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The development of the miniaturized waveform receiver with the function measuring Antenna Impedance in space plasmas

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Plasma wave is one of the most essential physical quantities in the solar terrestrial physics. The role of plasma wave receiver onboard satellites is to detect plasma waves in space with a good signal to noise ratio. There are two types of plasma wave receivers, the sweep frequency analyzer and the waveform capture. While the sweep frequency analyzer provides plasma wave spectra, the waveform capture obtains waveforms with phase information that is significant in studying nonlinear phenomena. Antenna sensors to observe electric fields of the plasma waves show different features in plasmas from in vacuum. The antenna impedances have specific characteristics in the frequency domain because of the dispersion of plasmas. These antenna impedances are expressed with complex number. We need to know not only the antenna impedances but also the transfer functions of plasma wave receiver's circuits in order to calibrate observed waveforms precisely. The impedances of the electric field antennas are affected by a state of surrounding plasmas. Since satellites run through various regions with different plasma parameters, we precisely should measure the antenna impedances onboard spacecraft. On the contrary, we can obtain the plasma density and by measuring the antenna impedances.
Several formulas of the antenna impedance measurement system were proposed. A synchronous detection method is used on the BepiColombo Mercury Magnetospheric Orbiter (MMO), which will be launched in 2014. The digital data are stored in the onboard memory. They are read out and converted to the analog waveforms by D/A converter. They are fed into the input of the preamplifiers of antenna sensors through a resistor. We can calculate a transfer function of the circuit by applying the synchronous detection method to the output waveform from waveform receivers and digital data as a signal source. The size of this system is same as an A5 board. In recent years, Application Specific Integrated Circuit (ASIC) is in attention which is a technique to integrate large scale and complicated circuits. Lots of ASICs have been applied to high energy astrophysics.
In this paper, we show our attempt to miniaturize the antennas impedances measurement system and Waveform Capture using the analogue ASIC. We design 8bits segment D/A converter that is implemented inside the waveform receiver ASIC chip. We improve input logic of the D/A converter to generate very weak signals accurately. The designed chip realizes the measurement of the antenna impedance as well as the waveform observation in the board size of business cards.