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Keywords: USB ports, USB-port power, current-sense amplifiers, voltage references, op amps, n-channel MOSFETs

APPLICATION NOTE 4563

Dynamic Siphon Steals Current from USB Port

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Abstract: This circuit exploits all the power available from a USB port by dynamically adjusting the amount of current delivered to the load, thereby siphoning a relatively constant (and maximum) current from the USB port. Included are a current-sense amplifier (MAX4173), voltage reference (MAX6129), and precision op amp (MAX4238).

A similar version of this article appeared in the Decmeber 15, 2006 issue of *EDN* magazine.

USB ports can be a handy source of 5V power. Not only can a USB port power a microcontroller and other essential circuitry, it often has enough current headroom left over to charge an energy-storage element such as a small battery or super-capacitor. The typical approach is to estimate the maximum current drawn by the essential circuitry, and then place an appropriate current-limiting device in the path of the energy-storage device (**Figure 1**). Though simple, this method doesn't utilize all of the available USB current. It therefore takes longer to charge the energy-storage device.

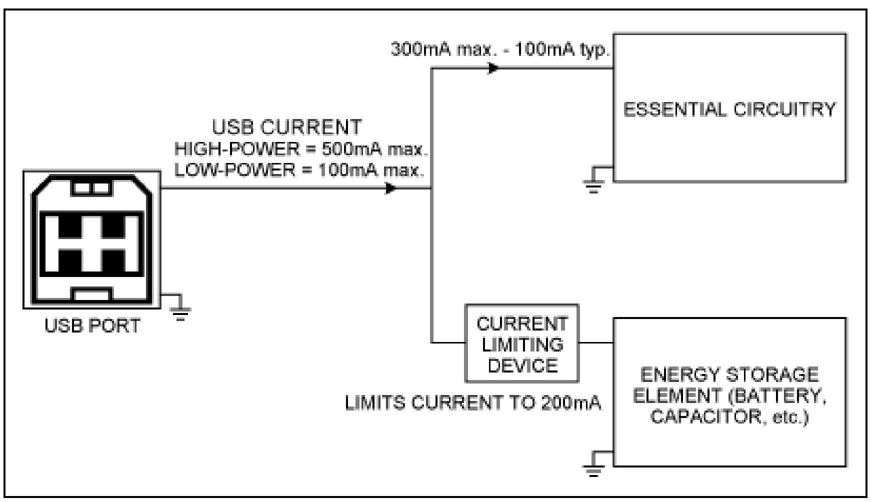

Figure 1. In this typical method for drawing power from a USB port, the storage-element current is limited to a fixed value that is less than optimal.

The circuit of **Figure 2** exploits all of the available USB power by dynamically adjusting the amount of current delivered to the energy-storage device, thereby siphoning a relatively constant (and maximum) current from the USB port. U1 (MAX4173), U2 (MAX6129), and the load-switch configuration (P1, N1, R2, and C4) form a control loop that limits the current flowing through P1. The circuit maximizes current flowing to the energy-storage element (**Figure 3**) by ensuring that the sum of battery and essential-circuitry currents never exceeds the maximum allowed for a USB high-power device (500mA).

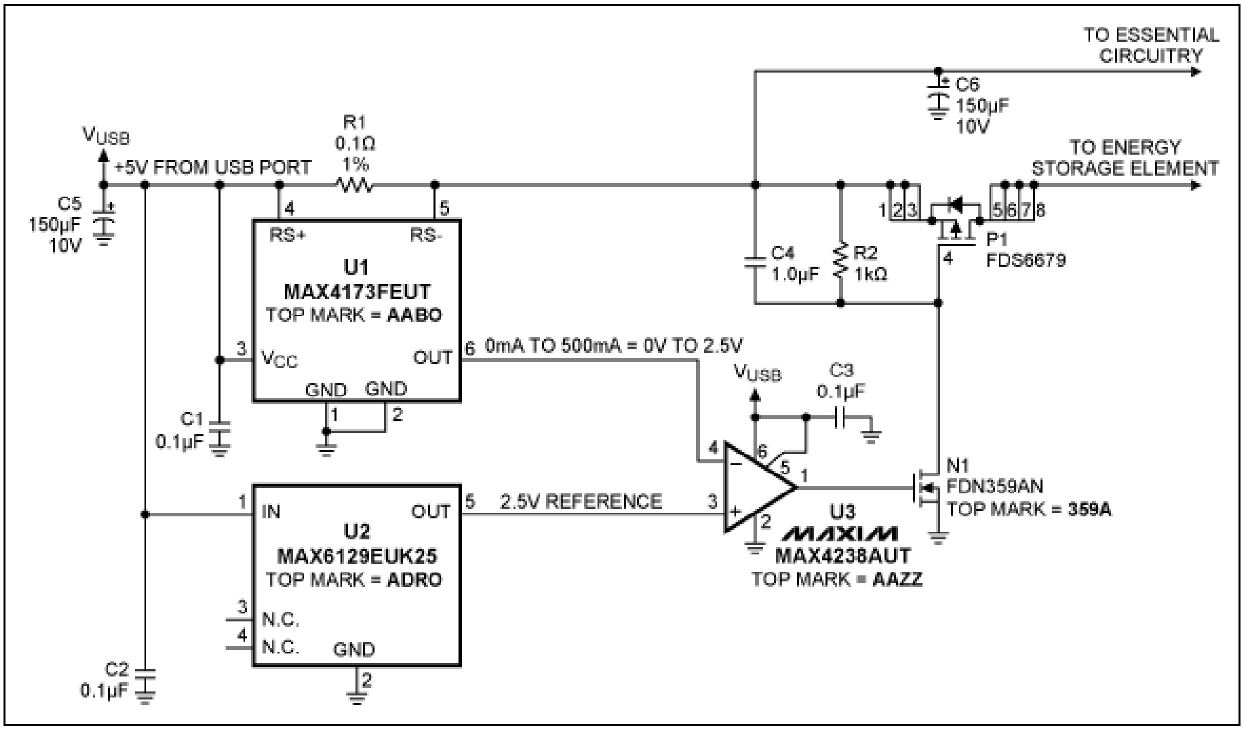

Figure 2. This circuit continuously monitors the total current drawn from the USB port, and dynamically adjusts the storage-element current as required to avoid exceeding the port's maximum output capability.

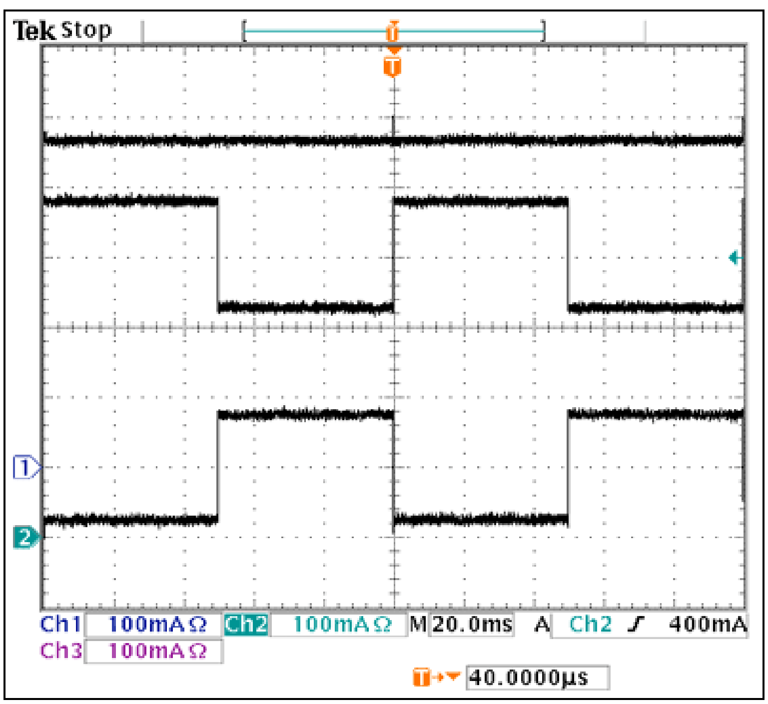

Figure 3. These waveforms from the Figure 2 circuit show that the sum of the essential-circuitry current (middle trace) and storage-element current (bottom trace) is always less than the 500mA maximum specified

for the USB port (top trace).

To reconfigure the circuit for USB low-power operation (100mA max), you can replace U1 with a MAX4173HEUT (a device with 100V/V gain) and R1 with a 250mΩ resistor.

Related Parts		
MAX4173	Low-Cost, SOT23, Voltage-Output, High-Side Current-Sense Amplifier	Free Samples
MAX4238	Ultra-Low Offset/Drift, Low-Noise, Precision SOT23 Amplifiers	Free Samples
MAX6129	Ultra-Low-Power Series Voltage Reference	Free Samples

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