Charging Simplified for High Capacity Batteries

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ANALOG DESIGN NOTE ADN008

Personal Data Assistants (PDAs), digital cameras, laptop computers and cell phones have enthusiastically embraced the Lithium-Ion battery as their power source of choice. While the few select designers of these devices had a wide variety of batteries to choose from (such as alkaline, NiMH and NiCd), the Lithium-Ion battery became the preferred power source. This preference was due to the Lithium-Ion's high energy density by weight and volume, its relatively low self-discharge rate and no "memory".

Until recently, the Lithium-Ion battery had not been selected by other hand-held equipment designers because of cost. However, the high volume of Personal Data Assistants (PDAs), digital cameras, laptop computers and cell phones has facilitated a trend in Lithium-Ion battery price reduction. Some of the more recent designs that use Lithium-Ion batteries are MP3 players, CD players, electric shavers, GPS units, medical monitoring devices and infusion pumps.

This is good news for the portable equipment designer, as now may be the right time to reconsider your design's power source. In applications where large bursts of current are not required, the Lithium-Ion battery is a perfect fit. Along with the reduction in price, Lithium-Ion battery technology has been experiencing great improvements that include increased battery capacity. The capacity of the Lithium-Ion battery is specified in milli-Amps-hours (mAh). This specification tells the user how long the battery can be discharged at a rate of '*x*' mA before the end voltage is reached. This specification also indicates the preferred charge current for the battery. For instance, the CGP345010, a Panasonic® Lithium-Ion battery with a typical capacity of 1550 mAh, has a preferred charging rate of 1.085A (or 70% of capacity). Panasonic suggests that the charging process takes approximately two hours at 20°C. If, for some reason, the electronics in the circuit do not provide this magnitude of current while the battery is charging, the charge time will increase.

The MCP73841 uses an external MOSFET during the charge phase, as is illustrated in Figure 1. This external MOSFET can be advantageous when dealing with increased Lithium-Ion battery capacity, higher requirements for shorter charging times and thermal issues.

In your design, you will want to charge your Lithium-Ion battery with as few worries as possible. This requires a more sophisticated, "smarter" battery charger. The MCP73841 has a tight voltage regulation tolerance of +/-0.5% and extremely low reverse discharge current. Other features that the MCP73841 provides to the battery-charging process are the addition of the preconditioning phase to the basic charging profile, cell temperature monitoring, safety timers, automatic charge termination, charge status indicator and automatic recharge. The preconditioning phase safely allows the user to charge batteries that have a voltage charge below the standard threshold voltage of 2.8V (for the MCP73841). The cell temperature is monitored to prevent battery cell damage by terminating the charging activity at higher temperatures.

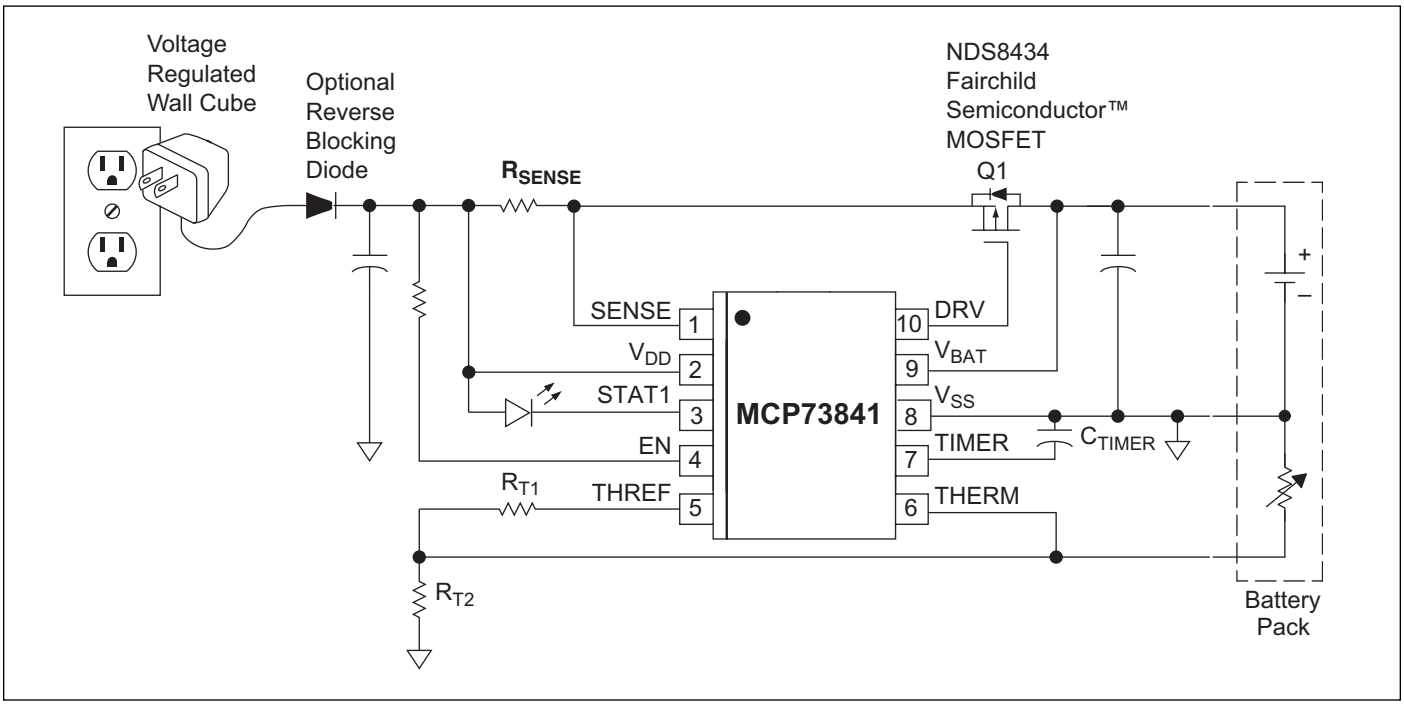

Figure 1. *The MCP73841, in conjunction with an external FET, can be used to charge a battery with a high capacity.*

The safety timers regulate attempts to charge a battery when the precondition, constant-current or constant-voltage phases take too long.

Lithium-Ion batteries are charged with a constant-current/ constant-voltage strategy, as is illustrated in Figure 2. At inception of the battery-charging process, it is determined whether or not the battery temperature is within a predetermined window (0°C to 45°C, typ.) and that its voltage is above the undervoltage lockout threshold. If these qualification parameters are met, the charge begins at the precondition phase illustrated in Figure 2. The battery voltage is tested and, if the battery voltage is above the preconditioning threshold, the constant-current phase is entered. The charge cycle continues until the end-of-charge condition has been reached, at which time the charge cycle is terminated. If the battery discharges below the recharge threshold, a new charge cycle is initiated.

Intelligent chargers sense temperature, have adjustable charge current and employ safety timers. The MCP7384X family of devices are highly advanced linear charge management controllers for use in space-limited applications. The MCP73841 combines high-accuracy constant-voltage, constant-current regulation, cell preconditioning, cell temperature monitoring, advanced safety timers, automatic charge termination and charge status indication in a 10-pin MSOP package. The MCP73841 is designed for applications utilizing single-cell Lithium-Ion or Lithium-Polymer battery packs and operates with an input voltage range of 4.5V to 12V.

The MCP73841 belongs to a family of battery charger devices. The features of this device family are summarized in Table 1.

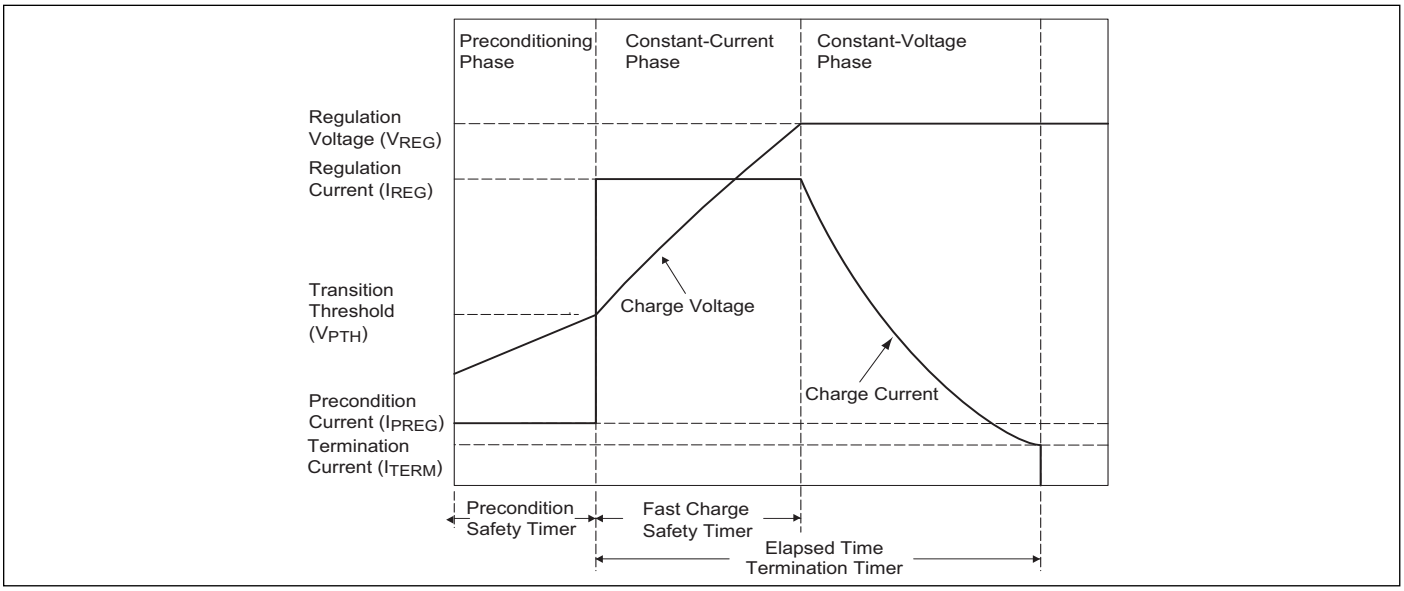

Figure 2. *This charging profile for a Lithium-Ion battery pack begins in the preconditioning phase, where 0.1C is used to charge the battery up to its transition threshold. In the constant-current phase, the battery is charged with a constant current equal to 1C. Once the battery reaches its regulated voltage, the constant-voltage phase is implemented until the charge current reaches the termination current, which is equal to 70% of the preconditioning current (0.07C).*

	MCP73841	MCP73842	MCP73843	MCP73844
Preset Voltage Regulation	4.1 or 4.2	8.2 or 8.4	4.1 or 4.2	8.2 or 8.4
Programmable Charge Current	Yes	Yes	Yes	Yes
Programmable Safety Charge Timers	Yes	Yes	Yes	Yes
Automatic End-of-Charge Control	Yes	Yes	Yes	Yes
Cell Temperature Monitor	Yes	Yes	—	—
Status Output	Yes	Yes	Yes	Yes

Table 1. *Summary of the functions of the MCP7384X family of battery management controllers.*

Recommended References:

"Battery Management Empower Portable Designs," Morrison, David G., Electronic Design, Feb. 17, 2003.

"Chips Charge Up for Lithium-Ion," Biancomano, Vincent, EETimes, August 21, 2003.

MCP73841/2/3/4 Data Sheet, "Advanced Single or Dual Cell Lithium-Ion/Lithium-Polymer Charge Management Controllers," Microchip Technology Inc., DS21823.

For more information, please visit www.microchip.com