Dual-functional metamaterial-integrated antenna for wireless power transfer and wireless communications

Woosol Lee and YK Yoon
Electrical and Computer Engineering, University of Florida, Gainesville, FL, USA

I. INTRODUCTION

Recently, a high demand for wireless power charging in the modern electronics has accelerated active research and development of wireless power transfer (WPT) technologies. For the portability of a wireless communication electronic system, the small form factor of both WPT and wireless communication antennas is highly anticipated without degrading the efficiency of the wireless power and signal coils/antennas. In order to reduce the size of the wireless electronic device, Cheng et al. [1] demonstrated a dual-function helix antenna concept for WPT and wireless communications. In other work, to enhance the performance of the WPT system and antenna, some researchers have utilized metamaterial (MTM) slabs [2]. MTMs are artificially engineered materials that have uncommon electromagnetic properties, such as evanescent wave amplification and negative refraction, thereby enhancing the transfer efficiency and gain of an antenna [3].

In this work, a dual-functional MTM integrated antenna for simultaneous WPT and wireless communications is demonstrated.

II. Dual-functional antenna design

A. Dual-functional operation

Fig. 1. shows the operation principle of the dual-functional MTM-integrated antenna. The dual-function loop antenna is connected to two path ways: one is to a 6.78 MHz WPT system, and the other is to a 915 MHz wireless communication system. A dual-functional capability comes from the MTM slab which is integrated on top of the loop antenna. When the MTM slab is placed on the loop antenna, it can help the loop antenna to have better WPT and antenna performance with the negative and near zero refractive property of the MTM slab.

B. Metamaterial slab and antenna design

The MTM and antenna are designed on a Rogers RO5880 substrate with a dielectric constant of 2.2, a loss tangent of 0.0009, and a thickness of 1.57 mm. The integrated device has a size of 108 × 108 × 10.28 mm^3.

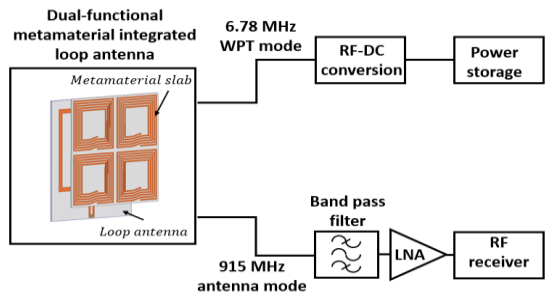

Figure 1: Conceptual operation principle of the dual-functional metamaterial integrated antenna

III. Experimental results

Table 1 shows the simulated result of the proposed device. When an MTM slab is added on top of the loop antenna, the performance of the WPT and antenna is improved.

TABLE 1. Simulated Performance of the Loop Antenna Without and With metamaterial slab

Parameters	Without MTM	With MTM
WPT Efficiency (100mm distance)	8.8 %	36.87 %
Antenna gain	3.6 dBi	6 dBi

IV. Conclusion

In this work, we show a dual-functional MTM integrated antenna. It is proved that the proposed device showed better performance when the MTM is integrated.

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