One-Hour Battery Charger Has Switch-Mode PWM Control

Because battery chargers control power, they resemble regulators in some respects. Linear chargers, for example, are less efficient than switching types when operating at high current and a large V_{IN}-V_{OUT} difference. A linear charger, powered by a 15V car battery and delivering 2A while charging an 8V, 6-cell NiCd stack must dissipate 14 watts. Efficient chargers therefore employ switch-mode DC-DC conversion for deriving the battery-charge voltage from V_{IN}.

An efficient fast-charge circuit (**Figure 1**) features a controller chip that normally implements linear regulation with an external pnp transistor. This circuit, however, substitutes a p-channel MOSFET for the pnp and implements switch-mode PWM regulation with the help of an inductor, two Schottky diodes, and a 60¢ dual timer (IC_1). The timer's "B" side is configured as a one-shot that receives nominal 70kHz triggers from the free-running "A" side.

During a charge, IC_2 monitors the slope of battery voltage vs. time. The MAX712 (for nickel-metal-hydride batteries) terminates charging when the slope reaches zero; the MAX713 (for NiCd batteries) terminates charging when the slope goes negative. As a backup provision, you can program an internal timer to terminate the charge after ¼, ½, 1, or 2 hours (times a multiple of 1.5X or 2X).

As a further backup, comparator circuits in IC2 monitor the battery temperature, preventing charging if the battery is too cold and terminating the charge if the battery becomes too hot. In every case, the IC applies a trickle charge of C/16 (125mA in **Figure 1**) after termination of the fast charge.

You can program IC_2 for charging 1 to 16 cells in series. The device simultaneously monitors and regulates battery voltage and charge current (via current-sense resistor R_6), and issues drive signals at the open-drain output DRV. These signals implement pulse-width modulation by altering the duty cycle of Q_1's gate drive.

Constructed with narrow-SO surface-mount components, the circuit fits easily into notebook computers and other portable equipment. When delivering two amperes it can charge a stack of six sub-C cells in less than one hour. The efficiency is 89% for V_{IN} = 12V and V_{OUT} = 9V, and the power dissipation is virtually constant at 2.3W for V_{IN} = 11 to 16V and V_{OUT} = 3 to 9V (V_{IN} must exceed the maximum battery voltage by at least 1V). Heat sinks are unnecessary because no component dissipates more than 0.5W.

(Circle 3)

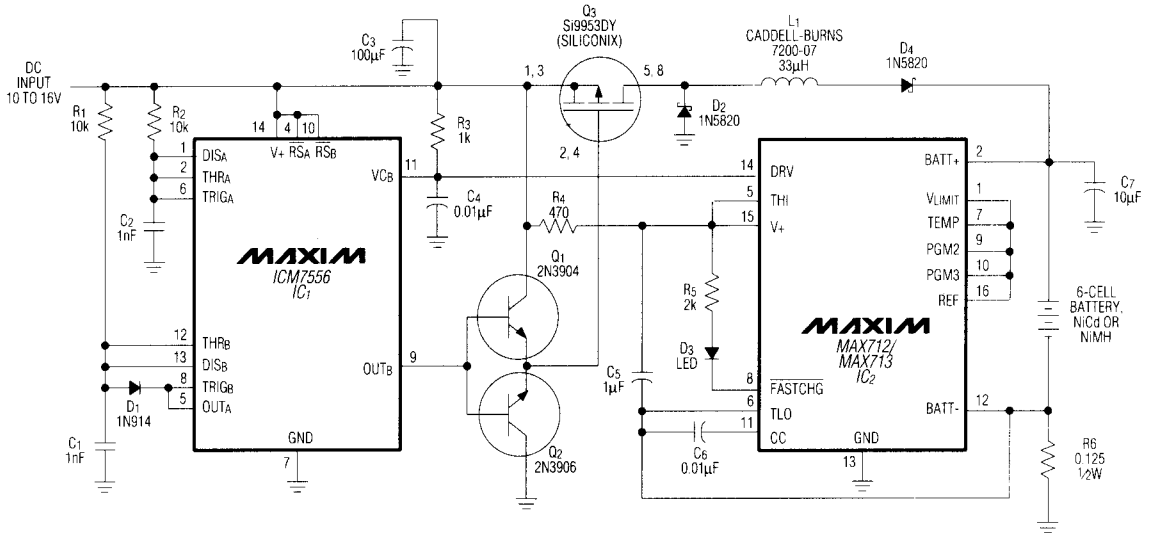

Figure 1. *This two-IC circuit provides efficient charging at a two-ampere rate for series connections of NiCd or NiMH cells.*