Keywords: buck-boost, boost, LDO, linear regulator, regulators, switching regulator

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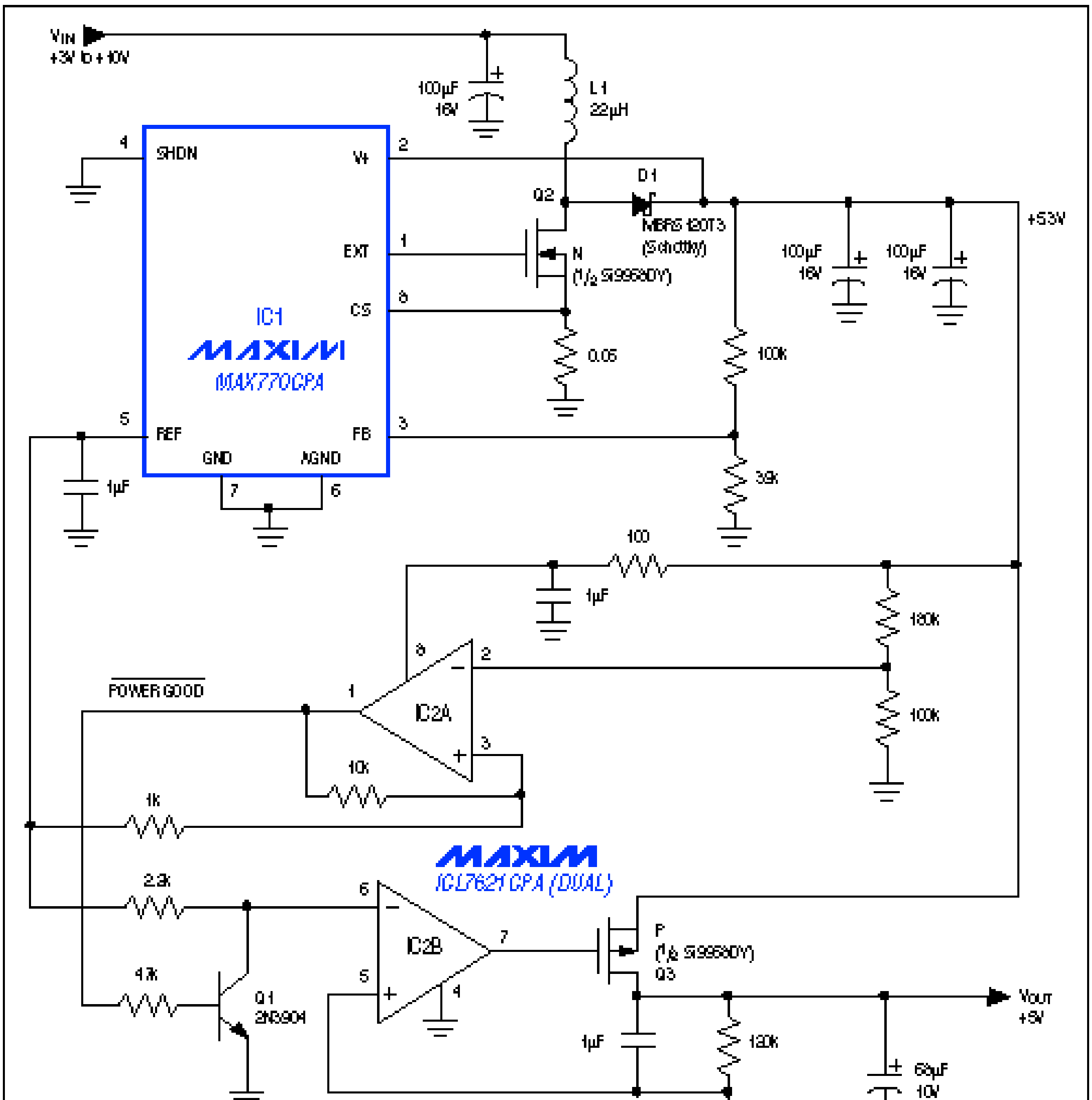
APPLICATION NOTE 544

Boost/Linear Regulator Derives 5V From Four Cells

This topology of a boost followed by a LDO regulator offers an efficient buck-boost solution for loads up to 1A. The board space is also optimized by using a dual MOSFET SO-8 package for the boost switch and the LDO pass element.

Boost regulators usually fall out of regulation when VIN rises above VOUT. But, following the boost regulator with a linear regulator enables the combination to maintain a nominal regulated output for inputs that range above and below that level. The circuit of **Figure 1**, for example, maintains a regulated 5V for inputs from 3V to 10V. For inputs above 3.2V, the circuit can start up under a full load of 1A.



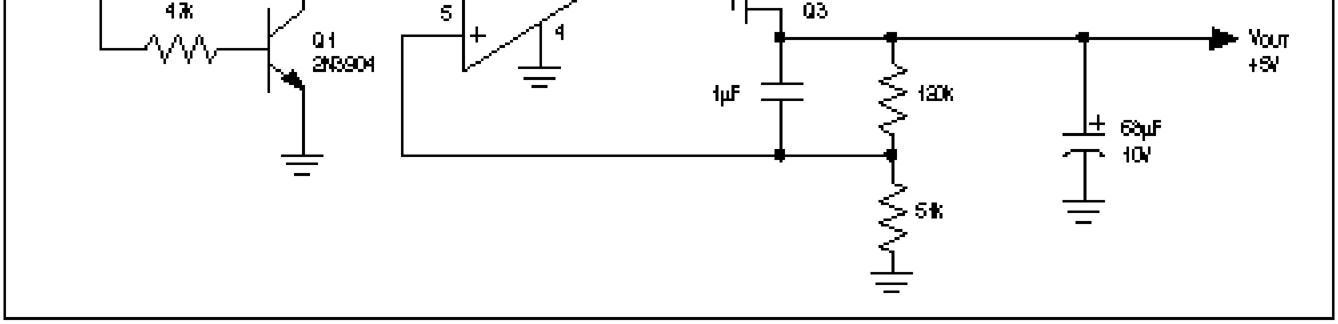


Figure 1. This boost/linear regulator maintains a 5V output for inputs from 3V to 10V, and starts under full load (1A) for inputs above 3.2V.

The boost regulator (IC1) is a switching type that produces a regulated output of approximately 5.3V for VIN less than 5.7V. For VIN above 5.7V it does not maintain switching action, so Q2 shuts off and dc current flows from VIN through L1 and D1. (This behavior is typical for boost regulators when VIN is greater than the nominal output voltage.) With high input voltages, the boost-regulator output rises above 5.3V, but the linear regulator (IC2B) assures a constant 5V output.

This configuration is suitable for 5V supplies derived from batteries of three to five cells, and for dual-input applications in which either a battery or an external dc source provides the input voltage. (Some systems, for example, let you remove the battery while applying power with an external charger.)

Boost regulators powered by their own output voltage (bootstrapped regulators) often have trouble starting under load. The difficulty centers on the external switching MOSFET-it can't substantially boost VOUT until it sees a full-amplitude gate drive, and the gate drive can't achieve full amplitude until VOUT is substantially boosted.

This difficulty is overcome by the POWER GOOD line. During turn-on the line is high, which disconnects the load from the boost regulator by turning on Q1 and disabling the linear regulator. The linear regulator then resumes normal operation after the boost regulator is up and running.

The dual MOSFET Si9958DY (n-channel and p-channel) is well suited for this application. When the p-channel device is in heavy use the n-channel is inactive, and when the n-channel device is active (boosting) the p-channel drops less than 0.5V. Thus, the SO-8 package rating (2W at room temperature) allows an output current of 1A for inputs from 3.2V to 7V. Above 7V or at higher temperature, the package rating limits the output current.

This circuit topology is useful over wide ranges of output current and input voltage, and yields reasonable efficiency over much of those ranges (**Figure 2**).

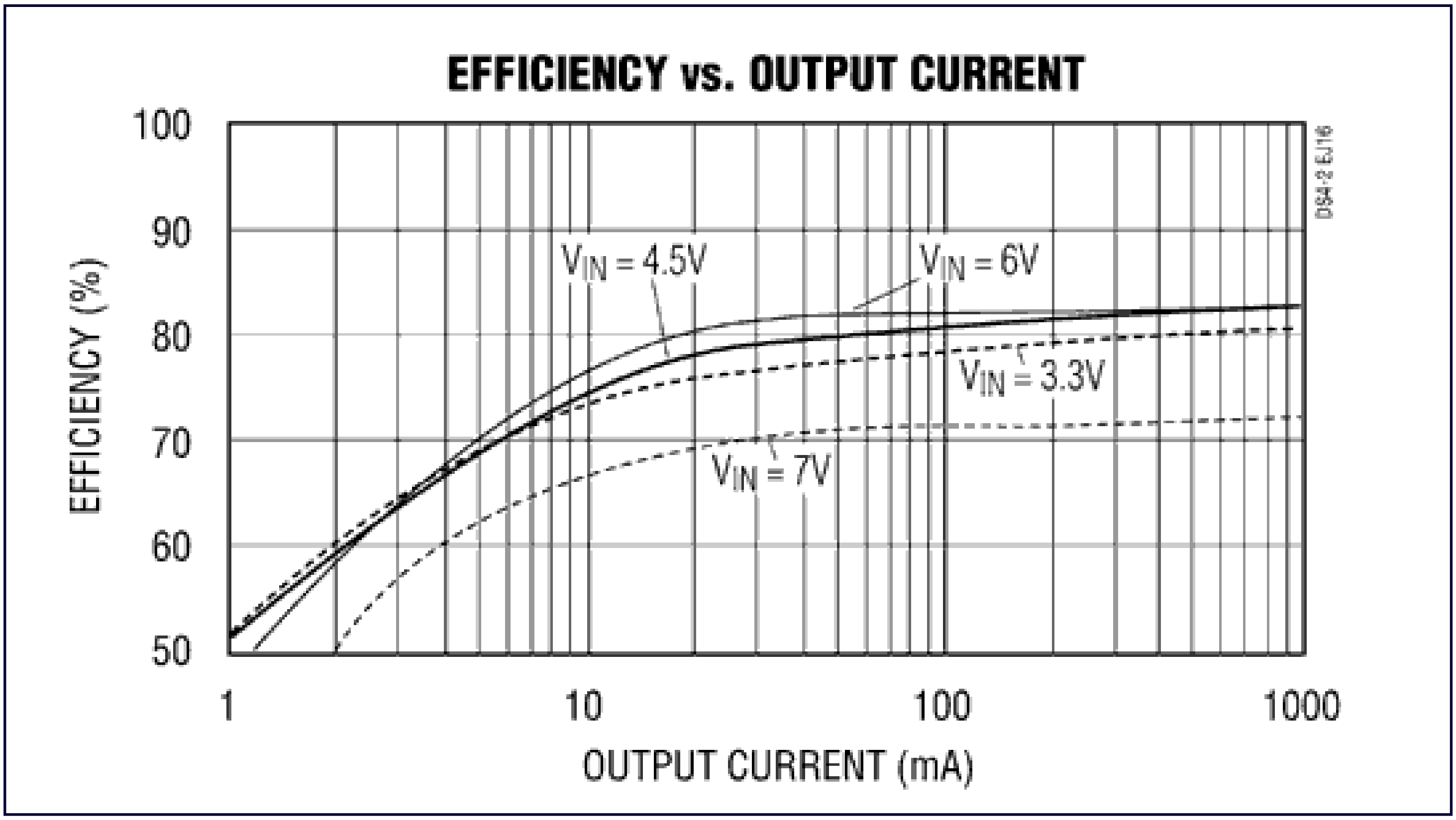


Figure 2. Efficiency for the Figure 1 circuit increases with VIN until the boost regulator shuts down, and then drops with the rise of dissipation in Q3.

A version of this idea has appeared in EDN.

Application Note 544: http://www.maxim-ic.com/an544

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