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ONE YEAR OF BEESAT-4 OPERATION: LONG-TERM ANALYSIS OF HOUSEKEEPINGS, GPS AND ATTITUDE CONTROL DATA

Abstract

The picosatellite BEESAT-4 was launched as a secondary payload on the 22nd of June 2016 from Sriharikota, India with a PSLV launcher. The SPL (Single Picosatellite Launcher) was integrated into the microsatellite BIROS. After its commissioning, BIROS released BEESAT-4 on the 9th of September 2016 into its sunsynchronous orbit in 515km altitude. Although BEESAT-4 was switched off during the time within BIROS, experiments showed that the batteries are loaded with a small discharge current. Therefore, separation of the CubeSat had to be executed within three months after integration. After the release, the satellite was charged for one orbit, before it began to transmit its beacon signal. It was directly received from several radio amateurs around the world and during the first pass over the ground station, telemetry was received, too. During the first months of operations several long term observations were conducted. These observations mainly focused on the energy budget, regarding the cycles of the batteries and the temperatures of all subsystems. The different satellite modes were commanded, according to their duty cycles and the energy budget remained positive, as predicted. The temperatures of all subsystems and components were within the margin, during eclipse and sun phases. Furthermore, the thermal simulation could be verified for the different satellite modes. The GPS receiver is the main payload of BEESAT-4. Precise position and orbit determination is the primary objective of the mission. The orbit determination is compared to the usually used prediction models, based on TLEs, provided by NORAD. Within a couple of days the In-Track difference can add up to more than 100km. Considering the idea of possible formation flights, this is not acceptable. The gained data was used to compare In-Track difference, Cross-Track difference and Radial difference and shows how many positions per orbit are needed to obtain acceptable accuracies. For GPS operations a three axes stabilized satellite is required. Therefore the attitude control system was tested extensively. Several modes, like target pointing, zenith pointing, earth pointing and inertial pointing were successfully executed for 30min. The power system sets time limits for long term attitude control experiments. The zenith pointing mode turns the GPS antenna towards zenith and is required for GPS operations. Additionally an Inter Satellite Link to BIROS is planned to be established, using UHF transceivers on both satellites. This leads to a much higher downlink rate of telemetry or payload data of BEESAT-4.