

較正機能を有するプリアンプ一体型小型プラズマ波動波形捕捉受信機の開発

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Development of the miniaturized waveform receiver with the built-in preamplifier and onboard measurement system

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Waveform capture receivers show us instantaneous physical phenomena as well as nonlinear phenomena which we detect hardly only by using spectrum frequency analyzer. Demands of waveform receiver observation are increasing. The characteristics of electric field sensors and the electronic circuits of waveform receiver affect observed waveform because these transfer functions of waveform receiver and the electric field sensor are complex in the frequency domain. We need to calibrate observed data using phase and gain information of electronic circuits and electric field sensors. We should measure transfer function of the circuit and the electric field sensor contain of phase and gain information. In particular, the transfer function of the electric field sensor is significant. Their impedance strongly depends on surrounding plasma conditions such as densities and temperatures. It should be then measured by the onboard system in space.

A synchronous detection method is used on the BepiColombo Mercury Magnetospheric Orbiter (MMO), which will be launched in 2014. The MMO has digitalized waveforms onboard, generates analog waveforms by D/A conversion and input them to the waveform receiver through a resistor. We can obtain a transfer function of the circuit by comparing output waveform with digitalized waveform and the antennas impedances by changing resistance. This system is also available to check characteristics of the waveform receiver. Since this system consists of many analogue components, miniaturization of this system using discrete analogue components is limited.

We will realize miniaturization of waveform receiver, measurement system and pre amplifier using analogue ASIC(Application Specific Integrated Circuits). The ASIC can realize the extreme miniaturization of analogue circuits. Miniaturized waveform receiver using ASIC has already realized by Fukuhara, et al[2012]. We have designed 8 bit segment D/A converter. Performance of designed 8 bit D/A converter is comparable to that of the commercial one. We have designed 10 bit D/A converter based on the performance of the 8 bit D/A converter. Furthermore, we also designed a low noise preamplifier implemented inside the same ASIC chip together with the waveform receiver. We will present performances of miniaturized 10 bit D/A converter and low noise preamplifier and will present new plasma observation system using miniaturized preamplifier, measurement system and waveform receiver.