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RF Front-End for SEAMS

Atharva Kulkarni(1),Sunil Pingale(1),Damayanti Gharpure(1),and Subramaniam Ananthakrishnan(1)
(1) Department of Electronic Science, SPPU, Pune, India-411007, e-mail: atharvak1994@gmail.com; sunilpingale92@gmail.com; dcgharpure@gmail.com; subra.anan@gmail.com

The opacity of ionosphere at the lower frequencies (less than 16 MHz) restricts astronomy through ground based radio telescopes. A space based solution for this problem is being explored for many years. This will open a new unexplored region of the electromagnetic spectrum. It will facilitate the study of the low frequency solar radiation and radio emission from planets. Previous attempts of space based radio astronomy such as Missions like RAE1 [1] and RAE2 have gathered low frequency astronomical data. Several other instruments such as STEREO-A and STEREO-B, WIND/WAVES, CASSINI [2-3], etc have also been used to observe the low frequency radio emissions.

In case of low frequency radio receivers, signal can be directly Nyquist sampled by the sampler. Before sampling it passes through gain blocks and filters. With the advent of digital technologies, Detector and averager section of a radio telescope are realized with the help of cluster of computing units such as GPUs and FPGAs.

At very low frequencies, making a resonant antenna becomes practically impossible because of the large wavelengths. Use of active antennas is a more practical solution to this problem [4]. Active antennas consist of an electrically small antenna along with a matching amplifier. Antenna, because of its short length, has very high capacitive impedance. This causes mismatch when connected to the matching amplifier with 50 ohm impedance. The high gain of the matching amplifier enables it to act as an impedance transformer.

The sensitivity of a low frequency instrument is limited because of the dominance of the galactic background radiation [5]. The receiver system is designed such that the system noise is less than the background radiation. Since the impedance of the antenna changes with its length, the amount of power received varies with the antenna length. Through computer simulations we tried to analyze the effect of length of antenna on the sensitivity of the system. To support the analysis we present the work done for a proposed Space based Low Frequency (less than 16 MHz) Electric and Magnetic Sensor (SEAMS). The paper provides a general overview of the design considerations for a sensitive low frequency radio instrument. Results from various simulations and calculations are also presented in the paper.

1. R.R. Weber, J.K, Alexander, and R.G. Stone, The Radio Astronomy Explorer satellite, a low-frequency observatory, Radio Science, Volume 6, Number 12, pages 1085-1097, December 1971

2. J.-L. Bougeret et al., Waves: the radio and plasma wave investigation on the wind spacecraft, Space Sci. Rev., 71(1–4) (1995) 231–263

3. D.A. Gurnett et al., The Cassini radio and plasma wave investigation. The Cassini-Huygens Mission, Springer, Berlin (2004) 395–463

4. K. Makhija et al., Space Electromagnetic and Plasma Sensor (SEAPS): A Laboratory Prototype for a Space Payload, MAPAN-Journal of Metrology Society of India (December 2016) 31(4):283–289 DOI 10.1007/s12647-016-0188-y

5. Chen, L. (2018). Antenna design and implementation for the future space Ultra-Long wavelength radio telescope. **arXiv:1802.07640 [astro-ph.IM]**