Development of Wideband Digital Radio Wave Receiver on-board Spacecraft to Jupiter

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Purpose of this study is to develop wideband, low electric power consumption, and lightweight digital radio wave receiver that is possible to be on-board spacecraft to Jupiter. That is one of the most interesting planet in the solar system whose magnetosphere involves strong wave-particle interactions and radio emissions from the polar ionosphere. Characteristic frequencies of the plasma environment extend up to 40MHz, so we have to develop wideband radio wave receiver that covers the observation frequency up to 40MHz.

Science targets now we are thinking are as follows.
(1) In-situ observation of Jovian decametric radio emissions without any solar wind scintillation effects.
(2) In-situ observation of Jovian UHR, ESCH and whistler waves.
(3) In-situ observation of electron density in Jovian ionosphere and magnetosphere.
(4) Identification of Galilean satellites effects to Jovian radio emission.
(5) Study of emission mechanism of the Jovian S-burst.

We have developed BBM1 (Bread-Board Model-1) and now developing BBM2 for reducing power consumption. BBM consists of preamplifier, low-pass filter (LPF), A/D converter (ADC), digital down converter (DDC) and FPGA (field-programmable-gate-allay) or DSP (digital-signal-processor). It is confirmed that BBM2 has enough advantage for reducing power consumption with well performance of conversion from high frequency signals to low frequency signals keeping its amplitudes and phases. Because these devices are for commercial use, we have to make environmental test near future to evaluate the performance under the strong radiation of the Jovian magnetosphere.

We have measured dynamic range of BBM1. It had 70dB dynamic range within the frequency range from 0.2 to 35MHz. At 39.8MHz, it is reduced to 60dB. Therefore, the BBM1 has enough dynamic range for observing intense Jovian radio emissions in the magnetosphere.

Also we have measured frequency response of BBM1. By using 2 kinds of input signals, namely
(1) 1MHz rectangular wave.
(2) Broadband natural/artificial radio waves received by antenna in campus of Tohoku University.
It is confirmed that this BBM1 has well frequency response for observing broadband natural radio waves. As conclusion, it is confirmed that this BBM1 has enough performance for observing intense Jovian radio emissions in the magnetosphere.

Schedule of development works is planned as follows.
(1) Make environmental test using BBM2 in this autumn (2006).
(2) Make final evaluation model consists of BBM2 in this winter (2006˜2007).
(3) Observation test will be held using final evaluation model and Solar/Jovian radio emissions at observatory of Tohoku University in next spring (2007).
(4) Observation will be held using final evaluation model and Auroral radio emissions in polar region in next summer (2007).
(5) Application for sounding rocket experiment and installing on-board a small stellite system is also planning.
(6) Design and manufacturing the flight model to be installed on-board a spacecraft to Jupiter.