ABSTRACTS (MASTER THESIS)

Development of the multiple-point observation system for space plasmas

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Space is filled with dilute plasmas that are essentially collisionless. In collisionless plasmas, kinetic energies of particles are exchanged through wave-particle interactions. These waves are plasma waves. The observation of plasma waves in space is essential in monitoring the space electromagnetic environment, as well as for understanding physical processes taking place in space. Consequently, plasma waves have been observed in the past scientific missions that target the investigation of space plasmas phenomena.

Recently, the missions on the basis of multiple-point observations have become the trend since conventional one-point observations cannot distinguish between time and spatial variations. We propose a new system for multiple-point observation [1]. The system consists of sensor probes that can measure electromagnetic waves and transfer data to the central station through wireless communication. We developed the prototype model of the sensor probe, and we also developed the new miniaturized plasma wave receiver for sophistication of the sensor probe.

Prototype model of the small sensor probe

We developed the prototype model of the small sensor probe. The sensor probe include the plasma wave receiver, the microcontroller, the wireless communication module, electromagnetic sensors, and the battery in 130 mm cubic. Thus it has the ability to measure plasma waves and transfer observation data through wireless. Figure.1 shows a photograph of the sensor probe. We verified the total performance for electric field measurements, and we found that analog components had enough characteristics to measure electric fields, and the A/D conversion and the wireless transmission worked correctly. We also found that the sensitivity for electric field is -140 dBV/m $/\sqrt{\mathrm{Hz}}$. The sensitivity is sufficiently high to capture intense plasma wave such as electron cyclotron harmonic waves.

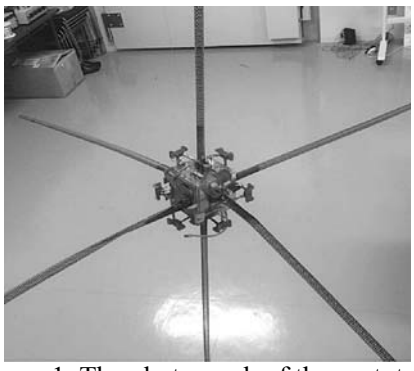

Figure 1. The photograph of the prototype model of the sensor probe.

Miniaturized spectrum plasma wave receiver

Plasma wave receivers are categorized into two types: waveform receiver and spectrum receiver. Present sensor probe measure waveform of plasma waves using waveform type of plasma wave receiver. Although the waveform receiver can provide phase data, it has disadvantages that it cannot measure continuously due to the data size of the waveform. Thus it is desirable to use both types of receivers in plasma wave observation.

We propose a new types of spectrum receiver that combine analog circuit and digital signal processing. The analog circuit of the receiver provide band-limited waveform of the plasma, and signal processor carry out Fast Fourier Transform to get detailed spectrum of the plasma wave. We developed the analog circuit of the new spectrum receiver by using ASIC (Application-Specific Integrated Circuits). We verified that the developed circuit can use for the new spectrum receiver.

References

[1] Kojima H, Fukuhara H, Mizuochi Y, Yagitani S, Ikeda H, Miyake Y, Usui H, Iwai H, Takizawa Y, Ueda Y, Yamakawa H "Miniaturization of plasma wave receivers onboard scientific satellites and its application to the sensor network system for monitoring the electromagnetic environments in space." *Advances in Geosciences.*, 21, 461-481, 2010.