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# POWER CONVERTER WITH HIGH GAIN, HIGH PERFORMANCE FOR SPACE THRUSTERS BASED ON ELECTROSPRAY TECHNOLOGY.

**Abstract**

The electrospray's high-gain power converter is responsible for providing the high voltage required for the ionization of propellant and generating an electric field to emit the ion beam. As a result of the high voltage and low power demands of electrospray thrusters, the design and optimization of these converters are crucial for achieving optimal system performance. Regarding state-of-the-art, power converters for electrospray thrusters found in the literature do not reach the desired powers and/or voltages at the desired efficiencies. This has led to a significant interest in the study of HV-DC/DC converters in electrospray applications. Previous studies show how it is possible to obtain a high-performance converter at high powers; however, for output power ranges around 5-10W, said performance is significantly lower[1][2], due to the predominance of the fixed losses of the system, not being able to achieve a constant output within the desired range and/or without been characterized for a real electrospray thruster but for an equivalent fixed load. This paper proposes a high-performance and high-gain DC-DC converter for use in electrospray thruster systems. While a Forward-Flyback converter with Cockcroft-Walton Voltage Multiplier (FF-CW) has been previously presented in the literature for Electrohydrodynamic (EHD) cooling systems[3], this paper addresses its suitability for supplying an electrospray thruster. Compared to previous approaches, the proposed converter enhances power efficiency. The low component count and modularity of the converter also enable replication for achieving opposite polarities by just inverting the CW diodes, to ensure propellant neutrality by alternating the extractor polarity between both outputs. The proposed topology enables Zero Voltage Switching (ZVS) to minimize losses. However, the effect of parasitic capacitances must be considered to determine the optimal operation point. The proposed topology provides an efficient solution for minimizing switching losses, this requires implementing a valley-switching strategy to achieve ZVS effectively. An open-loop hardware prototype is presented, and its operation is analyzed and compared with a fixed load and a real electrospray thruster at vacuum conditions. The paper concludes that the proposed converter is highly modular and scalable, enabling enhanced mission capabilities in small satellite platforms.

[1] Veeramraju,K.J.P., Kimball,J.W., An improved power processing unit for multi-mode monopropellant electrospray thrusters for satellite propulsion systems. IEEE Energy Conversion Congress and Exposition (ECCE),2019, 1302–1309.
[2] Visee,R.,deJong,M.J.C.,Timmerman,J., Miniaturized HV power supply. IEPC-2013-258, 2013.
[3] Serrano,J.A., Design and Optimization of a Forward-Flyback Converter with Cockcroft-Walton Voltage Multiplier to Supply Loads Based on Electrohydrodynamic Technology",Ph.D. dissertation, Universidad Politécnica de Madrid,Madrid,2022.