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APPLICATION NOTE 1029

Supply Generates 5V from Low-Voltage Solar-Cell Power

Abstract: This application note describes generating 5V supply voltage from very low input voltage of solar cells. Two stage, high efficiency, MAX866 step-up DC-DC converter and MAX1771 boost controller are used to start up and provide 5V rail under full load and as low as 0.8V input voltage.

Applications powered by solar cells often require a +5V power supply, but the cells typically provide only a 0.8V to 1.4V terminal voltage, with a 3A to 4A current capacity. Most dc-dc converters cannot start at such low voltages, nor can they start under full load. A two-step approach (**Figure 1**) enables the system to start up and produce the 5V rail under full load.

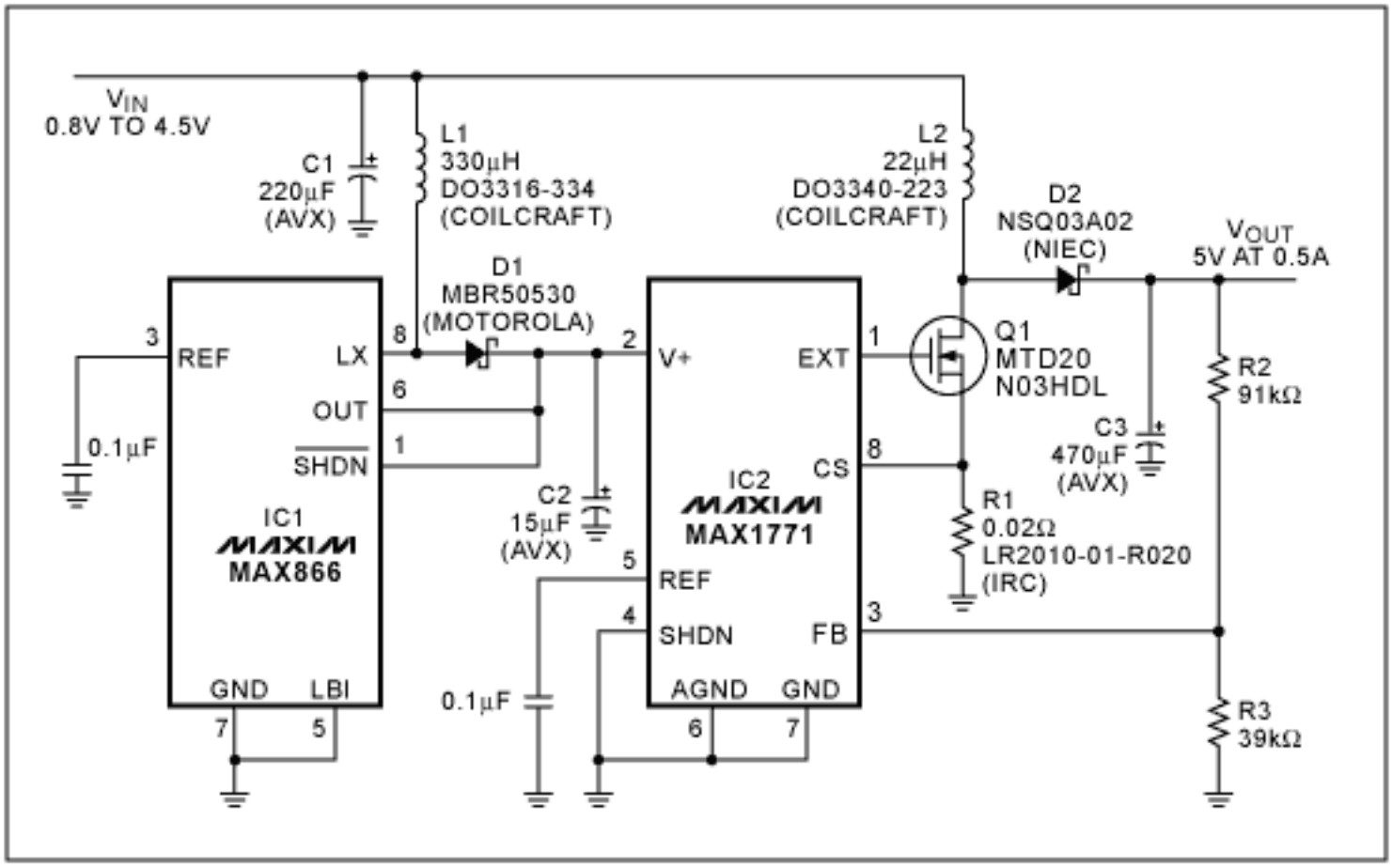

Figure 1. This two-stage step-up converter derives 0.5A at 5V from a typical solar-cell array, and guarantees start-up under full load.

IC1 operates in bootstrapped mode (powered by its own output) and boosts the input voltage from 0.8V (min) to 5V. Powered by 5V, the second converter (IC2) then delivers as much as 0.5A. IC2's output voltage (5V) is programmed by R2 and R3. IC1 thus enables IC2 to start regardless of load conditions. Providing IC2 with a full +5V supply also minimizes $R_{DS(ON)}$ in the external n-channel MOSFET by providing a 0V to 5V (max) gate drive (voltage swing).

To suppress input ripple due to power-supply switching, specify C1 as a 220µF, low equivalent series resistance (ESR) capacitor. This input capacitor also minimizes supply-voltage fluctuations by lowering the solar cell's

output impedance. The 330µH inductor (L1) enables a low start-up voltage for IC1. IC1's 15µF, low-ESR output capacitor (C2) minimizes supply-voltage ripple for IC2.

Make sure that the output-stage inductor (L2) is properly rated for maximum peak inductor current and maximum saturation current. The current-sense resistor (R3) limits peak current in this inductor to 100mV/R3. IC2's 470µF, low-ESR output capacitor (C3) reduces output ripple to less than 80mVp-p for load currents as high as 600mA. Smaller output load-current values permit smaller values for C1 and C3.

Figure 2 shows the overall conversion efficiency for different input voltages versus load current. The circuit delivers 200mA or more for V_{IN} = 0.8V, and 450mA or more for V_{IN} = 1.5V.

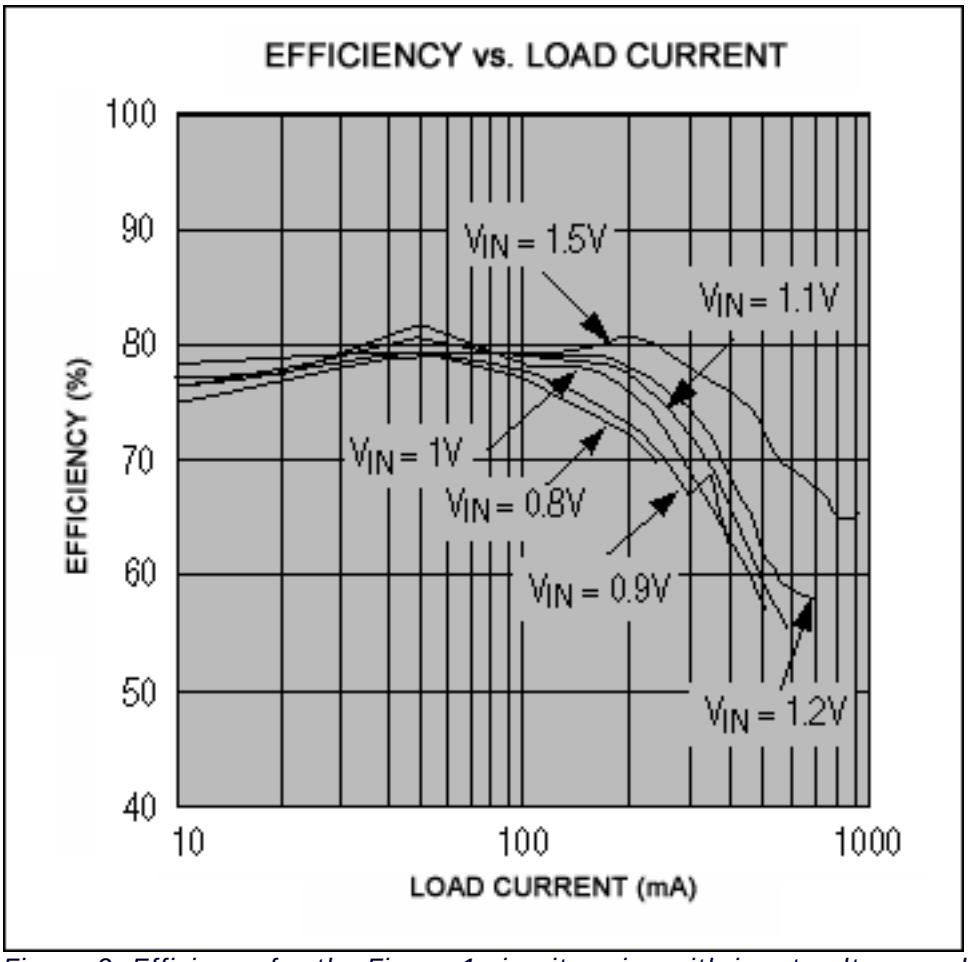

Figure 2. Efficiency for the Figure 1 circuit varies with input voltage and load current.

A similar idea appeared in the August 15, 1996 issue of EDN.

Application Note 1029: http://www.maxim-ic.com/an1029

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