SPACE PROPULSION SYMPOSIUM (C4)
Electric Propulsion (4)

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DEVELOPMENT OF THE ION ENGINE SYSTEM FOR SLATS

Abstract

JAXA is researching the super low altitude satellites for next generation earth observation satellites. The Super Low Altitude Test Satellite (SLATS) is the first test satellite in JAXA. Those satellites orbit the earth at the altitude of nearly 200 kilometers, where the air drag can't be neglected. Then an ion engine system (IES) is used for the air drag compensation. Kiku-8 ion thrusters meet the satellite system requirements due to their low power/thrust ratio, high thrust density and sufficient lifetime. Therefore, based on the Kiku-8 IES, we started the research and development of a new IES in order to use it for the super low altitude satellites. Although Kiku-8 IES consists of Ion thrusters, Power Processing Units, Controllers and a Propellant Management System, a Power Processing Unit and a Controller are combined in one component called PPCU (Power Processing Control Unit) and FPGAs is used instead of MPUs to reduce fabrication cost, volume and mass in the new IES. There is no design change except small dimensional change for Ion thrusters. However, the operational point of low power and low thrust is chosen for SLATS because SLATS is a small and low power satellite whose mass is only about 300kg. The PPCU has seven power supplies called a beam power supply(PS1), an acceleration grid power supply(PS2), a discharge power supply(PS3), a main hollow-cathode heater power supply(PS4), a main hollow-cathode keeper power supply(PS5), a neutralizer hollow-cathode heater power supply(PS6) and a neutralizer hollow-cathode keeper power supply(PS7). Those power supplies are switched on/off automatically according to the control logic in the FPGA. After the performance requirements for the PPCU were determined, the circuit design was conducted. In this process the trade-off study for various circuit topologies was carried out and a full-bridge typed phase shift converter was selected as PS1/PS2 and a double forward converter as PS3 taking account of high power efficiency. As for other power supplies, we selected forward converters for PS4 and PS6 and flyback converters for PS5 and PS7. The bread board model (BBM) of the PPCU was fabricated and tested using a dummy load and a practical load (thruster). The test results showed all performance requirements were filled. The discharge ignition transient response of PS3 was satisfactory. The PPCU BBM has the operational mode sequence for the simulation of SLATS operation and it was verified in the combined test with a ion thruster.