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Developing of a chip for the interface between plasma wave instruments and plasma particle instruments

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Since space plasmas are essentially collisionless, kinetic energies of plasma particles are exchanged through the plasma waves. These interactions among the space plasmas and the plasma waves are called the wave-particle interactions. The wave-particle interactions are very important in analyzing electromagnetic phenomena occurring in space.

The Wave-Particle Interaction Analyzer (WPIA) is proposed in order to analyze the wave-particle interactions quantitatively and directly, and it will be installed in the next satellite mission ERG of Japan. The WPIA needs to measure the timing of the each particles at the same accuracy as the sampling frequency of the plasma wave. In the case of the ERG, the relative time accuracy is guaranteed by using the time information from the plasma wave instrument. The most precise method is using the same clock for the particle detection as the sampling clock of the plasma wave. Developing the circuit which interface the particle observation pulse with the plasma wave instruments removes the complicated procedure of time setting and enables more simply observation with high accuracy. In this study, we develop the interface circuit which input each pulses derived from the particle to the plasma wave instrument. The circuit composed of discrete components is large scale because the number of outputs from the plasma particle instruments increases according to the number of view divisions. Using the application specific integrated circuit (ASIC), we design the new dedicated chip which takes signals from the plasma particle instruments to the plasma wave instruments.

The interface circuit consists of two stages. The pre-stage converts electric charge to voltage, and the post-stage detects the arrival of a plasma particle from the voltage of the pre-stage. We use a voltage follower circuit as the pre-stage and a comparator circuit as the post-stage. We have designed the pre-stage circuit. The waveform input to the pre-stage circuit is estimated a current pulse at the frequency of several GHz. In order to convert current pulse to voltage with small delay and distortion, we have designed an operational amplifier which is capable of operating at a high speed, and have requested to manufacture a chip. In the present paper, details of the interface circuit and measurement results of the manufactured chip will be focus on.

Keywords: Wave-particle interaction, Interface, ASIC