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## DEVELOPMENT OF HIGH ACCURACY MEMS RATE SENSOR FOR SMALL SATELLITES

**Abstract**

JAXA has developed a high accuracy, small, lightweight, and low-power 3-axis attitude rate sensor called Vibrating Structured Gyro Assembly (VSGA) for micro and small satellites. The VSGA contains three orthogonally mounted commercial-off-the-shelf (COTS) high-performance vibrating structure gyros (VSG) and the interface circuit. It is intended for use in low-cost and easy-to-use system for attitude determination on micro and small satellites. The VSG uses a silicon ring which measures the angular rate by using the Coriolis effect on the sensor element. The elements of the sensor are designed and manufactured by Microelectromechanical systems (MEMS) technology, that is, small, lightweight, and low-power consumption. The interface between satellite system and the VSGA is simplified by digital processing of microcontroller inside the interface circuit. For accuracy improvement, the detected angular rate are filtered and integrated with high sampling, and users can use both the averaged rate and the angle output. Because the bias rate of the VSG is slightly affected by temperature, onboard temperature compensation is implemented.

In order to establish the reliability while using COTS parts, JAXA has conducted performance tests and environmental tests. The Allan variance method is selected to evaluate gyro noise terms and the measured noise characteristics of VSGA are compared with simulation model. To evaluate the durability against space environment, the vibration, radiation, and thermal vacuum test has conducted.

This paper describes the design and test results of COTS based MEMS rate sensor for small satellites. Results will be presented from performance testing and environmental testing that has been performed by JAXA to qualify this technology for use of small satellite applications. VSGA has been integrated into JAXA's next Small Demonstration Satellite (SDS) scheduled for launch in JFY 2011 and will be demonstrated in orbit.