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基本波型直交フラックスゲート磁力計の電子回路の小型化

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Analog circuit chip dedicated to the Fundamental Mode Orthogonal Fluxgate Magnetometers

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The Fundamental Mode Orthogonal Fluxgate Magnetometers (FM-OFG) have a unique property in that the part of the sensor is much smaller than that of conventional fluxgates. The conventional “parallel” fluxgate magnetometers have contributed to many space missions. However, the sensor structure is complex, requiring a sufficiently large core to achieve a low noise level. Hence, it is unsuitable for the miniaturization of the instrument, considering the use of micro-/nanosatellites. FM-OFG is a new type of fluxgate magnetometer whose sensor consists of a pair of amorphous wire core and a pick-up/feedback coil. The FM-OFG sensor can be much lighter at about 1 gram per axis.

Miniaturizing electronic circuits is crucial to making the whole FM-OFG system smaller and lighter so that it can make best of its small sensor. An analog chip dedicated to the FM-OFG using a so-called ASIC (Application Specific Integrated Circuit) has been developed from this aspect. Its size is a few tens of millimeters square, and it contains the circuits that pick up signals from the sensor head and retrieve waveforms of detected magnetic fields based on a feedback configuration. As the first attempt, we developed the analog chip used for the FM-OFG onboard the sounding rocket called RIDE (Rocket Investigation of Daytime sporadic-E). The science target of the rocket campaign is to investigate the sporadic E layer in the ionosphere. The onboard instrument with our chip has been already developed, and we confirmed the instrument based on our chip shows performance enough to meet the requirements of this rocket experiment.

The remaining issue with the analog chip is its noise level. To expand the use of the chip in other space missions, the noise level should be lower by a factor of three. The noise in the low-frequency range is intrinsic to the MOS device. We are working to design a new ASIC chip to reduce the noise.

In the present paper, we introduce the design of the analog chip and show the performance that meets the specifications for the rocket experiment. We also discuss improving the design to reduce the chip’s noise.