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Improvement of dynamic range of ASIC waveform receiver for plasma wave observations

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Further reductions in mass, volume, and power of analog circuits are important in developing scientific instruments of plasma wave observations. Typical plasma wave receiver is roughly divided into two types: one is a waveform receiver and the other is a spectrum one. The waveform receiver provides a waveform with a high time resolution and phase information of a plasma wave. On the other hand, the spectrum receiver provides a frequency spectrum with a high frequency resolution and a high signal-to-noise ratio in comparison with waveform receivers.

We have been developing a plasma waveform receiver using Application Specific Integrated Circuit (ASIC) technology. Previous ASIC waveform receiver consists of a differential Gm-C Low-Path Filter (LPF), a main amplifier for the gain adjustment, a switched capacitor LPF for anti-aliasing with the cutoff frequency of 100 kHz, and a Gm-C LPF for reducing the clock pulse noise of the switched capacitor LPF. The previous ASIC receiver shows a sufficient low noise performance (210 nV/sqrt(Hz) at 10 kHz) and low power consumption (60 mW). However, the dynamic range of output voltage is not sufficient due to using operational transconductance amplifiers (OTAs) of Gm-C LPFs. In order to improve the dynamic range of the ASIC receiver, we have redesigned the ASIC receiver to exclude OTAs. In this study, we used active LPFs consisting of operational amplifiers (OPAs) instead of Gm-C LPFs using OTAs. As a result, the dynamic range increased by 80%. Moreover, the layout area decreased by 18%, and the number of transistors decreased by 60% in comparison with the previous ASIC receiver.

In this presentation, we will present the design principles of our ASIC receiver for plasma wave observations and discuss its electrical performances in detail.

Keywords: Analog ASICs, Plasma waveform receiver