One-chip voltage splitter conserves battery power

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Positive and negative supply voltages of equal magnitude are usually secured in a battery or other low-power floating-source arrangements by establishing system ground at half the source potential by means of a simple voltage divider. But this scheme more often than not consumes excessive power. Modifying Intersil's ICL7660 positive-to-negative voltage converter to work as a voltage divider, however, will increase the power-conversion efficiency to as high as 98% at an output current of 10 milliamperes.

The conventional voltage divider circuit shown in (a) uses two resistors and a unity-gain operational-amplifier buffer. While this circuit can function at relatively low power, depending upon the op amp used and the value of R, it will suffer from an inherently low power efficiency if the load should be connected between system ground and either V^+ or V^-. In such cases, the current flowing through the load will always be the same as that drawn from the battery, and thus the maximum efficiency can never be greater than 50%.

The ICL7660 can be made to simulate a divide-by-2 voltage converter by simply grounding pin 5 (normally the V^- lead) and using the normally grounded lead at pin 3 as the output, as shown in (b). The voltage distribution on the chip will be unchanged, since pin 3 is midway between V^+ and V^-, as before. And no power is lost in heating up any resistance, as the ICL7660 operates in the switched-capacitor (charge-transfer) mode to derive the output voltage.

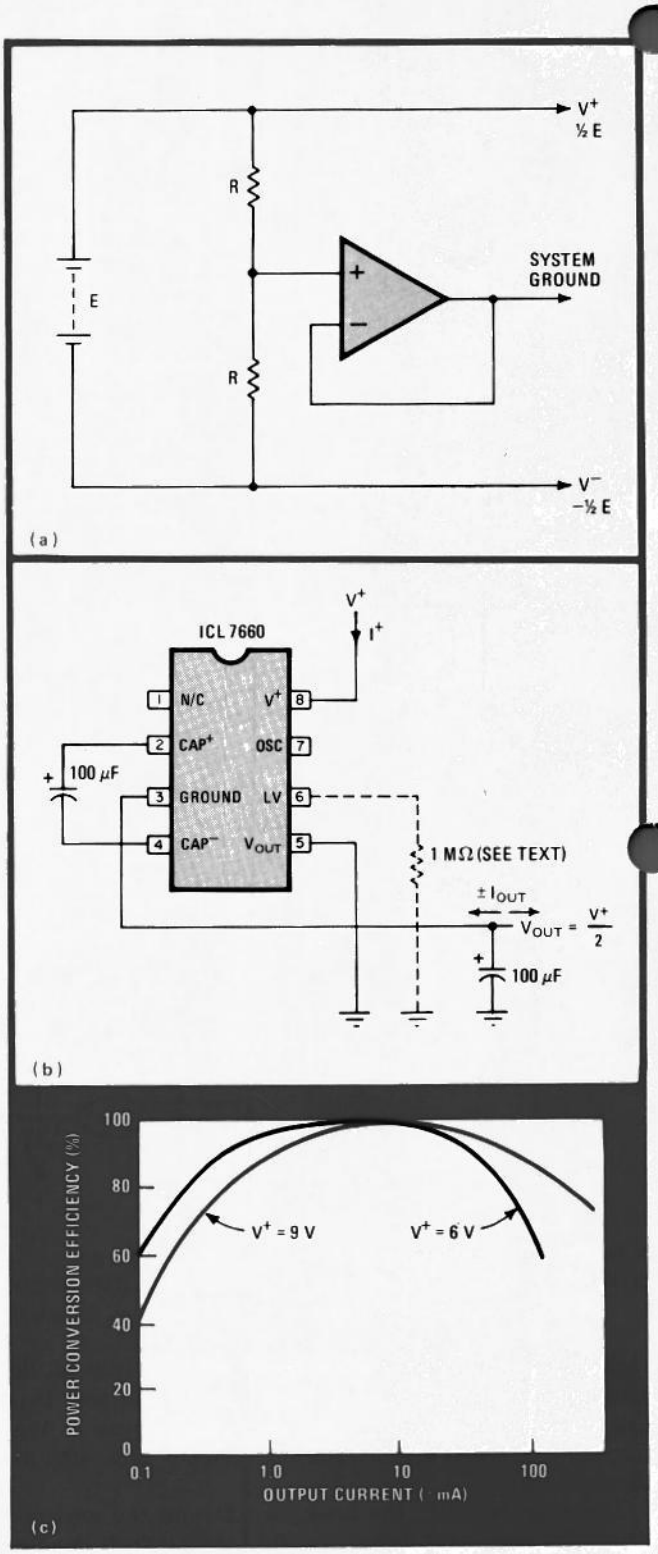
With this configuration, an open-circuit output voltage equal to $V/2 \pm 0.1\%$ is achieved. The output impedance is 13 ohms for a supply voltage of 9 V and 0.1 mA $< I_{out} <$ 80 mA, or 17 ohms for V = 6 V and an output current in the same general range.

Because the ICL7660 can source only an output current reliably, difficulty may be encountered if the load is connected between pins 3 and 8 of the device. To ensure startup for current-sinking applications, a 1-MΩ resistor is placed between pin 6 and ground. This step guarantees that there will always be some voltage across the on-chip oscillator and the control circuitry.

As for circuit performance (c), conversion efficiency will be no lower than 80% for V = 6 V and 0.5 mA $< I_{out} <$ 80 mA. In equation form:

$$\eta = (V_{out} I_{out} / V^+ I^+) 100$$

where I_{out} is the magnitude of the output current, regardless of sign. □



Efficient. Simple resistive voltage divider (a) dissipates excessive power and thus is ordinarily not suited to providing positive and negative supply voltages from floating source. Suitably wired ICL7660 converter (b) provides the function without power loss, yielding conversion efficiencies (c) approaching 98%.