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ON-ORBIT OBSERVATION OF TOTAL ELECTRON CONTENT IN THE IONOSPHERE BY UHF RANGING SIGNAL FROM THE GROUND

Abstract

There are many satellites and simulation models for measuring ionospheric density. However, there is no global 3D ionospheric map that can capture the time fluctuation of the ionosphere yet. The SPATIUM project (developed at Kyushu Institute of Technology and Nanyang Technological University) aims at 3D mapping of the ionosphere using a CubeSat constellation. This project's objective is to elucidate the dynamic interaction of the atmosphere, ionosphere, and magnetosphere. This paper describes the system developed for measurement of the total electron content (TEC) of the ionosphere using the SPATIUM-II satellite, which is the second generation of the SPATIUM project. SPATIUM-II occupies 1U of volume and performs the onboard processing of the ranging signal from the ground station (GS) using Chip-Scale Atomic Clock (CSAC), GPS receiver, software defined radio (SDR) and Raspberry Pi (RPi) for measurement of TEC. The electrons of the ionosphere result in radio wave propagation time delay. The

propagation time of ranging signal is proportional to TEC. CSAC is used as a precise clock. CSAC and GPS receivers are installed in both the GS and the SPATIUM-II satellite. The 1-PPS (one pulse per second) signal of GPS receiver is used for timing synchronization and measurement of the propagation time delay of ranging signal. The ranging signals are time-synchronized by RF switch and 1-PPS signal, and then received by SDR. The signal is A/D-converted by SDR and transferred to RPi as a digital signal. This digital signal is processed in the RPi for measurement of the TEC. This TEC measurement system has been successfully developed and verified by ground tests. The flight model is complete and ready for delivery. It is scheduled to be launched in 2021.