A CP Antenna with a Multi-Bending Strip for Handheld Reader Applications

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1. Introduction

Generally, RFID is a short-range wireless communication to compare the existing technology, bar code identification. The main difference between RFID and bar code is RFID eliminates the need for line-of-sight (LOS) reading. Comparing with the LF and HF RFID systems, the UHF RFID system has longer reading distance and higher data-rates, etc. Due to UHF allocation by countries, the frequency range for UHF RFID application is 902–928MHz in North America (USA, Canada) and South America (Brazil, Argentina, etc.), 865.5–867.6MHz in Europe and 922-928 MHz in Taiwan, etc. Furthermore, RFID handheld antennas are very often used to operate in proximity to user's hand, as well as other obstacles. Based on these reasons, user's holding effect and multi-patch effect [2-3], circular polarization (CP) patch antenna becomes the best candidate for the requests of the handheld RFID readers. For practical requirement, patch antenna for CP also can be switched by feeding construction without changing mechanical structure [7]. The prototype of the proposed design was implemented. Both of the simulated and experimental results of the proposed antenna are demonstrated.

2. Antenna configuration

The novel coupling patch antenna is designed at 925 MHz for UHF Taiwan's RFID reader application (922 ~ 928 MHz), as shown in Figure 1(a). This antenna is designed on high-dielectric constant ceramic of 60 and the substrate's dimension of 27 x 27 mm^2 with a thickness (t) of 4 mm. The commercial SMA connector is used to be 50 ohms in order to be connected to a transmission line or a coaxial cable from RF module.

The system ground plane of 80 x 80 mm^2 is etched on a FR4 substrate with a 0.8 mm thick and a dielectric constant 4.4. As prior arts, larger ground plane can be a better director to concentrate radiation beam width and a good shielding metal to reduce user's hand effect. The antenna ceramic substrate of 27 x 27 x 4 mm^3 is a high dielectric constant (ε_r = 60) ceramic for size reduction. The top radiating patch of 17 x 17 mm^2 was printed on the upper plate of the ceramic substrate and the antenna ground plane was formed on the lower plate of the substrate, respectively. Detailed dimensions of the proposed antenna were shown in Fig. 1.

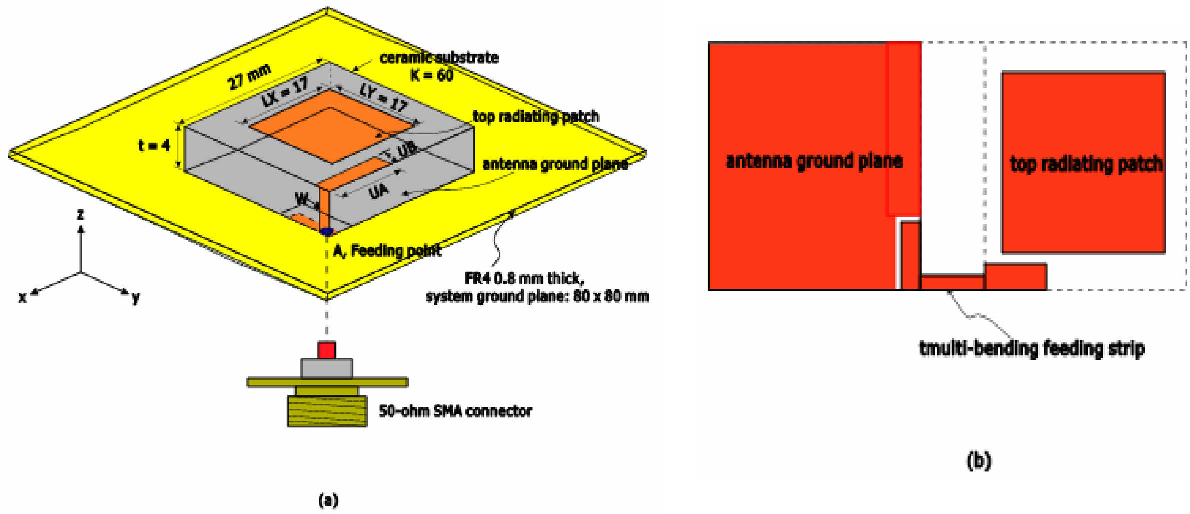

Fig. 1. The geometry of proposed antenna (a) 3-D view, (b) 2-D extending patterns of the proposed antenna

3. Results and Discussions

A prototype of the proposed antenna was implemented and investigated. The performance of the proposed antenna is mainly determined by the characteristics of the top radiating patch, the multi-bending feeding strip, high-dielectric ceramic material, and ground plane.

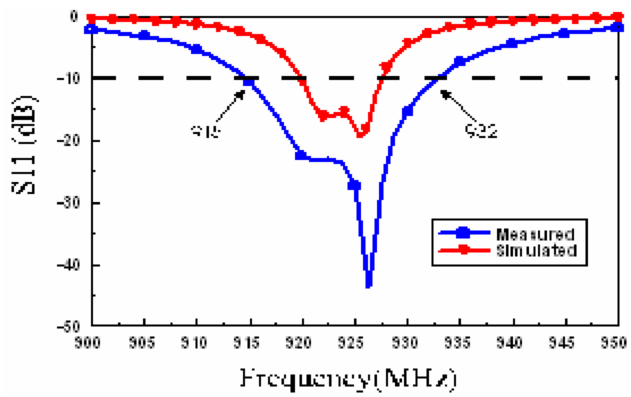

Fig.2. The return loss of the proposed antenna with novel corner-coupling feed

In Fig. 2, the impedance bandwidth determined by return loss 10 dB ranges from 915 MHz to 932 MHz, about 2% BW of center frequency, which can be completely covered the requirement of

RFID UHF band in Taiwan (922 ~ 928 MHz). The resonant frequency is excited by patch size, effectively a half wavelength on ceramic substrate. For further check on impedance matching, measured input impedance on a Smith Chart of the proposed antenna is shown in Fig. 3.

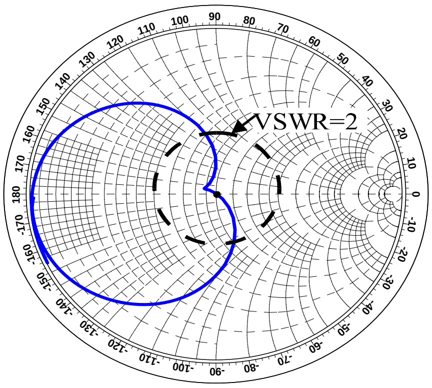

Fig. 3 Measured input impedance on Smith Chart for the proposed antenna.

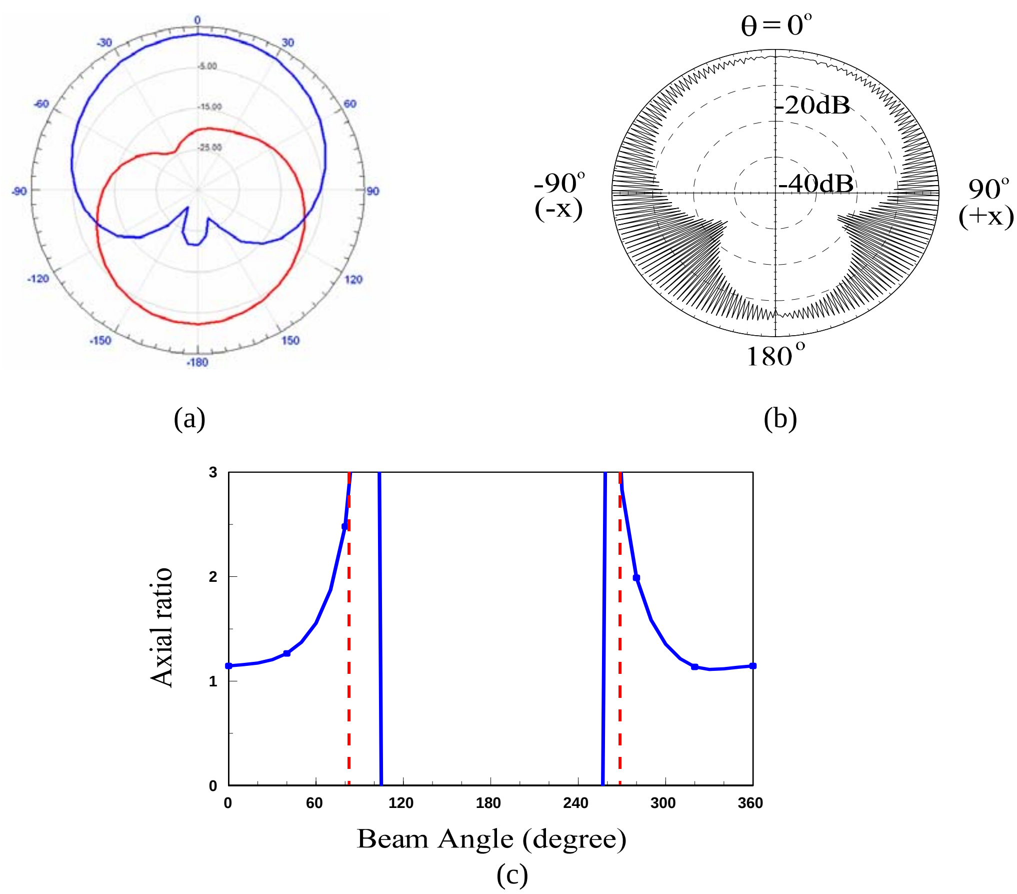

Fig. 4 Radiation patterns in x-z plane. (a) Simulated results in RHCP/LHCP components , (b) measured results in circular polarization, (c) in axial ratio.

For radiation characteristics, Fig. 4 shows the radiation patterns in x-z plane at 925 MHz for Taiwan’s RFID UHF band. The result is very similar to that of practical measurement. In Fig. 4(a), two main components of the proposed design were separated into RHCP and LHCP by

HFSS. The maximum radiation difference between RHCP and LHCP is at theta = 0. The result is very similar to that of practical measurement, shown in Fig. 4(b). By further comparison on RHCP and LHCP in Fig. 4(c), the 3-dB axial ratio beamwidth in x-z plane is more than 140° which covers from 0° ~ 70° and 280° ~ 360° . It means that the proposed design has a good RHCP performance.

4. Conclusion

The proposed design with a novel multi-bending feeding strip on ceramic substrate (ε_r= 60) has been presented and investigated. This antenna with a small dimension (80 x 80 x 4.8 mm^3) has good antenna performances and shows good CP radiation characteristics. By optimizing the coupling feeding mechanism, impedance matching and two orthogonal field components with 90° phase difference for circular polarization are obtained. The bandwidth of the prototype antenna covers from 915 MHz to 932 MHz which can be operated for Taiwan's RFID UHF band.

References

[1]. P. C. Sharma and K. C. Gupta, "A circularly polarized metallic patch antenna for RFID reader", Asia-Pacific Conference on Communications, pp. 116-118, Australia 2005.

[2]. K. Finkenzeller, *RFID handbook*, Second ED, John Wiley, New York, 2003

[3]. C. Lee, W. K. Han, I. Park, and H. Choo, "Design of a double-layered spiral antenna for radio frequency identification applications", IET Microwaves, Antennas & Propagation, vol. 4, No. 1, pp. 121 – 127, 2010.

[4]. J. S. Row and S.W. Wu, "Circularly-polarized wide slot antenna loaded with a parasitic patch" , IEEE Trans. on Antennas and Propagation, Vol. 56 , pp.2826-2832, 2008

[5]. H. L. Chung, X.-M. Qing, and Z. N. Chen, "A broadband circularly polarized stacked probe-fed patch antenna for UHF RFID applications", International Journal of Antennas and Propagation ,pp 1-8, 2007

[6]. C.Y. Huang, J.Y. Wu , and K.L. Wong, "Cross-slot-coupled microstrip antenna and dielectric resonator antenna for circular polarization", IEEE Trans. on Antennas and Propagation, Vol. 47, pp. 605-609 ,1999

[7]. R.H. Chen, and J.-S. Row, "Single-fed microstrip patch antenna with switchable polarization", IEEE Trans. on Antennas and Propagation, Vol. 56, No. 4, pp. 922-826, 2008.