ABSTRACTS (MASTER THESIS)

Development and integration of the high-speed current detection circuits in particle sensors dedicated to Wave-Particle Interaction Analyzer

(Graduate School of Engineering, Laboratory of Space Electromagnetic Environment Exploration, RISH, Kyoto University)

Motoyuki Kikukawa

Charged particles in space plasma do not exchange their kinetic energies through their collisions but through plasma waves. This is so-called ”wave-particle interaction.” It is indispensable for understanding space electromagnetic environments. Wave-Particle Interaction Analyzer (WPIA) is a new method of observing wave particle interaction. The size of WPIA system is large, because the WPIA consists of plasma wave receivers, particle detectors and the interface between them. It is difficult to mount the WPIA on a small satellite. Our attempt is to miniaturize the WPIA system using the Application Specific Integrated Circuit (ASIC) technology. In this research, we developed and integrated the new high-speed current detection circuits dedicated to particle sensors. The circuits feed particle detection pulses of particle detectors into an arithmetic logic unit on the WPIA.

The circuit implemented inside the ASIC consists of three stages. The first stage is the current voltage conversion circuit. It picks up current pulses of corresponding particles detected by particle sensors and converts into voltage signals with large enough amplitudes to drive the second stage. The second stage contains a comparator and a peak-hold circuit. They ensure picking up real signals by setting a threshold level.

We found that the circuits we developed output detection signals within 30 ns after particle detectors emit current pulses and the output signals reset within 12 ns after reset signals. The developed chip showed the capability to detect particles with a count rate of 106 /s and the enough accuracy of the arrival time of particles. The size of one channel in the developed circuits is 210 μm × 570 μm.

We can connect 16 of these circuits in parallel on one chip of 5mm square. Since we realize the very high-speed and small circuits, we can expect to mount them on a micro satellite.

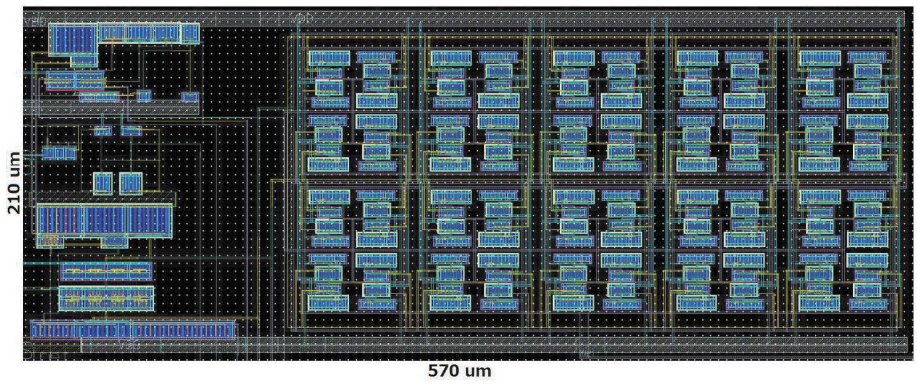

Figure 1. Layout of the designed chip for one channel of particle detectors.