SPACE POWER SYMPOSIUM (C3)
Advanced Space Power Technologies and Concepts (3)

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EXPERIMENTATION WITH DIRECT DRIVE POWER PROCESSING ARCHITECTURE IN CATHODIC ARC THRUSTER

Abstract

Electric thrusters require reliable, constant and specific quantities of electrical power to operate. To do this, a Power Processing Unit (PPU) is used to process the input supply voltage and current from a supply bus. The properties of the onboard electrical bus systems are dictated by the power supply system, either a solar array or RTG, as well as the electrical requirements of the onboard systems. Unfortunately, these systems usually run at relatively low voltages (28V to 160V) compared to electric propulsion systems, which need 300V for Hall effect thrusters or 3000-5000V for gridded ion thrusters. These thruster systems require a PPU to step up bus voltage, necessitating additional mass, volume and cooling onboard the spacecraft to operate. Additionally, wires carrying current at high voltage need extra insulation to prevent breakdown and arcs, and the longer the wire, the greater the risk of insulation failure over time in the space environment. Direct drive of the propulsion system electrics from the solar arrays is an alternative concept architecture for the operation of solar electric propulsion systems. Instead of using a PPU to increase the voltage of the main electrical bus to the operating requirements for the thruster, it has been proposed that a secondary bus be implemented that brings power at the desired voltage and current directly from the source to the thrusters. In this work, we present an existing electrical thruster design which has been modified to use this architecture and measure system performance. This thruster, a centre trigger pulsed cathodic arc thruster, can operate at ISS main bus voltages (120V) just as well as at the higher voltages (300V) required by Hall effect thrusters. This work provides insights and a demonstration into the potential of this technology, and discusses some of the technical and mission opportunities and challenges associated with it.