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REAL-TIME TARGET TRACKING ENERGY DELIVERY OF ACTIVE ARRAY WIRELESS POWER TRANSFER SYSTEM

Abstract

The wireless power transfer system considering the application of the space solar power satellite must minimize the energy storage device in it. This is because not only the payload of the system, but also energy loss and heat generation must be reduced in the multi-step power conversion process according to charging and discharging. Therefore, it is ideal to continuously transmit the renewable energy produced without storing it. For this purpose, a power transmission and a receiving system developed with the goal of 100 % duty-cycle operation are required. In addition, fast and precise target tracking and beam control are also required to minimize energy wasted during signal processing or calibration. A transmitter that combines an active phased array antenna with a retro-directive system composed of complete hardware or part software has been studied as the most suitable solution. However, retro-directive hardware using the phase conjugate circuit complicates the two-dimensional array transmitter, and an additional stable microwave source is required. Recently, due to the improvement of speed and reliability of the digital beamforming process, a separated DoA (direction of arrival) estimation system is also applicable.

In order to develop an accurate DoA estimation system that does not include an additional phase-locked loop circuit, a time modulated array (TMA) method using a single pole double throw (SPDT) switch was proposed. Not only the circuit was simple, but the scan range could be varied and the signal to noise ratio was improved. A practical two-dimensional DoA estimation system was fabricated using multiple switches, a phase modulator, and a power combiner. By using the linear vector modulator to rapidly change the phase of the measured signal and combining it with the reference antenna signal, it was possible to precisely analyze the phase difference and find the angle of arrival. The proposed DoA estimation system and a pilot signal transmitter of 2.45 GHz were installed in an active wireless power transfer system (5.8 GHz, 96 ch, 50 W/ch) which implemented in 2019, and wireless power transmission experiment was conducted while tracking a target 50 m ahead. We confirmed the smooth operation of real-time tracking power transmission while maintaining the beam width of 1.8° (1.57 m @ 50 m) by placing the LED built-in rectennas at intervals of 2 m in the azimuth direction.