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MISSION DESIGN OF A 3U CUBESAT FOR OPTICAL COMMUNICATION: SAMSAT-LED

Abstract

The efficiency of using light emitting diodes (LEDs) on board of nanosatellites and the possibility of observing them from Earth have already been proven by previous space missions, the main focus of which was to investigate how active lighting could help to provide optical identification, tracking and attitude determination of small spacecrafts. This paper presents SAMSat-LED (SLED) – a 3U CubeSat project developed at Samara National Research University to further study this technology. Its payload consists of a LED module directed towards the Earth to test a reserve approach for satellite communication and information transmission from space. For an altitude of 400 km, the visibility conditions of SLED were analyzed using an estimation of its apparent magnitude. Based on preliminary results, a powerful LED with a luminous flux of 12,000 lm was chosen, and later computer simulations and laboratory tests proved that it met the established mission criteria for both visibility and resistance to the space environment. A software for prediction was developed to determine when SLED will be within an observer's field of view (FOV) according to geographic coordinates. Simulation results have shown that, for an observer in Samara city, over three days, it should be possible to see SLED 15 times – 13 with an amateur telescope and another 2, depending on weather conditions, by the naked eye. Among many important possible applications, the educational one does not go unnoticed: SLED project offers students the possibility to participate in a real space mission and to get involved in international cooperation programs. With the help of the developed software, students from different institutions can predict when the nanosatellite will be in their FOV, which will allow them to send and receive Morse code-based messages to each other using the same spacecraft they have helped to design. A 3D model of SLED's construction and on-board systems was designed by students under the supervision of professors and researchers of Samara National Research University. Heat transfer calculations and energy balance analysis were performed, and a battery array capable of powering the system during different LED operating modes was chosen. The results have confirmed the feasibility of this mission and that the specifics of SLED offer advantages to be added to the data available so far. The relevance of continuing to develop this technology ranges from an educational point of view to real applications in the space industry.