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A NEW CONCEPT OF VARIABLE RESISTANCE RADIATOR: STRATOSPHERIC FLIGHT TEST & PERFORMANCE ANALYSIS

Abstract

Space and planetary environments put spacecraft components to hard test. Focusing on the thermal side, these conditions are not only extreme, but also variable during missions lifetime: the eclipses on Earth orbiting satellites or the variation of sunlight intensity on interplanetary missions are just a few example of the challenges that engineers have to face to ensure the survival of a space system. The solutions to these issues traditionally involve passive techniques, as coatings and insulating materials, along with devices that balance the heat fluxes incoming and outgoing a spacecraft: radiators. In the described context, this paper presents a new concept of radiator for space applications. This device, named multi-plate radiator, was developed researching alternative methods to easily guarantee flexibility on spacecrafts heat rejection systems. The radiator features a simple and low power design, which allows an active management of the heat exchanged by a spacecraft with the environment: this result is obtained by modifying the radiator geometry and consequently its equivalent thermal resistance. In detail, the radiator consists in three overlapped metallic plates, linked together and constrained so that is possible to separate them or put them in good thermal contact. By switching the radiator geometry between this two configurations it is possible to increase or decrease the radiator equivalent thermal resistance, thus controlling the heat dissipated towards the environment. In order to test the real performance of this concept, a complete setup of the radiator was built and flight-tested. The setup, named POLARIS, flew on the stratospheric balloon BEXUS18 in the framework of the REXUS-BEXUS programme; the flight took place from the ESRANGE Space Center on October 10th, 2014. The conditions experienced during the flight permitted to evaluate the radiator behavior in near-space environment, giving the opportunity to characterize its abilities. Post-flight analysis showed the radiator capability to double its equivalent thermal resistance when switching between the tightened plates configuration and the separated plates

one, using a negligible amount of power. Nevertheless, the radiator active thermal control capabilities are not restricted to this performance, which is strongly influenced by the flight setup design, but they could be easily tailored to face different mission environments by modifying drivers as the number of plates, their thickness and thermo-optic properties. In this paper, the design of the radiator flight setup is described and the main results obtained from the test in stratosphere are presented, together with the concept future developments.