



## **Development of a High-Fidelity Sensor Board with 24-bits of Resolution for Structural Health Monitoring**

**Martha Cuenca\*, Billie F. Spencer Jr., Hongki Jo, Jong-Woong Park, Kirill Mechitov**

\* *Presenting Author*

*Corresponding Author: Martha Cuenca  
Contact Email: mcuenca2@illinois.edu*

### **ABSTRACT**

The development of wireless smart sensor (WSS) technology has benefited structural health monitoring (SHM). It is more practical to mount a dense network of WSSs on a structure for SHM rather than deal with the complex installation of a wired sensor system. For a standard SHM campaign, it is valuable to have a sensor system that can measure typical low-level ambient vibration responses. Some methods that have been implemented by WSSs in order to measure low-level vibrations include using high-sensitivity and low-noise sensors and reducing the span of the analog-to-digital converter (ADC) to increase resolution. However, this can reduce the measurement range of the WSS and compromise its ability to capture larger structural responses. To counter this problem, a new sensor board that features an onboard eight-channel 24-bit ADC has been developed for WSSs. The onboard 24-bit delta-sigma ADC makes use of oversampling and noise-shaping techniques to output low-noise and high-precision data. The ADC first oversamples the signal to distribute the noise over a wide frequency range, then shifts the noise to higher frequencies, and finally uses a digital filter to eliminate a substantial amount of the noise, resulting in low noise for the frequency range of interest. With the onboard 24-bit ADC, there is no need to reduce its span for high-resolution sensing; both low-level vibrations and larger responses can be captured. Moreover, the new sensor board is versatile with a data rate of up to 16 kHz and a capability for simultaneous high-resolution and low-noise sensing over all of its eight channels. The board also features a three-axis accelerometer with a user-selectable switch to override the accelerometer measurements with external sensors. The development and preliminary implementation of this high-fidelity sensor board will be discussed.

**KEYWORDS:** *Wireless smart sensor, Structural health monitoring (SHM), Low-noise sensor board*