Nanosensors for Evaluating Hazardous Environments

Hazardous-Leak Detection and Isolation

Personnel working in a confined environment can be exposed to hazardous gases, and certain gases can be extremely dangerous even in concentrations as low as a few parts per billion.

Nanosensors can be placed in multiple locations over a large area, thus allowing for more precise and timely detection of gas leaks. ASRC Aerospace and its research partners are developing nanosensors to detect various gases, including hydrogen, ammonia, nitrogen tetroxide, and hydrazine. Initial laboratory testing demonstrated the capability to detect these gases in concentrations lower than parts per million, and current testing is evaluating sensitivity at concentration levels three orders of magnitude lower. Testing and development continue to improve the response and recovery times and to increase the sensitivity of the devices. The development team is evaluating different coatings and electrodes to determine the optimum configuration for detecting and identifying a variety of gases.

The small footprint of the nanosensors allows several devices to be placed into a single substrate. Each sensor is responsive in a different way to different gases. Embedding multiple devices into a single substrate results in better reliability and less frequent calibrations. The use of different coatings for individual elements of a multichannel sensor allows different gases to be identified. The sensor system is implemented by the use of a custom multichannel signal conditioner amplifier built on a small multichip module. This device processes the output of the sensors and transmits a signal that can be monitored and analyzed remotely. All the data is digitized and transmitted over the same cable pair used to power the amplifier. Connecting multiple outputs to a single cable pair will reduce the weight and expense associated with cabling in a spacecraft.

Although the initial work concentrated on the detection of nitrogen dioxide and nitrogen tetroxide, sensors are being developed and tested for detection of hydrogen, ammonia, hypergolic fuel (hydrazine), hypergolic oxidizer (nitrogen tetroxide, which is analyzed as nitrogen dioxide), and monomethylhydrazine. The sensors are being evaluated under a wide variety of environmental conditions, including various temperatures, humidities, and gas concentrations. The initial test evaluates the sensor's ability to identify and analyze three concentrations of hydrazine at constant temperature and humidity. The final objectives will be to optimize individual responses to various gases and to integrate the sensors onto a single substrate.

Monitoring of the environment is not limited to the detection of gas leaks, and monitoring will become increasingly important as longer-duration space missions are planned and executed. A wide array of nanosensors needs to be developed and qualified for space flight under realistic operating conditions, and this activity will continue for years to come.

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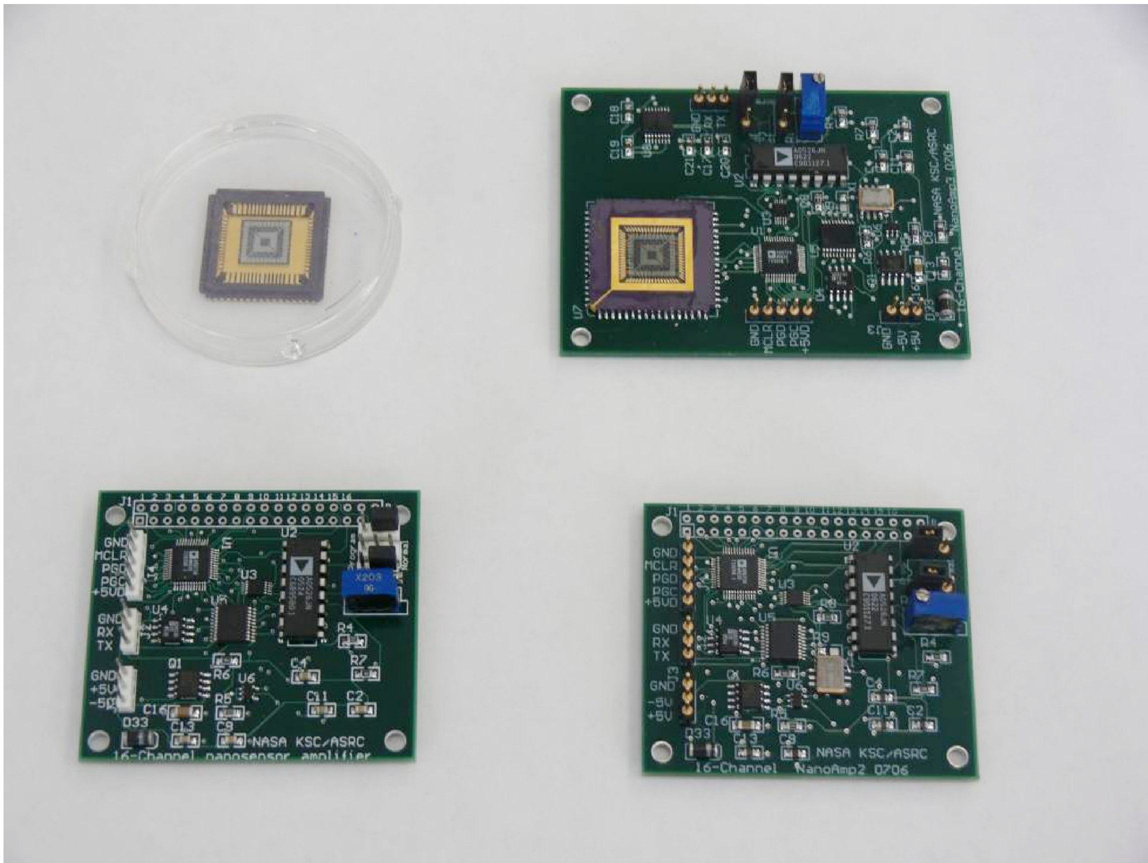

Sensor and signal-conditioning amplifier.