

Small Sensor Probe for Multiple Point Observation of Plasma Waves

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Recently, multi-spacecraft missions for observing space plasma phenomena have become the trend because multiple point observation is essential in overcoming the disadvantage of conventional one point observation. However, multi-spacecraft missions have a limit to the number of observation point and disposition of spacecraft because of the weight and the size. We propose a new system for multiple-point observation referred to as the monitor system for space electromagnetic environments (MSEE). The MSEE consists of small sensor probes that have a plasma wave receiver, a wireless communication module and electromagnetic sensors to measure electromagnetic waves and transfer observation data. The sensor probes are randomly distributed throughout the target area to observe plasma waves from multiple-point. Observation data are transferred to a central station, such as a satellite or a rocket through wireless communication.

We succeeded in designing and developing the prototype model of the MSEE sensor probe. The sensor probe includes the miniaturized plasma wave receiver, the microcontroller, the wireless communication module, and the battery in the 75 mm cubic housing. In addition, loop antennas, dipole antennas and actuators that are used for expanding dipole antennas are attached on the housing. The whole weight of the sensor probe is 692 g, and the total power consumption is 462 mW. 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.

Present sensor probe use miniaturized waveform capture (WFC) type of plasma wave receiver realized by Application Specific Integrated Circuit (ASIC). Although the waveform receiver can provide phase information of waves, it has disadvantages that it cannot measure continuously due to the limit of the telemetry capacity. Thus it is desirable to use both types of receivers in plasma wave observation. It requires spectrum type receivers for continuously observation. We proposed new spectrum type plasma wave receiver that overcome the disadvantage of conventional spectrum type receivers. New spectrum receiver copes with both high time resolution and high frequency resolution by combining analog circuits and digital signal processing. We succeeded in developing the analog circuit of the new spectrum receiver using ASIC.

In this presentation, we introduce the detail design and the performance of the prototype model of the sensor probe. We also introduce the new spectrum type receiver.

Keywords: plasma wave receiver, multiple-point observation, ASIC