

New Dual Input USB/AC Linear Li-Ion Battery Chargers

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Introduction

Digital Cameras, PDAs, mobile phones and MP3 players all use batteries that are commonly charged via either a wall adapter or through the USB. The LTC4076 and LTC4077 lithium-ion battery chargers are specifically designed to detect power at the inputs and automatically select the appropriate source for charging. Using a constant current/constant voltage algorithm, the chargers can be programmed to deliver up to 950mA of charge current with a final float voltage accuracy of $\pm 0.6\%$. The LTC4076 and LTC4077 include an internal P-channel power MOSFET and thermal regulation circuitry with no blocking diode or external sense resistor required. Thus, the basic dual-source charger requires only three external components.

The LTC4076 offers a programmable current based termination scheme. The $\overline{\text{CHRG}}$ open-drain status pin can be programmed to indicate the battery charge state according to the needs of the application. The $\overline{\text{PWR}}$ open-drain status pin indicates that enough voltage is present at one of the inputs to charge a battery. With power applied on both inputs, LTC4076 and LTC4077 can be put into shutdown mode, reducing the DCIN supply current to $20\mu\text{A}$, the USBIN supply current to $10\mu\text{A}$ and the battery drain current to less than $2\mu\text{A}$.

Internal thermal feedback regulates the charge current to maintain

a constant die temperature during high power operation or high ambient temperature conditions.

USB Compatibility

The HPWR pins of the LTC4076 and LTC4077 provide an easy method to choose between two different USB power modes: high power (usually $\leq 500\text{mA}$) and low power (usually $\leq 100\text{mA}$).

With the LTC4076, a logic high on the HPWR pin sets the charge current to 100% of the current programmed by the IUSB pin resistor, while a logic low on the HPWR pin sets the charge current to 20% of the current programmed by the IUSB pin resistor.

With the LTC4077, a logic high on the HPWR pin sets the charge current to the value programmed by the IUSB pin resistor, while a logic low on the HPWR pin sets the current to the value programmed by the IUSBL pin resistor.

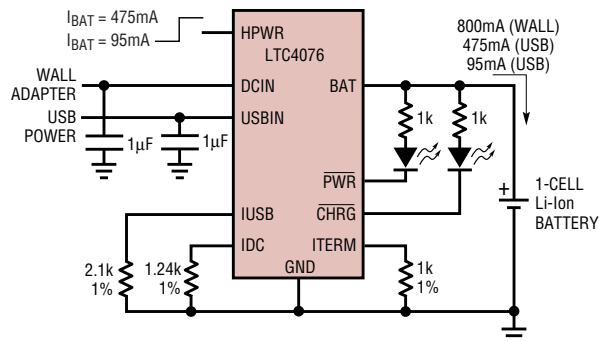


Figure 1. An LTC4076 USB/wall adapter Li-Ion charger

A weak pull down on the HPWR pin sets the part to default to the low power state. The HPWR pin provides a simple control for managing charge current as shown in Figure 1 and Figure 2. The presence of a wall adapter takes priority over the USB input and the IDC 1.24kΩ resistor sets the total maximum charge current to 800mA. When USB power is present, and a wall adapter is not, the IUSB 2.1kΩ resistor sets the charge current to 476mA with HPWR in its high state, and 95mA with HPWR in its low state for the LTC4076 (or 100mA with IUSBL 2kΩ resistor for the LTC4077).

Programmability

The LTC4076 and LTC4077 provide a great deal of design flexibility including programmable charge current and programmable current termination. The charge currents are programmed using a resistor from the IDC, IUSB and IUSBL (LTC4077 only) pins to ground as indicated in the following equations:

$$I_{\text{CHG}} = \frac{1000\text{V}}{R_{\text{IDC}}} \quad (\text{Wall Adapter Present})$$

$$I_{\text{CHG}} = \frac{1000\text{V}}{R_{\text{IUSB}}} \quad (\text{USB HPWR = High})$$

$$I_{\text{CHG}} = \frac{200\text{V}}{R_{\text{IUSB}}} \quad (\text{USBHPWR = Low, LTC4076 Only})$$

$$I_{\text{CHG}} = \frac{200\text{V}}{R_{\text{IUSBL}}} \quad (\text{USBHPWR = Low, LTC4077 Only})$$

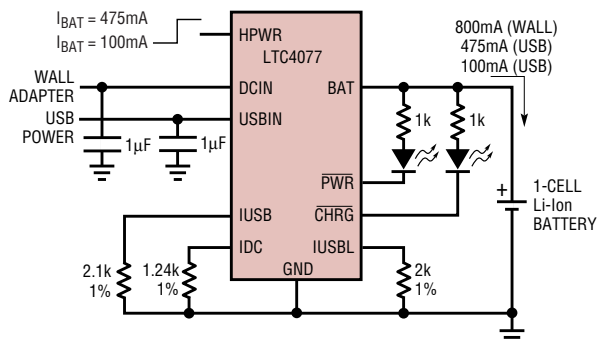


Figure 2. An LTC4077 USB/wall adapter Li-Ion charger

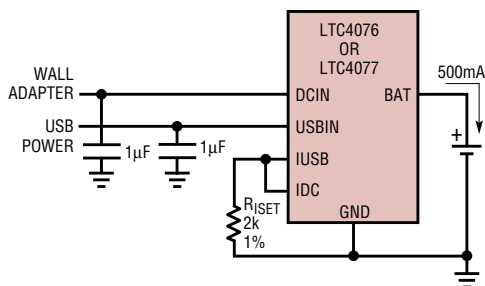


Figure 3. LTC4076 or LTC4077 dual input charger circuit. The wall adapter charge current and the USB charge current (HPWR = High) are both programmed to be 500mA with just one resistor.

Both the LTC4076 and LTC4077 terminate the charge cycle based on the battery current. For the LTC4076 the current threshold is programmable and for the LTC4077 the current threshold is fixed, as described below.

For LTC4076, the programmable current detection threshold, I_{TERM} , is set by connecting a resistor, $R_{I_{TERM}}$, from I_{TERM} to ground. The following formula programs the termination current:

$$I_{TERM} = \frac{100V}{R_{I_{TERM}}}$$

For the LTC4077 the termination current is fixed at 10% of the programmed charge current as set by IDC or IUSB (HPWR = High). When HPWR is in its low state, the termination current

is 50% of the current programmed by $R_{I_{USBL}}$.


The condition of the \overline{CHRG} pin indicates the charge state. A strong pull-down on the \overline{CHRG} pin indicates that the battery is charging. When the current termination threshold is reached the \overline{CHRG} pin assumes a high impedance state.

Avoiding Unnecessary Charge Cycles

LTC4076 and LTC4077 are designed to avoid unnecessary charge cycles to extend the life of Li-Ion batteries. When power is first applied or when exiting shutdown, the LTC4076 and LTC4077 check the voltage on the BAT pin to determine its initial state. If the BAT pin voltage is below the recharge threshold of 4.1V (which corresponds

to approximately 80%–90% battery capacity), LTC4076 and LTC4077 enter charge mode and begin a charge cycle. If the BAT pin is above 4.1V, the battery is nearly full and the charger does not initiate a charge cycle and instead enters standby mode. When in standby mode, the chargers continuously monitor the BAT pin voltage. When the BAT pin voltage drops below 4.1V, the charge cycle is automatically restarted. This feature eliminates the need for periodic charge cycle initiations, ensures that the battery is always fully charged, and prolongs battery life by reducing the number of unnecessary charge cycles.

Conclusion

LTC4076 and LTC4077 are complete Linear Li-Ion battery chargers compatible with portable USB applications. They are designed to accommodate charging from both a wall adapter and a USB input. The versatility, low quiescent current, simplicity, high level of integration and small size of the LTC4076 and LTC4077 provide an ideal choice for many portable USB applications. LTC4076 and LTC4077 are available in a small 10-lead low profile 3mm × 3mm DFN package. 

New Device Cameos

New Timing and High Voltage Output Enhance Push Button On/Off Controller


The LTC2954 is an upgrade to the LTC2950 family of push button controllers. Two features have been added: new push button controlled interrupt timing, and a high voltage open drain enable output capable of 33V operation.

The LTC2954 now provides interrupt and power down modes to allow more flexible and reliable system shut down. Once in the powered on state, momentary presses on the push button provide interrupts to system logic. This can be useful for system housekeeping and power down under

firmware control. Should the system require a forced power down, a long duration press and hold of the push button automatically releases the enable pin, thus turning system power off. The timing of this latter power down mode is adjustable with external capacitance on the power down timing pin.

The new high voltage enable output of the LTC2954-2 is ideally suited to drive the gate of a high voltage power PFET. This allows a user to connect/disconnect input power from its load simply by toggling the de-bounced push button input.

The LTC2954 operates over a wide 2.7V to 26V input voltage range while

consuming only 6µA of supply current and is available in 8-Pin 3mm × 2mm DFN and ThinSOT™ Packages. Two versions of the part are available to accommodate either positive or negative enable polarities. 

For further information on any of the devices mentioned in this issue of Linear Technology, use the reader service card or call the LTC literature service number:

1-800-4-LINEAR

Ask for the pertinent data sheets and Application Notes.