Paper ID: 46507
oral

IAF SPACE POWER SYMPOSIUM (C3)
Wireless Power Transmission Technologies and Application (2)

Author: Prof. tadashi takano
Nihon University, Japan, ttakano@ac.jaxa.jp

Prof. Mitsuhiro Shiono
Nihon University, Japan, shiono@ele.cst.nihon-u.ac.jp
Prof. Hiroyuki Oosaki
University of Tokyo, Japan, ohsaki@k.u-tokyo.ac.jp
Dr. Takehiro Imura
University of Tokyo, Japan, imura@edu.k.u-tokyo.ac.jp

BRUSHLESS SLIP RING WITH A LONG ROTATING AXIS TO TRANSFER A LARGE AMOUNT OF POWER

Abstract

The Reference System of a solar power satellite (SPS) by NASA uses a rotary joint (RJ) and a slip ring (SR), which direct a solar cell panel and a transmitting antenna to the sun and the earth, respectively. An SR with conducting contacts of brushes makes debris during operation, as is not suitable to be used for a long time in orbit. Therefore, the authors carried out the investigation of wireless SRs, which adopt no brushes. The electrodes in a wireless SR should be coupled by electromagnetic effects, which can be classified to: (1) electric coupling, (2) magnetic coupling, (3) coupling by electromagnetic wave propagation. For the application to SPS, the electric coupling is most advantageous as the associated rotary joint has a long and thick rotation axis. The electrodes of coupling capacitors can be formed on the surfaces of the stator and rotor in a RJ with an excellent precision of the gap. The obtainable value of the capacitance is enhanced greatly so that we expected much power could be transferred. The power circuit through mechanical separation requires two capacitors for a hot and return circuits. The long axis is appropriate to support two capacitors on the surface in a serial configuration. The capacitors have large reactance so that power transfer efficiency is greatly degraded. Moreover, the connecting lines between a power source, two capacitors and a load are long respectively so that the effect cannot be ignored. We analyzed the circuit performances and power handling capability on the basis of practical system parameters. The diameter of the capacitor is 6 m according to the design of the Reference System. The length of 1 m, and the gap of 2 mm between the electrodes of the coupling capacitor were assumed We made the capacitors in resonance with the added inductances of coils at the frequency of 100 kHz so that the power transfer efficiency was maximized. The sizes of the coils are within practical realization. The power handling capability is limited by discharge through the capacitor gaps, and the ohmic loss in the connecting lines and the attached coils. Those effects were analyzed, and it was shown that 1 GW power can be transferred through the proposed brushless SR. This device could be used for a satellite to transfer the power generated by solar cell paddles to the satellite main body.