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GENERIC THERMAL DESIGN STRATEGY FOR 50KG-CLASS MICRO-SATELLITES

Abstract

Recently, development of Micro-satellites with a mass of 100 kg or less has been paid great attentions. The Space Robotics Laboratory (SRL) of Tohoku University has three 50 kg class Micro-satellite projects. The first satellite, SPRITE-SAT, has been successfully launched into low Earth orbit in 2009 and has obtained useful operational data. Now, the flight model of the second micro-satellite RISING-2 is being integrated and the development of the third micro-satellite RISESAT is ongoing at SRL. The former two have cubic shape and the solar cells are body mounted, while the last one has two deployable solar panels. Satellite is exposed to severe thermal environment in orbit. In the case of micro-satellites, it is difficult to install active thermal control equipment because their volume and mass are limited. Therefore, it is always desired that required thermal condition can be satisfied by passive thermal control method. Though the mass and structural configuration are not exactly the same, micro-satellites developed by SRL have the same thermal design approach. First of all, the satellite's internal main structure has a central pillar configuration where the most of the internal instruments are mounted on. This central pillar is thermally almost isolated from the outer panels. These outer panels are thermally well connected with each other. Furthermore, most of the surfaces of the internal components are bare aluminum surface to isolate radiative coupling. In this way the whole satellite can be regarded as two-nodes system from thermal design point of view, which makes the thermal design process considerably simple and reliable. The parameters to be adjusted are basically the optical characteristics of the outer panels, thermal conductance between the central pillar and the outer panels (which can be adjusted by type, contact area, and thickness of the insulation material). The former defines the total thermal balance between the satellite and the environment, and the latter defines the temperature range of the nodes. This strategy allows step-by-step thermal design approach and is especially suitable to 50kg-class micro-satellites. This paper will describe suggested generic thermal design strategy. The operational data obtained by SPRITE-SAT, as well as the thermal design of RISING-2 and RISESAT together with the results of thermal vacuum tests will be illustrated. Also detailed numerical thermal simulation results will be summarized to discuss the influence of deployable solar panels.