control architecture that allows for ruggedness and compactness. The combination provides both portability and battery operation on a simple camcorder battery for up to eight hours.

Optical detection of gaseous HF is confounded by the need for rapid sampling with minimal contact between the sensor and the environmental sample. A sensor is required that must simultaneously provide the required sub-parts-per-million detection limits, but with the high specificity and selectivity expected of optical absorption techniques. It should also be rugged and compact for compatibility with operation onboard spacecraft and submarines.

A new optical cell has been developed for which environmental sampling is accomplished by simply traversing the few-mm-thick cell walls into an open volume where the measurement is made. A small, low-power fan or vacuum pump may be used to push or pull the gaseous sample into the sample volume for a response time of a few seconds. The optical cell simultaneously provides for an enhanced optical interaction path length between the environmental sample and the infrared laser. Further, the optical cell itself is comprised of inert materials that render it immune to attack by HF. In some cases, the sensor may be configured so that the optoelectronic devices themselves are protected and isolated from HF by the optical cell. The optical sample cell is combined with custom-developed analog and digital control electronics that provide rugged, compact operation on a platform that can run on a camcorder battery.

The sensor is inert with respect to acidic gases like HF, while providing the required sensitivity, selectivity, and response time. Certain types of combustion events evolve copious amounts of HF, very little of other gases typically associated with combustion (e.g., carbon monoxide), and very low levels of aerosols and particulates (which confound traditional smoke detectors). The new sensor platform could warn occupants early enough to take the necessary countermeasures.

This work was done by Jeffrey Pilgrim and Paula Gonzales of Vista Photonics, Inc. for Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18892-1.

A Probabilistic Mass Estimation Algorithm for a Novel 7-Channel Capacitive Sample Verification Sensor

NASA's Jet Propulsion Laboratory, Pasadena, California

A document describes an algorithm created to estimate the mass placed on a sample verification sensor (SVS) designed for lunar or planetary robotic sample return missions. A novel SVS measures the capacitance between a rigid bottom plate and an elastic top membrane in seven locations. As additional sample material (soil and/or small rocks) is placed on the top membrane, the deformation of the membrane increases the capacitance. The mass estimation algorithm addresses both the calibration of each SVS channel, and also addresses how to combine the capacitances read from each of the seven channels into a single mass estimate. The probabilistic approach combines the channels according to the variance observed during the training phase, and provides not only the mass estimate, but also a value for the certainty of the estimate.

SVS capacitance data is collected for known masses under a wide variety of possible loading scenarios, though in all cases, the distribution of sample within the canister is expected to be approximately uniform. A capacitance-vs-mass curve is fitted to this data, and is subsequently used to determine the mass estimate for the single channel's capacitance reading during the measurement phase. This results in seven different mass estimates, one for each SVS channel. Moreover, the variance of the calibration data is used to place a Gaussian probability distribution function (pdf) around this mass estimate. To blend these seven estimates, the seven pdfs are combined into a single Gaussian distribution function, providing the final mean and variance of the estimate. This blending technique essentially takes the final estimate as an average of the estimates of the seven channels, weighted by the inverse of the channel's variance.

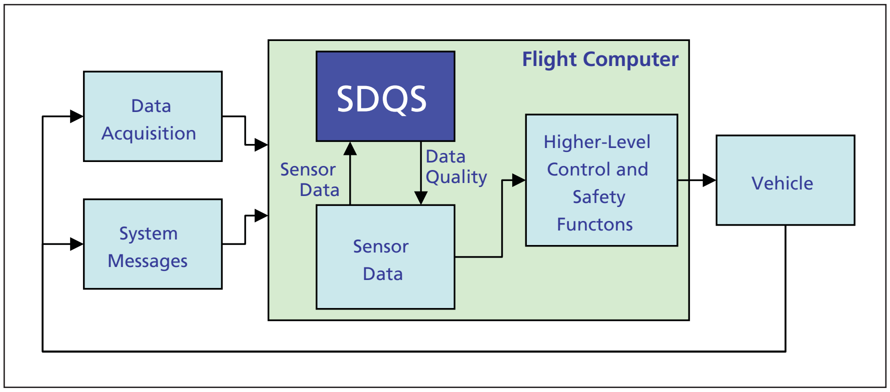
This work was done by Michael Wolf of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-48143

Low-Power Architecture for an Optical Life Gas Analyzer

A simple camcorder battery can be used for as long as eight hours.

John H. Glenn Research Center, Cleveland, Ohio

Analog and digital electronic control architecture has been combined with an operating methodology for an optical trace gas sensor platform that allows very low power consumption while providing four independent gas measurements in essentially real time, as well as a user interface and digital data storage and output. The implemented design eliminates the cross-talk between the measurement channels while maximizing the sensitivity, selectivity, and dynamic range for each measured gas. The combination provides for battery operation on a simple camcorder battery for as long as eight hours. The custom, compact, rugged, self-contained design specifically targets applications of optical major constituent and trace gas detection for multiple gases using multiple lasers and photodetectors in an integrated package.



The **Sensor Data Qualification** (SDQ) system receives inputs from system messages and data acquisition. The sensor data includes first-stage and upper-stage flight-critical sensors.

Commercial off-the-shelf digital electronics including data acquisition cards (DAQs), complex programmable logic devices (CPLDs), field programmable gate arrays (FPGAs), and microcontrollers have been used to achieve the desired outcome. The lowest-power integrated architecture achieved during the project was realized in the prototype that utilized a custom FPGA digital board (in combination with a custom-built, low-power analog electronics board) and a low-performance commercial microcontroller. The FPGA generated all the necessary control signals for the analog board, and performed data acquisition and low-level, time-critical data processing. The microcontroller was used to implement high-level data analysis, the user interface, and data storage and output. Further power savings were realized by operating the four lasers sequentially, rather than operating them in parallel. A several-Hz update rate was achieved even with sequential operation, much faster than required for gas measurement on the International Space Station.

A rugged and flexible multiple gas sensor platform was developed, which involves laser diode-based optical absorption spectroscopy coupled to an elegant optical path length enhancement solution and advanced digital and analog electronic design. The optical absorption cell is shared by multiple lasers and detectors, which minimizes the footprint of the device. On the other hand, the optical layout is simple and flexible: no precise alignment is required. The laser diodes are easily interchangeable, which, in principle, allows reconfiguring the sensor to measure different sets of trace gases. Custom power-efficient analog and digital electronic boards are designed to minimize the power consumption of the sensor. Further power savings are realized by fast time-multiplexing the measurements of different gases, rather than implementing them in parallel. This development allows a fully integrated multiple gas monitor to operate on simple camcorder batteries for a period of several hours.

This work was done by Jeffrey Pilgrim and Andrei Vakhtin of Vista Photonics, Inc. for Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18894-1.