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Educational Pico and Nano Satellites (4)

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DESIGN, DEVELOPMENT AND IN-ORBIT PERFORMANCE AND VALIDATION OF THE THERMAL SUBSYSTEM OF SRMSAT NANOSATELLITE

Abstract

SRMSAT is the first nano-satellite developed by undergraduate students and faculty of SRM University in collaboration with the Indian Space Research Organization (ISRO). The satellite weighs around 11kg and is a 280mm cubic structure. SRMSAT was launched on-board the Polar Satellite Launch Vehicle (PSLV C-18) as a piggyback satellite on October 12, 2011 with an intended mission life of 1 year at a height of 866km and a 20 deg equatorial orbit. It carried a Near-IR spectrometer as the payload, to measure the concentration of greenhouse gases. The primary objective of the mission was to provide undergraduate students with a hands-on experience with the design and realization of a nano-satellite.

This paper focuses on the thermal design of the satellite, implementation, testing on ground as well as in-orbit performance. The primary goal of the thermal subsystem was to ensure that all components are maintained well within their operating temperatures. As a technology demonstration, most of the electronics used were COTS (commercial off-the-shelf) components which led to a very limited operating range of 0 and 40 deg C for the design. Due to the power and size constraints of the satellite, the thermal design was completely passive. After preliminary steady state analytical studies, the thermal mathematical model of the satellite was constructed using NX-IDEAS. Transient analysis was performed on Thermal Mathematical Models for different Beta angles of the orbit viz., the extreme cases and the intermediate positions of the earth with respect to the sun. Iterative analysis was done and a final flight thermal design was finalized. A combination of MLIs, thermal tapes, OSRs and isolators were used for thermal control. The satellite was tested on ground and qualified for flight. Apart from the above mentioned challenges, the satellite had localized thermal control constraints. A high heat dissipating power amplifier proved to be the Single Point Failure for the mission and a battery that had a very low tolerance (23+/-5 deg C) as its operational temperature range.

The satellite has been operational for over 3 years and the health parameters are reported to be normal. This proves, apart from the successful functioning of other subsystems, the robustness of the thermal design in handling the dynamic thermal loads in-orbit for an extended period of time. This paper will also present an analysis of the thermal housekeeping data collected over a period of 3 years.