



SNE Industrial Fieldbus Interface

The purpose is to enable a smart sensor to communicate health and status information to other devices.

John F. Kennedy Space Center, Florida

Programmable logic controllers (PLCs) have very limited diagnostic and no prognostic capabilities, while current smart sensor designs do not have the capability to communicate over Fieldbus networks. The aim is to interface smart sensors with PLCs so that health and status information, such as failure mode identification and measurement tolerance, can be communicated via an industrial Fieldbus such as ControlNet.

The SNE Industrial Fieldbus Interface (SIFI) is an embedded device that acts as a communication module in a networked smart sensor. The purpose is to enable a smart sensor to communicate health and status information to other devices, such as PLCs, via an industrial Fieldbus networking protocol. The SNE (Smart Network Element) is attached to a commercial off-the-shelf Anybus-S interface module through the SIFI. Numerous Anybus-S modules are available,

each one designed to interface with a specific Fieldbus. Development of the SIFI focused on communications using the ControlNet protocol, but any of the Anybus-S modules can be used.

The SIFI communicates with the Anybus module via a data buffer and mailbox system on the Anybus module, and supplies power to the module. The Anybus module transmits and receives data on the Fieldbus using the proper protocol. The SIFI is intended to be connected to other existing SNE modules in order to monitor the health and status of a transducer. The SIFI can also monitor aspects of its own health using an on-board watchdog timer and voltage monitors. The SIFI also has the hardware to drive a touchscreen LCD (liquid crystal display) unit for manual configuration and status monitoring.

The SIFI communicates with the Anybus module via a data buffer and

mailbox system located on the Anybus module. The SIFI also has headers to connect with the digital and analog SNE modules. A microcontroller is used to control communications with the Anybus module. The microcontroller is capable of processing data either received from or to be transferred to the Anybus module.

Communication is via a parallel interface. The microcontroller is also connected to a real-time clock and 128 kB of external non-volatile FRAM (ferroelectric RAM) memory. For internal diagnostics, the microcontroller is connected to a watchdog timer and is capable of monitoring the levels of the ± 12 V and ± 10 V voltages.

This work was done by Angel Lucena of Kennedy Space Center; and Matthew Raines, Rebecca Oostdyk, and Carlos Mata of ASRC Aerospace Corporation. Further information is contained in a TSP (see page 1). KSC-13425

Composite Thermal Switch

This switch can be incorporated in portable electronic devices like cell phones, PDAs, laptop computers, and battery-powered electric vehicles.

John H. Glenn Research Center, Cleveland, Ohio

Lithium primary and lithium ion secondary batteries provide high specific energy and energy density. The use of these batteries also helps to reduce launch weight. Both primary and secondary cells can be packaged as high-rate cells, which can present a threat to crew and equipment in the event of external or internal short circuits. Overheating of the cell interior from high current flows induced by short circuits can result in exothermic reactions in lithium primary cells and fully charged lithium ion secondary cells. Venting of the cell case, ejection of cell components, and fire have been reported in both types of cells, resulting from abuse,

cell imperfections, or faulty electronic control design.

A switch has been developed that consists of a thin layer of composite material made from nanoscale particles of nickel and Teflon that conducts electrons at room temperature and switches to an insulator at an elevated temperature, thus interrupting current flow to prevent thermal runaway caused by internal short circuits. The material is placed within the cell, as a thin layer incorporated within the anode and/or the cathode, to control excess currents from metal-to-metal or metal-to-carbon shorts that might result from cell crush or a manufacturing defect. The safety of high-rate cells is thus

improved, preventing serious injury to personnel and sensitive equipment located near the battery. The use of recently available nanoscale particles of nickel and Teflon permits an improved, homogeneous material with the potential to be fine-tuned to a unique switch temperature, sufficiently below the onset of a catastrophic chemical reaction. The smaller particles also permit the formation of a thinner control film layer (< 50 μm), which can be incorporated into commercial high-rate lithium primary and secondary cells.

The innovation permits incorporation in current lithium and lithium-ion cell designs with a minimal impact on

cell weight and volume. The composite thermal switch (CTS™) coating can be incorporated in either the anode or cathode or both. The coating can be applied in a variety of different processes that permits incorporation in the cell and electrode manufacturing processes. The CTS responds quickly and halts

current flow in the hottest parts of the cell first. The coating can be applied to metal foil and supplied as a cell component onto which the active electrode materials are coated.

This work was done by Robert McDonald, Shelly Brawn, Katherine Harrison, Shannon O'Toole, and Michael Moeller of Giner, 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-18767-1.

XMOS XC-2 Development Board for Mechanical Control and Data Collection

NASA's Jet Propulsion Laboratory, Pasadena, California

The scanning microwave limb sounder (SMLS) will use technological improvements in low-noise mixers to provide precise data on the Earth's atmospheric composition with high spatial resolution. This project focuses on the design and implementation of a real-time control system needed for airborne engineering tests of the SMLS. The system must coordinate the actuation of optical components using four motors with encoder readback, while collecting synchronized telemetric data from a GPS receiver and 3-axis gyrometric system. A graphical user interface for testing the control system was also designed using Python.

Although the system could have been implemented with an FPGA (field-programmable gate array)-based setup, a processor development kit manufactured by XMOS was chosen. The

XMOS architecture allows parallel execution of multiple tasks on separate threads, making it ideal for this application. It is easily programmed using XC (a subset of C). The necessary communication interfaces were implemented in software, including Ethernet, with significant cost and time reduction compared to an FPGA-based approach.

A simple approach to control the chopper, calibration mirror, and gimbal for the airborne SMLS was needed. The XMOS board allows for multiple threads and real-time data acquisition. The XC-2 development kit is an attractive choice for synchronized, real-time, event-driven applications. The XMOS is based on the transputer microprocessor architecture developed for parallel computing, which is being revamped in this new platform.

The XMOS device has multiple cores capable of running parallel applications on separate threads. The threads communicate with each other via user-defined channels capable of transmitting data within the device. XMOS provides a C-based development environment using XC, which eliminates the need for custom tool kits associated with FPGA programming. The XC-2 has four cores and necessary hardware for Ethernet I/O.

This work was done by Robert F. Jarnot of Caltech and William J. Bowden of the University of British Columbia for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

The software used in this innovation is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-48054.

Receiver Gain Modulation Circuit

Applications would be in testing and development of new algorithms to detect gain anomalies and correct drifts that affect climate-quality measurements over an accelerated time scale.

Goddard Space Flight Center, Greenbelt, Maryland

A receiver gain modulation circuit (RGMC) was developed that modulates the power gain of the output of a radiometer receiver with a test signal. As the radiometer receiver switches between calibration noise references, the test signal is mixed with the calibrated noise and thus produces an ensemble set of measurements from which ensemble statistical analysis can be used to extract statistical information about the test signal. The RGMC is an enabling technology of the ensemble detector. As a key component for achieving ensemble detection and analysis, the RGMC

has broad aeronautical and space applications. The RGMC can be used to test and develop new calibration algorithms, for example, to detect gain anomalies, and/or correct for slow drifts that affect climate-quality measurements over an accelerated time scale.

A generalized approach to analyzing radiometer system designs yields a mathematical treatment of noise reference measurements in calibration algorithms. By treating the measurements from the different noise references as ensemble samples of the receiver state, i.e. receiver gain, a quantitative description of the

non-stationary properties of the underlying receiver fluctuations can be derived. Excellent agreement has been obtained between model calculations and radiometric measurements. The mathematical formulation is equivalent to modulating the gain of a stable receiver with an externally generated signal and is the basis for ensemble detection and analysis (EDA).

The concept of generating ensemble data sets using an ensemble detector is similar to the ensemble data sets generated as part of ensemble empirical mode decomposition (EEMD) with exception