Automatic latch-off circuit saves batteries

Kieran O'Malley, On Semiconductor, West Kingston, RI

Although rechargeable batteries offer many advantages, they can suffer damage and shortened service lives if they're fully drained of their charge. The circuit in **Figure 1** shuts off a battery-powered appliance—in this instance, an LED flashlight receiving power from NiMH (nickel-metal-hydride) cells—when the battery voltage falls below a preset limit. Although intended for an LED flashlight, this circuit can apply to any battery-powered application. Without ensuring that the user will remove the batteries for recharging, this circuit latches the flashlight off when the battery voltage falls below the usable limit and thus provides a strong hint that it may be time to recharge.

Although a simple nonlatching voltage comparator can switch off power, removing the battery's load causes a voltage rebound, and the comparator restores power, forcing the light into a flashing mode. This circuit turns off the flashlight, and it remains off until the user manually turns on the light using switch S_1.

A 600-mA NCP1421 PFM step-up synchronous-rectifier dc/dc-converter, IC_1, from On Semiconductor (www.onsemi.com) forms the heart of the circuit, but the basic design applies to many other converters offering similar features (**Reference 1**). The NCP1421's key features include an integrated LBI/EN (low-battery input/enable) and an open-drain LBO (low-battery output). Operating from two AA-size NiMH batteries, the circuit comprises the components of a normal boost regulator: an inductor, input and output capacitors, and a current-sense circuit to the right of IC_1. A combination of the LED's forward voltage, which R_3 and R_2 divide down, and voltage across current-sense resistor R_1 produces a feedback voltage for comparison with the NCP1421's 1.2V nominal reference voltage.

On the input side, IC_1's LBI/EN pin connects to the battery through a voltage-divider network formed by resistors R_4, R_5, and R_{10}. The NCP1421 remains enabled while the voltage on LBI/EN exceeds 1.2V. When the voltage on LBI/EN falls below 1.2V, the LBO-detector pin goes low, switching on Q_3 and supplying current to Q_1's base. When Q_1 switches on, Q_2's base goes low and latches the virtual SCR (silicon-controlled rectifier) formed by Q_1 and Q_2, an MBT3946DW1 integrated dual transistor, IC_2.

In addition, Q_1 latches the LBI/EN pin low to prevent IC_1 from turning on again upon load removal. To restart the circuit, switch S_1 must interrupt the circuit's power. Resistors R_4, R_5, and R_{10} set the battery-voltage trip point for the LBO detector. R_5 also sets the current drawn from the battery when the SCR activates. The circuit switches off when the battery voltage drops to approximately 1.3V, a point at which the LBI/EN pin reaches 1.2V. **EDN**

REFERENCE

NCP1421 data sheet, www.onsemi.com/pub/Collateral/NCP1421-D.PDF.

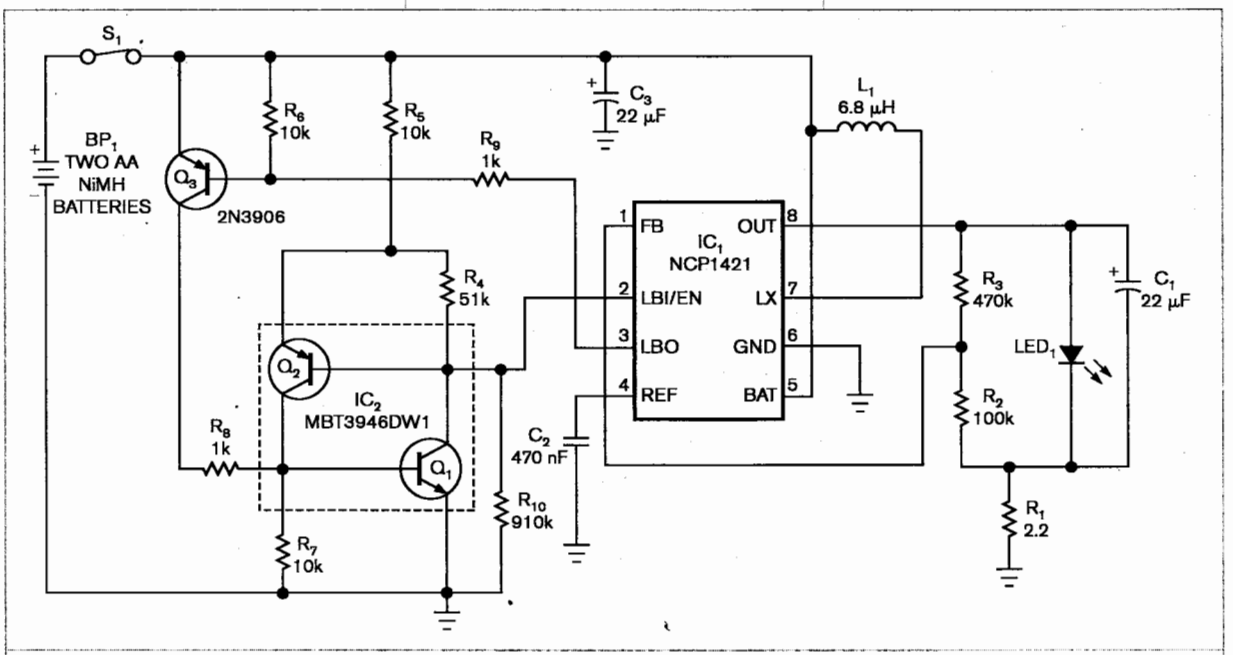

Figure 1 This circuit extends the lives of rechargeable batteries by removing power at a preset voltage and preventing overdischarge.