IAF SPACE POWER SYMPOSIUM (C3)
Space Power System for Ambitious Missions (4)

Author: Mr. VISHAL KUMAR MEENA
Indian Space Research Organization (ISRO), Liquid Propulsion Systems Centre (LPSC), India, vpiloda@gmail.com

Mr. Kiran Ravikumar
Indian Space Research Organization (ISRO), Liquid Propulsion Systems Centre (LPSC), India, r_kiran@lpsc.gov.in
Mr. Avichal Srivastava
Indian Space Research Organization (ISRO), Liquid Propulsion Systems Centre (LPSC), India, avichal@lpsc.gov.in

VOLTAGE SCALABLE DISCHARGE SUPPLY FOR HIGH SPECIFIC IMPULSE ELECTRIC THRUSTER

Abstract

In an electric thruster, a very high specific impulse can be achieved by increasing the discharge voltage which results in extended mission life for a given amount of fuel. For this reason, the interest in electric propulsion for deep space science and exploration mission has been increased significantly in recent years. However, the maximum discharge voltage is limited by the breakdown voltage of rectifier diodes. Avalanche breakdown happens when the electric field in depletion region becomes large enough to force the electrons to knock out the covalent bonds. Breakdown voltage is usually increased by the means of decreasing the doping but it increases the diode resistance and forward cut-in voltage. Maximum achievable breakdown voltage is limited due to thermal consideration for a given semiconductor material. As wide band-gap diodes are still not in a fully mature stage to be used in deep space application, silicon diodes are widely preferred which have relatively less breakdown voltage. To overcome this limitation, a novel way is proposed to attain high output voltage by using cascoded rectifiers. Each rectifier is connected to a separate secondary winding. A simple energy recovery snubber is used to alleviate the severe parasitic ringing across the cascoded rectifiers. It also reduces the circulating current in the primary and reduces RMS current stress on the switching devices which results in improved system reliability. A precise voltage sharing across the rectifier diodes has been achieved which is insensitive to the variations in the diode junction parasitic capacitor. This proves the potential of this architecture in further scaling the voltage. A prototype model of 2.5kW, 800V discharge power supply has been realized to verify the feasibility and to validate the theory. Converter works in soft switching condition to achieve high efficiency. Experimental results are analyzed and discussed.