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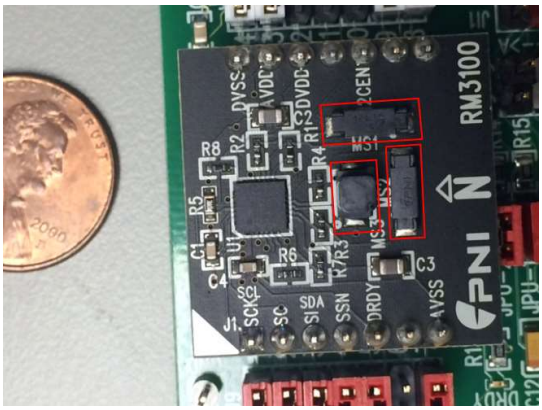
Development of new research quality low resource magnetometers for small satellites

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



PNI Induction magnetometer compared to a penny. (Photo Credit: Mark Moldwin, UM)

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 DC field. As illustrated by the functional diagram shown below (on back), the magnetometer is a LR circuit with a Schmitt Trigger for counting pulses. 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. We have radiation tested the sensor up to 250 kRad of Total

Ionizing Dose (TID).

One of the NASA Space Technology Mission Directorate (STMD) 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 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. The sensor was recently selected as part of the NASA Artemis Lunar HERMES (Heliophysics Environmental and Radiation Measurement Experiment Suite) NEMISIS (Noisy Environment Magnetometer Instrument in a Small Integrated System) sensor package.
The STMD Smallsat Technology Program and the Heliophysics Division's H-TIDEeS technology program are supporting this effort. Dr. Eftyhia Zesta at Goddard Spaceflight Center (GSFC) and Prof's Mark Moldwin and Jamie Cutler at the University of Michigan lead this project.

The New Magnetometer for Small Satellites project is managed by the Small Spacecraft Technology Program (SSTP), which is chartered to develop and mature technologies to enhance and expand the capabilities of small spacecraft with a particular focus on communications, propulsion, pointing, power, and autonomous operations. The SSTP is one of nine programs within NASA's STMD. For more information about the SSTP, please visit: http://www.nasa.gov/smallsats

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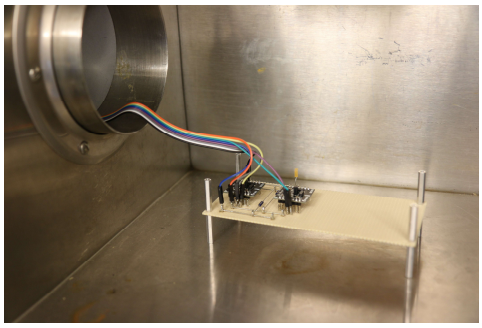
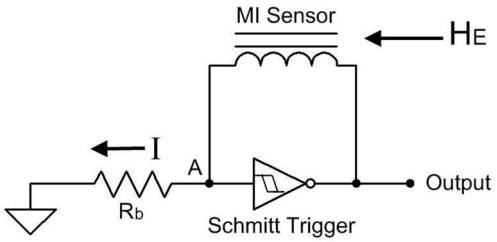


A dual-sensor undergoing initial thermal vacuum testing. (Photo Credit: Bret Bronner, UM)



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

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