

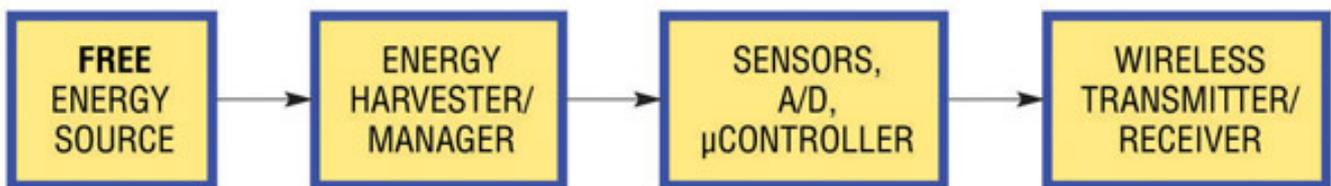
## Energy Harvesting Gets A Boost

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A wide range of low-power industrial sensors and controllers are turning to alternative sources of energy as the primary or supplemental means of supplying power. Ideally, such harvested energy will eliminate the need for wired power or batteries altogether.

Transducers that create electricity from readily available physical sources such as temperature differentials (thermoelectric generators or thermopiles), mechanical vibration (piezoelectric or electromechanical devices), and light (photovoltaic devices) are becoming viable sources of power for many applications. Numerous wireless sensors, remote monitors, and other low-power applications are on track to become near “zero” power devices using harvested energy only (commonly referred to as “nanoPower” by some).

Although energy harvesting has been emerging since early 2000 (its embryonic phase), recent technology developments have pushed it to the point of commercial viability. In short, in 2010 we are poised for its “growth” phase.



**Figure 1:** The four main blocks of a typical energy-scavenging system.

### Commercial Acceptance

Even though the concept of energy harvesting has been around for a number of years, the implementation of a system in a real world environment has been cumbersome, complex and costly. Nevertheless, examples of markets where an energy harvesting approach has been used include transportation infrastructure, wireless medical devices, tire pressure sensing, and of course, building automation.

In the case of building automation, systems such as occupancy sensors, thermostats, and light switches can eliminate the power or control wiring normally required and use a mechanical or energy harvesting system instead. Similarly, a wireless network utilizing an energy harvesting technique can link any number of sensors together in a building to reduce heating, ventilation and air conditioning (HVAC), and lighting costs by turning off power to non-essential areas when the building has no occupants. Furthermore, the cost of energy harvesting electronics is often less than running sense wires, so there is clearly economic gain to be had by adopting a harvested power technique.

A typical energy scavenging configuration or system, (represented by the four main circuit system blocks shown in **Figure 1** below), usually consists of a free energy source such as a thermoelectric generator (TEG) or thermopile attached to a heat generating source, such as an HVAC duct for instance. These small thermoelectric devices can convert small temperature differences into electrical energy. This electrical energy can then be converted by an energy harvesting circuit (the second block in **Figure 1**) and modified into a usable form to power downstream circuits.

These downstream electronics will usually consist of some kind of sensor, analog-to-digital converter, and an ultralow power microcontroller (the third block in **Figure 1**). These components can take this harvested energy, now in the form of an electric current, and wake up a sensor to take a reading or a measurement then make this data available for transmission via an ultralow power wireless transceiver — represented by the fourth block in the circuit chain shown in **Figure 1**. Each circuit system block in this chain, with the possible exception of the energy source itself, has had its own unique set of constraints that have impaired its commercial viability — until now.

Low cost and low power sensors and microcontrollers have been available for quite sometime; however, it is only within the last couple of years that ultralow power transceivers have become commercially available. Nevertheless, the laggard in this chain has been the energy harvester and power manager. Existing implementations of the power manager block are a low performance discrete configuration, usually consisting of 35 components or more. Such designs have low conversion efficiency and high quiescent currents.

Both of these deficiencies result in performance compromised in an end system. The low conversion efficiency will increase the amount of time required to power up a system, which in turn increases the time interval between taking a sensor reading and transmitting this data. A high quiescent current limits how low the energy-harvesting source can be since it must first overcome the current level needed for operation before it can use any excess to supply power to the outputs.

### **New Boost Converter & System Manager**

What has been missing until now has been a highly integrated DC/DC boost converter that can harvest and manage surplus energy from extremely low input voltage sources. However, Linear Technology's LTC3108, an ultralow voltage boost converter and power manager, greatly simplifies the task of harvesting and managing surplus energy from extremely low input voltage sources such as thermopiles, thermoelectric generators (TEGs), and even small solar panels. Its step-up topology operates from input voltages as low as 20 mV. This is significant since it allows the LTC3108 to harvest energy from a TEG with as little as 1°C temperature change. Its step-up topology operates from input voltages as low as 20 mV. This is significant since it allows the LTC3108 to harvest energy from a TEG with as little as 1° temperature change.

The LTC3108 uses a small step-up transformer to boost the input voltage source to

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a LTC3108 which then provides a complete power management solution for wireless sensing and data acquisition. It can harvest small temperature differences and generate system power instead of using traditional battery power. The LTC3108 takes a “systems level” approach to solving a complex problem. It can convert the low voltage source and manage the energy between multiple outputs. The AC voltage produced on the secondary winding of the transformer is boosted and rectified using an external charge pump capacitor and the rectifiers internal to the LTC3108.

With analogue switchmode power supply design expertise in short supply around the globe, it has been difficult to design an effective energy harvesting system as illustrated in **Figure 1**. However, with the introduction of the LTC3108 thermal energy harvesting, DC/DC boost converter and system manager that’s all about to change.

This revolutionary device can extract energy from solar cells, thermo-electric generators or other similar thermal sources. Furthermore, with its comprehensive feature set and ease of design, it greatly simplifies the hard-to-do power conversion design aspects of an energy harvesting chain.

*For more information visit [www.linear.com](http://www.linear.com) [1].*

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