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A Polarization Reconfigurable RFID Reader Antenna

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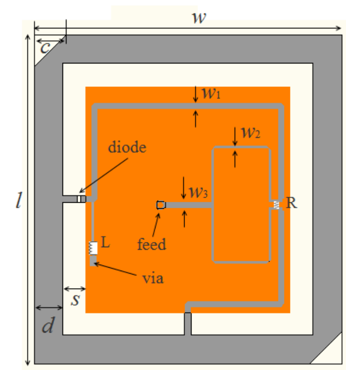
***Abstract*—A novel RFID reader antenna with polarization reconfigurable performance is proposed. The radiating part of the reader is a printed square ring, and a reconfigurable feeding network with embedded PIN diode is introduced to reconfigure the polarization. The proposed reader antenna can obtain a linear and a circular polarization at 910∼930 MHz with switching ON/OFF these diodes. The reader antenna is fabricated and measured. The performance of reconfigurable polarization proves the proposed antenna is suitable for wireless communication, diversity systems and portable devices.**

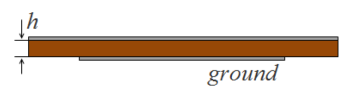
I. Introduction

With the development of modern wireless communication systems, within a limited space, the front-end antenna is required to achieve multi-functions which are achieved by several numbers of antennas, normally. Polarization diversity or reconfigurability is a typical example [1-4]. The polarization diversity or reconfigurability can offer an improved effectiveness in receiving the communication signal and have an exceptional ability of reducing multi-path fading. Furthermore, urban environments or complex environment with multi-patch propagation benefit from polarization diversity. An effective way to implementation of the polarization reconfigurability is using polarization reconfigurable antenna. At the same time, a reader antenna in an RFID system is facing such requirements [5-6]. In an RFID system, a reader is utilized to send signals to a tag that is attached to the object and to receive signals reflected by the tag. To eliminate any likelihood in which polarization could be completely mismatched when the orientation and polarization of a tag are unknown, antennas for RFID readers are often designed to be circularly polarized. On the other hand, if the orientation and polarization of the tag antenna are known, one can use linearly polarized antennas to decrease the polarization loss of reader antennas. This requires an RFID reader antenna with reconfigurable polarization feature.

According to the analysis mentioned above, a polarization reconfigurable RFID reader antenna is proposed. The proposed antenna can reconfigure its polarization characteristics as a linear polarization and a circular polarization, and this feature can improve the reader's reading efficiency. The proposed antenna has two radiating patterns in front and at back, repetitively, and this feature can improve the antenna's reading range and a more user friendliness.



(a)



(b)

Fig. 1. Structure of the proposed polarization reconfigurable antenna. (a) top view, (b) side view.

II. Polarization Reconfigurable Antenna Design

The geometry of the proposed antenna is shown in Fig. 1. The antenna is printed on an FR4 substrate with a thickness $h = 1$mm and permittivity $\epsilon_r = 4.4$. The proposed antenna can be divided into two parts, the radiating part and the feeding network. The radiating part is comprised of a printed periphery square ring, and the feeding networks are comprised of a Wilkinson power divider and a controlled PIN diode with its bias circuit. The lengths of the Wilkinson power dividers two output arms are different. The above arm is longer than the below one about a quarter of the operating wavelength.

An SMA connector is used to back feed the antenna and the input resistance of the antenna is 50Ω. Some of the optimized key parameters of the antenna and its reconfigurable feeding network are listed as follows: $w = l = 90$mm, $d = 8$mm, $c = 9$mm, $h = 1$mm, $s = 6$mm, $w_1 = w_3 = 1.9$mm, $w_2 = 0.98$mm, $R = 100\Omega$, and $L = 100$nH. Note that d is the width of the square ring and s is the slot between the top square ring and the back ground. By adjusting the widths of d and s, the operating

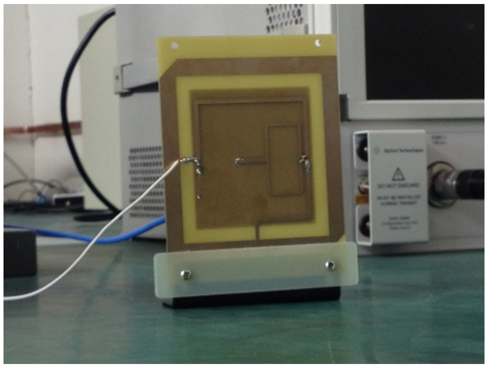


Fig. 2. Fabricated prototype of the proposed antenna.

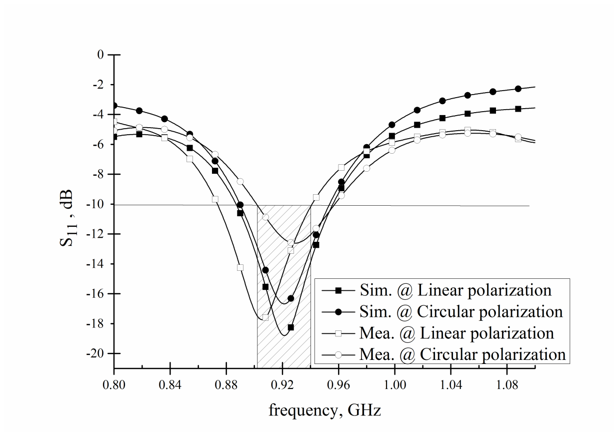


Fig. 3. Simulated and measured return losses.

frequency of the antenna will vary. In order to obtain a better axial ratio at circular polarization, two cutaways with length c are achieved.

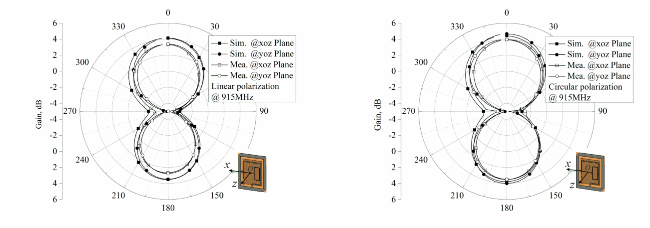
A PIN diode switch is embedded in one of the feeding arm. The embedded switch is MACOMs MA4AGBLP912 PIN diode. The embedded direction of the PIN diode and the DC-bias circuits of the four switches can also be found in Fig.1a. The DC voltage is applied to the PIN diode through the square ring. A high impedance DC line with a width of 0.1mm is used to connect the back grounds through a via. At the same time, an inductance L of 120nH is used to load the DC current to the ground and block coupling high-frequency currents.

III. Result and Discussion

In order to verify the performance of the proposed antenna, a prototype is fabricated and measured. The photograph of the antenna is shown in Fig. 2.

The simulated and measured return losses of the both reconfigurable modes are given in Fig. 3. The return loss measurement is carried out using an Agilents E8361A network analyzer. The bandwidth of the simulated impedance smaller than -10 dB is 908-930MHz. Radiation patterns are measured using a spherical near-field measurement system.

The simulated and measured patterns of the both reconfigurable modes in the *x-z* plane and *y-z* plane at 915 MHz are



(a) (b)

Fig. 4. Simulated and measured radiation patterns. (a) Linear polarization. (b) Circular polarization.

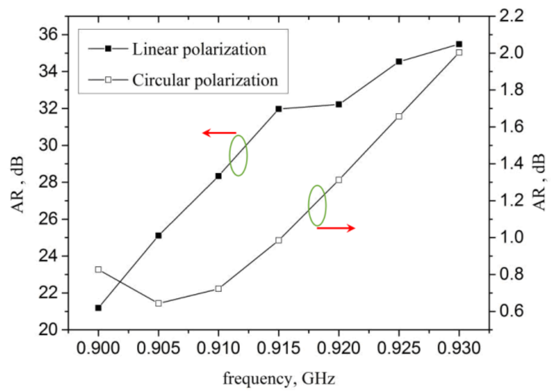


Fig. 5. Measured axial ratio.

illustrated in Fig. 4. As shown in the figures, good agreement between the simulated and measured results can be observed. At 915 MHz the peak gains are 4 dB and 4.1 dB for the linearly polarized and circularly polarized modes, respectively. Fig. 5 shows the measured axial ratio at the both reconfigurable modes.

Acknowledgement

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