Research on Wireless Power Transfer with Near-field coupling using Multi-antenna

○Mingda Wu[1],　Qiaowei Yuan[2],　Qiang Chen[1],

Department of Communications Engineering, Graduate School of Engineering, Tohoku University[1]
Sendai National College of Technology[2]

1. Introduction

Wireless power transfer (WPT) is a hot topic in recent years, for its potential application to charge portable electronic devices without cords. Because of the existing of eletromagnetic hazard, the power transfer efficiency (PTE) become an important parameter to evaluate the performance of a WPT system. Pervious study focused on the PTE of a 2-port WPT system was carried out by the present authors[1]. It was found that the maximum PTE was obtained when both transmitting and receiving sides were conjugate matched with the transmitting and receiving circuit, respectively.

In this paper, the maximum PTE of a multi-antenna system is investigated with impedance matching.

2. Calculation method & Simulation result

A 4-antenna system, which can be represented as a 4-port network shown in Fig.1, has 1 transmitting antenna and 3 receiving antennas. When 4 ports are impedance matched, we have following equations:

$$\Gamma_A = \Gamma_1^*,\ \Gamma_B = \Gamma_2^*,\ \Gamma_C = \Gamma_3^*,\ \Gamma_D = \Gamma_4^*$$

Using Mason's Rule and scattering parameters, we can calculate the maximum PTE and the loads required to satisfy the matching condition.

The Fig.2 is the model used to analysis and simulation, where antenna A is a transmitting antenna and antenna B, C, D are three receiving antennas. 4 anntenna are paralle l with each other. 4 antennas have same radius with 0.1 cm and same material with PEC. In the Fig.2, $d = 50$ cm, $l = 30$ cm and $\theta = 120°$.

Frequency characteristics of total PTE is shown in the Fig.3, we find that the total PTE first increases then decreaces as the frequency increase from 30 MHz to 150 MHz, and gets its maximum around 107 MHz.

3. Conclusion

This research shows the method to calculate the PTE of 4-antenna system under impedance matching, and

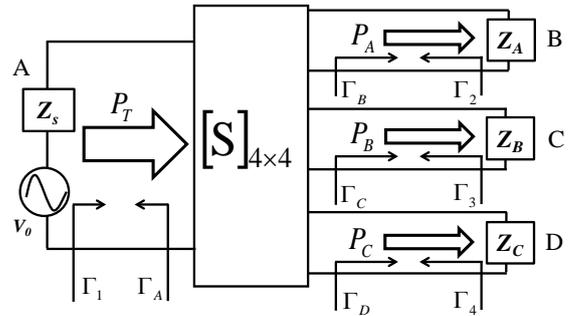shows the frequency characteristics of this system.
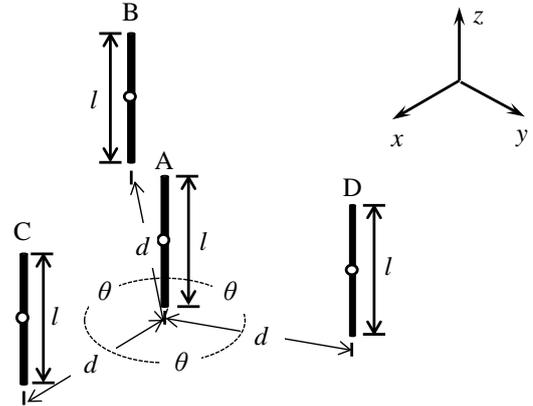

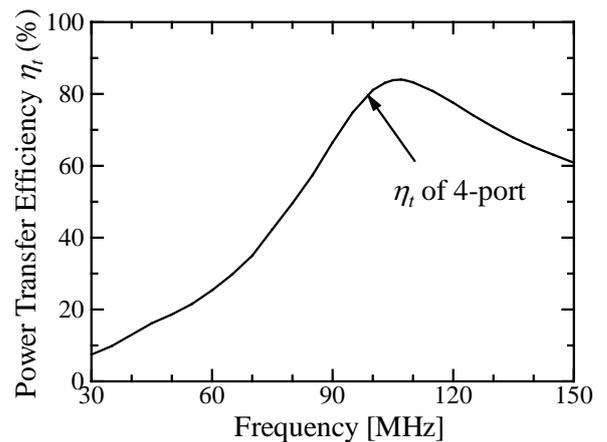Fig.1 4-port network system

Fig. 2 Simulation Model

Fig.3 PTE frequency characteristics

Reference

Qiang Chen, etc., "Antenna Characterization for Wireless Power-Transmission System Using Near-Field Coupling," IEEE Antennas Propag. Mag., vol. 54, no. 4, pp. 108-116, Aug. 2012.