

Temperature Test of Fluxgate Magnetometer for Deep Space Exploration

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BepiColombo mission to Mercury is the first large-sized joint space science project in Japan and Europe. This mission consists of two orbiters that will be launched in 2011-2012, and aims the interdisciplinary and comprehensive studies of Mercury, including the surface, the interior, and in particular the magnetosphere. The terrestrial planets with intrinsic magnetic field are only the earth and Mercury. So, it is the most important to observe magnetic field to trace the history of Mercury's magnetosphere, which enables us the first comparative studies with Earth. And for such a detailed magnetic field observations, a fluxgate magnetometer will be a key instrument for the comprehensive missions. However, during such missions, scorching environment is to be expected in Mercury orbit, because probe vehicle is subjected to 10 times as strong sunlight as earth, and mission requirement of fluxgate sensor is to have heat resistance of +160 degrees.

Fluxgate magnetometer is a one of the popular and old magnetometer, and it has played an important role in the investigation of inter planetary space, the interaction of the solar wind with planets, moons asteroids and comets and in the exploration of the surface and interior of bodies in the solar system, and has been improved a lot of point. But it is known to have not good temperature characteristics and it is necessary to improve it. Because, in the long view, a temperature-resistant of +/-200 degrees fluxgate sensor with low noise core will also be needed for the purpose of next future observations like Venus mission, deep space explorations, and lunar base. However, a few temperature characteristics test has been carried out until today, and one of the most notable is experiment for the MAREMF-OS/MARS-96 (W Magnes et al 1998). They successfully tested within temperature range of +/-100 degrees and insisted that their test facility has a capability to test within temperature range of +/-150 degrees. But it is not enough for Mercury mission and for future missions. So, it is urgently necessary to carry out both extremely high and low temperature range of +/-200 degrees.

In the last fiscal year, we have carried out high temperature tests, up to +200 degrees and successfully measured temperature characteristics of sensitivity, noise, and offset of a fluxgate sensor for mission to Mercury, using a hand-made high temperature test system. In this system, the fluxgate sensor is placed in a gypseous container that has two gypseous tubes, one is the entrance of hot air, and the other is for exhaust. And a fan heater system generates hot air up to +450 degrees, which is connected to the gypseous tube entrance. So the temperatures up to +200 degrees can be easily reached. But, parts of the test facility have to be packed into a magnetic shielding because of the huge Earth field and electric train related disturbances. A Helmholtz type calibration coil is placed between the container and the inner magnetic shielding case to apply test fields to the sensor during the measurement cycle, which is used for measuring sensitivity of the sensor. And ceramic wool heat insulator is also placed between the container, the calibration coil, and the inner magnetic shielding case, to prevent them getting hot. The actual temperature is measured by two Pt-1000 elements positioned on the fluxgate sensor and on a table close to the sensor. The analogue output data of the fluxgate electronics are converted by a 20-bit ADC with 64Hz sampling, and the temperature data are done by a 14-bit ADC, with 1Hz, and they are monitored by two PCs.

During the test, sensitivity, noise, and offset were measured at each temperature step of 10 degrees. To avoid measurement errors caused by a temperature gradient in the fluxgate sensor, it took 9 hours to finish all steps.

We will show the high temperature test system and a preliminary result of the temperature characteristics of the fluxgate sensor here.