SPACE POWER SYMPOSIUM (C3)
Wireless Power Transmission Technologies, Experiments and Demonstrations (2)

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DESIGN AND DEVELOPMENT OF A 1-U CUBESAT FOR A SPACE SOLAR POWER RECEPTION DEMONSTRATION

Abstract

Work is ongoing at the University of North Dakota on a demonstration mission for space-to-space microwave wireless power transmission. Prior work has covered the mission, in general, and the transmitting spacecraft, in depth. This paper focuses on the receiving spacecraft, a 1-U CubeSat (10 cm x 10 cm x 10 cm, 1.33 kg) that will receive the transmitted power using a deployable rectifying antenna (rectenna) array. This spacecraft will characterize the amount of power received at a number of distances from the transmitting craft (which it will be ejected from, once both are inserted into orbit, and gradually drift away from) and transmit these readings to the ground to facilitate the evaluation of the space solar power (SSP) implementation and the performance of the transmitting craft.

The design work on this spacecraft has focused extensively on the selection of the rectifier architecture. Several diode configurations (including both single-diode and multiple-diode approaches) have been evaluated. Selection criteria evaluated include the power handling levels, efficiency and harmonics. The power management and distribution (PMAD) system combines the DC power from the various rectifier units in the rectenna array.

The structure of the CubeSat has been designed to house and deploy the (comparatively) large rectenna array, which springs into position after being release by nichrome wire after ejection from the primary (transmitting) spacecraft. A comparison of the theoretical maximum power generation using the rectenna versus solar panels is presented, based on a nominal low-Earth orbit. The relative performance of the two power generation techniques, at the separation distances selected for empirical evaluation, is presented. The point of equivalent generation is determined, using simulation in Systems Toolkit.

The paper concludes by discussing the next steps required and a timeframe to the performance of this generation mission. Both technical and political prospective impediments are discussed.