IAF SPACE POWER SYMPOSIUM (C3)
Space Power System for Ambitious Missions (4)

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RELIABLE AVIONICS POWER SYSTEM FOR COMMERCIAL AUTONOMOUS SCIENCE (CAS) MICRO ROVERS

Abstract

The realm of planetary exploration is gravitating towards a smaller class of rover. These Commercial Autonomous Science (CAS) microrovers are technically and scientifically ambitious and offer high return on investment. With mission resource constraints and limited mass, power, and communications, these rovers must leverage light-weight yet robust power systems which enable autonomous exploration initiatives, environmental survivability, fault detection, isolation, recovery, and ultimately mission success. This paper highlights MoonRanger, a microrover launching aboard a 2023 NASA Commercial Lunar Payload Services (CLPS) flight to the lunar south pole to autonomously explore for polar ice, and discusses in detail its own power system.

Use of a Radioisotope Thermoelectric Generator (RTG) is not a feasible power option for most CAS micro rovers, MoonRanger included, due to mass, budget, schedule, and legality. Instead, the rover is equipped with a custom designed solar panel with 30.7% efficiency able to sustain the rover's battery system for a 14 day lunar mission. Coupled with 200 Wh of lithium ion battery power, the rover's power system supports autonomous exploration into darkness for up to 4 hrs of dark survival. This custom power system is a fraction of the mass and cost of a traditional rover. Power generated by the solar panel is distributed to the rest of the rover system via compartmentalized power switching groups. This compartmentalization improves fault isolation for the rover's on-board fault detection and mitigation system as well as for operators on Earth. For missions with lower budget and time, like MoonRanger, rigorous testing and purchasing of space-rated parts is not as feasible. This power system organization can also be used to isolate the various power switching groups allowing for simpler testing, integration, and operational mode configuration.

This paper describes how the rover's solar panel attributes, power generation, analysis, distribution, and storage systems facilitate MoonRanger's ambitious exploration goals. Discussion of the lean approach to part selection, testing, and power analysis provides a solution for low budget, short duration missions. An overview of the Concept of Operations (CONOPs) goals and requirements provides context on the benefits of power distribution and fault detection, isolation, and recovery processes enabling high speed autonomous exploration initiatives. The paper concludes with discussion of "firsts" and lays the path for future development of commercial micro-rover power systems and lessons learned.