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DEVELOPMENT AND TESTING OF A LED-BASED OPTICAL DATA LINK FOR THE LEDSAT CUBESAT

Abstract

The increasing number of CubeSats launched for scientific and technology demonstration missions requires improving the reliability of the space-to-ground data link. While traditional RF-based transceivers are subject to failure in a significant percentage of all launched nano-satellites, the downlink reliability can be significantly improved with LED-based systems. The installation of LED boards on the external surfaces of a nano- or micro-satellite platform can allow the down link of basic scientific or housekeeping data in case of a RF-based communication system failure. This costs little in terms of average power consumption, volume occupation, and increase in CubeSat mass. It takes advantage of the usage of an underexploited band for communications. Optical data can be acquired by observing the satellite eclipse passes with a telescope and optical sensors. The LEDSAT (LED-based Small Satellite) 1-U CubeSat is equipping 140 LEDs on all the external surfaces to test the effectiveness of LED-based boards in Low Earth

Orbit, to improve optical orbit and attitude determination, and for testing a back-up light communication system. The satellite has been conceived by Sapienza University of Rome and the University of Michigan and selected for the ESA Fly Your Satellite! Programme and part of the Italian Space Agency (ASI) IKUNS Programme, and it will be launched in 2020. The LEDSAT light communication data encoding has been refined for supporting the joint usage of photodiodes and narrow field telescopes for data down link. With respect to the traditional, Charge-Couple Devices-based observations, Photo Diodes (APDs and PINs) allow for an optical data rate increase of at least one order of magnitude, in addition to a significant simplification of the data decoding procedure. The optical communication data acquisition can be completed by a majority of observatories. A testing campaign is being conducted for investigating the actual performances of the LED-based communication on a stratospheric balloon. The achievements and lessons learned from this campaign will be used for improving the LEDSAT optical communication method to be tested. This paper will deal with the advances in the development of a light-based optical communication method to be tested on the LEDSAT CubeSat. In addition to the data link design, the testing campaign carried out in 2019 will be described in-detail, with focus on the tests conducted for the University of Michigan stratospheric balloon flight. The light communication tests carried out by LEDSAT will be described, as well as the expected results and future perspectives.