900mA Li-Ion Charger in 2mm × 2mm DFN is Thermally Regulated for Faster Charge Time
by David Kim

Introduction
It can be tough to design a high-performance linear Li-Ion battery charger for cell phones, MP3 players and other portable devices. The overriding design problem is how to squeeze the charger into ever-shrinking boards, while managing the heat inherently generated by the charge process. The typical solution is to lower the maximum charge current to a sub-optimal value to avoid overheating, thus increasing charge time.

The LTC4059 is designed to shorten charge time even while squeezing the charger into the smallest spaces. The LTC4059 is a 2mm × 2mm DFN package constant-current/constant voltage Li-Ion linear charger with a built-in 900mA MOSFET, accurate charge current monitor output and thermal regulation control. Thermal regulation in this device is different, and much better, than the thermal shutdown found in most chargers. Thermal feedback control allows a designer to maximize the charge current, and thus decrease charge time without the risk of damaging the LTC4059 or any other components. Figure 1 shows a typical application.

Figure 2 shows a complete 2.5mm × 2.7mm charging circuit that includes the LTC4059 and two passive components. The internal MOSFET architecture requires no blocking diode or external sense resistor.

In addition to its minuscule size, the LTC4059 includes other important features for the latest cellular phones, wireless headsets, digital cameras, wireless PDAs and MP3 players. Supply current in shutdown mode is very low—10µA from the input supply, and under 1µA from the battery when the input supply is removed. It also has the capability of charging single cell Li-Ion batteries directly from a USB port.

Constant Current/Constant Voltage/Constant Temperature
The LTC4059 uses a unique architecture to charge a battery in a constant-current, constant-voltage or constant temperature fashion. In a typical operation, to charge a single cell Li-Ion battery, the user must apply an input voltage of at least 4.5V to the Vcc pin along with a 1% resistor connected from PROG to GND (using the formula $R_{PROG} = 1000 \times \frac{1.21V}{I_{CHG}}$) and EN pin under 0.92V. When all three conditions are met, the charge cycle begins in constant-current mode with the current delivered to the battery equal to $1210V/R_{PROG}$.

If the power dissipation of the LTC4059 and/or high ambient temperature results in the device junction temperature rising to near 115°C, the part enters constant temperature mode and the thermal feedback loop of the LTC4059 decreases the charge current to regulate the die temperature to approximately 115°C. This feature allows the user to program a charge current based on typical operating conditions and eliminates the need for the complicated thermal over-design necessary in other linear chargers. Typically, the thermal feedback loop conditions are temporary as the device junction temperature returns to normal.

Figure 4 shows a charger that combines both wall adapter and USB power inputs.
Monitor the Current of Automotive Load Switches

With its 60V input rating, the LTC6101 is ideally suited for directly monitoring currents on vehicular power systems, without need for additional supply conditioning or surge protection components.

Figure 12 shows an LT1910-based intelligent automotive high-side switch with an LTC6101 providing an analog current indication. The LT1910 high-side switch controls an N-channel MOSFET that drives a controlled load, and uses a sense resistance to provide overload detection (note the surge-current of lamp filaments may cause a protection trip, thus are not recommended loads with the LT1910). The sense resistor is shared by the LT6101 to provide the current measurement.

The LTC6101 supplies a current output, rather than a voltage output, in proportion to the sense resistor voltage drop. The load resistor for the LTC6101 may be located at the far end of an arbitrary length connection, thereby preserving accuracy even in the presence of ground-loop voltages.

Conclusion

The LTC6101 and LTC6101 are precise high side current sensing solutions. Although very similar in obvious respects, each has its unique advantages. The LT6100 draws much less power, can be powered down while maintaining high Z characteristics, and has nearly indestructible inputs. The LTC6101 can withstand up to 70V, is infinitely gain configurable, and provides an open drain output.