



Initial Report of the Onboard Frequency Analyzer/Waveform Capture (OFA/WFC) on board the ERG(ARASE) Satellite and its Calibration Technique

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1. Extended Abstract

The ERG (Exploration of energization and Radiation in Geospace, ARASE) satellite was launched on December 20, 2016 to understand dynamics around the Van Allen radiation belt such as particle acceleration, loss mechanisms, and the dynamic evolution of space storms in the context of cross-energy and cross-regional coupling [Miyoshi et al., 2012].

The Plasma Wave Experiment (PWE) is one of the science instruments on board the ERG satellite to measure electric field and magnetic field in the inner magnetosphere. PWE consists of three sub-components, EFD (Electric Field Detector), OFA/WFC (Onboard Frequency Analyzer and Waveform Capture), and HFA (High Frequency Analyzer). Especially, OFA/WFC measures electric and magnetic field spectrum and waveform from a few Hz to 20 kHz. OFA/WFC processes signals detected by a couple of dipole wire-probe antenna (WPT) and tri-axis magnetic search coils (MSC) installed onboard the satellite. PWE-OFA subsystem calculates and produces three kind of data; OFA-SPEC (power spectrum), OFA-MATRIX (spectrum matrix), and OFA-COMPLEX (complex spectrum). They are continuously processed 24 hours per day and all data are sent to the ground. OFA-MATRIX and OFA-COMPLEX are used for polarization analyses and direction finding of the plasma waves. The PWE-WFC subsystem measures raw (64 kHz sampled) and down-sampled (1 kHz sampled) burst waveform detected by the WPT and the MSC sensors. It activates by a command, automatic triggering, and scheduling.

The observed spectrum and waveform need calibration because the characteristics of the sensors and that of the electric circuits of the receivers change depending on the aging degradation. Particularly, it is well known that the impedance of the electric field antenna in space change depending on the sheath impedance and plasma parameters (e.g. plasma density, temperature, etc). We developed the onboard calibration system (SoftWare-based CALibration; SWCAL) for the middle frequency range receiver (OFA/WFC) and implemented as a part of the onboard software of the PWE. An arbitrary frequency square wave is fed into the receiver or preamplifier under the control of the SWCAL system. The system performs a fast Fourier transform (FFT) on the signal output from the A/D converters, and collects frequency responses of the fundamental and that of odd-numbered harmonics below 32.768 kHz. The transfer function can be derived on the ground by dividing observed responses into the reference square signal in the frequency domain. The antenna impedance can be derived by a comparison between a total-circuit response and an internal-circuit response.

In this presentation, we introduce initial results observed by OFA/WFC and onboard calibration technique implemented in PWE.

References

1. Y. Miyoshi et al., The Energization and Radiation in Geospace (ERG) Project, in Dynamics of the Earth's Radiation Belts and Inner Magnetosphere, Geophys. Monogr. Ser., vol 199, edited by D. Summers, I. R. Mann, D. N. Baker, and M. Schulz, pp.103-116, AGU, Washington, D.C. doi:10.1029/2012BK001304, 2012.