



Development of the ASIC waveform receiver for the SS 520-3 sounding rocket experiment

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Extended Abstract

The Japanese SS 520-3 sounding rocket experiment is an important mission to detect in-situ wave-particle interaction causing the ion outflow phenomena at the cusp. In this study, we have developed a waveform receiver using Application Specific Integrated Circuit (ASIC) technology to reduce the resources (size and power) for the rocket experiment. The ASIC waveform receiver observes electric fields in the VLF range below 10 kHz. The ASIC waveform receiver consists of four-stage circuit blocks to capture the plasma waves. First stage is a differential input low pass filter (LPF). This filter removes common mode noises from the other instruments onboard the rocket. Second stage is a main amplifier to adjust the gain. Third stage is a switched capacitor (SC) filter composed of the sixth order Chebyshev characteristics to prevent aliasing. The cut off frequency of the SC filter can be changed by the clock frequency. Final stage is an LPF to remove ringing noises generated by the clock of the SC filter. The size of ASIC waveform receiver chip (1 ch) is 2.8 mm², the power consumption is 26 mW with ± 1.65 V supply, and the dynamic range is 72% of the power supply voltage. The size of printed circuit board mounting the ASIC chip is 6426 mm². A waveform receiver onboard the ERG satellite, which consists of the discrete devices, has 18648 mm² size and 1 W power consumption. In comparison between the ASIC waveform receiver (this study) and the waveform receiver onboard the ERG satellite, we have achieved the significant reduction of the resources by using ASIC technology. The ASIC waveform receiver has a wide operating temperature range (0 to 60 deg. C) for the rocket experiment. We performed a temperature test for the chip, and confirmed that the ASIC waveform receiver chip can operate in the temperature stress between minus 5 and 60 deg. C. Furthermore, we performed a radiation test (alpha ray of 220 MeV onto the ASIC chip) up to 400 krad to install the ASIC waveform receiver in satellite experiments in the future. The equivalent input noise at a frequency of 100 Hz increased by up to 10 dB by the effects of the Total Ionizing Dose. However, the ASIC waveform receiver did not break down during the radiation test.

In this presentation, we will present the ASIC waveform receiver for the SS 520-3 sounding rocket experiment in detail.