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SPACE POWER SYMPOSIUM (C3)
Small and Very Small Advanced Space Power Systems (4)

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THROUGH-LIFE MODELLING OF NANO-SATELLITE POWER SYSTEM DYNAMICS

Abstract

Being able to accurately predict the amount of energy collected by, and dissipated around a spacecraft early in the mission programme has been a problem for developers for many years. Text-book solutions are still common-place for preliminary design of electrical power systems, accounting only for orbit-average and peak level power demand, resulting often in significant over-design through the use of excessive safety margins. This paper presents the mathematical models which form the foundations of a steady-state – dynamic coupled architecture developed specifically for nano-satellite platforms.

Firstly, a baseline design of the vehicle power system is achieved using established closed-form methods to calculate solar array area and battery capacity requirements. This information provides inputs to a numerical analysis from which detailed time-dependent information about the system over orbit time-scales is achieved. The mathematical equations used to define interaction between inter-power system elements and the interaction between on-board sub-systems within the numerical models are presented, in addition to the switching logic required to simulate real in-flight behaviour.

Nano-satellites are often power-limited systems, such that the benefits from using through-life modelling philosophies could significantly improve performance and reduce cost. This is achieved through better mission scheduling as a result of greater confidence in behaviour, but also greater energy collection and distribution through optimisation of the platform design and configuration.

Finally, results from an example mission are presented, which show the range of information available from the system architecture detailed within, and the potential improvements made possible over those power system design approaches currently available.