Calibration Setup for Thrust Stand for use in small Vacuum Chambers

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Electric Propulsion Basics

• Magnetic field used to accelerate ions out of thruster causing it to move forward
• High specific impulse, low thrust
• Steady State operation vs. Pulsed operation
Background on Thrust Stand

- Used during thruster testing
- Stand is a linkage system that amplifies displacement
- Linkage improves accuracy of measurements
- Quantifies low-thrust propulsion system performance
- Measurements of deflection from known forces allows for calibration.
- Linear relationship between force and deflection
Objectives

• Control the overall setup and record data from sensors with an Arduino microcontroller and LabVIEW software
• Analyze the addition of a secondary linkage to amplify the displacement measured by the sensor
• Provide a setup to deliver the following calibrations:
  • Steady State Calibration: Calibration to simulate steady state thruster operation
  • Pulsed Calibration: Calibration to simulate pulsed thruster operation
Calibration Control

- Arduino Mega 2560 microcontroller
- EasyDriver stepper motor driver
- LabVIEW interface
- Linear Gap Displacement Transducer (LGDT)
- Solenoid Control Circuit
Secondary Linkage

• Adds sensitivity
• Shows an increased deflection
• Allows greater variation in thruster size, down to extremely low thrust levels
Steady State Calibration

- A stepper motor raises and lowers known masses to deflect stand while sensor collects secondary linkage displacement data.
Pulsed Calibration

- A solenoid pulses on for 50 ms at a frequency of up to 10 Hz. The strength of the magnetic field is controlled by the current applied to the solenoid. Sensor collects deflection data.
The relationship between the deflection measured by the sensor and the force produced by the thruster is shown to be linear as expected for the thrust levels.
• Secondary linkage, shown in pink, amplifies deflection measured. Secondary linkage will have a greater angular deflection than the primary linkage.
Conclusions

• The secondary linkage will provide a greater deflection than the primary linkage alone.

• Dual calibration method ensures that useful data can be recorded on this stand when operating thrusters under steady state or pulsed conditions.
Acknowledgements

I would like to thank Oregon Space grant for this opportunity, my mentor Kurt Polzin, as well as James Smith and Adam Kimberlin for their help. I would also like to thank my fellow interns and my family for their support.

Sources


Questions?