Keywords: load disconnect, step-up regulator, boost converter, NniMH output, regulator feedback step-up DC-DC converter

APPLICATION NOTE 657

Simple Circuit Disconnects Load

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Abstract: This application note shows how an external power MOSFET acts as a load-disconnect switch and allows a switching regulator to start up with heavy loads and low-input voltages. The load-disconnect circuit boosts a single NiMH cell output to 3.3V and delivers output currents to 600mA. The MAX1703 step-up DC-DC converter is featured in the design.

Placing a load-disconnect circuit on the output of a bootstrapped step-up regulator allows the regulator to start with load currents much higher than would otherwise be possible (**Figure 1**). During shutdown, the disconnect completely isolates the battery from the load. The circuit boosts a single NiMH-cell output to 3.3V and delivers output currents to 600mA. Step-up regulators are excellent for portable applications because they exhibit high efficiency, low supply current (120µA operating, 20µA in shutdown), and ample current once started. Many, however, cannot start with maximum load from low supply voltages, such as those from single-cell batteries. This problem arises because most low-voltage CMOS boost regulators derive power from their own outputs, which equal V_{IN} minus a diode drop at start-up. Low values of input voltage don't allow the switching transistor to become fully enhanced at start-up, so the transistor presents a high impedance that limits the peak inductor current. As a result, the circuit cannot produce enough current to simultaneously supply the load and charge the output capacitor.

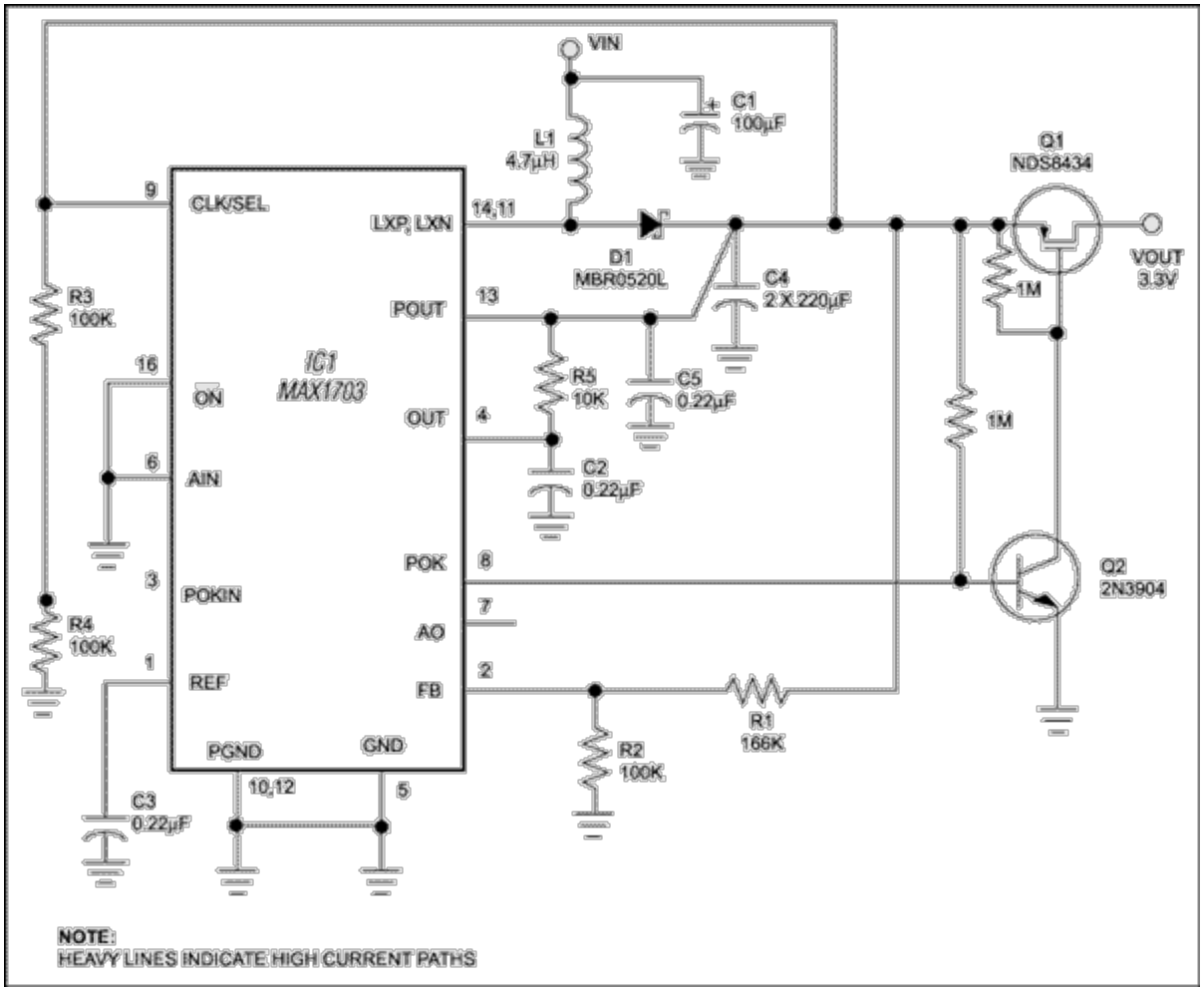

Figure 1. The addition of a couple of transistors enables a switching regulator to start with full load and low input voltages.

To get around this problem and ensure reliable start-ups, most regulator ICs incorporate an undervoltage lockout (UVLO). IC_1, for example, is a synchronous boost converter whose bootstrapped operation cannot start until its output voltage exceeds the internal UVLO threshold of 2.3V. You can overcome this start-up limitation with an external power MOSFET, Q_1, operating as a load-disconnect switch, and by using the power-OK (POK) comparator built into many low-voltage switching regulators. R_3 and R_4 set the POK threshold at 2.5V, allowing V_{IN} to rise above the UVLO threshold. Q_2 inverts the POK output before driving Q_1. Q_1 disconnects the load, allowing V_{OUT} to rise to a level (above UVLO) that ensures full enhancement of Q_1 when it turns on. As a result, the circuit can start under full load with input voltages as low as 0.8V (**Figure 2a**). Because the circuit takes the regulator feedback before this switch, the MOSFET you choose for a given application depends on the load current and minimum acceptable level of load regulation. The MOSFET shown is a low-threshold device. Connecting the FB terminal (Pin 2) to ground and removing R_1 and R_2 produces a 5V regulated output, whose performance is similar to that of the 3.3V version (**Figure 2b**). (DI #2487)

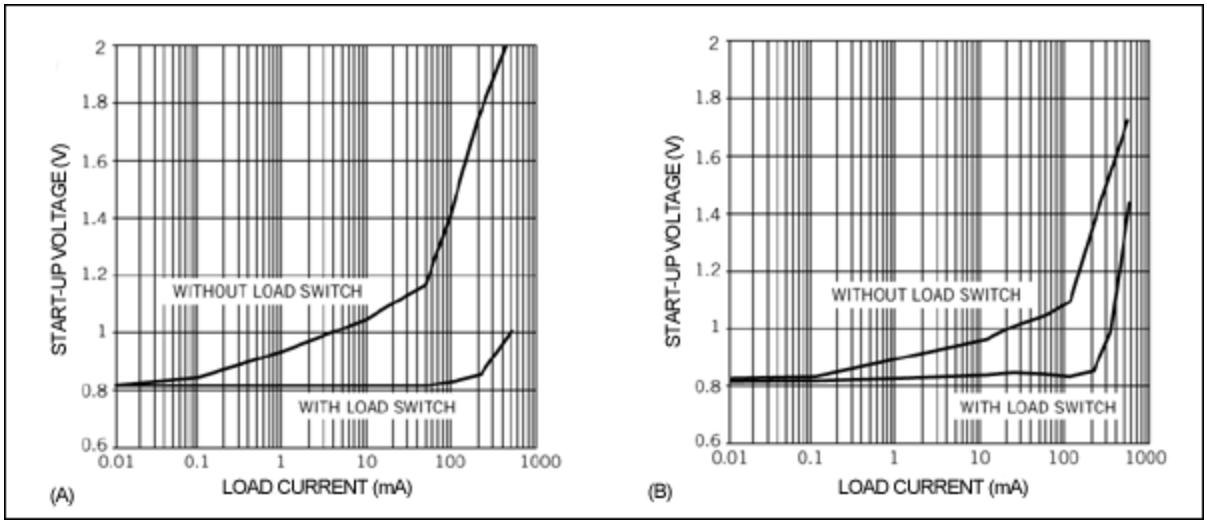

Figure 2. The load-disconnect switch in Figure 1 allows the regulator to start up with heavy loads and low input voltages (a). A slight modification of the circuit in Figure 1 provides 5V-output operation (b).

Related Parts		
MAX1703	1-Cell to 3-Cell, High Power (1.5A), Low-Noise, Step-Up DC-DC Converter	Free Samples

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