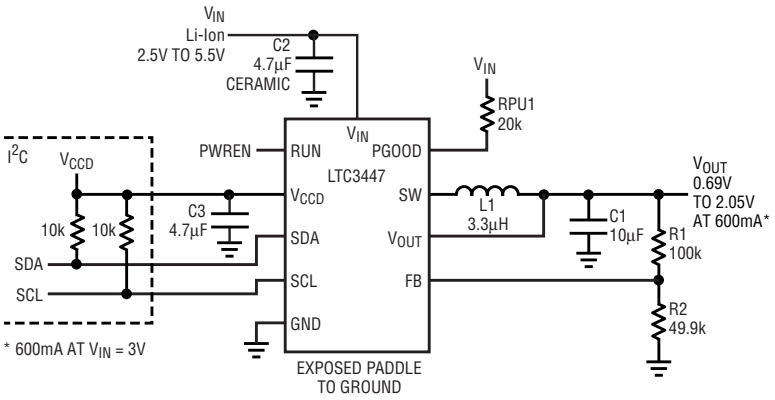

Figure 1. A typical Li-Ion-to-programmable-output application suitable for powering a microprocessor

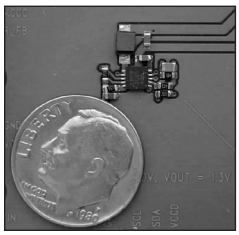

Figure 2. Very little space is needed for a programmable output solution. This circuit includes optional start-up resistors and I²C pull-up resistors.

The Efficiency Advantage

In an effort to extend battery life, many µProcessors use a variety of power modes. Reducing the supply voltage to circuits not in use and then increasing the supply voltage when in use is a common technique. The LTC3447 is designed to easily accomplish such tasks thru its I²C interface. The 6-bit DAC allows the designer to easily change the supply voltage level from 0.69V to 2.05V. Another technique is to simply reduce the current load of the µprocessor. The LTC3447 can sense light load conditions and enter power-saving Burst Mode operation for further power savings. Using the LTC3447 to combine both these techniques can greatly extend the life of the battery. Figure 3 shows the efficiency of the LTC3447. Notice the jump in efficiency for light load currents when Burst Mode operation is enabled.

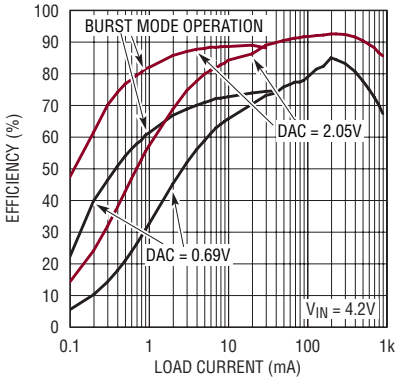

Figure 3. Efficiency of the circuit in Figure 1