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SEAMS Phase I- Data Acquisition System and On-Board Computer

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Space Electric and Magnetic Sensor (SEAMS Phase I) aims at observing the Radio Frequency Interference from Earth in low frequency (below 30MHz) radio astronomy. Thus, a space-based system is designed to overcome the ionospheric opacity at low frequency [1]. Two electrically short orthogonal monopole antennae along with their matching networks and gain stages are used to receive the RFI and are acquired and processed by the data acquisition system. The data acquisition system is designed in the form of direct sampling receiver using dual high speed ADC and Virtex-5 FPGA (Figure 1) which samples the signal at Nyquist sampling rate [2]. The RF Frontend and Digital Backend system will be able to detect the RFI from the ground and from the Sky using approximately 2 meters of antenna.

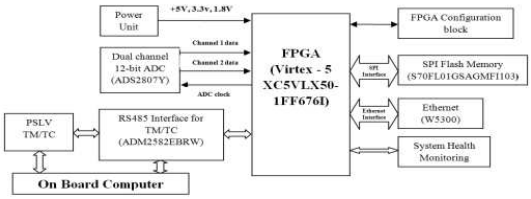

Figure 1. Block Diagram of Digital Backend

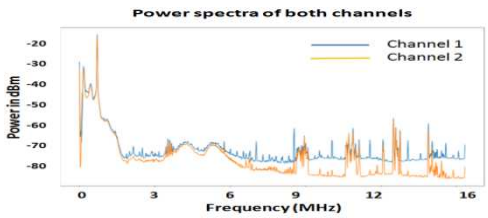

Figure 2. Two channel Power Spectra

A pipeline architecture computes the Fast Fourier Transform (FFT) [3] and calculates power spectrum of each channel with a frequency resolution of ≈ 16kHz is as shown in Figure 2. The Channel 1 signal is corrupted by Power supply noise due to its vicinity to the signal line as seen in the spectrum which is being rectified in the new design. The power spectra along with health monitoring data and time stamps are stored in an onboard flash memory which will be passed on to the PS4 communication link (refer to Figure 1). SEAMS receiver works in 3 modes: the voltages, one-time power spectrum, and binned power spectrum of each channel. The backend system consists of a telemetry and telecommand interface [2] with the PS4.

A dedicated On-Board Computer (OBC) is designed and works as the master control of the entire SEAMS payload. To start with the OBC turns ON the supply for the Antenna deployment mechanism and at the same time switches OFF the Frontend and Backend to reduce power consumption. The Tele-commands from the Main (PS4) system are accepted by the On-Board Computer and are given to Digital Backend for the downloading respective types of data -namely raw ADC data , one time power spectrum, or Binned Power spectrum. The system stores the data in the flash memory as per the command issued. The OBC also generates appropriate signals to toggle the states of RF switches and to control the entire RF Frontend system to implement the calibration, observation and housekeeping data modes. The OBC also receives the command from PS4 to download the data from the Backend to the PS4 system. The acquired data will be used to map the RFI in LEO as a function of location and variation in time [3].

1. "Design and Implementation of Data Acquisition and Analysis System for SEAPS", Rupali Borade, Damayanti Gharpure, S. Ananthakrishnan, Department of Electronic Science, Savitribai Phule Pune University, Pune, India, presented in CMNA IIT Indore, October 2018.
2. FPGA based data acquisition and processing system for space electric and magnetic sensors (SEAMS), R Borade, GN George, DC Gharpure, Presented at ETMN 2020, AIP Conference Proceedings 2335 (1), 030005
3. Instrumentation for SEAMS: Phase I, Atharva Kulkarni, Aditi Nagulpelli, Rasika Sali, Nikhil Navale, Damayanti Gharpure, Avinash Deshpande, Subramaniam Ananthakrishnan, Presented at URSI GASS 2021, Rome, Italy.