Paper ID: 70329
student

IAF SPACE PROPULSION SYMPOSIUM (C4)
Interactive Presentations - IAF SPACE PROPULSION SYMPOSIUM (IP)

Author: Mr. José-María Jiménez-Coronado
Costa Rica Institute of Technology (ITCR), Costa Rica

Dr. Johan Carvajal-Godinez
Costa Rica Institute of Technology (ITCR), Costa Rica

VACUUM ARC THRUSTER ARCHITECTURE FOR GREEN ORBIT MAINTENANCE WITH SMALL SATELLITE MISSIONS

Abstract

The number of satellite space missions has increased in recent decades; this is given the ease of access to space-grade components for new actors in the field. This democratization, although it has made it possible to achieve the goals of different sectors, increases the probability of inter-satellite collisions and, with these, the generation of space debris, posing a risk to all crewed and uncrewed missions.

The way to prevent a satellite space mission from generating debris at the end of its lifetime is by removing the structure of the satellite from its orbit, taking it into a graveyard orbit, recovering the structure with another mission or performing a maneuver to re-enter the atmosphere so that the structure and components of the satellite disintegrate due to the high temperature generated by friction with the atmosphere. The latter is the one considered in this work, in which an architecture is designed for a plasma micro thruster of the Vacuum Arc Thruster (VAT) type, which uses electric arcs to erode a metallic cathode and thus expel ions to generate thrust.

This contribution proposes the physical architecture of the system, mapping functions modeled by standard languages to specific components. In addition, a logic architecture is proposed for the control of the device through a state model that allows executing timed and scheduled ignitions and, additionally, the monitoring of the incidence of inter-electrode welding, which is one of the main causes of failures in VATs. Not much information about control logic is presented in published research about VATs, so the purpose of this logic architecture is to set a baseline for more complex and tailored systems. This paper's approach towards documenting the system's logic is that the design is given without the orientation to a specific platform to allow even entry level hardware to be used within a final implementation by the reader.

The design was verified by using the Simulink simulation environment with its Stateflow and Simscape libraries, which allowed, through the implementation of free to access, simplified simulation models (including the electrical, logic, physical and joint models) of the thruster, to observe the interaction between the physical and logic architectures. The performance of the thruster was calculated using a recent theoretical model, and the result was compared to other existing implementations using simulations in NASA's GMAT software.