Electronics/Computers

Modular Wireless Data-Acquisition and Control System

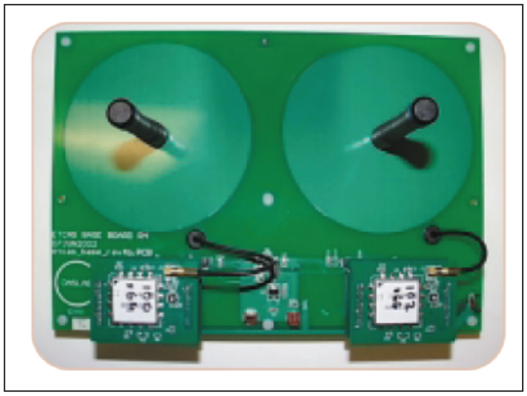
This system can be used to build an autonomous, highly reliable instrumentation network.

John F. Kennedy Space Center, Florida

A modular wireless data-acquisition and control system, now in operation at Kennedy Space Center, offers high performance at relatively low cost. The system includes a central station and a finite number of remote stations that communicate with each other through low-power radio-frequency (RF) links. Designed to satisfy stringent requirements for reliability, integrity of data, and low power consumption, this system could be reproduced and adapted to use in a broad range of settings. Examples of potential applications include industrial instrumentation, home automation, wireless intrusion-detection systems, remote reading of meters, medical instrumentation, telecommunications, automotive systems, homeland security, and military reconnaissance.

The central station has been implemented on several platforms, such as single board computers, personal computers, and the like, running custom software developed by NASA. Through its RS-232 port (a standard port for asynchronous serial data communication), the central station is connected to radio-transceiver modules (see figure) identical to the corresponding modules in the remote stations.

The remote stations contain programmable microcontrollers that can be easily reconfigured to perform many functions, depending on the application. For example, the microcontrollers can buffer data, process data, provide excitation for sensors, perform signal-conditioning and -conversion functions, and control local equipment. The microcontroller architecture can easily accommodate local "smart sensor" instrumentation that has self-calibration and self-diagnosis capabilities. Moreover, by suitable processing of data, the microcontrollers gain the ability to make decisions regarding operation and regarding the selection of relevant information to send to the central station; as a result, the bandwidth needed for communication is reduced and the system can be made less complex than it would otherwise be.



The **Central Station Hardware** includes communication modules that contain generic RF circuit boards. Identical communication modules are used in the remote stations.

The remote stations include power-management modules. An efficient power-management scheme enables the remote stations to operate on batteries for several years (sampling rate dependent). Each remote station stays in a low-power-consumption mode until either it receives a message from the central station or another event triggers its power-management module to supply power to the other modules.

The output power of the radio transmitter in each station is made low (≈10 mW) to minimize interference. The range of each station is 300 feet (about 90 m) with a small whip antenna and can be increased by use of a directional antenna. The system is based on a spread-spectrum transceiver and uses an in-house developed algorithm to central communication over more than 100 frequency pairs on a 433- or 918-MHz base frequency. The wireless links currently operate at a data rate of 19.2 kb/s, but are capable of 115 kb/s.

The central station normally communicates with all remote stations directly, but the system can reconfigure itself to restore communication when a remote station moves out of range or interference occurs. Upon loss of the RF signal from a remote station, the central station initiates a routine to determine which remote station(s) can become a relay for the lost station. The routine can occur on multiple levels to create a chain of stations and thereby enable long-distance communication using relatively low power.

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Microwave System for Detecting Ice on Aircraft

This system can distinguish among ice, water, and ice/water mixtures.

John H. Glenn Research Center, Cleveland, Ohio

A microwave-based system has been developed as a means of detecting ice on aircraft surfaces, with enough sensitivity to provide a warning before the ice accretes to a dangerous thickness. The system can measure the thickness of ice from a few mils (1 mil = 0.0254 mm) to about 1/4 in. (≈6 mm) and can distinguish among (1) ice, (2) water (or deicing fluid), and (3) a mixture of ice and water (or deicing fluid). Sensors have been ruggedized to withstand the rain erosion environment.

The system (see Figure 1) includes a microwave module that contains a con-