

A Complete Battery Backup Solution Using a Rechargeable NiCd Cell

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Battery-powered systems, including notebook computers, personal digital assistants (PDAs) and portable instruments, require backup systems to keep the memory alive while the main battery is being replaced. The most common solution is to use an expensive, nonrechargeable lithium battery. This solution requires low-battery detection, necessitates battery

access and invites inadvertent battery removal. The LTC1558 battery backup controller eliminates these problems by permitting the use of a single, low cost 1.2V rechargeable Nickel-Cadmium (NiCd) cell. The LTC1558 has a built-in fast-/trickle-mode charger that charges the NiCd cell when main power is present.

Figure 1 shows a typical application circuit with an LTC1558-3.3 providing backup power to an LTC1435 synchronous step-down switching regulator. The backup circuit components consist of the NiCd cell, R11-R14, C11-C12, L11 and Q11. SW11 and R15 provide a soft or hard reset function.

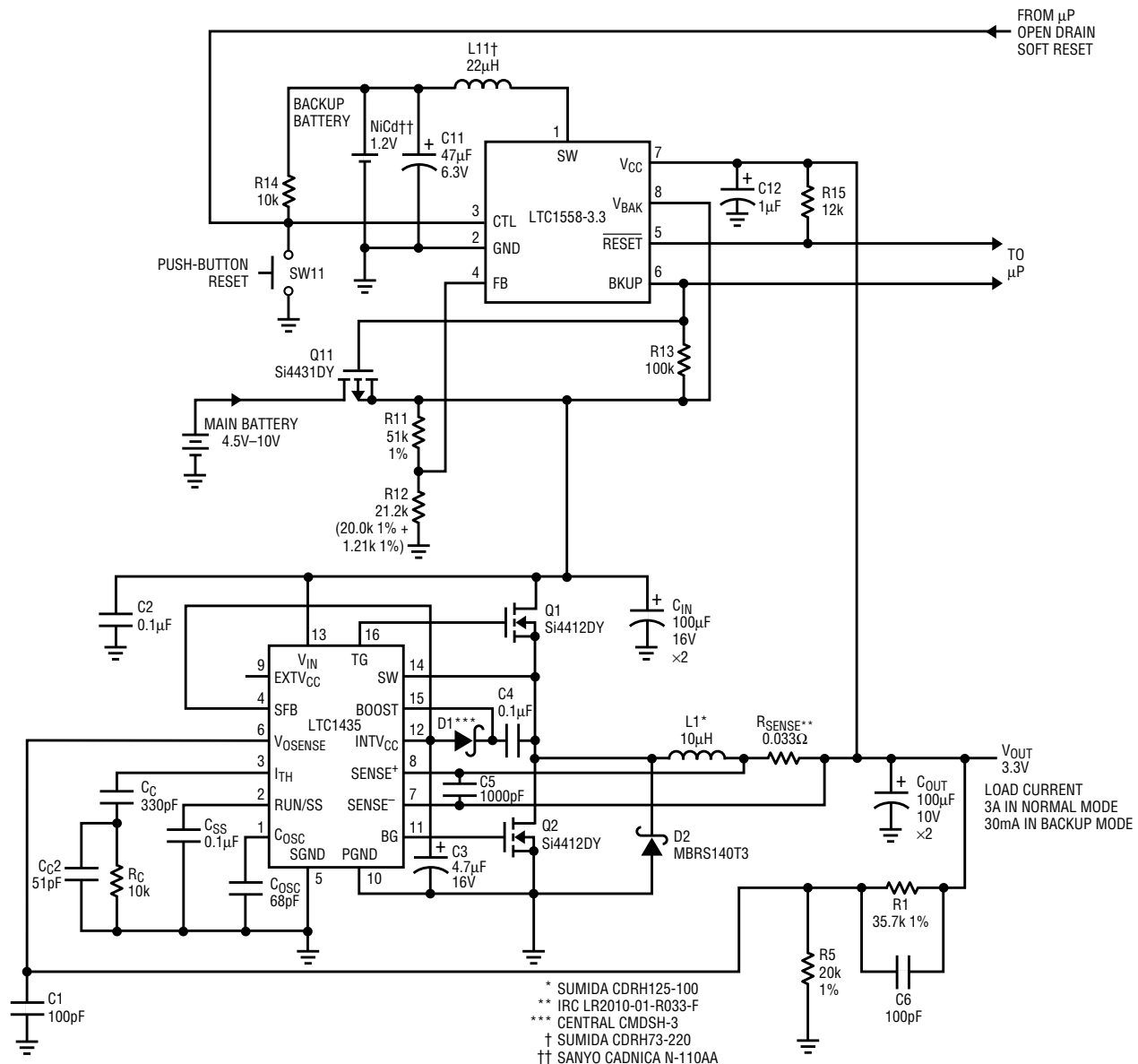


Figure 1. LTC1558 backup system with LTC1435 as main system regulator

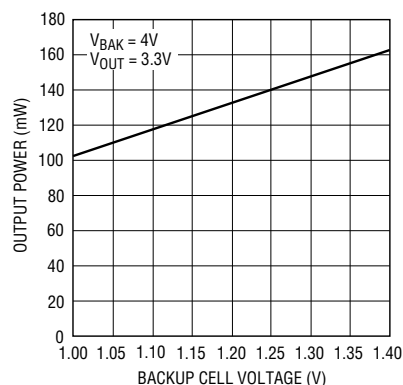


Figure 2. 3.3V output power vs backup cell voltage

Normal Mode (Operation from the Main Battery)

During normal operation, the LTC1435 is powered from the main battery, which can range from 4.5V to 10V (for example, a 2-series or 2-series \times 2-parallel Li-Ion battery pack, or the like) and generates the 3.3V system output. The LTC1558 operates in standby mode. In standby mode, the LTC1558 BKUP (backup) pin is pulled low and P-channel MOSFET Q11 is on. The NiCd cell is fast charged by a 15mA current source connected between the LTC1558's V_{CC} and SW pins. Once the NiCd cell is fully charged (according to the LTC1558's gas-gauge counter), the LTC1558 trickle charges the NiCd cell. R14 sets the trickle-charge current according to the formula $I_{(TRICKLE)} = 10 \cdot (V_{NiCd} - 0.5) / R14$. The trickle-charge current is set to overcome the NiCd cell's self-discharge current, thereby maintaining the cell's full charge.

Backup Mode (Operation from the Backup Battery)

The main battery voltage is scaled down through resistor divider R11-R12 and monitored by the LTC1558

via the FB pin. If the voltage on the FB pin drops 7.5% below the internal 1.272V reference voltage (due to discharging or exchanging the main battery), the system enters backup mode. In backup mode, the LTC1558's internal switches and L11 form a synchronous boost converter that generates a regulated 4V at V_{BAK} . The LTC1435 operates from this supply voltage to generate the 3.3V output voltage. The BKUP pin is pulled high by R13 and Q11 turns off, leaving it

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body diode reverse biased. The BKUP pin also alerts the system microprocessor. C11, a 47 μ F capacitor, provides a low impedance bypass to handle the boost converter's transient load current; otherwise, the voltage drop across the NiCd cell's internal resistance would activate the

Table 1. V_{FB} and V_{BAK} voltages

Relative % Below V_{REF}	% of V_{REF}	V_{FB}	V_{BAK}
-0%	100%	1.272V	4.332V
-6%	94%	1.196V	4.073V
-7.5%	92.5%	1.177V	4.008V

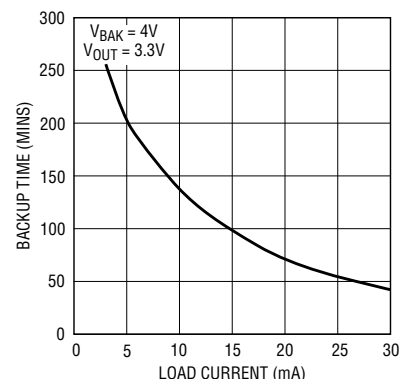



Figure 3. Backup time vs 3.3V output load current

LTC1558's undervoltage-lockout function. Table 1 shows several values of V_{FB} vs the V_{BAK} voltage. Figure 2 shows the maximum output power available at the 3.3V output vs the NiCd cell voltage. Over 100mW of output power is achieved for a NiCd cell voltage greater than 1V. Figure 3 shows the backup time vs the 3.3V load current using a Sanyo Cadnica N-110AA cell (standard series with a capacity of 110mAhrs). Over one hour of backup time is realized for less than 80mW of 3.3V output power.

Recovery from Backup Mode to Normal Mode

When a new main battery pack is inserted into the system, Q11's body diode forward biases. Once the voltage at the FB pin increases to more than 6% below V_{REF} , the boost converter is disabled and the system returns to normal mode. The BKUP pin pulls low and turns Q11 back on. This allows the new battery pack to supply input power to the LTC1435. The LTC1558 now accurately replenishes the amount of charge removed from the NiCd cell through the internal charger and gas-gauge counter. 

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