DESIGN OF RECTENNA FOR 5.8 GHZ SPACE SOLAR POWER SATELLITE

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ABSTRACT

Space Solar Power Satellite (SSPS) operating at the frequency of 5.8 GHz is proposed as a study model to confirm the feasibility of microwave energy transmission from the outer atmosphere to the earth. The SSPS is composed of a transmitting antenna in space and receiving antennas (rectennas) on the earth. Technological issues of the rectenna are highly efficient conversion of received microwave energy to DC electrical power with suppressing higher-order harmonic components. The re-radiation at the higher-order harmonic frequencies from the rectenna yields undesired influences for other wireless communication systems and/or radio astronomy. For rectenna elements operating at the frequency band of 2.45 GHz, we proposed some types of circular microstrip patch antenna (CMSA) with slits. These antenna elements suppress re-radiations successfully at higher-order harmonic frequencies. Furthermore, we proposed a full-size rectenna consisting of a receiving antenna array and wire mesh reflectors. Such geometry makes it possible to penetrate of sunlight to the ground and focus the RF energy upon rectenna antenna array placed at the focal point of the reflector. Microwave energy reflected from the wire mesh structure is concentrated upon the rectenna array. Rectifiers in the rectenna realize highly efficient RF-DC conversion with the high RF input power.

In this paper, we discuss a full size rectenna and its elements operating at the frequency band of 5.8 GHz and propose their design method suited to SSPS. First, we develop CMSAs with slits at the frequency of 5.8 GHz. It is clarified that the slits located along surface current streams related to the dominant TM110 mode of a normal CMSA can suppress higher-order harmonics with retaining a resonance of the dominant mode. We employ the finite-difference time-domain (FDTD) technique to design and analyze the antenna elements, and confirm experimentally the effectiveness of the proposed rectenna element.

Second, we discuss characteristics of the wire mesh reflector focusing the RF energy upon the rectenna array. It is clarified that the reflector can be employed at both frequency bands of 2.45 GHz and 5.8 GHz. The characteristics of the reflector are examined as a function of wire spacing in detail by using the 2-Dimensional FDTD method. The various numerical results are useful to determine the rectenna structure.

Finally, we give a summary and conclusions.