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STATE-OF-THE-ART RF GENERATOR FOR INDUCTIVELY COUPLED PLASMA SOURCES

Abstract

A radio frequency (RF) generator is an inherent part of any space propulsion system based on RF ion thruster. The RF generator is responsible for ignition and sustaining of a plasma discharge. In operation the generator measures and regulates RF power transmitted into the discharge. Power control is necessary to achieve an optimal operation point of the propulsion system. In addition, the RF generator should be resilient to diverse emergency situations like a short-circuit of output or a high voltage breakdown onto the load.

This paper describes the design and testing of the compact-size high-efficiency RF generator for RF ion thrusters which require up to 250 W of RF power to supply plasma discharge. The RF generator is developed in a way to be integrated into a propulsion system with minimum effort. For operation it requires a single DC power supply in a range from 18 V to 32 V and one communication interface – CAN or RS-485. All auxiliary voltages are formed inside the RF generator and there is no need to use an external high voltage power source to supply output power stage of the generator. The developed RF generator is compatible with a wide range of loads. If it is used to supply an RF ion thruster with inductively coupled plasma discharge, the inductor value could be in a range from 0.5 μH to 10 μH . Operation frequency or output current frequency of the generator is programmed with a detachable resonant panel mounted on the case. The operation frequency could be set in a range from 1 MHz to 15 MHz . By applying modern approaches for power electronics design and contemporary electronic components the RF generator was successfully fitted into a compact case. The final dimensions are about 100x70x20 mm³. The power stage of the generator is based on resonant topology with the ability to switch between ZVS and CVS modes depending on the load. That allowed to reduce power losses substantially and to exceed 90% level of power efficiency.