Open Source Micro Propulsion Development for Small Satellites

AIS-gPPT Series Pulsed Plasma Thrusters

Applied Ion Systems

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OVERVIEW

• First and only fully independent open-source home-based advanced electric propulsion R&D program
• Provide substantial technical resources for the open source/open space community through *Applied Ion Systems*
  - cad, electronics, build pictures, specs, simulations, walkthroughs, test reports, tutorials, etc.
• Reducing the barrier of entry in the field through low-cost DIY open-source approach and engaging the community
  - unconventional approach from current academia and industry efforts
  - full build details, live propulsion testing (recent)
• Ultra low cost, simple to build, miniaturized, fully deployable EP modules
  - enthusiasts, start-ups, academic research, etc.
AIS-gPPT1 Gridded Pulsed Plasma Thruster
AIS-gPPT1 – Design Overview

- Flat stacked plate geometry
- 32mm x 32mm x 16mm
- Grid of channels for extended lifetime
- Common materials (copper plate, Teflon plate, PEEK hardware)
- Low energy range operation (<5J)
- Electrothermal-mode PPT
- Top to bottom: anode, fuel, cathode, insulator, igniter
AIS-gPPT1 – High Vacuum Ignition Testing
AIS-gPPT2-1C Gridded Pulsed Plasma Thruster
AIS-gPPT2-1C – Design Overview

- Flat stacked plate geometry
- 19mm x 19mm x 16mm
- Sub-joule electrothermal PPT
- Single channel micro-PPT
- Modified ignition configuration
  - reverse igniter (center igniter bore with cathode pin)
  - reduced ignition spacing
- Top to bottom: anode, fuel, igniter, insulator, cathode
AIS-gPPT2-1C – Thruster Components
AIS-gPPT2-1C – High Vacuum Ignition Testing

0.84J, 1Hz, 1300V

0.23J, 2Hz, 680V
AIS-gPPT2-1C – Impulse Bit Micro Pendulum
AIS-gPPT2-1C – Impulse Bit Testing
AIS-gPPT3-1C Gridded Pulsed Plasma Thruster
• Flat stacked plate geometry
• 19mm x 19mm x 18mm
• Sub-joule electrothermal PPT
• Optimization for reduced energy operation (<0.25J)
• Reduced fuel bore diameter and increased fuel bore length to improve lifetime
• Embedded N52 permanent magnet in anode to create magnetic nozzle
• New fuels (Ultem and PEEK) in addition to Teflon
• Tapped anode plate
• Direct integration with electronics module
AIS-gPPT3-1C Thruster Components
AIS-gPPT3-1C Integrated Propulsion Module
AIS-gPPT3-1C Integrated Propulsion Module - Design Overview

- 40mm x 38mm x 24mm
- 3.3V nominal operating voltage
- Power @3.3V: <550mW
- Impulse Bit @3.3V: 0.65uNs
- Rep Rate @3.3V: 0.25-0.33Hz
- Mass: 34 grams
- Current Tested Shot #: 2098
- Plug/Play: V+, GND, EN, TRIG
- Primary and ignition bank voltage readout
AIS-gPPT3-1C Propulsion Module – High Vacuum Testing
FUTURE WORK

• Two completed AIS-gPPT3-1C (Version 3) propulsion modules off to Spain for joint collaboration project with Fossa Systems
  o Fully open source advanced mission with both satellite and thruster
  o Possible first ever PQ to fire propulsion in orbit
  o First fully open source, independent, home-built and engineered thruster to fire in orbit
• Continue optimization and characterization of current gPPT series thrusters
• V4 module – increased rep rate, lifetime testing to 100k shots, new fuels
• Make thrusters available – hobbyist, start-up, academic labs, etc.
• Other propulsion technology – colloidal electrospray, FEEP, RF Plasma, etc.
Fossa Systems-Applied Ion Systems Collaboration
Liquid Metal FEEP Concept Design
Thank You for Listening!