Nanopower Electronics Provide Wireless Links Without Using Batteries

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One part of wireless technology that is currently in a rapid growth phase is ultra-low power. Sensors and the wireless transmission of their data offers many valuable possibilities in the monitoring and control of building HVAC systems, gathering meteorological and climate data, providing real-time measurement of stresses on the structure of aircraft, and many other applications. This report presents a number of new developments in the area, from ZigBee and IEEE802.15.4 wireless, to devices that harvest energy from the environment to power those devices with no need for batteries.

CEL/LS Research ZigBee/802.15.4 Module

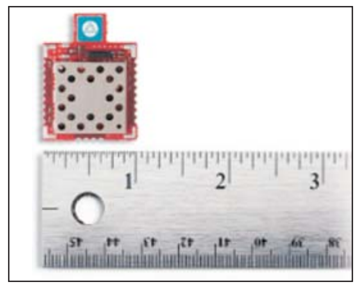
California Eastern Laboratories and LS Research have signed an exclusive global agreement to design, manufacture and market miniature transceiver modules for ZigBee and other low cost, low power IEEE 802.15.4 data transmission applications. The CEL/LSR Freestar module is based on Freescale™ Semiconductor's MC13192 transceiver and its MC9S08GT60 microprocessor It is a fully-integrated, drop-in RF transceiver solution that is ideal for office and building automation, applications including HVAC and lighting control, and security systems. Fully FCC and CE-certified and RoHS compliant, it features an integrated capability for 10 mW or 100 mW power and provides up to 4000 feet of range, line-of-sight.

LSR has also streamlined the communications protocol, resulting in the lowest power consumption in transmit mode of any module on the market. 10 mW transmit requires 125 mA from a 2.4-3.6 VDC supply, while 100 mW transmit draws 150 mA. Receive current consumption is 42 mA. In the standby mode, the current is less than 5 µA. In a networked system, each module would be powered up at intervals determined by the requirements for the sensor or control operated by the module. Low duty cycles greatly extend battery life.

AeroComm's ZigBee Solution

AeroComm's new ZB2430 module, based on Texas Instruments' leading edge 802.15.4 SoC & Z-Stack™ technology, is a powerful ZigBee compliant solution. The ZB2430 provides OEMs with 2.4 GHz module performance in low power consumption, integration, long range, features and functionality.

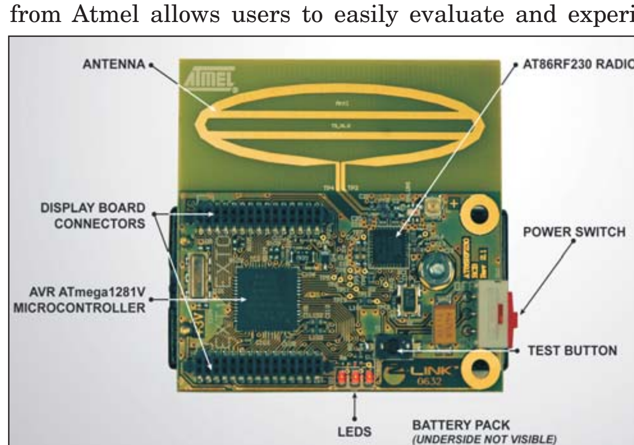
ZB2430 is ideal for power-restricted or battery-powered applications. Its receive (25 mA from a 3V supply)) and power-down mode performance offers OEMs a low power consumption transceiver module. Power output is variable from 0 to 100 mW, with maximum current draw of 169 mA at 100 mW. Since the ZB2430 works in the ISM band, the module can be used globally—allowing OEMs to standardize on one platform for their end products. Although the IEEE 802.15.4 (PHY & MAC) and ZigBee stack are industry standards, AeroComm's flexible "ZigBee Your Way" approach allows OEMs to customize a solution that best meets their needs.



With the embedded Z-stack firmware, ZB2430 is built for secure, low power, mesh network applications. Modules are offered as Coordinators, Routers or End Devices. Network scan, auto-configuration, dynamic routing, discovery and security all enable the Mesh network. Additionally, the 128 kB of embedded Flash provides room for larger, more complex application profiles. A GUI based utility and test software allow an OEM to easily configure and optimize the device.

Atmel WPAN (IEEE 802.15.4) Demonstration Kit

The ATAVRRZ200 Demonstration Kit (photo below) from Atmel allows users to easily evaluate and experi-



ment with a ZigBee/IEEE 802.15.4 system. The major components—transceiver IC, low power MPU, antenna and interconnections are evident in the photo.

Depending on the application requirements, the LR-WPAN may operate in either of two topologies: the star topology or the peer-to-peer topology. Software for operation of the demonstration board is included. With two of the boards in operation, users can explore many different possible applications for the technology.

Energy Harvesting can Augment or Replace Batteries in Many Systems

ZigBee and other IEEE 802.15.4 applications are among the first large-scale applications of ultra-low power wireless, and we can expect new developments in the near future. Their extremely low power requirement makes it possible to eliminate batteries in many cases, replacing them with electric power generated by numerous small and inconspicuous devices that convert heat, light and motion into electricity.

The concept of converting energy from motion, vibration, sunlight and other “incidental” sources has recently expanded to the consumer market. Tiny generators are available for “roller sneakers” and other commonly used devices. Piezoelectric converters can be embedded in shoes, clothing or outerwear, and the energy used to recharge batteries or be stored in a large-value “super capacitor” to replace batteries. As long as the average power supplied matches the consumption of the unit being operated (MP3 player, handheld video game, etc.), no batteries are required.

The most established methods of energy harvesting, wind and solar power, are also advancing, with thin-film solar cells and small-scale wind generators reaching the lowest prices ever for these technologies, in terms of dollars per watt.

In commercial and military applications, the effort is substantial. Piezoelectric energy harvesting from industrial or HVAC machinery is being studied by graduate students at numerous universities. The figure of merit used to evaluate various methods is energy density. An individual’s activity can be captured by devices that have demonstrated energy densities in the range of 500 µW per cm^3. Thus, a small piezoelectric or other vibrational transducer can easily provide a few mW with the person barely aware of its presence. This is easily sufficient for many low duty cycle applications such as GPS location monitors or multi-function health monitors.

In an industrial environment, where heat and vibration far exceed typical human activity, much greater amounts of waste energy can be converted into electricity and stored for use in manufacturing WLAN monitoring and control, security systems and environmental monitoring systems. Although normal sources of power are available in an industrial plant, energy harvesting is attractive for systems that are located in areas that are difficult to access, or for systems that are regularly dismantled and reconfigured.

Other applications with obvious energy harvesting capabilities include wildlife tracking systems, active livestock tracking and monitoring systems with greater capability than RFID can support, long-term meteorological monitoring sites, and many others.

Energy harvesting technologies that are currently in development include MEMS piezoelectric converters, thermal energy harvesters using IC fabrication techniques, and strain-induced energy converters such as “smart wires” that both alter shape in response to applied current and create current when stressed. To increase the total power that can be obtained, these technologies are often combined with wind generators, solar cells and miniature rotary generators. Practical objectives would be a few watts of nearly continuous power generation, which would support many current portable computing, entertainment and wireless communications devices. In a military environment, additional power may be needed, which may be stored in fuel cells, obtained by a solar panel or created with human-powered generators.