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THE ANALYSIS OF POWER MANAGEMENT AND PERFORMANCE FOR THE KOREAN SAR SATELLITE BASED ON DAWN-DUSK ORBIT

Abstract

Synthetic Aperture Radar (SAR) is a powerful and well established microwave remote sensing technique which enables high resolution measurements of the Earth surface independent of weather conditions and sunlight illumination. The SAR satellite comes into the spotlight in the observation satellite field because the SAR satellite can implement the imaging mission even though it is night time, which is different from the satellite with optical payload. The Korea Aerospace Research Institute (KARI) has been developing the first Korean SAR satellite. The Korean SAR satellite will operate in a nominal 06:00 AM local time of ascending node and 18:00 PM local time of descending node. Typically, the satellite will pass over the Korean region in two pass sequences daily, once during the early morning (at Dawn) and once at late afternoon (at Dusk). This is the reason why it names the orbit for the Korean SAR satellite as the dawn-dusk orbit. The dawn-dusk orbit is a type of sun-synchronous orbit that allows a satellite to be permanently bathed in sunlight. This allows the satellite to be powered almost entirely by its solar panels. For the power management point of view, the dawn-dusk orbit has a good advantage that the satellite does not experience the eclipse due to the Earth except for short period around winter solstice. The Korean SAR satellite cruises in a dawn-dusk orbit with an altitude of 550 Km, period of 96 minutes, and inclination of 97.6 degrees. The Korean SAR satellite experiences the eclipse about 3 months per year and is in eclipse region for the maximum 22 minutes per orbit in winter solstice. The SAR satellite requires higher power than the satellite with the optical payload because the SAR is the type of radar which radiates the electromagnetic waves with high power. Although the Korean SAR satellite flies in dawn-dusk orbit, it has a limit of imaging number per day according to the time of the subdivisions of the seasons when the satellite operates for and the energy capability which can determine how many continuous imaging is possible. Therefore, it is essential that the analysis of the power management and performance should be implemented in the design phase. In this research, the power management and performance of the Korean SAR satellite were analyzed for each phase from the Launch and Early Operation Phase (LEOP) to the End-Of-Life (EOL) phase. The Korean SAR satellite has the 5 years mission life time. The requirements for the satellite power are that the solar panels shall produce 1400 Watts orbit average power at EOL and that the satellite shall be capable of providing the one day energy balance. Based on one day energy balance capability, the satellite is able to accomplish daily full battery charging with satisfying the requirement of the minimum possible operation number for the imaging mission at EOL. The minimum requirement of the operation number for the imaging mission is that the satellite shall perform the imaging operation for the Korean Peninsula pass when an eclipse exists.

So the minimum requirement of the operation number for the imaging mission during the period when the satellite orbits in an eclipse is four times per day. The maximum duration requirement for the SAR imaging operation is limited to the maximum 2 minutes and for the X-band downlink operation is limited to the maximum 10 minutes per orbit. The analysis was performed with the assumption based on these requirements. The analysis results show that the energy margin is positive for one day considering all operation conditions including the worst case condition in winter solstice at EOL. The possible operation number for the imaging mission per day is able to meet the requirement of the mission operation number in the worst condition.