Keywords: voltage monitor, voltage detector, voltage converter, charge-pump inverter, voltage tripler

APPLICATION NOTE 968

Load-Disconnect Switch Halts Battery Discharge to Protect Rechargeable Batteries

Jul 09, 1998

Abstract: This design idea shows a voltage detector, the MAX8211, and charge pump inverter, the MAX680, that form a load-disconnect switch. This load-detect switch uses only 8µA and halts battery discharge to protect rechargeable batteries from deep discharge.

Deep discharge can damage a rechargeable battery. The **Figure 1** circuit, by disconnecting the battery from its load, halts battery discharge at a predetermined level of declining terminal voltage. Transistor Q1 acts as the switch. The overall circuit draws about 500µA when the switch is closed and about 8µA when the switch is open.

Choosing the upper and lower voltage thresholds V_U and V_L lets you set values for R1, R2, and R3:

$$R1 = R2 \times [(V_L/1.15) - 1]$$
$$R3 = 1.15 \times R1/(V_U - V_L)$$

To start the circuit, battery voltage (V+) must exceed V_U. The micropower voltage detector IC1 then powers IC2, but only while V+ remains above V_L. Otherwise, the loss of power to IC2 removes gate drive from Q1, turning it off. As shown, the circuit disconnects a 3-cell nickel-cadmium battery from its load when V+ reaches a V_L of 3.1V. An approximate 0.5V hysteresis prevents the switch from turning on immediately when the load is removed; V+ must first return to V_U (3.6V).

IC2 is a dual charge-pump inverter that normally converts 5V to 10V. The capacitors C2, C3, and two diodes on the chip's positive-voltage side form a voltage tripler that generates an approximate 2(V+) gate drive for the high-side, floating-source MOSFET switch Q1.

Gate drive declines with battery voltage, causing the on-resistance of Q1 to reach a maximum of ≈0.1Ω just before V+ reaches its 3.1V threshold. A 300mA load current at that time will cause a 30mV drop at the disconnect switch; the drop will be 2mV to 3mV less for higher battery voltages. Resistor R4 assures turn-off for Q1 by providing a discharge path for C3.

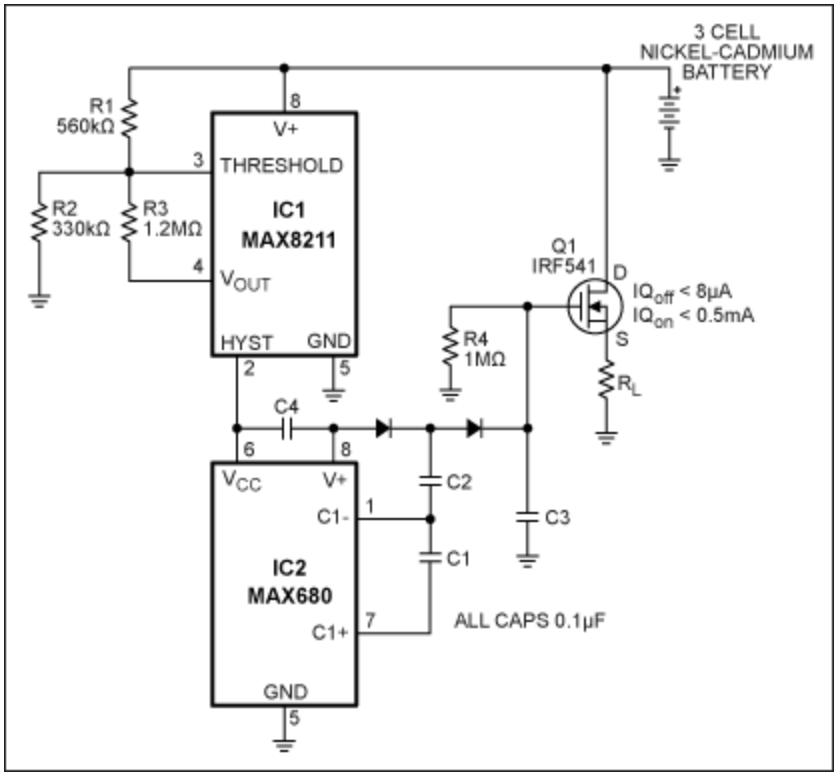

Figure 1. When battery voltage drops below a threshold set by R1 and R2, the voltage-detector chip (IC1) removes power from the charge pump IC2, which turns off the high-side switch Q1 by removing its gate drive.

Related Parts		
MAX680	+5V to ±10V Voltage Converters	Free Samples
MAX8211	Microprocessor Voltage Monitors with Programmable Voltage Detection	Free Samples

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