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

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OPTIMAL DESIGN OF RECTENNA ARRAY IN MPT SYSTEM FOR SSPS

Abstract

This paper presents several optimal design considerations of rectenna array in MPT (Microwave Power Transmission) System for SSPS (Space Solar Power Station) to improve the total rectifying efficiency. It is found that the backward scattering due to the rectenna radar cross section (RCS) must not to be neglected especially under the condition of oblique incidence in previous MPT demonstration systems in the world. A microwave energy reception approach for SSPS applications based on the concept of artificial perfectly matched layer is proposed. By embedding rectifying diodes into well-designed metamaterial cells, the obtained rectenna simultaneously exhibits a nearly perfect impedance matching to the air and the rectifying circuits, and strong impedance mismatching to the air at harmonic frequencies, leading to a simple structure that can be implemented using commercial multi-layer printed circuit board technology. A demonstration experiment has been executed at 2.18 GHz and the prototype operating at 5.8 GHz is under manufacturing. The microwave power densities at the center and edge of rectenna array may be greatly different. Since the rectifying diodes are very sensitive to the input microwave power, it would be inconvenient that various rectify circuits need to be designed to maintain high rectifying efficiency. By utilizing FET as switches or rectifying devices, the configuration of the rectifier can automatically adapt to the input power level. Compared with traditional rectifiers, it can provide a consistent high RF-to-dc power conversion efficiency over a significantly extended operating input power range. It is conducive to unified rectifying circuits design. According to the power density distribution at rectenna array, the non-uniform array design is indispensable even the operating input power range of rectifier is extended. For such large rectenna array in SSPS, it is reasonable to use different RF or DC power combine circuits at different areas to enhance total efficiency.