

Development of High-Power Charge Pump Rectifier for Microwave Wireless Power Transmission to EV trucks

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For a means to combat global warming, EV trucks have been attracting attention in the transportation industry. EV trucks have the great advantage of emitting no CO₂ while driving. On the other hand, They have the problems with large capacity batteries. One of the methods to solve the problems is microwave wireless power transmission (MWPT). MWPT present automatic car charging for moving car systems. The proposed MWPT system to EV trucks is shown in Figure 1. This system is used by 5.8 GHz microwave. In the precedent study, 2.45 GHz uniform beam on the rectenna array has been realized and has been demonstrated the feasibility of the power transmission system for EV truck[1]. Thus, We are focusing on the rectifiers in the receiving units of the MWPT system. The size of the proposed rectenna is a rectangle of 2.2 m × 6.5 m. The required total dc power of the EV truck is 50 kW. The required output dc power of the rectifier per 45 mm square was calculated to be 7.1 W. We design a 5.8 GHz charge pump rectifier which satisfies the requirements by numerical simulations. Charge pump rectifiers are usually used to increase the output voltage at low power. In this study, However, we used the charge pump rectifier to reduce the current through a diode at high power. There is no example of using a charge pump rectifier at high power. Thus, the efficiency of the charge pump rectifier circuit at high power was confirmed by numerical simulations.

The designed rectifier is shown in Figure 2. The characteristic impedance is 50 Ω. NPC-H220A (Nippon Pillar Packing co., Ltd) is used as a substrate model and its relative dielectric constant is 2.16. This circuit is composed of microstrip lines with 1.15 mm width.

The simulation results shows the maximum rf-dc conversion efficiency of 79.4 % at 122 Ω when input power is 9 W. Thus, dc output power is 7.14 W, and the charge pump rectifier satisfies the power requirement. The size of the designed charge pump rectifier is within a rectangle of 15.3 mm × 40.5 mm, and the rectifier satisfies the requirement.

We confirmed the effectiveness of the charge pump rectifier circuit at high power. We also showed the feasibility of the power receiving part of the EV truck.

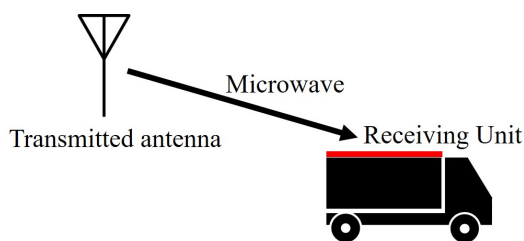


Figure 1. The proposed MWPT system

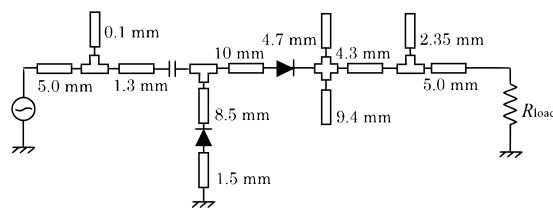


Figure 2. The designed charge pump rectifier

References

- [1] N. Shinohara, Y. Kubo and H. Tonomura, "Mid-distance wireless power transmission for electric truck via microwaves," 2013 International Symposium on Electromagnetic Theory, Hiroshima, 2013, pp. 841-843.