Study on the development of analog integrated circuits for the space electromagnetic environment monitor

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Environments in space are strongly controlled by electromagnetic phenomena. Since space plasmas are collisionless, we can recognize a status of electromagnetic environments by monitoring plasma/radio waves. Plasma wave receivers can be used to monitor space electromagnetic environments. For example, they can monitor the interaction between the huge structures such as space power station/satellite and space plasmas that might cause artificial disturbances around them. However, since the weight and size of typical plasma wave receivers are heavy and large, they are not suitable for the electromagnetic environment monitors, which are distributed around space structures in order to make it possible to monitor in multiple points. Therefore, we need to re-design plasma wave receivers and to realize a very light weight and compact monitor instrument.

To develop the compact monitoring system, we design a part of analog electric circuits for the monitoring system, based on the ASIC (Application Specific Integrated Circuit) technology. Using ASIC technology, we can realize small and light weight analog circuits, and reduce its electricity consumption.

We have designed several important components of the whole analog circuits for the space electromagnetic monitor instruments i.e., differential amplifiers and AD converters. The differential amplifiers are required low noise characteristics on their observation band frequency. In computer simulation, we have realized the noise level of them as 100nV/(Hz)$^{1/2}$ at 100 Hz and as 30nV/(Hz)$^{1/2}$ in the frequency range above 1kHz. This noise level is lower than the specification of space electromagnetic environment monitor. In its function and performance tests, its noise level reaches 300nV/(Hz)$^{1/2}$ at 100 Hz and 100nV/(Hz)$^{1/2}$ in the frequency range above 1kHz. In its performance, we need further improvement of the noise level by re-designing.

In the present paper, we introduced the results of our design and performance tests of the ASIC dedicated for the space electromagnetic environment monitor. Further, we propose the analog block diagram of the monitor system. In this diagram, we show the possibility of realization for a new type of instrument in space.