National Aeronautics and Space Administration

Sensors

In Situ Health Monitoring Of Piezoelectric Sensors

Tests and identifies degraded sensors without having to remove them

NASA's John C. Stennis Space Center is soliciting partners interested in the commercial application of an in-situ measurement system for monitoring the performance of piezoelectronic sensors, particularly accelerometers. With this technology, characteristics such as resonant frequency, response, cable status, connectivity, bonding and linear range, can be determined. Sensors can be tested in a very wide frequency range, extending to 200 MHz and beyond, without removing them from their mounted locations, and without requiring specially constructed transducers or special wiring. Assessments can be performed in-situ, and can be conducted with hand held test equipment or integrated into instrumentation systems.

BENEFITS

- **Simplified Testing:** Allows testing of piezoelectric sensors without requiring physical contact
- **Reduced Re-Calibration Costs:** Does not require removing mounted sensor or sending to a calibration lab
- **Increased Testing Parameter Range:** Provides both normal and as-mounted resonant frequencies
- **Improved Accuracy:** Provides entire frequency response over the range of the device (unlike commonly used shaker tables)
- **Illuminates in situ problems:** Can identify degraded sensor bonds, faulty cabling and sensor damage

technology solution

THE TECHNOLOGY

On occasion, anomalies may appear in the highly dynamic test data obtained during rocket engine tests, which are investigated and corrective action may be mandated before subsequent testing. A typical challenge is the appearance of spurious signals in accelerometer data channels, of unknown cause. An in situ health monitoring apparatus, that includes (1) an exciter circuit that applies a pulse to a piezoelectric transducer and (2) a data processing system that determines the piezoelectric transducer's dynamic response to the first pulse was developed. The dynamic response can be used to evaluate the operating range, health and as-mounted resonance frequency of the transducer, as well as the strength of a coupling between the transducer and a structure, and the health of the structure. The monitoring system provides the full frequency of the sensor, the linear range, and resonant frequencies-both normal and as-mounted-for different configuration types. The system also provides the ability to monitor piezoelectric transducers between propulsion tests to detect any trend indicative of transducer failure or detachment. The system can be made portable, in a battery powered sealed box, for testing in the field. Physical contact with the sensor is not necessary, therefore, monitoring can be done as far away as 250 feet, or longer if certain provisions are made. With slight modifications, this monitoring system can be used with all common transducer instrumentation.

With this monitoring system, degraded sensor performance can be quickly and economically identified. This system can evaluate installed piezoelectric sensors, without requiring physical contact with or removing them from their mounted locations. Tests are conducted through cabling. Because it is not necessary to remove the device, data that reflect the device's specific physical configuration (such as as-mounted resonant frequency) are retained, and devices that are physically inaccessible can still be tested. The testing system is not limited to identifying degraded performance in the sensor's piezoelectric elements; it can detect changes within the entire sensor, and sensor housing.

APPLICATIONS

- Accelerometers
- Automotive sensors
- Structural sensors
- Sensors for manufacturing equipment
- Any application where vibration is monitored
- Any piezoelectric sensor
- Applicable in Nondestructive Testing (NDT)

PUBLICATIONS

U.S. Patent No. 8,401,820 B2

More Information

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