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# FLEXIBLE AND SCALABLE THERMAL DESIGN OF MODULAR ON-ORBIT ASSEMBLY MICROSATELLITE

**Abstract**

The demand and development of on-orbit service technology have directly led to more standardized, universal and modular design methods in spacecraft design. Taking into account the "plug and play" characteristic of various equipment and functional modules, it is convenient for spacecraft on-orbit maintenance and function expansion. However, due to the limitation of its own tasks and characteristics, the thermal control system is relatively lagging behind in the development of on-orbit service technology. In addition, traditional thermal control methods are not well suited for assembling spacecraft on orbit. Therefore, this paper proposes a flexible thermal control system design method that takes into account modularity, thermal performance and scalability for the scalable on-orbit assembly of modular microsatellites.

This paper establishes thermal models for typical standardized and modular sub-systems on micro satellites, and analyzes the heat transfer characteristics and heat distribution of a single micro satellite unit with a sandwich space structure. On the basis of the thermal insulation layout, the modular satellite units were then defined as three different types of high, low and ordinary temperature based on thermal control requirements. Furthermore, targeted thermal control functions were designed to enable modular satellite units to have different characteristics such as heat dissipation / storage, low-temperature refrigeration, or heat transfer. In accordance with the special requirements of on-orbit assembly, the working scenarios of three types of micro-satellite modular units and the corresponding interface heat transfer cases are analyzed by examples in the last section of this paper.

Finite element thermal analysis calculations prove that this method can effectively meet the thermal control scalability requirements of more than 15 micro-satellite units assembled in orbit. The temperature of common sub-systems inside the satellite units is always within its rated operating temperature range. The custom-designed satellite unit has good adaptability and can be perfectly connected with other units, which can be suitable for equipment or devices with special thermal control requirements such as CCD cameras or thrusters. At present, the principle prototype of the system has been completed and related thermal tests are in progress.