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DEVELOPMENT OF A LOW-COST PERMANENT MAGNET CYLINDRICAL HALL EFFECT THRUSTER FOR CUBESATS

Abstract

A group of undergraduate students at Simon Fraser University have developed an initial prototype of a low-cost Cylindrical Hall-Effect Thruster (CHT) for CubeSats. The purpose of this thruster is to enable universities and space start-ups to develop advanced mission architectures which would otherwise be unobtainable. The entire system including the thruster, propellant feed system, and propulsion control unit is designed to fit within approximately 1U of volume with options for extended propellant storage. Due to the volume constraints, the team opted to develop a cylindrical design instead of the more traditional annular design - which is more efficient at larger scales. By using a CHT it is possible to enable missions that would otherwise be impossible with chemical propulsion or other types of lower ISP electric propulsion systems. However, unlike Gridded Ion Thrusters and other advanced electric propulsion systems, CHTs are relatively simple and can be developed at a lower cost. To further reduce the mass and system cost the CHT features permanent magnets instead of the more typical electromagnets. Samarium-cobalt magnets were used for their high magnetic flux density and resistance to both thermal and radiation demagnetization.

In deep space where the magnetic field becomes too weak to use magnetorquers, there are few options for the desaturation of reaction wheels. The CHT has been designed to be integrated and upgraded with an optional thrust vector control system which can be used for general attitude control or the desaturating of reaction wheels.

In order to enable easy integration with off-the-shelf systems and other standard CubeSat systems, the propulsion control system (PCS) conforms to the PC/104 specification. The PCS was developed with its own fault-tolerant microcontroller to act as the electronic control and interface with the rest of the satellite. The PCS firmware was developed with a modular approach that allows for streamlined prototyping, error detection, and code optimization. A QTCreator application was developed called the Zoran Control System. This application can be used on both Windows and Mac and connects directly to the propulsion control system for integration and testing purposes.