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EVALUATION OF THERMAL ANALYSIS OF ORBITAL ENVIRONMENT OF MICROSATELLITE ALE-1

Abstract

The Space Robotics Lab at Tohoku University has developed a 60kg class aeronomy study microsatellite, ALEe, as a collaborative research project with ALE Co.,Ltd. ALEe is planned to launch in 2018 on the fourth Epsilon rocket. The mission of the ALEe satellite is to release artificial meteors from the satellite, and then to observe the meteor from a specific point on the ground by re-entering it at a target location for entertainment and scientific demonstration purposes. This paper tackles the necessary thermal design of the ALEe microsatellite, the physical characteristics of which were then varied and evaluated using the software 'Thermal Desktop/SINDA/Fluint'. Moreover, thermal vacuum tests were conducted to acquire an accurate thermal conductance of the hinge mechanism for detailed thermal analysis and design.The design of ALEe has a number of challenges that need to be addressed. ALEe is unique in its way of carrying a Helium gas tank to shoot the meteors. Furthermore, it features a barrel that is attached to a mass driver to release the small pellets. Both devices need applicable thermal control. The allowable temperature range for the correct operation of the Helium tank in a space environment is, 25 degrees to 45 degrees celsius, while for the mass driver, the temperature range is 0 degrees to 50 degrees celsius. Therefore, attaching MLI on surface of the satellite and changing the areas of the MLI were examined. These potential thermal designs were put into thermal vacuum tests. Given ALEe's surface area and power limitations, passive thermal control was deemed necessary to guarantee mission success and safety operation of high pressure gas tank under the extreme environments that result from varying orbital situations such as the 'cold case' and the 'hot case'.ALEe follows a near-circular orbit with a nominal altitude of 400 km and an inclination of 97.4^{o}. We defined the hot case and cold case as the orbit with solar flux of 1423 W/m^2 and 1361 W/m^2 respectively. The trajectory of the satellite while maintaining the direction in which the sunlight is most widely received by the extended panel to get solar power is determined to be the hot case.The trajectory for which only the cover surface of the MLI keeps receiving the sunlight is determined to be the cold case. In addition, the nadir point mode, in which the payload points towards the traveling direction, was analyzed.