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CUBESAT THERMAL MANAGEMENT SYSTEM DESIGN SUPPORTED BY MULTIDISCIPLINARY DESIGN OPTIMISATION

Abstract

Thanks to its low costs and technical developments, cubesats are becoming one of the key players for scientific and technological missions in Low Earth Orbit. In addition, new interesting concepts for interplanetary nanosatellites missions are also appearing. The future for the small satellites depends on the increments of performance and reliability of enabling and critical technologies such as navigation, propulsion, communications and thermal management. The last one is a challenging area of research, especially for missions with stringent thermal requirements such as astrobiology experiments, or observation in particular spectral bands (e.g. IR imaging payloads). The goal of this study is to describe in detail the design methodology for Thermal Management System (TMS) supported by Multidisciplinary Design Optimisation (MDO) of a 12U CubeSat platform in low earth orbit. The reference mission is Space Rider Observer Cube (SROC) and the main objective is to fly around Space Rider vehicle performing observations in visible, near-infrared and thermal infrared wavelengths. In order to design the TMS, a tool in MATLAB environment, that performs both thermal analysis and thermal design using Multidisciplinary Design Optimisation (MDO), has been developed. Firsts, orbit, attitude and platform data are exploited to perform a first thermal analysis. If the temperatures of the equipment result to be out of the operative range, a solution of TMS will be found using the MDO taking into account the low mass and power constraints. The TMS configuration has been obtained considering different surface treatments, radiators, thermal straps and heaters. In particular, for this mission, the use of heaters and thermal straps for critical items, like pack batteries, is suggested to maintain the temperature in the operative range. The effectiveness of this preliminary configuration of TMS is verified with commercial thermal analysis software, proving that the temperature data met the needs of the mission. In this paper, the results obtained by the application of this design methodology are presented. Particular attention is given to favour, where it is possible, the use of a passive thermal control system in order to limit the power demanding. Eventually, the paper highlights the benefits and criticalities of this methodology in terms of design time, quality and cost.