Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PCG31-22 Room:202 Time:May 28 17:30-17:45

Recent progress in developing search coil magnetometer using ASIC technology toward micro-satellite experiments

OZAKI, Mitsunori[1*] ; YAGITANI, Satoshi[1] ; KOJIMA, Hirotsugu[2] ; KOJI, Hiroki[1] ; ZUSHI, Takahiro[2]

[1]Kanazawa University, [2]RISH, Kyoto University

Magnetic field components of plasma waves are essential for probing space plasma environments. Search coil magnetometers are commonly used in satellite experiments and well-adapted to the measurements in the frequency range from a few Hz to several tens of kHz. A search coil sensor is installed at the top of a few-meter long mast or boom to reduce a noise contamination from a satellite. Then a preamplifier could be installed inside the satellite due to thermal and radiation conditions in space. Such a preamplifier separated from a sensor has disadvantages for the signal-to-noise ratio and the system resource. Recently, application specific integrated circuits (ASICs) are one of key technologies for increasing demands of plasma wave observations using multiple micro satellites. In order to further reduce mass, volume, and power consumption of analog circuits in typical plasma wave instruments, we have developed a low noise ASIC preamplifier for search coil magnetometer. The preamplifier is an important analog component of plasma wave observation to determine the noise equivalent magnetic induction (NEMI). In this study, a current-sensitive preamplifier for search coil magnetometer was developed and fabricated on a 6-mm^2 silicon chip by using a standard 250 nm complementary metal-oxide semiconductor (CMOS) technology. A search coil sensor shows a maximum value of its impedance at the resonance frequency. The NEMI at the resonance frequency is determined by multiplying the sensor impedance by the current noise of preamplifier. Thus, the ASIC preamplifier using CMOS technology is more suitable for search coil magnetometer compared to a preamplifier using bipolar junction transistors, because MOS transistors show the very low current noise. The NEMI of developed ASIC preamplifier combined with a 100-mm-long search coil is 30 fT/$\sqrt{}$Hz at 2 kHz with a power consumption of 15 mW. The radiation hardness assurance of the ASIC preamplifier is at least 100 krad total ionizing dose, which is equivalent to approximately the total amount for 10 year duration at the geostationary orbit. The temperature dependence of the gain of the ASIC preamplifier is 0.04 dB/deg C in the worst case. The ASIC preamplifier showing such sufficient NEMI, low power budget, and environmental tolerance in space can be installed in the close vicinity of the search coil sensor located at the top of a mast. Also the ASIC preamplifier can provide large mass saving. As an application, we have embedded a new ASIC preamplifier for 3-axis loop antennas into a palm-sized sensor probe as a monitor system for space electromagnetic environments. The sensor node includes the ASIC preamplifiers, an ASIC waveform receiver, a CPU, and a wireless communication module in the cubic body ($8 \times 8 \times 8$ cm).

In this presentation, we will report the present status of our ASIC preamplifier and also introduce some applications using the ASIC preamplifier for plasma wave observation.

Keywords: Search coil magnetometer, ASIC