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FROM RTGS TO MEGSAT: ADVANCING POWER GENERATION FOR FUTURE MARS HABITATS

Abstract

As the frontiers in Space Exploration expand, a growing number of studies are dedicated to the development of a Mars habitat, which would serve as a human outpost in the solar system.
Currently, the cutting-edge technology for Mars missions heavily depends on Radioisotope Thermoelectric Generators (RTGs), power generation systems exploiting the heat from the natural decay of radioisotope materials. The most recent model, the Multi-Mission Radioisotope Thermoelectric Generator (MMRTG), utilized in both the Curiosity and Perseverance rovers, features a specific power of 2.8 W Kg^{-1}, a beginning-of-life electrical power of 110 W_{el} and an operational lifetime of 14 years.
With the aim of establishing a more robust and longer mission, this paper explores the feasibility of a Space Solar Power concept. MEGSat, a constellation of solar-panel equipped satellites orbiting the Red Planet, aims to provide a continuous power supply, alleviating the power storage subsystem and ensuring a prolonged lifetime.
As an high-level analysis, the proposed concept is investigated within the framework of a smaller mission, such as a Mars rover. This analysis intends to lay the groundwork for a future project, capable of powering an entire habitat.
Firstly the feasibility of the most promising power transmission systems, including Laser Power Transmission and Microwave Power Transmission, is analyzed. The propagation of both systems through the Martian atmosphere is evaluated, to estimate the losses and dispersion associated with such a mechanism.
A concept for the satellites and solar panels is subsequently presented, following a comparative analysis between the current available technologies. Various orbits are analyzed for the constellation, aiming to determine the optimal balance between transmission quality and satellite lifetime and stability, considering the effects of multiple perturbations.