Paper ID: 39099
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24th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Satellite Operations (3)

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ANALYSIS OF THE COMMUNICATION ANOMALY DURING E-ST@R-2 MISSION OPERATIONS

Abstract

To increase probability of success of future nanosatellite missions, data gathered from orbit operations are of paramount importance, especially if anomalies are observed. E-st@r-2 Cubesat was launched on April 2016 in the framework of the Fly Your Satellite! programme of the European Space Agency. Few anomalies were detected during operation, which compromised the mission either temporary or permanently. This paper describes the investigation of a major anomaly that seriously affected mission operations, i.e. low Signal-to-Noise ratio of downlink communication. In particular, no signal could be received at the main control station. Only ground stations with high gain antennas and/or proper system set up could receive and decode e-st@r-2 packets, whereas standard radio amateur station failed. For this reason, both space and ground segments were identified to be part of the problem. The analysis performed to cope with the issue covered several phases of mission lifecycle, from design to assembly, integration and test, until operations. The investigation on the anomaly has been done by means of analysis and test activity. A loss of 12 to 15 dB was estimated with respect to the link budget. A fault tree analysis was developed to identify the failure or combination of failures that resulted in the mishap. A failure modes and effects analysis of communication system was carried out, as this subsystem was identified as the major contributor to the anomaly. In parallel, testing activity was performed on the engineering model of cubesat. A thorough test campaign was planned and executed at equipment, subsystem and system level. Test results on the engineering model were compared with orbit data and results of qualification campaign on the flight unit. The investigation showed that possible causes of the anomaly could be either incomplete deployment of the antenna, or incorrect antenna connection, or loss of power in the transceiver, or a combination of these causes amplified by the tumbling motion of the CubeSat. Taking into account the extensive test campaign executed on the flight unit during development, the failures of antenna deployment and of high-power amplifier circuit are extremely unrealistic. Instead, a potential defect was detected on the coaxial cable connection to the antenna, which might have caused the final mishap under investigation. The analysis also showed that an effective ground segment helps mitigating the impact of the anomaly, thus increasing mission success to a great extent, and it is worth investing more on this mission element.