SPACE POWER SYMPOSIUM (C3)
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IMPLEMENTATION OF A POWER SIMULATOR FOR ENERGY BALANCE ANALYSIS OF A LEO SATELLITE

Abstract

A LEO satellite performs imaging missions while it orbits the earth 15 times a day. The electrical power generated by solar array is stored in a battery during daylight period, and consumed during eclipse period or mission operations. The state of charge of the battery should be higher than defined value for safe mission operations. When planning the next mission, mission validity is determined by estimating battery status. For the reliable estimation, the exact power simulation is required. A power simulator for the LEO satellite is a useful tool for analyzing mission validity and energy balance for various mission scenarios. It estimates amount of power generated and consumed, depth of discharge, bus voltage, charging/discharging current, etc. In this paper, the power estimation algorithm to implement the satellite power simulator is described by modeling the solar array (SA), the satellite load and the battery. To simulate the SA power generation, three different operation modes which are DET (Direct Energy Transfer), MPPT (Maximum Power Point Tracking), CV (Constant Voltage) of SAR (Solar Array Regulator) are considered with the solar array model. The satellite load power is estimated using the satellite unit power database, the unit on/off configuration at satellite operation modes. The bus voltage and battery charging/discharging current at the specific DoD (Depth of Discharge) are calculated based on the battery characteristics. Utilizing the satellite power simulator, we can conveniently analyze the energy balance and the validity of a planned mission of a LEO satellite. The experimental result shows that the estimation of the battery voltage and current using the power simulator is similar to the test result using an EQM (Engineering Qualification Model) battery. The experimental result also shows that the planned mission scenario satisfies the energy balance condition and the DNEL (Disconnect Non-Essential Load) restriction.