National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Instrumentation

RFID-Enabled Wireless Instrumentation

Yields low-mass power source and long operational lifetime

Innovators at NASA Johnson Space Center have developed a wireless instrumentation system whose sensor tags can operate for years in a low-power hibernation state with instantaneous over-the-air passive RFID wakeup using only a small coin cell battery. The sensor tags, which are embedded with a processor and memory bank for acquired data, are placed about the vehicle and stream data only when queried by a fixed-location RFID interrogator. Otherwise, the tags remain dormant to preserve battery life. In the hibernating configuration, the microcontroller is the only circuit drawing power in the wireless sensor tag, and it is operating in the lowest power mode possible. This architecture proves extremely useful on long-duration missions and for early sensor tag integration into vehicles during assembly when the sensors may remain dormant years before being operated. This wireless low-mass technology will be implemented aboard the Cygnus CRS-2 NG-18 spaceflight mission.

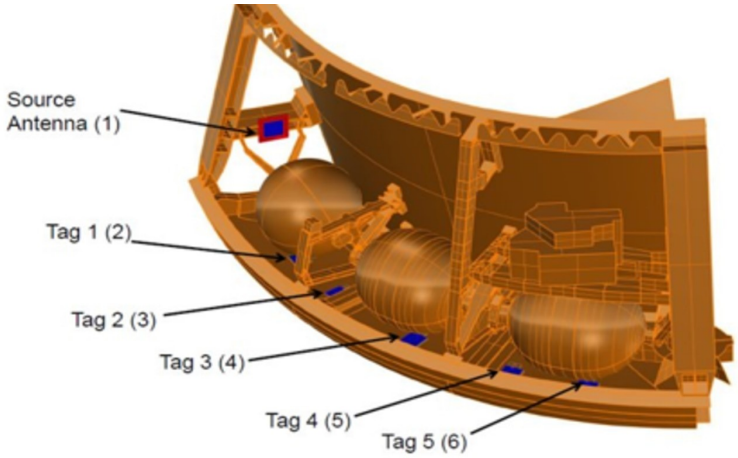
BENEFITS

- Lower mass than wired systems
- RFID-enabled data streams at 10-100 Hz from large sensor population
- Sensor instruments feature low-mass power source
- Long operational lifetime
- Low-power hibernation with instantaneous over-the-air wakeup for more than 5 years on a single CR2032 coin cell battery
- When active, sensors can stream 10 Hz thermocouple data for more than 200 days
- Interrogator built from COTS components has relatively small size (deck of playing cards form factor)

THE TECHNOLOGY

With a form factor close to a deck of playing cards, the system interrogator has custom software to interface with and service a population of sensor tags at the required data rates. Each EPCglobal C1G2 sensor tag uses incident interrogator energy to charge its small integrated circuit (IC), which reads an internal memory bank, encodes identification data, and uses that information to modulate and backscatter a reply to the interrogator using reflected interrogator energy. Two tag interfaces allow the attached processor to power the reading/writing of data to the tag memory and then allows the interrogator to power the reading of the tag memory data. When neither of the two interfaces are engaged, the RFID IC is completely powered down. Reading and writing tag memory consumes relatively little power compared to the power draw of active transmitter/receiver protocols like Bluetooth, Zigbee, and Wi-Fi. Compared to passive sensing protocols, this wireless instrumentation system enables sampling of a larger population of tags without the computational burden associated with surface acoustic wave (SAW) sensing. RFID-Enabled Wireless Instrumentation technology allows the RFID interrogator to write data through the interface of a sensor tag memory bank using only interrogator power. With only minimal cost to the sensor's power budget, the microcontroller unit can read that data out over the serial interface. The sensor can transmit and receive data at no effective cost to its small coin cell battery power supply.

This technology is readiness level (TRL) 8 (actual system completed and "flight qualified" through test and demonstration) and the innovation is now available for your company to license. Please note that NASA does not manufacture products itself for commercial sale.



The antenna and distributed sensor tags stream low-rate thermocouple data from a heatshield. In hybrid sleep/wake mode, sensors run for 5+ years on a CR2032 coin cell battery; in active state, they stream 10 Hz data for 200+ days.

APPLICATIONS

The technology has several potential applications:

- Vehicle and robotic sensor suites
- Infrastructure and utilities monitoring
- Smart roads

PUBLICATIONS

Patent No: 11,195,072; 11,062,099

Wagner, Raymond S, Hafermalz, D. Scott, Champagne, Nathan J, and Seegmiller, Ray. Internal Radio-Frequency Instrumentation System (IRIS): RFID-Enabled Wireless Vehicle Instrumentation. Proc. Of IEEE Aerospace Conference. March, 2017.

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MSC-26233-1, MSC-26501-1, MSC-TOPS-91

More Information

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NP-2022-04-3049-HQ