

Semester/Master's Thesis

Design and Commissioning of a Propulsion Control Module for a Water Electrolysis Propulsion System

Topic

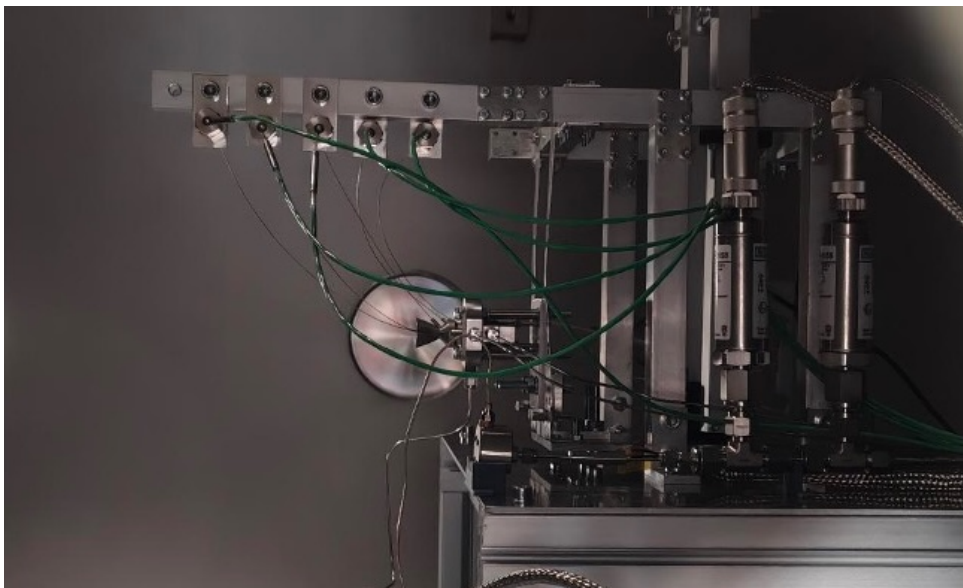


Figure 1: Ice2Thrust propulsion testbench at the Chair of Space Mobility and Propulsion

Water Electrolysis Propulsion (WEP) is one of the most promising green propulsion technologies under development today. A WEP spacecraft is filled on the ground with pure water rather than highly toxic propellants, and splits it in orbit into hydrogen and oxygen for use in a hot- or cold-gas thruster. Besides its performance, water makes docking and in-orbit refilling far simpler and safer. To enable docking and in-orbit refilling, the Ice2Thrust project (ice2thrust.space) is developing a 12-thruster cold-gas attitude and orbit control system (AOCS)

The aim of this project is to design and commission the propulsion control module (PCM) of the AOCS. The PCM receives commands from the on-board computer, consisting of desired translations and rotations. The PCM then decides which of the 12 thrusters to fire and drives the corresponding solenoid valves. The PCM must fit a standard PC104 form factor and receive either 3.3, 5, or 12 V power from the spacecraft bus.

You will build on a baseline architecture consisting of a STM32 microcontroller communicating over CAN (for on-board operation) and a wireless link (which is to be defined within the project, intended for debugging and testing), driving a MAX22216 solenoid driver over SPI.

Build-up of a system prototype using development boards is expected as a first step. Using this prototype, a command interface should be developed, allowing the user to manually open and close valves and push

firmware updates to the PCM. Validation of the PCM will be performed through hardware in the loop testing, taking advantage of Ice2Thrust's high-frequency pressure and thrust balance data acquisition. With the team's support, you will integrate and test existing thruster allocation algorithms within the firmware. Based on the software and hardware tests, a design for a single PCB containing all the required functionality will be derived.

The project forms an integral part of the Ice2Thrust propulsion system, whose testing is well underway. As a result, the topic is already well-defined, with an interface control document and system requirements provided as a digital annex.

Tasks

- **Familiarisation and Conceptual Design**

- Ice2Thrust system familiarisation
- Requirements definition
- Component selection
- Software architecture definition

- **Development Board Prototype**

- Command interface and basic firmware implementation
- Wireless communication protocol implementation
- Valve driver implementation
- Hardware-in-the-loop testing, verification of PWM parameters and valve control functionality

- **Integrated PCB Design**

- Integration of tested components in a PC104 PCB design
- Documentation of design and results
- (Optional) Manufacturing and validation of functional PC104 board

Your Profile

- Student in any engineering or informatics discipline.
- Previous experience with embedded programming or PCB design preferred.

Contact

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