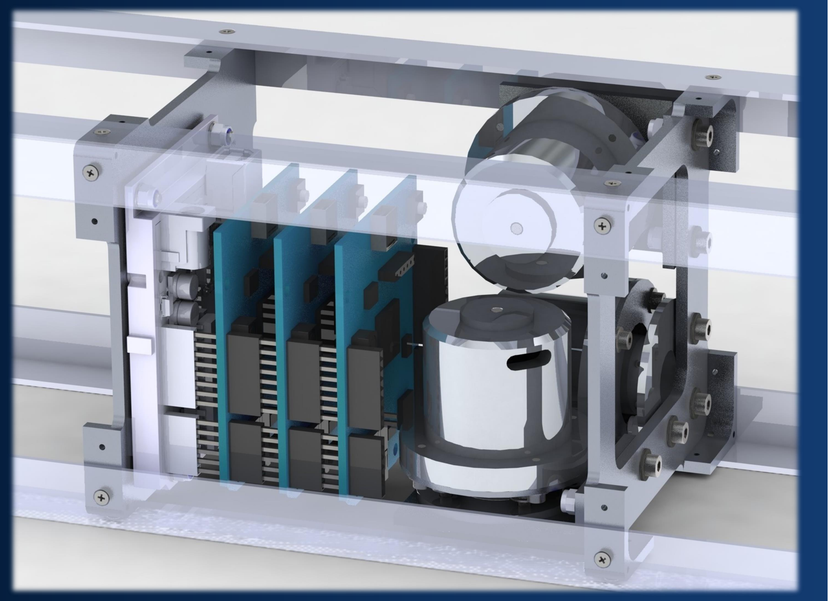
Imperial College London

Reaction Wheels Attitude Control System - Mini Satellite Super Project

Members S Chen, M Collins, K Gunde, D Malinski, M Ridgwell

Supervisor Dr. Mihailo Ristic

This project aimed to design and manufacture a three-axis reaction wheel attitude control system for a 3U CubeSat. It is designed to counteract disturbance torques exerted on the satellite and keep the solar panels pointed towards the sun.



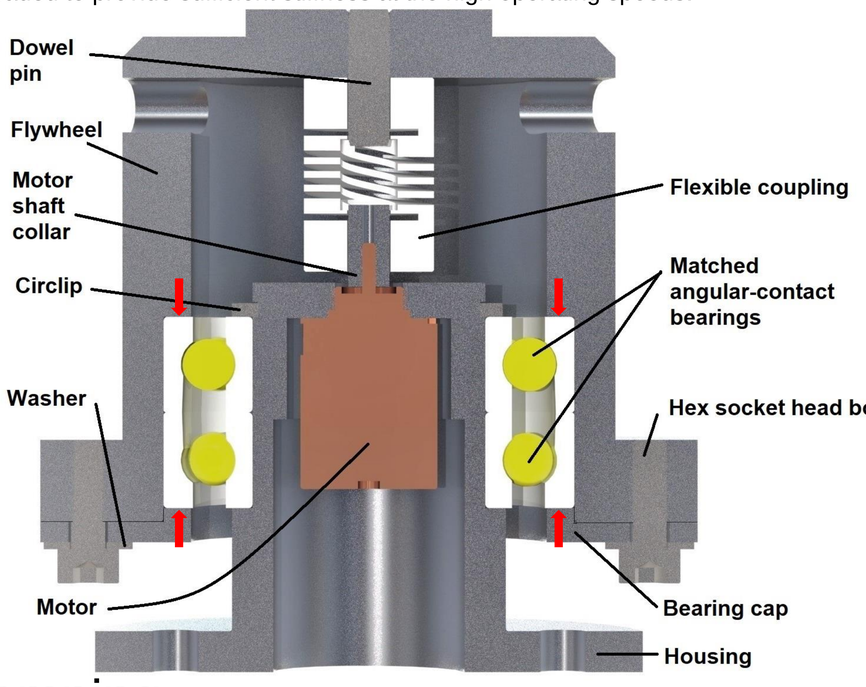
Reaction wheels store angular momentum via a flywheel, which exerts a torque to rotate the satellite when it accelerates. Among other things, the system needed to:

- Store more than 1.66 mNm·s of angular momentum.
- Take up 95.885 x 90.17 x 90 mm of space, and weigh less than 550 g

Three reaction wheels are mounted orthogonally, two on separate L-plates and one directly bolted to the satellite structure. Each reaction wheel is powered by a 0.5 W Maxon BLDC motor and controlled by an Arduino and three motor shields.

Reaction wheel unit

The flywheel is driven by a BLDC motor via a flexible coupling. The matched bearings are preloaded to provide sufficient stiffness at the high operating speeds.



Damping

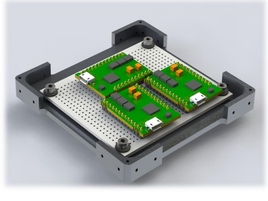
Multiple rubber washers isolated reaction wheels from the satellite. Nyloc nuts were used to prevent fasteners from loosening.

Electronics

Initially used an Arduino and three BLDC shields

- Shields can be stacked to save space
- One shield can control one motor

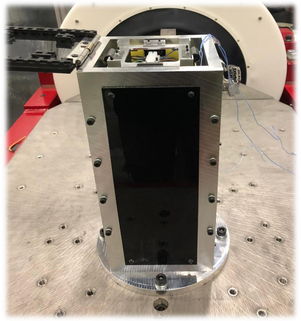
However, they were incompatible with the motor. For the redesign, three Maxon controllers were selected; these were to be mounted on a matrix board.



Testing & outcomes

Launch Vibration test:

- Entire satellite was tested to simulate the launch environment by shaking.
- Reaction wheel system passed without issues.

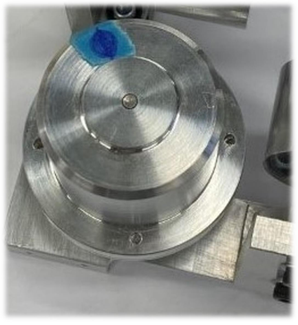


Motor performance test:

The test would verify:

- Motor has sufficient torque to overcome frictional and disturbance moments.
- The reaction wheel can the reach intended speed.

This test was incomplete as the motor had insufficient torque to overcome the bearings' friction.



Following testing and analysis, a 5W Maxon motor and smoother bearings were chosen. Other dimensions were also adjusted. The original arrangement remained.