# Supply derives 5 and 3.3V from USB port

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The circuit in **Figure 1** derives its power from a USB port and produces 5 and 3.3V supply rails for portable devices, such as digital cameras, MP3 players, and PDAs. The circuit allows the port to maintain communications while, for example, charging a lithium-ion battery. $IC_2$ boosts the battery voltage, $V_{BATT}$, to 5V, and $IC_3$ buck-regulates that 5V output down to 3.3V. $IC_1$, a lithium-ion battery charger, draws power from the USB port to charge the battery. Pulling its SELI terminal low sets the charging current to 100 mA for low-power USB ports, and pulling SELI high sets 500 mA for high-power ports. Similarly, pulling SELV high or low configures the chip for charging a 4.2 or 4.1V battery, respectively. To protect the battery, $IC_1$'s final charging voltage has 0.5% accuracy. The $\overline{CHG}$ terminal allows the chip to illuminate an LED during charging.

$IC_2$ is a step-up dc/dc converter that boosts $V_{BATT}$ to 5V and delivers currents as high as 450 mA. Its low-battery detection circuitry and true shutdown capability protect the lithium-ion battery. By disconnecting the battery from the output, "true shutdown" limits battery current to less than 2 µA. An external resistive divider between $V_{BATT}$ and ground sets the low-battery trip point. Connecting the low-battery output, LBO, to shutdown, SHDN, causes $IC_2$ to disconnect its load in response to a low battery voltage. The internal source impedance of a lithium-ion battery makes $IC_2$ susceptible to oscillation when its low-battery-detection circuitry disconnects a low-voltage battery from its load. As the voltage drop across the battery's internal resistance disappears, the battery voltage increases and turns $IC_2$ back on. For example, a lithium-ion battery with 500-mΩ internal resistance, sourcing 500 mA, has a 250-mV drop across its internal resistance. When $IC_2$'s circuitry disconnects the load, forcing the battery current to zero, the battery voltage immediately increases by 250 mV.

The n-channel FET at LBO eliminates this oscillation by adding hysteresis to the low-battery-detection circuitry. The circuit in **Figure 1** has a low-battery trip voltage of 2.9V. When $V_{BATT}$ drops below 2.9V, LBO opens and allows SHDN to switch high, turning on the FET. With the FET turned on, the parallel combination of 1.3 MΩ and 249 kΩ eliminates oscillation by setting the battery turn-on voltage to 3.3V. The turn-off and turn-on points are according to the following equations:

$$V_{BATT}(TURN-OFF)=V_{LBI}\times\frac{R_1+R_2}{R_2},$$

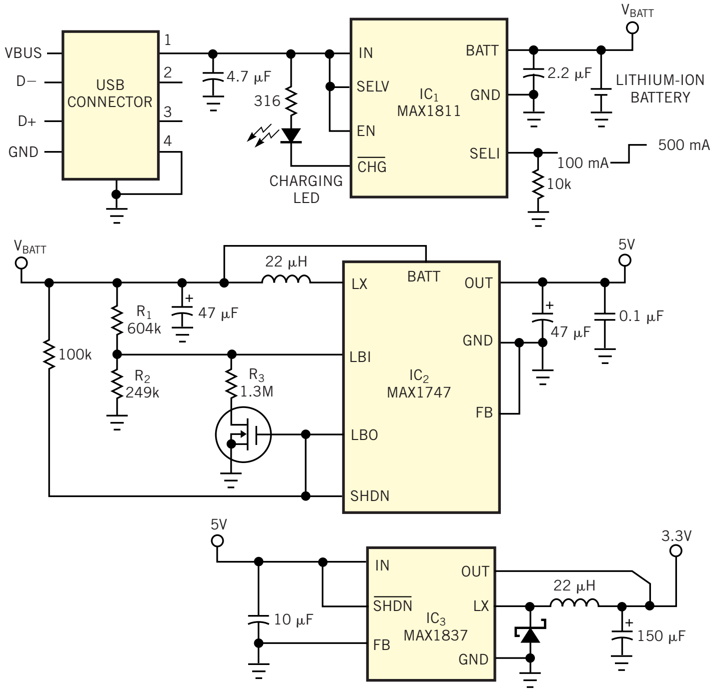
where $V_{LBI}$=0.85V, and

$$V_{BATT}(TURN-ON)=V_{LBI}\times\frac{R_1+R_2'}{R'_2},$$

where

$$R_2'=\frac{R_2R_3}{R_2+R_3}.$$

**Figure 1**



**Drawing power from a USB port, this circuit generates 5 and 3.3V supply voltages for portable applications.**

Finally, a step-down converter, $IC_3$, provides buck regulation to convert 5V to 3.3V and delivers currents as high as 250 mA with efficiency exceeding 90%.

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