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THERMAL MANAGEMENT SYSTEM DESIGN AND ANALYSIS OF RASHID ROVER - EMIRATES LUNAR MISSION

Abstract

Rashid Rover is the first mobile project of the Emirates Lunar Mission. Rashid intends to explore the Moon to contribute to the international effort for future human presence beyond Earth. Rashid will perform science experiments serving the open issues in lunar researches using different scientific instruments on board at the mid-latitudes of the Moon.

Due to the absence of atmosphere on the Moon, Solar radiation produces temperature extremes on the lunar surface. Depending on target landing site, lunar surface temperature can range from -155C to 88C during daytime. The huge variation in temperature from sunrise to sunset poses a challenge to Rashid's thermal design. Due to the need of Rashid's survivability in this harsh environment, thermal management system plays a crucial role in the success of the mission.

Given that, Rashid is developed by utilizing commercial off-the-shelf components with limited operational temperature range of -40C to 85C. Thermal control subsystem will maintain Rashid temperature within the allowable limits throughout the mission. This is achieved by applying passive and active thermal control methods in the design. For passive control, multi-layer insulation blanket is used to thermally isolate Rashid to avoid temperature fluctuations from environment interactions. Moreover, solar optical reflector is used to reject the excess heat dissipated by the components and thermal surface treatment is applied with an appropriate emissivity/absorptivity ratio for proper heat exchange. For active control, resistor-type heater is embedded only in the battery unit due to its narrow temperature range.

Extensive thermal analysis of Rashid has been carried out for extreme cold and extreme hot conditions at different sun angles with various operation scenarios. Simulation outcomes show that Rashid is well maintained within the temperature limits with additional uncertainty margins to account for modelling assumptions. This paper describes the design implementation of Rashid's thermal management system and discusses thoroughly the thermal analysis results and conclusions.