

Beamforming Planar Loop Array for Wireless Power Transfer

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This paper presents magnetic beamforming using planar-type loop array for magnetic resonance wireless power transfer. The loop array is composed of a source loop and multiple repeater loops. Each loop is connected with capacitor in series. Magnetic beamforming is achieved by appropriate combination of the capacitor in each loop. Each loop of the array does not resonate but the loop array resonates because appropriate combination of capacitor meets impedance matching at the source. By controlling the capacitance of each loop, a desired shape of beamforming can be obtained.

A 4x4 loop array at the frequency of 6.78MHz is designed for magnetic beamforming. The receiver is positioned in parallel with the plane which is 50cm away from the loop array. Each loop in the array and the receiver loop have the same size of 20cm x 20cm. The appropriate capacitance of each loop in the array except for a source loop is designed by genetic algorithm (GA) for maximum efficiency and the capacitance of the source loop is determined by impedance matching condition. The designed 4x4 loop array has the following functions. First, the magnetic beamforming to a desired direction is possible. Efficiencies are calculated by relocating the receiver along the plane whose separation is 50cm from the loop array when the magnetic field is focused on a specific direction. The maximum efficiency of 62.1% is obtained when the receiver is positioned at the specific position where the beam is focused on. Efficiency is gradually decreased as the receiver is farther away from the specific position. The results show that the magnetic beamforming is achieved. Second, the selective wireless power transfer is possible when there are multiple receivers. The efficiencies of four receivers positioned in four corners of the loop array are 2.0%, 53.0%, 0.6% and 2.9%, respectively, when the beam is focused on the second receiver. Finally, the loop array is insensitive to an alignment of the receiver. At the center of the plane, the efficiency is 69.6%. When the receiver is tilted at 45° and 90°, the efficiencies are 64.5% and 52.9%, respectively. Detailed design and performance of the loop array will be discussed in the presentation.