Keywords: Voltage-Inverter IC Forms High-Efficiency Rail Splitter

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APPLICATION NOTE 1199

Voltage-Inverter IC Forms High-Efficiency Rail Splitter

A switched-capacitor voltage inverter configured as a "rail splitter" (IC1 in **Figure 1**) provides a bipolar (dual-rail) local power supply that is useful in single-rail systems featuring one or more dual-rail ICs. Moreover, the tiny SOT-23 package and associated components require very little board area.

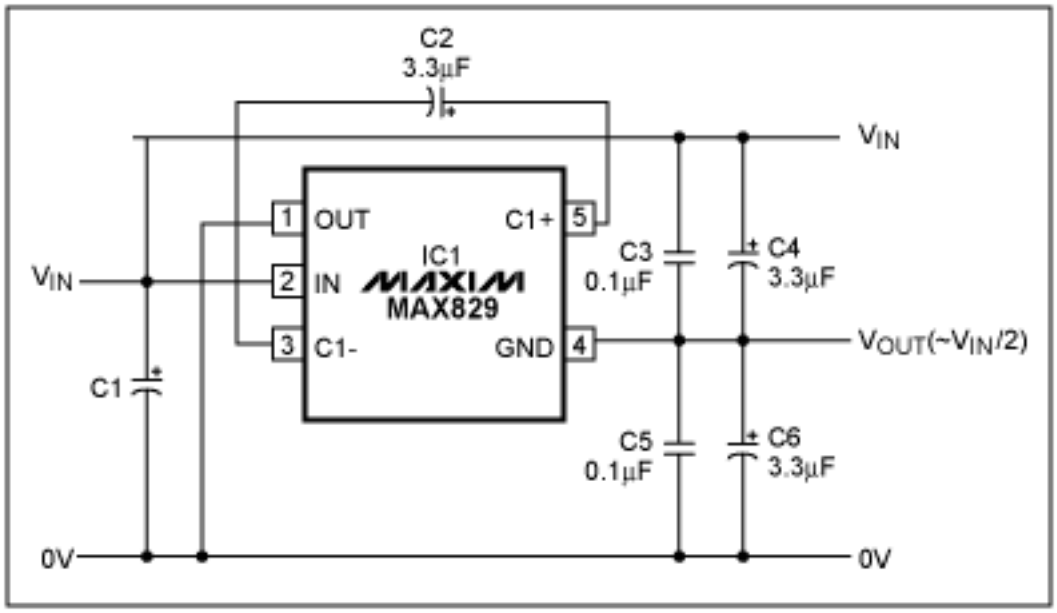

Figure 1. This compact and efficient charge-pump circuit implements a local dual-rail supply for single-rail systems.

After power is applied, the flying capacitor (C2) connects alternately across the storage capacitors C3/C4 and C5/C6. This action equalizes the voltages on those capacitors and draws current from V_{IN} or V_{OUT} as required to maintain $V_{OUT} \approx ½V_{IN}$.

If the loads across V_{IN}-V_{OUT} and V_{OUT}-0V are equal, the IC sits in a quiescent state and draws about 36µA. To keep V_{OUT} at the mid-rail level, the flying capacitor needs only to supply the difference current caused by unbalanced loads. Efficiency is degraded by the IC's quiescent current for load currents below 100µA, but above 1mA the efficiency is greater than 90%—an excellent feature for low-power or battery-powered applications. (Voltage error and efficiency vary with the load current, as shown in **Figures 2** and **3**.)

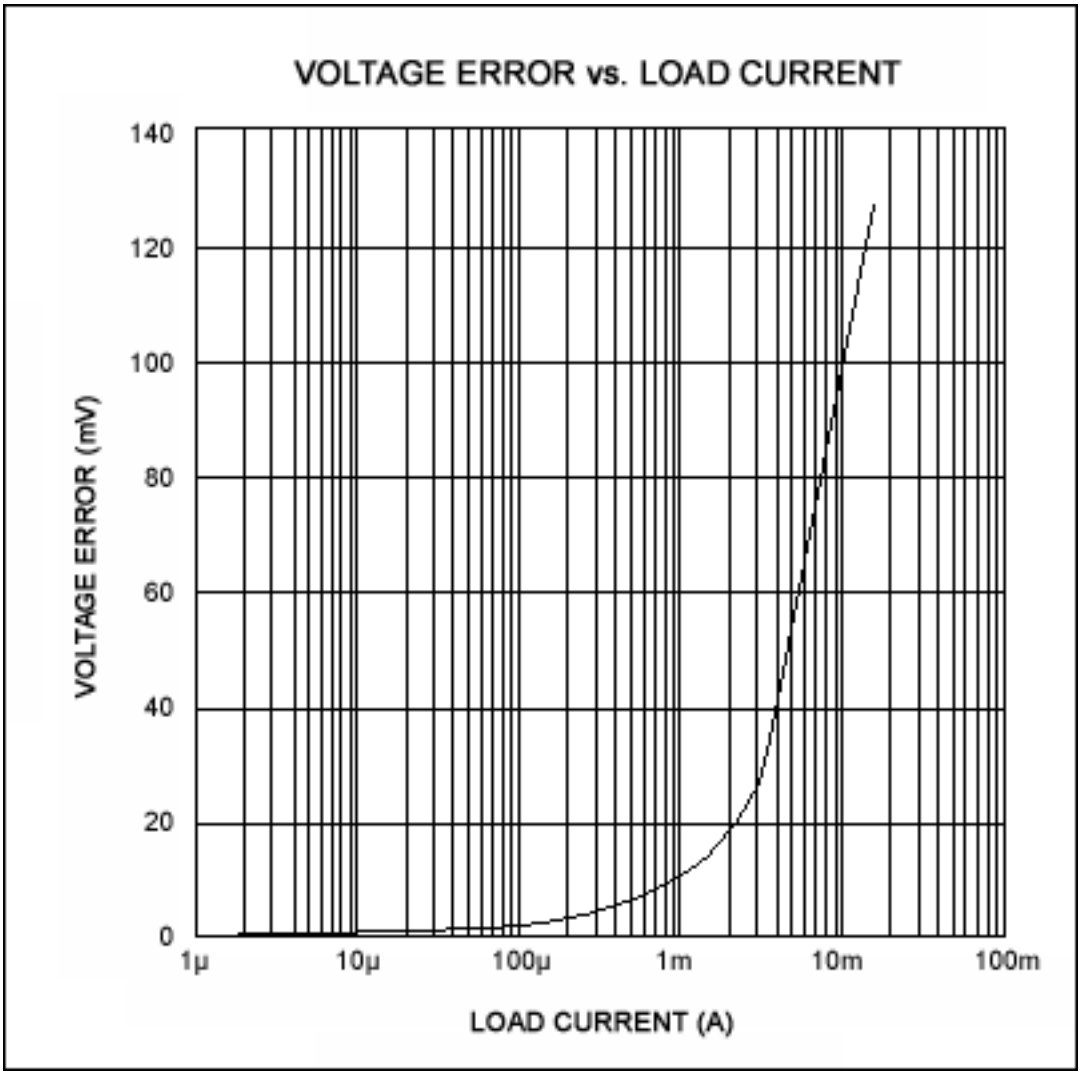

Figure 2. The output voltage error in Figure 1 increases with load current.

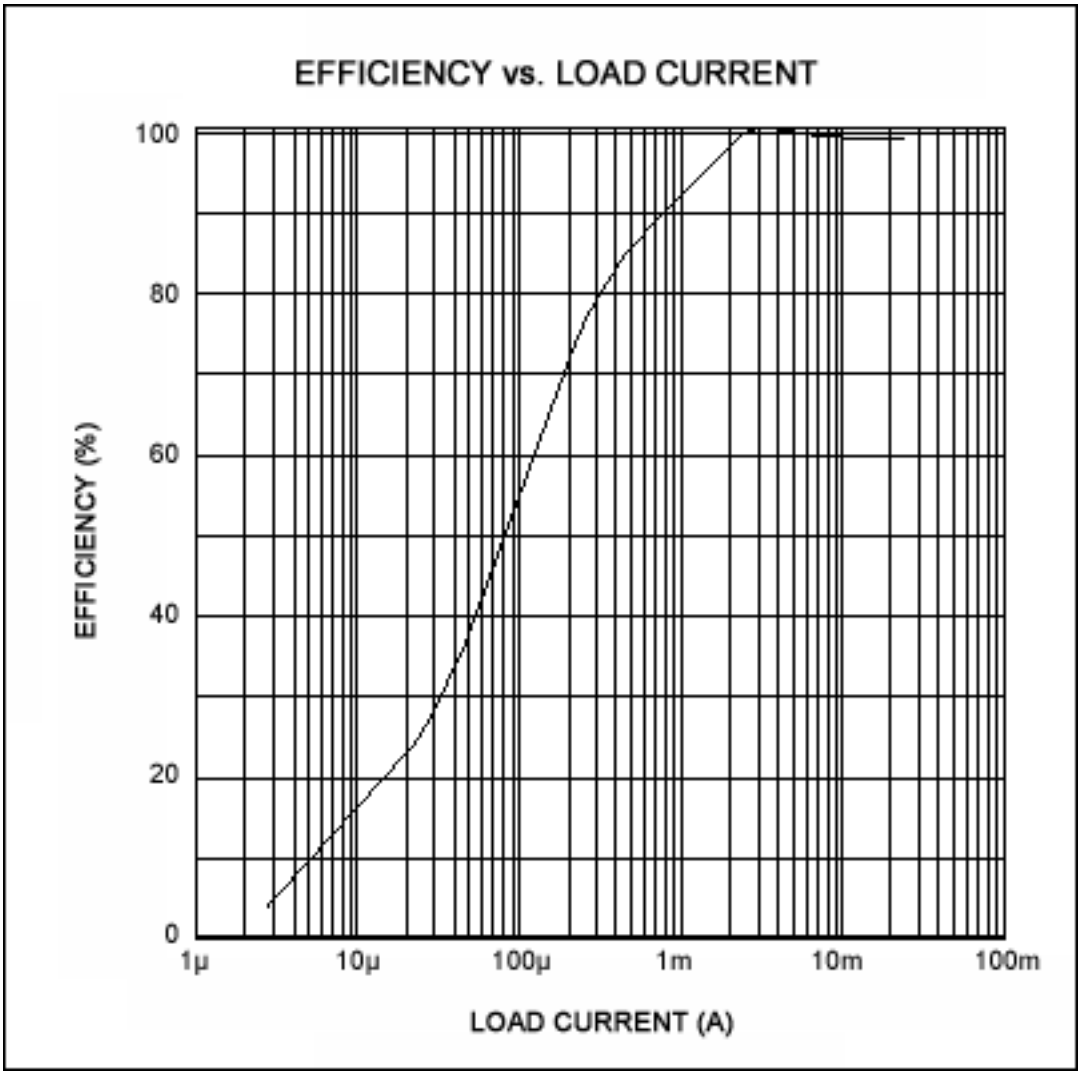

Figure 3. Efficiency also increases with load current in Figure 1.

This switched-capacitor circuit provides better regulation than that of a simple voltage divider, and better efficiency than that of a simple combination of divider and op-amp buffer. Its main drawback is the increase in output noise with load (see **Table 1**). V_{IN} is restricted (by the IC specifications) to a maximum of 5.5V, which is the maximum voltage allowed between pins 2 and 4 or between pins 1 and 4.

R_{LOAD} (Ω)	INPUT CURRENT (µA)	V_{OUT} ERROR (mV)	OUTPUT CURRENT (µA)	RIPPLE (mV_{P-P})	EFFICIENCY (%)
∞	36.5	—	—	—	—
10M	36.5	—	0.25	—	0.34
10M	37.7	—	2.5	—	3.32
100k	48.9	0.1	25	—	25.56
10k	156	1.4	250	~1	80.04
1k	1240	13.5	2490	~5	99.72
470	2630	28.5	5260	~8	98.83
100	11,410	126.9	23,700	~30	98.71

A similar idea appeared in the August 1, 1997 issue of *EDN*.

Application Note 1199: http://www.maxim-ic.com/an1199

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AN1199, AN 1199, APP1199, Appnote1199, Appnote 1199