Electronic Design

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Voltage Converters Can Help Improve Battery Power Efficiency

This article explains how to extend the battery lifetime of a device by adding a nanopower converter to an existing system, which may increase the battery run time by up to 20%.

Battery-operated circuits must be energy-efficient for the battery to last a long time. For this, energy-efficient components are selected and combined into a system. The fewer building blocks in an electrical circuit, the greater the energy efficiency of the overall system. *Figure 1* shows an electrical water meter as an example of a battery-operated device. The system uses a MAX32662 microcontroller with just one supply voltage. The input voltage range lies between 1.71 and 3.63 V.

The microcontroller can be supplied directly by the battery, which delivers a voltage of 2 to 3.6 V, depending on the temperature and state of charge. Only a few additional components are required in the circuit, which means that the overall system efficiency can be very high. However, the current consumption of the microcontroller is largely independent of the actual supply voltage. Whether the microcontroller is operated with 2 V or 3.6 V makes no difference to this IC.

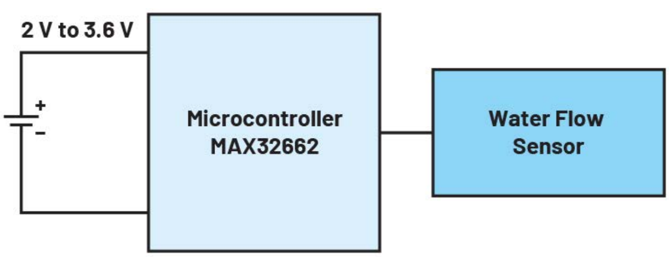
Water Meter with Nanopower Switching Regulator

For cases like this one, new nanopower switching regulators can be used. With these types of switching regulators, the battery voltage can be converted efficiently to a lower value, such as 2 V. A nanopower switching regulator delivers the required current for the microcontroller at the output, but it requires less current at the higher voltage on the battery side. *Figure 2* shows the circuit for a water meter with an added high-efficiency nanopower switching regulator, a MAX38650.

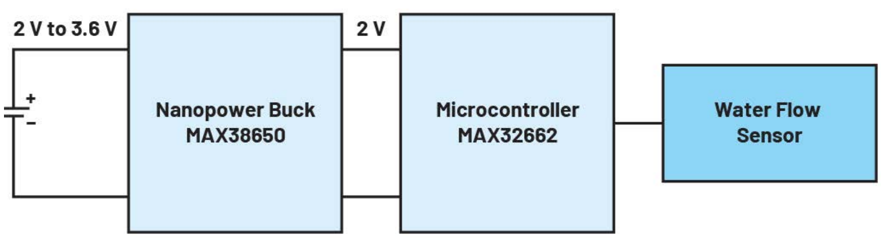
Adding this IC can significantly extend the battery life—life extensions of 20% and higher are easily possible. The exact savings effect differs from case to case because of the numerous influencing parameters, such as temperature, peak currents, periodic switch-off of the sensor, and others. The quiescent current of the added DC-DC converter is decisive here. If the switching regulator consumes too much energy, the anticipated savings disappear.

Saving Power with a Nanopower Voltage Regulator

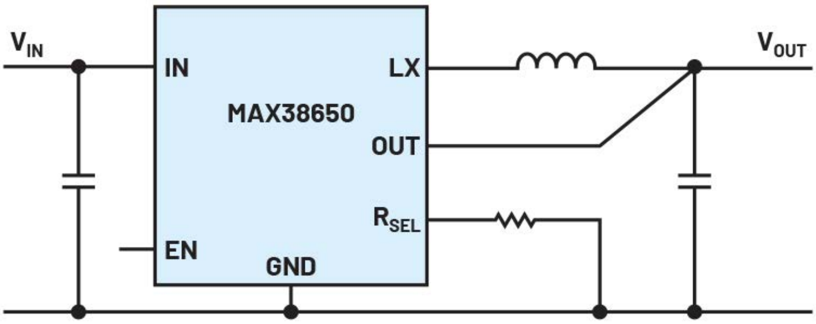
Figure 3 shows a circuit with the MAX38650 nanopower voltage regulator. As the name indicates, the quiescent current of this IC is in the nanoampere range. During operation, the switching regulator only draws 390 nA of quiescent current. During times when the DC-DC converter can be



1. The microcontroller incorporates an integrated fixed voltage regulator in a battery-operated water meter.



2. A nanopower voltage regulator was added to the water-meter circuit.



3. Shown is a nanopower regulator circuit.

switched off, it only needs 5 nA of shutdown current. This nanopower voltage converter is well-suited for saving energy in a system such as that in *Figure 1*.

As shown in Figure 3, only a few passive external components are required. Instead of a resistor voltage divider, only one resistor on the R_{SEL} pin is used to set the output voltage. A resistor voltage divider consumes a considerable amount of current, which, depending on the voltage and resistor, can greatly exceed the quiescent current of the MAX38650. Thus, this IC uses a variable resistor; it's only briefly checked when the circuit is switched on.

The IC detects the setpoint value for the output voltage—for a short time during switch-on, 200 µA of current is passed through this variable resistor. The resulting voltage is measured and then stored internally in the IC. This means there are no energy losses during operation through a conventional voltage divider.

By adding a voltage converter, it's possible to increase the efficiency of a system and extend the life on a charge.

Frederik Dostal is a power management expert with more than 20 years of experience in this industry. After his studies of microelectronics at the University of Erlangen, Germany, he joined National Semiconductor in 2001, where he worked as a field applications engineer. During his time at National, he also spent four years in Phoenix, Arizona working on switch-mode power supplies as an applications engineer. In 2009, he joined Analog Devices, where he has since held a variety of positions working for the product line and European technical support, and currently brings his broad design and application knowledge as a power management expert. Frederik works in the ADI office in Munich, Germany.