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A NOVEL DUAL-BUS SATELLITE ELECTRICAL POWER SYSTEM

Abstract

With the continuous capability promotion of high-power synthetic aperture radar (SAR) spacecraft, the power requirement continues to increase. The platform power may reach 2kW or even 5kW, and the payload power may exceed 20kW or even reach 50kW. The traditional satellite electrical power system (EPS) scheme is difficult to satisfy the power needs of the future high-power SAR satellite. In this paper, a novel dual-bus satellite EPS with high power density, high efficiency, and high reliability is proposed.

The proposed dual-bus satellite EPS consists of a 42V fully regulated bus and a 100V unregulated bus. The 42V bus is generated by a three-port power conditioning unit (PCU) employing the Buck-Buck-Boost (B3R) converter topology. The B3R topology integrates the solar array power regulation and the battery charging and discharging into one module, which significantly improve the power density of the PCU. The 100V bus is generated by a boost type array power regulator (APR) adopting the maximum power point tracking (MPPT) technique. The incremental conductance method is implemented with analog circuits to extract the maximum power of the solar array. To ensure the EPS reliability and power quality, an isolated bi-direction DC/DC converter is used between the 42V bus and the 100V bus. The DC/DC converter provides a current from one bus to the other according to the command signal. To achieve high power conversion efficiency, the dual active bridge topology and the phase-shifting modulation are adopted.

To validate the feasibility and effectiveness of the proposed EPS, a set of mockups has been developed and tested. The power density of the 42V/2kW PCU reaches 250W/kg. The MPPT tracking accuracy of the 100V APR is 99%, and the power conversion efficiency is greater than 96%. Moreover, the power density of the 2kW bi-directional exceeds 200W/kg, and the power conversion efficiency is greater than 94%.