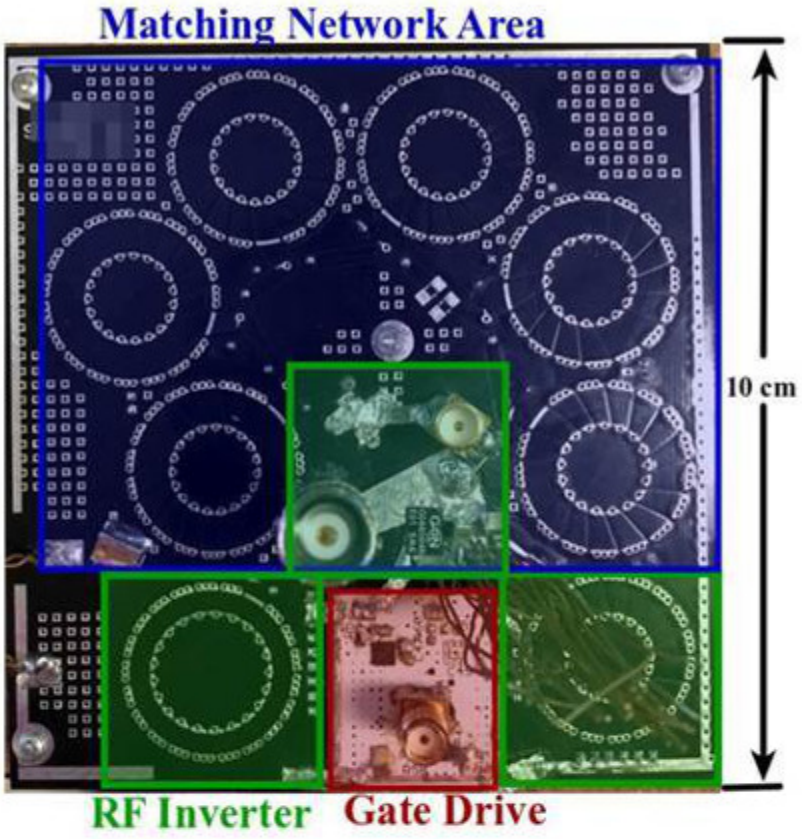
Docket #: S17-109

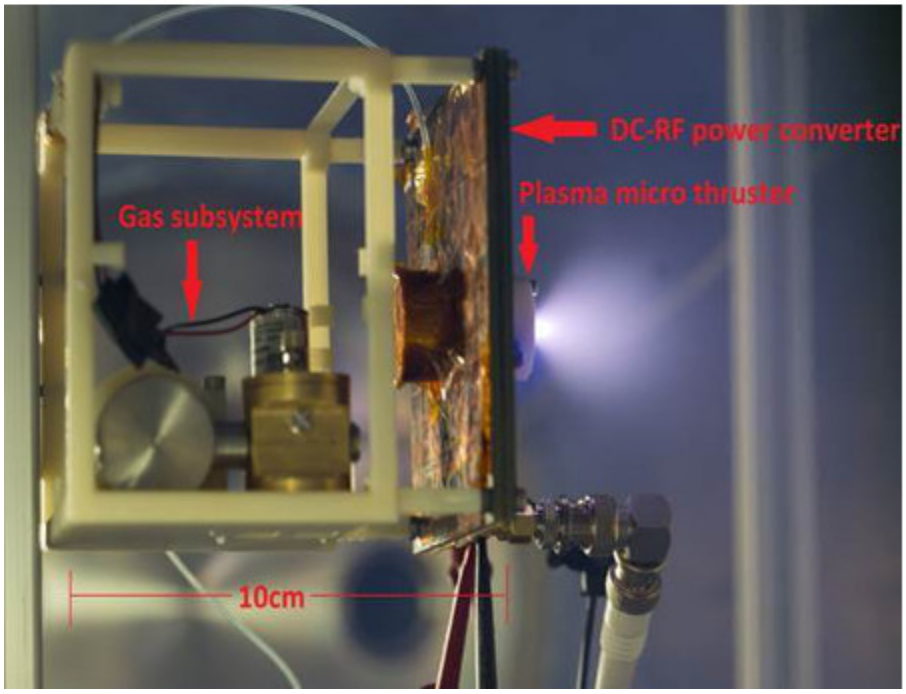
Compact Power And Thruster System for Small Satellites

Engineers from Stanford and the Australian National University have developed a robust micro electric propulsion system to maneuver miniature satellites (CubeSats) and thereby extend their lifetime. Currently, most small Low Earth Orbit satellites do not have propulsion because they are not large enough for the conventional power electronics needed to drive micro-thrusters. This leaves them vulnerable to atmospheric drag and poor orbit position which limits their lifespan to 6-12 months.

This invention solves that problem by integrating the power supply into the structure of the satellite itself. Specifically, the electrical components of a dc to ac RF power converter are embedded inside a printed circuit board (PCB) where an electro-thermal plasma ion micro thruster is mounted. The resulting rigid PCB is mechanically strong enough to serve as a side panel of the satellite, leaving space inside the CubeSat available for propellant or instrument payload.

The PCB-integrated thruster can be used for orbital maneuvering and station keeping to extend the lifespan of small satellites such as CubeSats used for as communication, earth imaging and interplanetary mining.





PCB inverter and matching network and 1 U CubeSat integrated Tiny Pocket Rocket design showing essential components: TinyPR centered within the battery powered RF sub-system and fed by the gas propellant sub-system.

Stage of Research
The inventors have created a prototype power board (13.8 MHz 14V input 15 W RF power inverter) with PCB inductors and demonstrated its ability to power the miniPR 3.0 inside a vacuum chamber. Proof of concept experiments verified: no parasitic discharge; high voltage gain (14 Vdc to 600 VRF); and up to 90% efficiency (12W load power) under pulsed operation.

Applications

- **Small and miniature satellites (CubeSats)** - orbital maneuvering and station keeping to extend lifetime of satellites with end user applications such as communication, earth imaging and interplanetary mining

Advantages

- **Compact** - minimal footprint saves internal volume of satellite for other payload (e.g., propellant, scientific instruments)
- **Longer lifetime** - maneuverable satellite can sustain a desired position for a variety of functions, extending the lifetime beyond the conventional 6-12 months
- **Low cost** - if mass-produced, integration into PCB would be less expensive than conventional systems with components soldered onto the board
- **Robust** - designed with air core inductors (instead of magnetic cores) so PCB power can operate in harsh space environments

Publications

- C. Charles, W. Liang, L. Raymond, J. Rivas-Davila and R. Boswell, "Vacuum Testing of a Miniaturized Switch Mode Amplifier Powering an Electrothermal Plasma Micro-Thruster," Frontiers in Physics (2017), doi:10.3389/fphy.2017.00036

Patents

- Published Application: 20200378372
- Issued: 11,828,273 (USA)

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