UHF RFID Tag Antenna for Stacked Position Applications

#Hyunho Wi[1], Byeongkwan Kim[1], Chang Won Jung[2], Myun-Joo Park[1], Young-Seek Chung[1], Byungje Lee[1]
[1] Department of Wireless Communications Engineering, Kwangwoon University
447-1, Wolgye-Dong, Nowon-Gu, Seoul, 139-701, Korea
[2]Graduate School of NID Fusion Technology, Seoul National University of Science and Technology, 172, Seoul, 139-743, Korea
bj_lee@kw.ac.kr

Abstract

The UHF RFID tag antenna, which has lower performance degradation when a number of tags are stacked, is presented. When tags are vertically stacked, the proposed tag antenna requires smaller additional wake up power than the conventional tag antennas.

Keywords : UHF tag antenna Item level RFID

1. Introduction

Radio Frequency Identification (RFID) is an automated identification technology without physical contacts by using the electromagnetic wave propagation in many applications such as service industry, transportation, security system, and manufacturing process control. Most RFID applications use a box or pallet level item tagging because there are several drawbacks to attach the RFID tag on item level tagging. When the Item level RFID tags are often located closed by or stacked each other it leads the deterioration of the system performance such as read rates and read range due to the mutual coupling and electromagnetic interference of multiple tags [1, 2]. Especially, on the stacked positions, the performance is significantly decreased [3]. The dipole types of the tag antennas generally have been used in many applications of the UHF RFID systems. However, on the vertically stacked positions, dipole antennas radiate the maximum power to the vertical axis, so this makes more mutual coupling effect among them. Therefore, the Item level RFID tagging demands the tag antennas which have lower degradation of the performance when they are closely stacked each other [4]. In this paper, the compact loop type of a tag antenna, which has the same phase and amplitude of the current distribution, is proposed to obtain a null point along the vertical axis to reduce the mutual coupling effect of multiple tags.

2. Antenna structure and result

Fig. 1 shows the structure of proposed tag antenna designed on the FR-4(ε_r= 4.4). The overall size of antenna is $30\times30\times0.4$ mm^3. The microchip located at the center of the feed loop has the characteristic impedance of about (20-j120) Ω at 915 MHz. Fig. 2 shows the measured input impedance of the proposed antenna is about (21.2+j120.2) Ω, so that it can provide the conjugate matching between the microchip and the tag antenna. The proposed tag antenna consists of the inductive feed loop and two bent radiating elements. As shown in Fig. 3, the outer line current distribution of the proposed tag antenna is similar to the surface current distribution of an electrical small loop antenna. The proposed tag antenna has a null point along the z-axis and an omnidirectional pattern as shown in Fig. 4, so that it can reduce the electromagnetic interference between tags which are stacked along the vertical axis and separated more than the far-field distance. To verify the performance of the proposed tag antenna, using a commercial RFID reader (Thing Magic Mercury4 Reader), the wake up power for a single tag alone and two of tags stacked and separated by the distance (d) along the vertical axis is measured. The distance between the reader antenna and tags is fixed at 70 cm. Fig. 5 shows the measured result of the Omron Wave tag and the

proposed tag. The Omron Wave tag needs the additional power of about 8.6 dBm to read both of tags separated by the distance (d) of 50 mm, but the proposed tag antenna requires about the power of 1.2 dBm.

3. Conclusion

In item level RFID system, the performance of the stacked tags can be significantly degraded due to the electromagnetic interference of multiple tags. The loop type tag antenna with smaller performance degradation on the stacked positions is proposed, and its radiation pattern gives a null point along the z-axis so that inference between the stacked tags can be reduced. The proposed tag antenna can read the multiple tags with smaller or no additional power on the item level RFID systems.

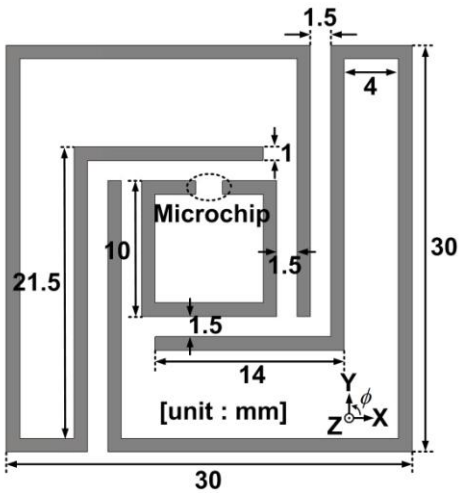

Figure 1: Structure of proposed tag antenna.

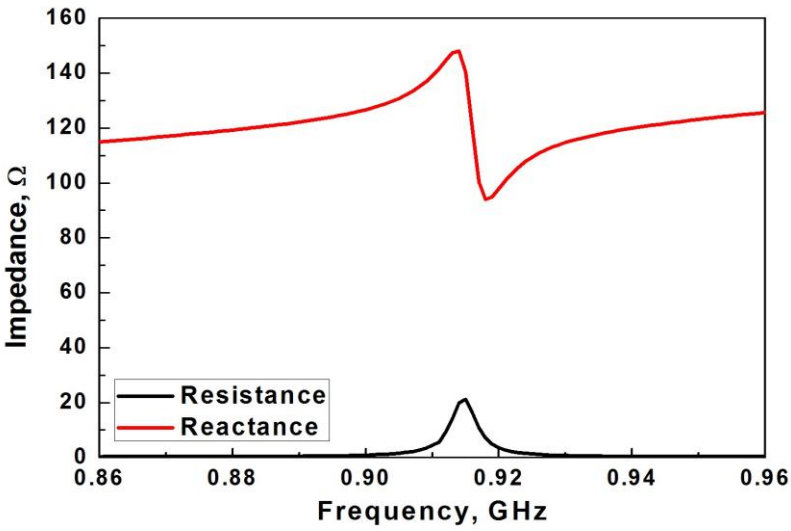

Figure 2: Measured input impedance of the proposed antenna.

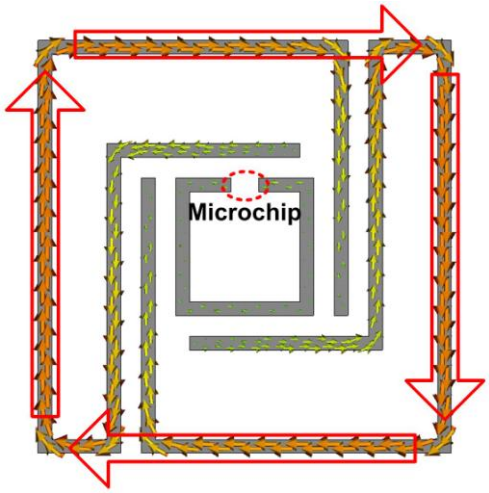

Figure 3: Surface current distribution at 915MHz.

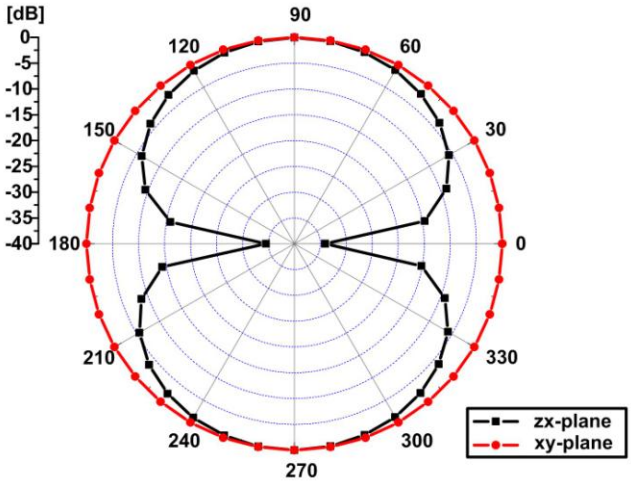

Figure 4: Simulated radiation patterns at 915MHz.

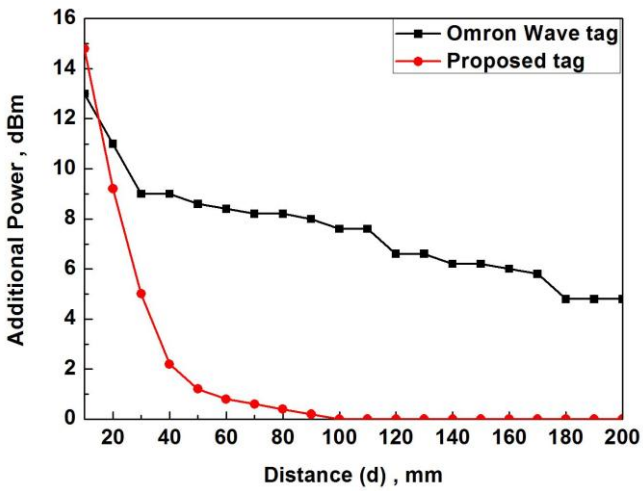

Figure 5: Measured additional wake up powers as function of distance (d) between tags.

References

[1] Y. Tanaka, Y. Umeda, O. Takyu, M. Nakayama, K. Kodama, “Change of Read Range for UHF Passive RFID Tags in Close Proximity,” IEEE International Conference on RFID, USA, pp. 338-345, 2009.

[2] X. Chen, F. Lu, T. Ye, “Mutual Coupling of Stacked UHF RFID Antennas in NFC Applications,” IEEE Antennas and Propagation Society International Symposium, USA, pp. 1-4, 2009.

[3] F. Lu, X. Chen, T. Ye, “Performance Analysis of Stacked RFID Tags,” IEEE International Conference on RFID, USA, pp. 330-337, 2009.

[4] Y. J. Ahn, F. J. Harackiewicz, S. J. Kim, M. J, Park, Y. S. Chung, B. J. Lee, “Electrically Small Loop Antenna for UHF Band RFID Tag,” IEEE Antennas and Propagation Society International Symposium, USA, pp. 1-4, 2008.