National Aeronautics and Space Administration

technology opportunity

A High-Temperature Enabled Communication Circuit for DC Power Lines

A simple, low-power solution to a number of communication problems in high-temperature or noisy environments

NASA's Glenn Research Center is offering a sensor and actuator networking innovation applicable to smart vehicle or component control. This innovation requires no additional connectivity beyond the wiring providing power. This results in lower system weight, increased ease and flexibility for system modifications and retrofits, and improved reliability and robustness. The technology was specifically designed for harsh, high-heat environments but has applications in multiple arenas. The device is compatible with most communication protocols.

Benefits

- **Protocol non-specific:** Circuit/method defines physical layer; bit recessive and thus Control Area Network (CAN) compatible
- **Virtually unlimited temperature range:** Available sensors (or op amps) limit the temperature, not the device design
- **Fast response time:** Carrier lock achieved in 2-3 cycles enabling immediate data transmission with no need for large synchronization preambles
- **Less susceptible to noise:** Innovation operates in a lower, unused frequency spectrum and can withstand a noise-to-signal ratio of 20 dB
- **Easier to use in retrofits:** Design eliminates the need for new wiring or multiplexers
- **Cost effective:** System uses inexpensive off-the-shelf components

Applications

- Jet Engines
- Oil Field Services
- Power Turbines
- Biomedical Devices
- Nuclear Power Plants
- Factory Automation
- Solar Power Collectors

Technology Details

How It Works

The innovation consists of both a device and a technique. The device is radiation hard and capable of withstanding temperatures up to 225° C using available silicon-on-insulator semiconductor components. The technique is a method of modulating a signal to be placed on a DC power bus. The signal is modulated by on-off keying and uses capacitive coupling. The demodulation is accomplished using an asynchronous quadrature detection technique. The technique relies on a quasi-discrete Fourier transform that occurs by using the quadrature components of the carrier frequency as generated by the microcontroller and as a function of the selected crystal frequencies driving its oscillator. The detected signal is changed into a direct current using an absolute value circuit containing no diodes (as diodes can't operate at high temperatures). The local power for the circuit is derived from a 5-volt regulator whose input is the supply rail. The data imposed upon the supply rail does not substantially present itself upon the local power rail of the circuit since the lower excursions are above the dropout voltage of the regulator and also within the regulator's power supply rejection specifications.

Why It Is Better

The device can draw power for itself and associated sensors and actuators from an existing power bus, communicate with similar devices or a central processor by placing a signal on the same power bus, make smart decisions within its operational loop, and affect control outputs to associated sensors and actuators. There is no limit to the number of sensors/actuators that could be placed in the network. All of this can be accomplished in a high heat (up to 225° C) environment with a bandwidth range of 1500 bps. Existing solid state electronics can't operate at temperatures above 125° C, restricting the ability of manufacturers to install commercially-available sensors and instrumentation in high heat environments such as jet engines, smelting operations, or deep drilling equipment. The ability to draw power and communicate over a power bus reduces weight and mass. With less wiring, the risk of interconnection breakdown and failure diminishes. While this innovation has particular application to high heat environments where weight is a concern (jet engines), the innovation's simplicity and off-the-shelf components make it suitable for multiple applications.

Patents

Glenn has filed a patent application for this technology.

Licensing and Partnering Opportunities

Glenn's Technology Transfer and Partnership Office seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to consider licensing the Communications Circuit (LEW-18207-1) for commercial applications.

For More Information
For more information about this and other technology licensing opportunities, please visit:

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