Very Low Cost Li-Ion Battery Charger Requires Little Area and Few Components

by David Laude

Introduction

The LTC1734 is a precision, low cost, single-cell, linear Li-Ion battery charger with constant voltage and constant current control. The small quantity and low cost of external components results in a very low overall system cost and the part's 6-pin SOT-23 package allows for a compact design solution. Previous products usually required an external current sensing resistor and blocking diode whose functions are included in the LTC1734. Other features include:

- ❏ 1% accurate float voltage options of 4.1V or 4.2V
- ❏ Programmable constant current range of 200mA to 700mA
- ❏ Charging current monitor output and manual shutdown for use with a microcontroller
- ❏ Automated shutdown with no battery drain after supply removal
- ❏ Undervoltage lockout
- ❏ Self protection for overcurrent and overtemperature

Applications include such compact devices as cellular phones, digital cameras and handheld computers. The LTC1734 can also be used as a general purpose current source or for charging nickel-cadmium or nickel-metal-hydride batteries.

A Simple, Low Cost Li-Ion Charger

A battery charger programmed for 300mA in the constant current mode with a charge current monitoring function is shown in Figure 1. The PNP transistor is needed to source the charging current and resistor R1 is used to program the maximum charging current. Note that no external current sense resistor or diode to block current is required. When the supply is opened or shorted to ground, the charger shuts down and no quiescent current flows from the battery to the charger. This feature extends battery life. Capacitor C2 can consist of up to 100µF of bypass caps, which would normally be distributed along the battery line. The supply voltage can range from 4.75V to 8V, but power dissipation of the PNP may become excessive near the higher end.

The programming pin (PROG) accomplishes several functions. It is used to set the current in the constant current mode, monitor the charging current and manually shut down the charger. In the constant current mode, the LTC1734 maintains the PROG pin at 1.5V. The PROG pin voltage drops below 1.5V as the constant voltage mode is entered and charge current drops off. The charge current is always one thousand times the current through R1 and is therefore proportional to the PROG pin voltage. At 1.5V the current is the full 300mA, whereas at 0.15V the current is 300mA/10 or 30mA. If the grounded side of R1 is pulled above 2.15V or is allowed to float, the charger enters the manual shutdown mode and charging ceases. These features enable smarter charging by allowing a microcontroller to monitor the charging current and shut down the charger at the appropriate time. The I_{SENSE} and BAT pins are used to monitor charge current and battery voltage, respectively; the DRIVE pin controls the PNP's base.

A Programmable Constant Current Source

An example of a programmable current source is shown in Figure 2. To ensure that only the constant current mode is activated, the BAT pin is tied to ground to prevent the constant voltage control loop from engaging. The control inputs either float or are connected to ground. This can be achieved by driving them from the drains of NMOS FETs or from the collectors of NPNs. When both inputs are floating, manual shutdown is

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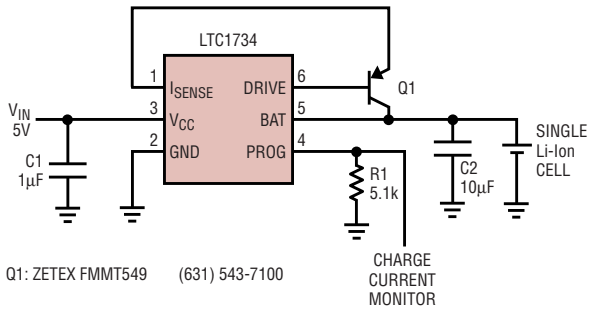

Figure 1. Simple, low cost charger programmed for 300mA output current

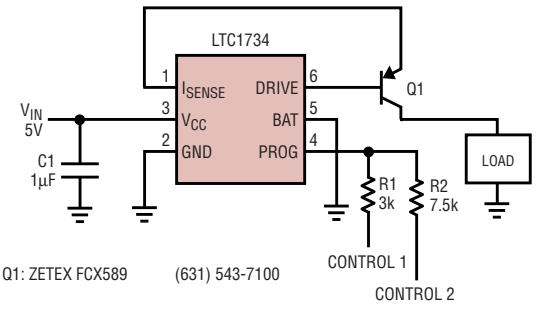

Figure 2. Programmable current source with output current of 0mA, 200mA, 500mA or 700mA

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entered. Connecting Control 1 to ground causes 500mA of current to flow into the load, whereas Control 2 results in 200mA of current. When both control inputs are grounded the current is 700mA. A voltage DAC, connected to the PROG pin through a resistor, could also be used to control the current. Applications include charging nickel-cadmium or nickel-metal-hydride batteries, driving LEDs or biasing bridge circuits.

Conclusion

Low cost, small footprint, reduced component count, precision and versatility make the LTC1734 an excellent solution for implementing compact and inexpensive battery chargers or constant current sources.