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Electrically Small Loop Antenna for UHF Band RFID Tag

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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

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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 53×53 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 Ω at 915 MHz. The measured impedance of the proposed tag antenna is 13.6+j140 Ω 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.

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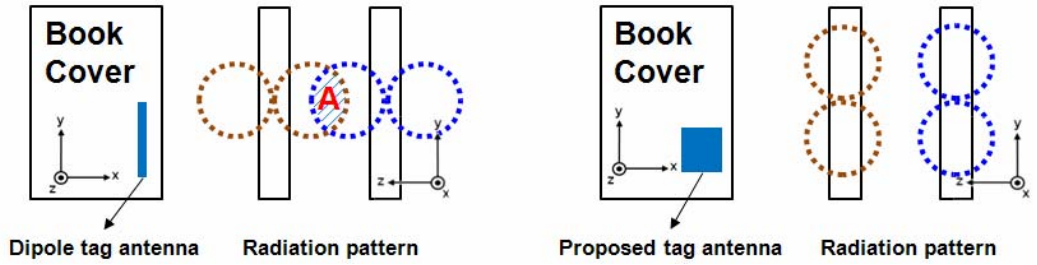
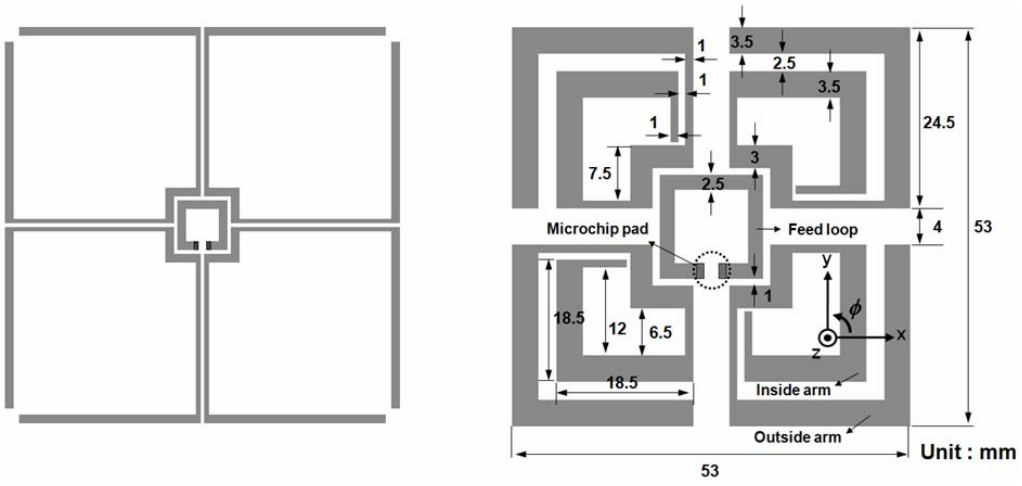


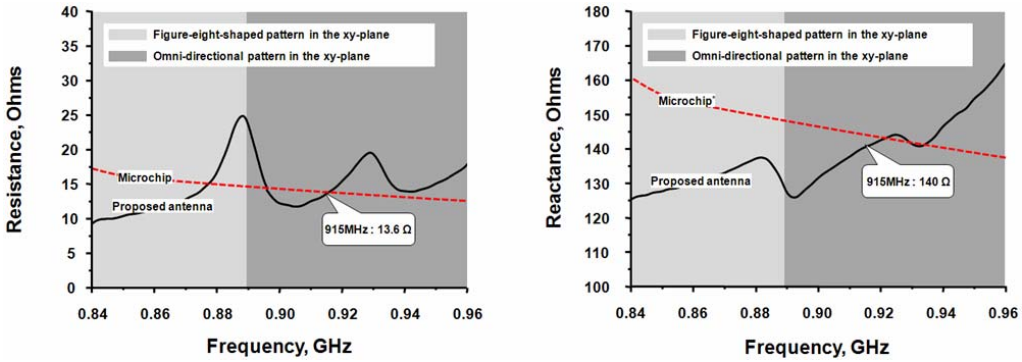
(a) Label type of dipole tag antenna **(b) Proposed tag antenna**

Fig. 1 Interference among adjacent tag antennas



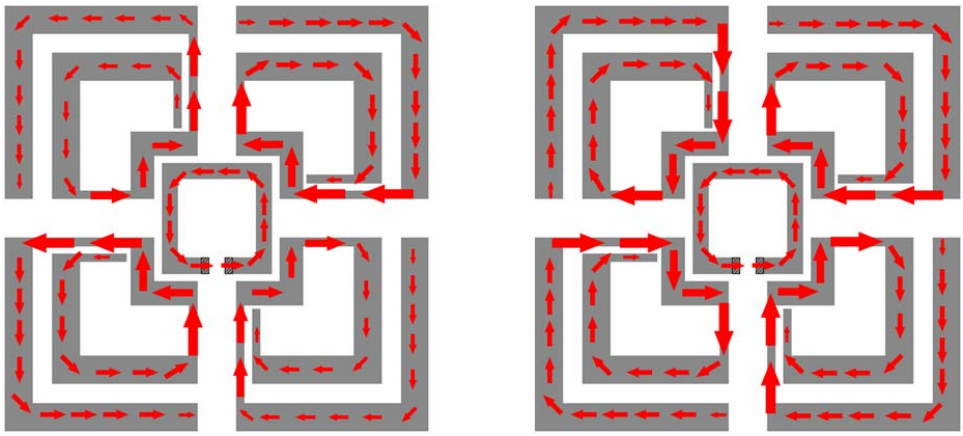
(a) Basic structure **(b) Proposed structure**

Fig. 2 Structure of proposed tag antenna



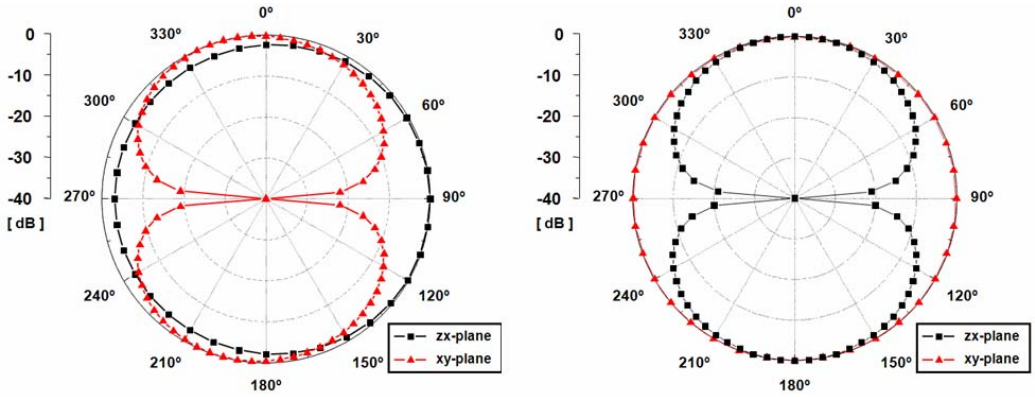
(a) Resistance **(b) Reactance**

Fig. 3 Measured impedance of proposed tag antenna



(a) 880 MHz **(b) 915 MHz**

Fig. 4 Current distribution of proposed tag antenna



(a) 880 MHz **(b) 915 MHz**

Fig. 5 Simulated radiation pattern of proposed antenna