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Design and development of miniaturized sweep frequency analyzer using ASIC technology

Satoshi Okada^{1*}, Hajime Fukuhara¹, Hirotsugu Kojima¹, Hiroshi Yamakawa¹

¹RISH, Kyoto University

Space plasma is essentially collisionless, and its kinetic energy is transferred through plasma waves. Plasma wave receivers, which capture these waves, have contributed to the investigation of electromagnetic environment in space. Sweep frequency analyzer (SFA), one of the types of the plasma wave receivers, provides spectral information on plasma waves with good frequency resolutions. General SFA is basically a heterodyne receiving system, provides the spectrum information with the good signal to noise ratio. The SFA has a PLL, a frequency synthesizer. This PLL makes a number of fine sweep frequency steps. It takes several seconds to complete all sweep steps. Thus, this type of SFA generally has disadvantage in temporal resolution.

We propose a new kind of the SFA combined with FFT in FPGA (Field Programmable Gate Array). To improve the temporal resolution, we widen frequency range of each sweep step and decrease the number of sweep steps. The bandwidth brought out of the double-superheterodyne receiving is also widened. Observed signals are converted into digital signals and input to the FPGA. Logic FFT blocks in the FPGA apply the FFT to these digital signals. Thus, we can obtain the frequency resolution which is equals to the widened bandwidth divided by the FFT points. This new type of SFA realizes low noises, high frequency resolution, and high temporal resolution at the same time.

Plasma wave receivers, include SFA, are required to have low noise and wide dynamic range with amplification in wide band. These requirements lead analog circuits in each receiver to be large and make it difficult to realize small plasma receivers with discrete parts or commercial integrated circuits. We use ASIC (Application Specific Integrated Circuit) technology to make breakthrough in this present state. The ASIC technology enables extreme miniaturization of analog circuit. We have developed several analog circuits in the SFA, such as a differential amp, a low pass filter, PLLs, and a band pass filter using ASIC. In the session, we will introduce the new SFA and development of required circuits with showing each performance.

Keywords: Space electromagnetic environment, Space plasma, Plasama wave, Plasama wave receiver, Sweep frequency analyzer, ASIC technology