

## Breakthrough toward the tiny plasma wave receiver onboard scientific satellites and its further application in space

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Extensive attempts on developing tiny plasma wave receivers are introduced. The plasma wave receiver is one of the key instruments onboard scientific satellites which target electromagnetic phenomena taking place in space. The plasma wave receiver is a kind of sophisticated radio receivers. It provides waveforms and/or frequency spectra of plasma waves in the typical frequency range up to 10MHz. Plasma wave receivers play a role in identifying wave-particle interaction processes in space plasmas. They also provide the information of local plasma density as well as geomagnetic activity.

Since the intensity of plasma waves excited in space is distributed in the wide range, the plasma wave receiver is required to have the capability to cover the wide dynamic range more than 100dB. Thereby, the use of large analogue circuits such as filters and amplifiers cannot be avoidable. To meet severe requirements on the mass and size of onboard instruments in recent space missions such as planetary missions and formation flight missions, the extreme miniaturization of analogue circuits in plasma wave receivers is indispensable.

For these five years, the attempt of developing tiny plasma wave receivers has been made in Kyoto University under the collaboration with JAXA. The extreme miniaturization is realized by using the analogue ASIC device. Most of the essential analogue components of plasma wave receivers are implemented inside the small chip with the size of 5mm x 5mm. The process of the 'mixed signal 0.25um' is used, which is provided by Taiwan Semiconductor Manufacturing Company (TSMC). The circuit design and layout are conducted in Kyoto University and the chip is fabricated by TSMC.

Up to now, the successful implementation has been achieved in the waveform capture receiver, which is a kind of plasma wave receivers. The waveform receiver, which is manufactured on the A5 size board in the usual way, can be realized on the business card size board by using the ASIC chip.

On the other hand, the success of developing the analogue ASIC of plasma wave receivers extends their usage to new applications. The new application described in the present paper is the sensor network in space. The sensor network consists of small sensor nodes which are randomly distributed around the target area. Each sensor node carries the tiny plasma wave receiver based on the analogue ASIC device as well as other necessary components such as the telemetry and power supply system. The sensor network system overcomes the disadvantage of the single point observation via spacecraft. Such sensor node system in space has not been accomplished. However, the prototype of the small sensor node with the plasma wave receiver has been already developed.

The analogue ASIC has the potential for causing the breakthrough in the plasma wave receiver onboard scientific satellites. The tiny plasma wave receiver using the ASIC has the potential for expanding its application to others. The present paper shows the extensive attempt for miniaturizing plasma wave receivers in Kyoto University and discusses the further new application of the tiny plasma wave receiver.

### [Reference]

[1] Kojima, H., H. Fukuhara, Y. Mizuochi, S. Yagitani, H. Ikeda, Y. Miyake, H. Usui, H. Iwai, Y. Takizawa, Y. Ueda and H. Yamakawa, 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.