

Eight Tips for Alternate-Energy Users

Jon Titus, Senior Technical Editor



You might wonder what forms "alternate energy" can take. To me, alternate energy means a source of power not connected to local electric utility. Thus energy could come from batteries, photovoltaic cells, thermal arrays, and so on. But you cannot simply replace line power in a circuit with power from any one of these low-energy alternate sources. Based on my research and conversations with experts, I offer the following points:

1. Create an energy budget that sets the current and voltage envelope for your design. This overall budget will help you determine what components to use and what power sources to evaluate. The power budget has the same importance as the overall objective of your project. If you don't have a target, you won't know where to aim for power savings.
2. If you plan to use "harvested" energy, understand the implications of each type, wind, sun, vibrations, liquid flow, and so on. In almost all cases, you will need batteries to store energy for times when free energy isn't available. Batteries can range in size from AA cells to coin cells, and even down to a small SMT device such as the Cymbet rechargeable EnerChip solid-state battery that provides a 3.3-V output. Always examine battery-manufacturers' specifications to determine how ambient conditions and load characteristics affect battery life.
3. Each source of energy requires a different approach to power-conversion circuits. Piezoelectric sources can create hundreds of volts, but only in short bursts, while photovoltaic (PV) cells can produce lower voltages and higher currents. Choose power-supply and converter circuits with care and match them to the energy-harvesting sources you will use. Also, keep in mind external conditions that can affect energy harvesting. New construction could block wind and light, PV arrays will pick up dirt that attenuates sunlight, and vibration-energy harvesters have a fixed bandwidth.
4. Have a backup-energy plan. If one alternate-energy source doesn't meet all requirements, can you easily modify your design to adapt to another type of power source? Some energy-harvesting modules and circuits can handle several types of sources, but these components usually add cost and take up more board space than circuits created for a single type of power source. But the former offer more flexibility and give customer a variety of energy sources to choose from.

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5. Take advantage of reference designs. Semiconductor companies have much experience with alternate-energy sources, battery chargers, and regulators. Their reference circuits can help you choose and evaluate circuits appropriate for a design. Companies also supply evaluation boards with many test points that simplify measurements. In October 2011, Texas Instruments announced a bq25504EVM-674 ultra-low power boost-converter design that includes battery management for energy-harvester circuits. The board works with most MCUs and 3-V coin-cell batteries.

6. Because alternate-energy sources usually offer small amounts of power, carefully evaluate all components in your system for potential energy savings. Can you shut off or reduce power to some circuits when a system will not use them? Communication ports can waste power when not in use. Look for subassemblies, processors, and circuits can operate in standby or sleep modes. Microcontrollers in the MSP430 family, for example, let an internal ADC capture data and save it in memory even during "sleep" periods. Consider the transitions into and out of sleep or standby states, too. The longer the transition period, the more power a device uses during that phase.

7. Test your power assumptions. Tools from EnergyMicro and IAR Systems let you monitor current drawn by an MCU, and in some cases used by a complete system, and correlate it with the MCU code. A plot of power vs. code helps find periods of excessive power use and adjust code accordingly. You might find a high-power device, such as a wireless transceiver, continues to operate after program steps should have put it into a sleep mode. EnergyMicro recently announced a Battery Estimator tool that helps determine battery life for a microcontroller-based circuit.

Even minor code changes can help. As I noted in a column about low-power operations, when you use a register as a counter, count down rather than up. A down count automatically sets a flag when the count value reaches zero. But if you count up, you may need to obtain a value for a compare operation, which takes extra time and requires a memory transfer. (Ref. 1.)

8. In a wireless network, power requirements can help you choose an appropriate communication protocol. A WiFi transceiver, for example, must come up to full power and take time to connect with an access point before it can send data. But a network that uses IEEE 802.15.4 transceivers can quickly wake up, send its data, and go back to sleep. Simple protocols usually offer the best power efficiency. Keep transmissions short to save power at the transmitter and at the receiver. (Ref. 2.)

References

1. Titus, Jon, "[Tips to Help Reduce Power Demands](#) [1], ECN, January 2008.
2. Titus, Jon, "[Wireless Sensor Networks Go the Distance](#) [2]," ECN, August 2011.

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