



## TECHNOLOGY SOLUTION

### Instrumentation



# Data Transfer for Multiple Sensor Networks

Performs well over a broad temperature range

At extreme temperatures, few electronic components are available to support intelligent data transfer over a common, linear combining medium such as wire or the airwaves. NASA Glenn's innovation allows the operating frequency of a sensor instrument to be time variant because the sensor is part of the frequency generator's transfer function. Each instrument associated with a sensor imparts a unique (orthogonal) signature onto the continuous output of that sensor. As a consequence, the outputs of numerous instruments may be simultaneously superimposed upon one another via a linear combining medium and then be separated at a common receiving node in a more temperate location using any number of linear source separation techniques. A listening node, using various techniques, can pick out the signal from a single sender, if it has unique qualities; e.g., a "voice." This technique is analogous to the human brain recognizing and following a single conversation in a party full of people talking and other distracting noises.

#### BENEFITS

- High temperature: Allows detection of desired sensor parameters at elevated temperatures
- Efficient: Uses a gate count orders of magnitude less than if a full processor was embedded
- Light weight: Allows many sensors to operate on the same wire bus



## THE TECHNOLOGY

High-temperature sensors have been used in silicon carbide electronic oscillator circuits. The frequency of the oscillator changes as a function of changes in the sensor's parameters, such as pressure. This change is analogous to changes in the pitch of a person's voice. The output of this oscillator, and many others may be superimposed onto a single medium. This medium may be the power lines supplying current to the sensors, a third wire dedicated to data transmission, the airwaves through radio transmission, or an optical or other medium. However, with nothing to distinguish the identities of each source, this system is useless. Using frequency dividers and linear feedback shift registers, comprised of flip flops and combinatorial logic gates connected to each oscillator, unique bit stream codes may be generated. These unique codes are used to amplitude modulate the output of the sensor (both amplitude shift keying and on-off keying are applicable). By using a dividend of the oscillator frequency to generate the code, a constant a priori number of oscillator cycles will define each bit. At the receiver, a detected frequency will have associated with it a stored code pattern. Thus, a detected frequency will have a unique modulation pattern or "voice," disassociating it from noise and from other transmitting sensors. These codes may be pseudorandom binary sequences (PRBS), ASCII characters, gold codes, etc. The detected code length and frequency are measured, offering intelligent data transfer.

This is an early-stage technology requiring additional development. Glenn welcomes co-development opportunities.



NASA Glenn's innovation has great potential for high temperature sensing in jet engines

## APPLICATIONS

The technology has several potential applications:

- High temperature sensing in jet engines, missiles, and rockets
- Deep hole sensing for energy extraction (oil, gas, geothermal)
- Ground vehicle internal combustion engine sensing

## PUBLICATIONS

Patent No: 9,872,293; 10,433,308