Paper ID: 18639
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SPACE POWER SYMPOSIUM (C3)
Wireless Power Transmission Technologies, Experiments and Demonstrations (2)

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DEVELOPMENT OF PHASED-ARRAY ANTENNA SYSTEM FOR WIRELESS POWER TRANSMISSION EXPERIMENT

Abstract

We are developing a phased-array antenna system as a breadboard model (BBM) for space experiments using a small satellite toward the solar power satellite (SPS). The purposes of the space experiments are to demonstrate a precise directional control of wireless power transmission (WPT) technology from space to the ground and to clarify the propagation characteristics of the microwave power in the ionosphere. WPT is a critical and inherent technology of the SPS. The SPS generates electricity in orbit and transmits energy using microwave from space to the ground. A very long distant and precise microwave power transmission with an accuracy of μ radian using a huge transmitting antenna that consists of hundreds of millions of antenna elements will be required toward the SPS. Also, the large scale antenna will be produced deformity by thermal cycle environment in the orbit. A phased-array antenna possesses a potential for precise beam directional control and beam forming under such conditions. We designed and fabricated the BBM in order to evaluate an effect of phase error of the microwave circuits produced at the time of the manufacturing and generated by temperature fluctuation on the microwave beam control. The BBM consists of 16 panels that each forms three layer structures and has functions of phase control, amplification, and radiation from the array antennas. Frequencies of 5GHz band was designed. Total output power is around 160 W. Size of the BBM is around 60 cm times 60 cm. The front layer forms a phased-array antenna that consists of micro-strip elements. Every four elements compose a sub array set which is connected to an output port of the microwave circuit. In the middle layer, microwave circuits are mainly installed in order to supply the high-power microwave to the antenna elements. The input signal in the microwave circuit is divided to four branches. Every branch includes the series of a 6-bit digital phase shifter, a pre-amplifier, and a power amplifier. We confirmed around 40 dB as a small-signal gain and around 34 dbm as output power characteristics (Po1dB) for each output port. Thermal radiator that cools a power amplifier by the air blows was installed on the back layer. In this paper, we will describe results of microwave beam control experiments concerning a effects of the phase errors by the thermal fluctuation of the high power amplifier and a compensation of the mechanical deformation of the antenna panels.