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THERMAL DESIGN OF LARGE-POWER MULTI-MODE SPATIAL ACTIVE SYNTHETIC APERTURE RADAR ANTENNA

Abstract

Active synthetic aperture radar (SAR) antenna is a kind of main payloads for microwave remote sensing satellite, with the ability of single and full polarization. It possesses the characteristics of huge configuration, numerous transceiver modules, large heat dissipation, multiplex modes, and long-time operation. The SAR antenna array, sized of 10m or larger, is composed of several hundred transceiver modules (T/R module), more than ten different work modes, and different heat dissipation. The maximum heat dissipation is up to 7000W, and heat flux load of T/R module exceeds**5000 W/m2**. The payload is designed to work for 10-20min under peak power or nearly 1h continuously under lower consumption in an orbit circle. In order to ensure the imaging quality and prevent the effect on pointing accuracy caused by thermal deformation, the array **temperature consistency** is required to be less than 10 degree Celsius. Heat dissipation and temperature consistent of T/R module are the primary key thermal design difficulties. In addition, the thermal design is required to adapt frequent **mode switching**, external **heat flux variation** and **radiation coupling** between antenna and solar array. In this paper, based on the view of modularization and integration, passive and active thermal control methods are carried. The heat dissipating problem is solved by choosing reasonable heat transfer channel and optimizing discharge window. **Heat pipe network** is arranged to expand the thermal path of T/R modules, and improve temperature uniformity on a single block. **A new intelligent temperature track servo thermal control strategy** is adopt to solve the temperature differences of T/R modules , which are caused by frequent mode switching, external heat flux variation and radiation coupling between antenna and solar array. Numerical analysis and Thermal Balance Test (TBT) are accomplished. The result of analysis is consistent with TBT, and it proves that the maximum temperature is controlled within 45 degree Celsius, and the maximum temperature difference between T/R modules is less than 3 degree Celsius. The paper brings a new thermal design for large-power multi-mode spatial active SAR antennas.