

Southern Illinois University Carbondale OpenSIUC

Conference Proceedings

Department of Electrical and Computer
Engineering

7-2008

Electrically Small Loop Antenna for UHF Band RFID Tag

Young-Joon Ahn
Kwangwoon University

Frances J. Harackiewicz
Southern Illinois University Carbondale, fran@engr.siu.edu

Sung-Joo Kim
Kwangwoon University

Follow this link for additional works at: http://opensiuc.lib.siu.edu/ece_confs

Published in Ahn, Y. J., Harackiewicz, F. J., Kim, S. J., Park, M. J., Chung, Y. S., & Lee, B. (2008). Electrically small loop antenna for UHF band RFID tag. *Antennas and Propagation Society International Symposium, 2008. AP-S 2008*, 1 - 4. doi: 10.1109/APS.2008.4619847 ©2008 IEEE.

Personal use of this material is permitted. However, permission to reprint/republish this material for advertising or promotional purposes or for creating new collective works for resale or redistribution to servers or lists, or to reuse any copyrighted component of this work in other works must be obtained from the IEEE. This material is presented to ensure timely dissemination of scholarly and technical work. Copyright and all rights therein are retained by authors or by other copyright holders. All persons copying this information are expected to adhere to the terms and constraints invoked by each author's copyright. In most cases, these works may not be reposted without the explicit permission of the copyright holder.

Recommended Citation

Ahn, Young-Joon; Harackiewicz, Frances J.; Kim, Sung-Joo; Park, Myun-Joo; Chung, Yong-Seek; and Lee, Byungje, "Electrically Small Loop Antenna for UHF Band RFID Tag" (2008). *Conference Proceedings*. Paper 7.
http://opensiuc.lib.siu.edu/ece_confs/7

This Article is brought to you for free and open access by the Department of Electrical and Computer Engineering at OpenSIUC. It has been accepted for inclusion in Conference Proceedings by an authorized administrator of OpenSIUC. For more information, please contact opensiuc@lib.siu.edu.

Authors

Young-Joon Ahn, Frances J. Harackiewicz, Sung-Joo Kim, Myun-Joo Park, Yong-Seek Chung, and Byungje Lee

Electrically Small Loop Antenna for UHF Band RFID Tag

Young-Joon Ahn⁽¹⁾, Frances J. Harackiewicz⁽²⁾, Sung-Joo Kim⁽¹⁾, Myun-Joo Park⁽¹⁾, Yong-Seek Chung⁽¹⁾, and Byungje Lee⁽¹⁾

(1) Dept. of Wireless Communications Engineering, Kwangwoon University, Korea

(2) Dept. of Electrical and computer Engineering, Southern Illinois University Carbondale, Illinois, USA

Abstract

UHF band RFID tag antenna which has a similar radiation pattern of the electrically small loop antenna is presented. The structure of the proposed tag antenna is a small circular dipole array on the xy -plane, and the antenna is fed by inductively coupled loop to flow a uniform amplitude and in phased current along its circumference. Since its radiation pattern has an omnidirectional pattern in the xy -plane, the proposed tag antenna can reduce the interference among adjacent tag antennas arranged parallel to xy -plane.

Introduction

Recently, Radio frequency identification (RFID) system has been required more and more not only long range identification but also multiple identifications at distribution logistics, manufacturing companies, and postal services [1]. Especially, the multiple identifications are needed at postal services and libraries which deal with thin and small goods. There usually uses a label type of a dipole tag antenna, which has an omnidirectional pattern in the zx -plane. Owing to this radiation pattern, the interference region ('A' as shown in Fig. 1a) among adjacent tag antennas which are arranged parallel to xy -plane is generated. To avoid this problem, the tag antenna whose radiation pattern is similar to that of an electrically small loop antenna is proposed. The radiation pattern of the proposed tag antenna is orthogonal to that of the conventional dipole tag antenna. Therefore, the proposed tag antenna can reduce the interference among adjacent tags as shown in Fig. 1b even if tag antennas are arranged parallel to xy -plane. However, the electrically small loop antenna is actually very difficult to design because of its small radiation efficiency [2]. It is usually obtained by replacing the wire of the small loop by several dipole antennas arranged on a circumference and

fed by an uniform amplitude and in phase current along the circumference [3], [4]. Whether the proposed tag antenna is operating as an electrically small loop antenna is verified by simulated and measured results.

Antenna Structure and Results

Fig. 2a represents the basic structure of the proposed tag antenna. The proposed tag antenna is a dipole array where 4 elements are circularly located on the xy-plane, and each element is fed by inductively coupled loop to match the conjugate impedance of the microchip [5]. To reduce overall size of the proposed tag antenna, the dipole-arms is further bent. Fig. 2b shows the detail dimensions and structure of the proposed tag antenna. Its overall size is $53 \times 53 \text{ mm}^2$. Fig. 3 shows the measured impedance characteristics of the proposed tag antenna and microchip. The impedance of the microchip has $13.9 - j143.6 \Omega$ at 915 MHz. The measured impedance of the proposed tag antenna is $13.6 + j140 \Omega$ at 915 MHz. This result shows that an antenna is matched with the conjugate impedance of a microchip. Fig.3 also shows the proposed tag antenna has two resonant frequencies. This is because the electrical length of the inside bent dipole-arms is different from that of the outside bent dipole-arms. Fig. 4 shows the current distribution of the proposed antenna. While it operates as an electrical dipole antenna at 880MHz, it acts like a small loop antenna at 915 MHz. The currents at 915MHz are in phase and uniformly distributed on the radiating dipole edges along the circumference of the ϕ direction so that the proposed antenna radiates an omnidirectional pattern similar to that of a small loop antenna. Fig. 5 shows the measured radiation pattern of the proposed tag antenna. The maximum reading distance of the proposed antenna is 7 m in an anechoic chamber.

Conclusion

In this work, UHF band RFID tag antenna, which has a similar radiation pattern of the electrically small loop antenna, is proposed. For a label type of a dipole tag antenna, the interference among adjacent dipole tag antennas arranged parallel to xy- plane is generated so that the identification rate of the tag antenna decreases. However, the proposed tag antenna which has an omnidirectional pattern in the xy-plane, can reduce this problem.

References:

- [1] K. Finkenzeller, *RFID Handbook*, John Wiley & Sons, 2002.
- [2] C. A. Balanis, *Antenna Theory Analysis and Design*, John Wiley & Sons, 1997.
- [3] J.D. Kraus, *Antennas for All Applications*, McGraw-Hill, 2002.
- [4] S. Sevskiy and W. Wiesbeck, "Ultra-broadband omnidirectional printed dipole arrays," *IEEE Antennas and Progat. Soc. Int. Sympo.*, vol. 3A, pp. 545-548, Jul. 2005.
- [5] H. Choo and H. Ling, "Design of electrically small planar antennas using inductively coupled feed," *IET Electron. Lett.*, vol. 39, pp. 1563-1565, Oct. 2003.

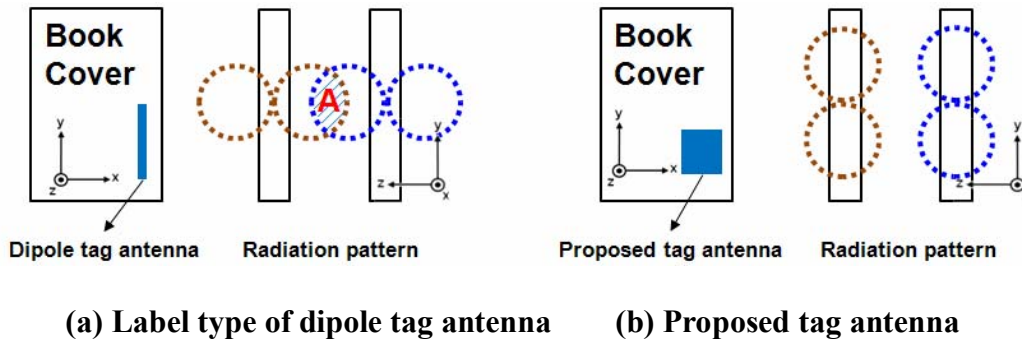


Fig. 1 Interference among adjacent tag antennas

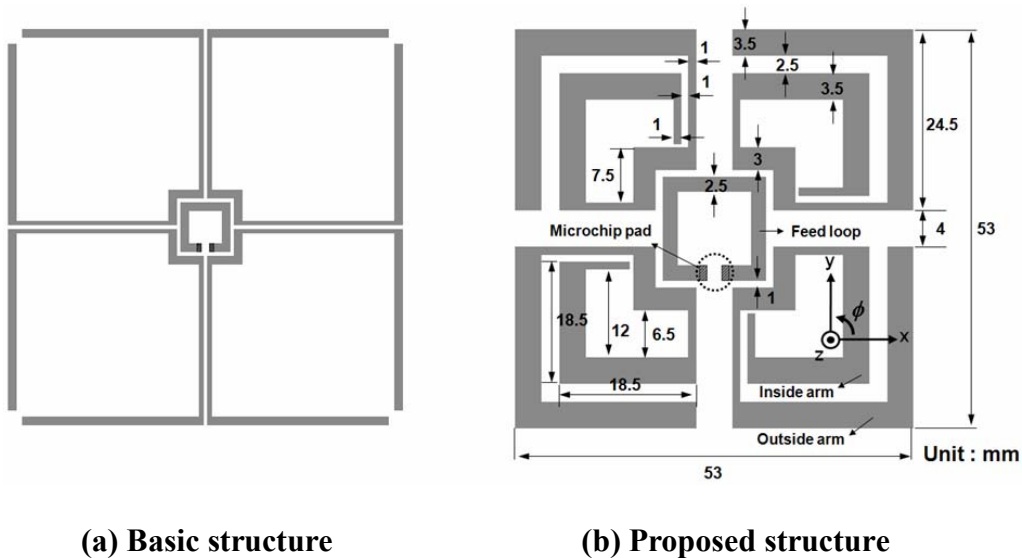
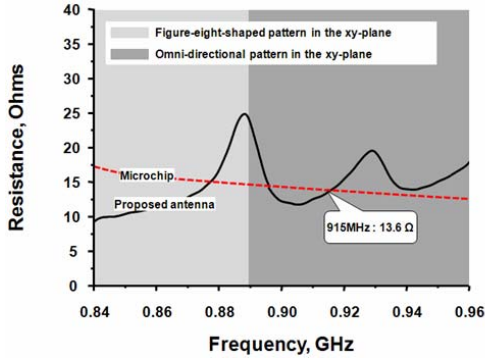
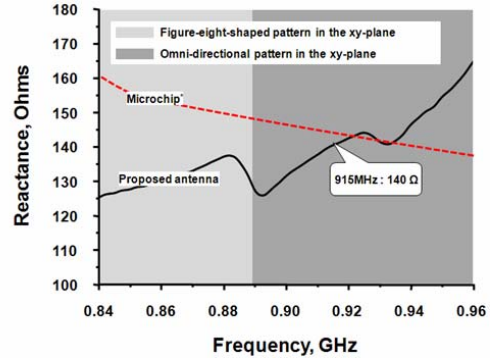


Fig. 2 Structure of proposed tag antenna

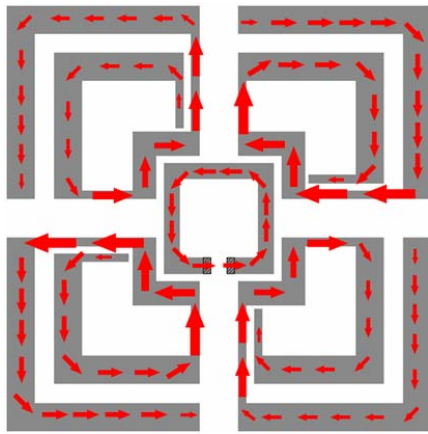


(a) Resistance

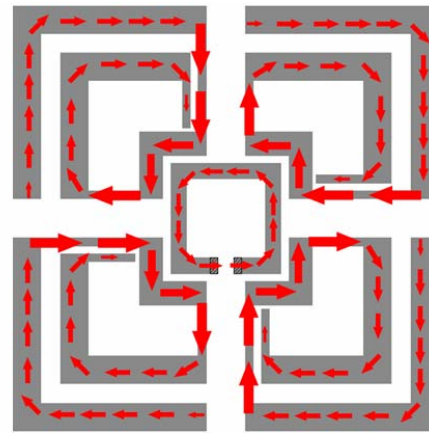


(b) Reactance

Fig. 3 Measured impedance of proposed tag antenna

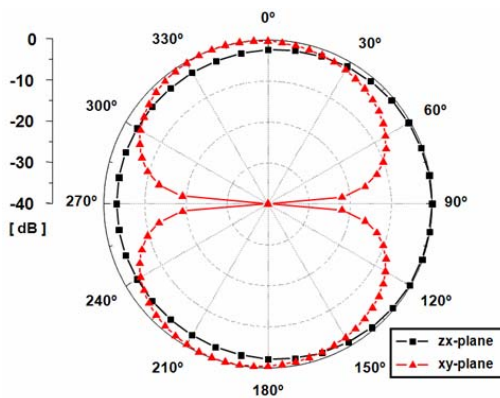


(a) 880 MHz

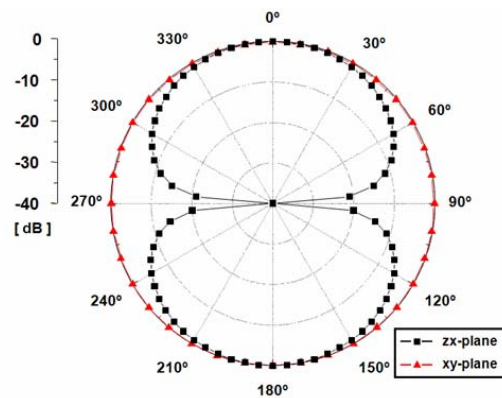


(b) 915 MHz

Fig. 4 Current distribution of proposed antenna



(a) 880 MHz



(b) 915 MHz

Fig. 5 Simulated radiation pattern of proposed antenna