

PowerCube: Integrated Power, Propulsion, and Pointing for CubeSats

### Tethers Unlimited

#### Technical Abstract

The PowerCube is a 1U CubeSat module that provides integrated propulsion, power, and precision pointing to enable the low-cost CubeSat platform to be used to conduct high-performance missions. The PowerCube concept integrates three innovative component technologies to provide these capabilities: First, a Proton Exchange Membrane (PEM) water-electrolysis fuel cell supplies gH<sub>2</sub>/gO<sub>2</sub> to a simple pressure-fed thruster to provide 300 Ns of impulse per 100 mL of water. This approach enables the CubeSat to launch with 'inert' propellant to comply with P-POD limitations on stored energy and then process the water on-orbit into high-Isp fuel. Second, a deployable solar array that stows along the long sides of the CubeSat and deploys in a 'windmill' configuration provides up to 96 W peak. Third, a 3DOF 'carpal-wrist' gimbal, in conjunction with magnetic torque coils, enables sun-tracking of the solar panel, vectoring of the thruster, and precision pointing of payloads. The combination of ample power and water electrolysis will provide up to 6 m/s of delta-V per 90 minute orbit for a 3U CubeSat. Compared to other CubeSat propulsion technologies, the PowerCube thruster will enable more rapid orbital maneuvering and significantly lower contamination issues. Our Phase I effort developed a detailed baseline design for the PowerCube, and built and tested a proof-of-concept prototype of the water-electrolysis thruster. The Phase II effort will mature the electrolysis thruster component to the engineering model level, develop and simulate methods for attitude control and precise pointing of both panels and payloads using the gimbal and torque coils, and develop a detailed design for the entire PowerCube module to enable flight validation in follow-on Phase III efforts.

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