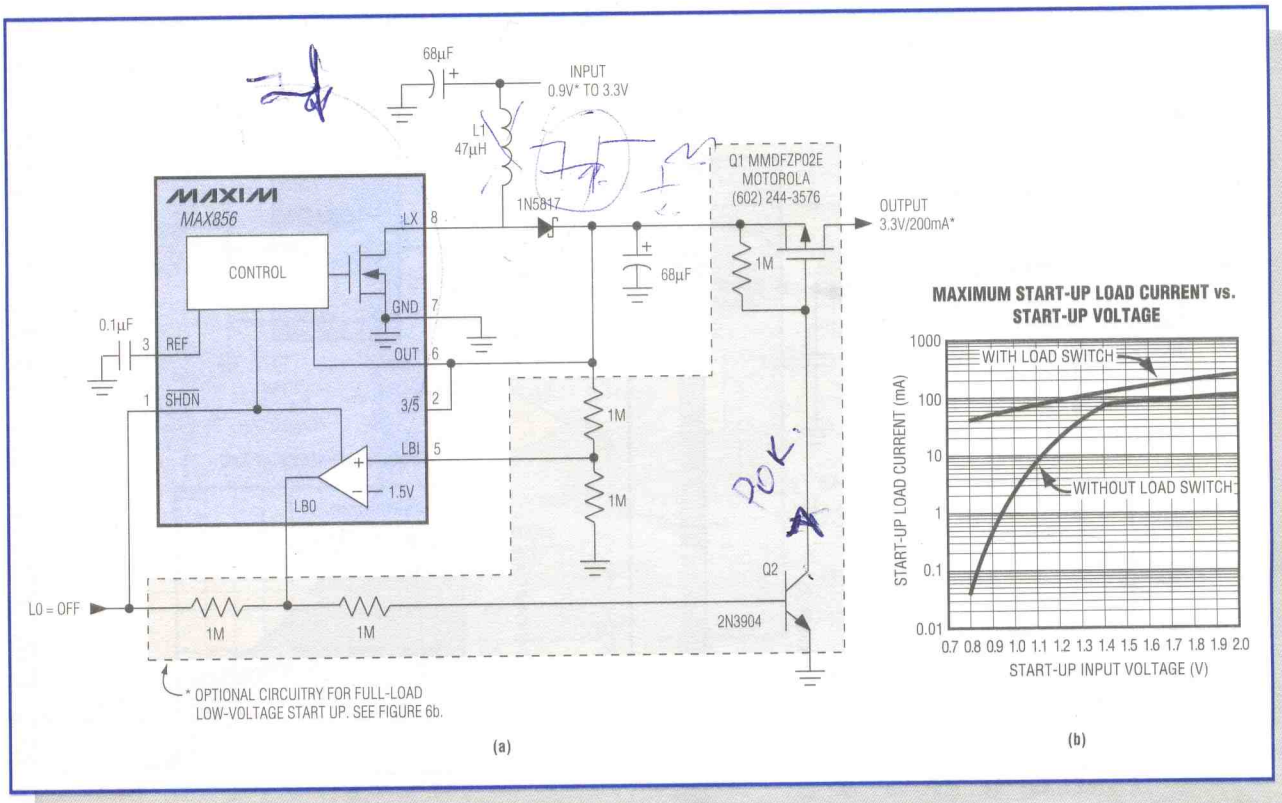

Figure 6. This low-power, CMOS step-up converter (a) generates 3.3V from 1-cell and 2-cell inputs. The optional load-disconnect circuitry (dashed lines) enables the circuit to start with inputs as low as 0.8V (b).

And, its quiescent current does not rise as V_{IN} approaches V_{OUT}.

This last characteristic is especially important for small portables whose steady-state load is no greater than 100µA. In such designs, the milliamp or more of quiescent-current rise (typical of a low-dropout regulator with bipolar pass transistor) accelerates the battery discharge at a time when the battery can least afford it: near the end. Typically, the IC in Figure 5 draws 15µA of operating current whether in or out of dropout.

Boosting from low-cell-count batteries

The cell count for batteries in earlier-generation designs was high—not to provide more energy, but rather to allow generation of the system voltages with low-cost linear regulators (or even with no regulator at all). The latest generation of voltage-conversion ICs, on the other hand, lets you reduce the cell count while adding a minimum number of external parts. Usually, this extra cost is more than offset by the benefits of lower cell count: smaller size, less weight, and (sometimes) longer battery life. To illustrate, the 4.5Whrs of available energy in two AA cells exceeds the 3Whrs in a 6-cell, 9V alkaline battery by 50%, even though the two batteries are comparable in size and weight.

The step-up regulator of **Figure 6a** provides high, 88% efficiency for 2-cell and 1-cell inputs, and its high, 500kHz switching frequency enables the use of very small inductors. The IC's quiescent current is only 60µA at light or zero loads—an attractive feature for portable products whose supply voltage must remain active when the product is turned "off." As the product enters such an idle or suspend mode, load current falls to microamps and must not be dominated by current into the regulator IC. For equipment that truly shuts down, the IC provides a very low-current shutdown mode in which it draws less than 1µA.

One-cell regulators

It makes sense to operate from a 1-cell battery when size is of prime importance. Reasonable efficiency and cost is now possible when operating with inputs below one volt, so many hand-held applications have become new candidates for 1-cell operation. The switching frequency for