NASAfacts

Development of New Research-Quality Low-Resource Magnetometers for Small Satellites

New Magnetometer Enables Boom-less CubeSats

Researchers from the University of Michigan (UM) and NASA Goddard Spaceflight Center (GSFC) are partnering to develop new types of magnetometers for use on future small satellites. These new instruments not only fulfill stringent requirements for low-amplitude and high-precision measurements, they are also enabling the team to develop a new approach to achieve high-quality magnetic measurements from space, without the need for a boom. Typically, space-based magnetometers are deployed on a boom that extends from the space vehicle to reduce exposure of magnetic noise emanating from the spacecraft, which could potentially contaminate measurements. The UM/NASA team has developed algorithms to identify and eliminate spacecraft magnetic noise, which will allow placement of these economical, science-grade instrument magnetometers on and inside the satellite bus, instead of on a boom.

One of the new types of instruments—called an induction magnetometer—shows considerable promise over other chip-based technologies and provides characteristics consistent with modern designs of a fluxgate magnetometer. The new induction magnetometer is a modified commercial magneto-inductive magnetometer from PNI Sensor Corporation. In this induction magnetometer, the magnetic field is measured by using a Schmitt Trigger. This is a simple counter that counts the time between oscillations of the produced electromotive force (emf) in the circuit. The emf is dependent on the strength of the applied direct current (DC) field. As illustrated by the functional diagram shown below (on back), the magnetometer is an inductor resistor (LR)

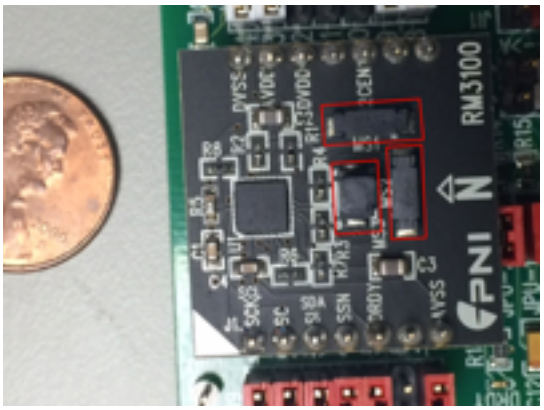

Figure 1. PNI Sensor Corporation induction compared to a penny. (Photo Credit:

circuit with a Schmitt Trigger for counting pulses. In figure 3, H_E is the external magnetic field parallel to the coil. The total field that the sensor experiences is due to the external field H_E and the field generated by the circuit. The Schmitt trigger causes the current through the circuit to oscillate as the voltage passes a set “trigger” value. The DC field can then be measured by simply counting the number of trigger values. Since the device is a simple counter, it allows the elimination of radiation-sensitive analog-to-digital converters, and enables temperature sensitivities of the new sensor to be accounted for directly in the circuitry.

One of the NASA Small Spacecraft Technology Program (SSTP) Smallsat Technology Partnership program’s goals is to support the development of small, low mass, low power consumption, and low cost space instruments (often referred to as reducing SWaP+C or SWaP2 – Size, Weight and Power + Cost or Price). This

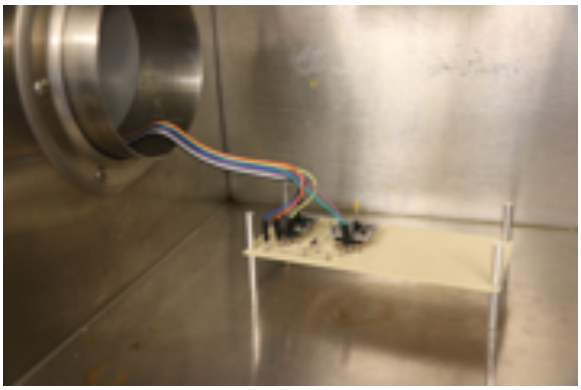

Figure 2. Two PNI Sensor Corporation induction magnetometers in a thermal chamber undergoing testing.

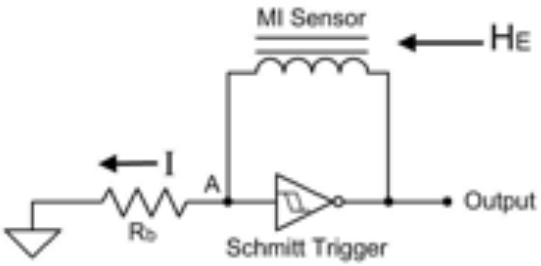

Figure 3. The functional diagram of the induction magnetometer circuit. HE is the external magnetic field to be measured.

new technology will result in a small, low mass, less expensive magnetometer instrument concept. The new sensors and approach will enable future constellations of small satellites to measure the background magnetic field environment in space, which will help scientists to understand space weather and the structure of the space environment.

GSFC will test and qualify the magnetometer at the Goddard Magnetic Facility in addition to providing test data from the Dellingr Cubesat. Access to this data will enable both the UM and GSFC teams to test their noise cleaning software techniques and to together identify the better merged approach. Dr. Eftyhia Zesta at GSFC and Professors Mark Moldwin and Jamie Cutler at the University of Michigan lead this project.

The Development of New Research Quality Low Resource Magnetometers for Small Satellites project is managed and funded by the SSTP within the Space Technology Mission Directorate. The SSTP expands U.S. capability to execute unique missions through rapid development and in space demonstration of capabilities for small spacecraft applicable to exploration, science, and the commercial space sector. The SSTP will enable new mission architectures through the use of small spacecraft with goals to expand their reach to new destinations, and challenging new environments.

For more information about the SSTP, visit:
www.nasa.gov/directorates/spacetech/small_spacecraft/

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