IAF SPACE PROPULSION SYMPOSIUM (C4)
Joint Session between IAA and IAF for Small Satellite Propulsion Systems (8-B4.5A)

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VERSATILE, LOW COST, MICRO-PROPULSION TECHNOLOGY DEMONSTRATION PLATFORM USING THE 3U CUBESAT STANDARD

Abstract

As miniaturized technologies become more prevalent, small satellite mission opportunities are expanding revealing a growing need for micro-propulsion systems that support orbital maneuvers and pointing requirements. Ground based testing of propulsions systems can attain a Technology Readiness Level (TRL) of 6. Space based testing is required to reach TRL levels of 7 or above, after which the propulsion systems can be considered for wider use. However, the inherent risks associated with untested propulsion systems limits the availability of secondary payload technology demonstration missions. The use of the CubeSat standard as a primary technology demonstration platform for micro-propulsion systems increases options for on-orbit testing and qualification. A rapid, low cost, development and demonstration platform for micro-propulsion systems is designed to increase the TRL of promising technologies and provide them with space flight heritage. The 3U CubeSat standard forms the base platform to minimize cost and complexity. The design includes multiple thrusters acting to spin the spacecraft around a specified axis. Inducing spin rather than translational motion minimizes potential issues with unknown trajectories after firings while allowing accurate measurements of thruster performance. This also adds an inherent redundancy to the system in the event a single thruster does not operate correctly. Misalignments of the thrusters combined with off-center moments of inertia will introduce tumble in conjunction with the spin. A dynamics model analyzing the induced tumble establishes manufacturing tolerances required for controllable operation. Other considerations include power and link budgets, thermal management, potential interactions with the thruster plume to the spacecraft surfaces, and interference with electrical systems on the CubeSat. The Pocket Rocket electrothermal plasma thruster is used as a test case. Induced tumbles are managed using reaction wheel bundles and magnetorquers, with the option of a gravity boom for further stabilization. Power and link budgets close, and only passive thermal control is needed for the satellite. Thruster placement is chosen to maximize spin rate to measure performance, but minimize interactions between the plume and sensitive spacecraft surfaces. Using the design considerations presented, the method can be adapted to any other type of micro-propulsion system, giving a versatile, low cost, rapid technology demonstration platform for on-orbit micro-propulsion testing and qualification.