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Microstrip-Fed Switchable Circular Polarization Antenna with Cross Slot Structure

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1. Introduction

Recently the importance of polarization diversity is increased in modern wireless communication system. In wireless local area networks (WLAN), polarization diversity is used to avoid the detrimental fading loss caused by multipath effects. A circular polarized antenna with a low profile, small size, and light weight is required in mobile satellite communications [1]. Single-feed circular polarized microstrip antennas with square, triangular, and circular patches have been reported [2 - 4]. To acquire circular polarization (CP), some methods by embedding a cross slot of different slot lengths in a circular patch is utilized [5]. A switchable polarization has the advantage of frequency reuse because dual polarization can be obtainable at a single frequency. In this paper a switchable circular polarization antenna of cross slot structure with microstrip single feed is presented. The proposed antenna has been changed the circular polarization by length of cross slot on the patch, which is switched on and off using pin-diodes. Details, simulated and experimental results of the proposed switchable antenna are dealt with.

2. Antenna Design

The geometry of the proposed antenna is shown in Fig. 1. The substrate size of the proposed antenna is 140 × 120 mm^2. A circular patch with a radius of 13 mm is implemented on a 1.6 mm thick FR4 substrate (ε_r = 4.4 and tanδ = 0.018) and fed by a microstrip line. The cross slots embedded on the radiation patch are with unequal slot length ℓ_3= 17.6 mm and ℓ_4 = 16.7 mm. The lengths of the other cross slot ℓ_1 , ℓ_2 embedded on the ground plane are the same as 15 mm, respectively. The required slot-length ratio of the cross slot is decided from the simulation. In addition, the slot-length ratio can be increased by embedding an additional cross slot on the ground plane [4]. The width (w1) of cross slots in the radiation patch and the width (w2) in the ground patch are 0.7 mm each. The gap (w3) of the separated circular patch is 0.1 mm. Two diodes are placed properly at the longer slot of the cross slots on the radiating circular patch, so that the best axial ratio is obtained. The position of both diodes is placed at 7.2 mm from the circular patch's center. Once two diodes on the patch with cross slot are off, the antenna is operated as RHCP. While two diodes are on, LHCP is generated. To implement the DC bias circuit, a very narrow gap line along the longer slot of the radiation circular patch is used. As the length of DC bias line is fixed on $\lambda_g/4$, RF signal is behaved as open circuit at the end of the bias line. The DC bias pad is connected with the ground by means of a shorting pin. Also two capacitors of 10 pF are utilized for DC blocking on the ground patch. The feed network is configured by a microstrip line with a 50 Ω SMA connector. The $\lambda_g/4$ transformer is used for the impedance matching with the radiation patch. To isolate DC bias current, DC block capacitors of 10 pF are provided between the feed line and the transformer. The pin-diode is HMPP-3890, which has an ohmic resistance of 2.5 Ω in the forward biased state and a capacitance of 0.2 pF in the reverse biased state, respectively. The dimension of the diode is 1.1 × 1.3 mm^2.

3. Simulation and Experimental Results

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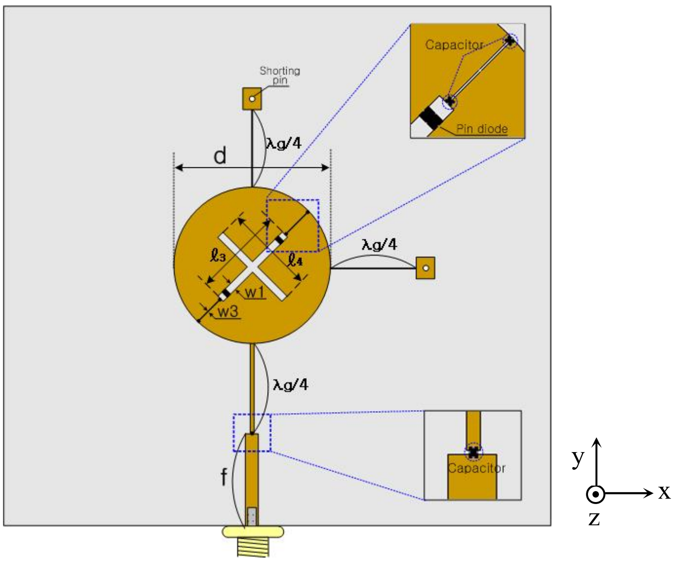
The proposed antenna is simulated by Ansoft HFSS 10.0TM. Fig. 2 shows the return loss of simulated and measured results for RHCP and LHCP. In Fig. 3 the simulated and measured results for the axial ratio performance are shown. The minimum value of the axial ratio for RHCP operation is 0.95 dB at 2.46 GHz and 0.83 dB at 2.531 GHz for LHCP operation, respectively. The measured result of the axial ratio is covered over the impedance bandwidth. The 3 dB axial ratio bandwidth is about 0.7 %. Fig. 4 shows the measured radiation patterns of y-z plane for RHCP at 2.46 GHz and for LHCP at 2.531 GHz, respectively. The measured peak gain of the proposed antenna is 1.45 dBi at 2.46 GHz for RHCP, while the gain is 0.76 dBi at 2.531 GHz for LHCP.

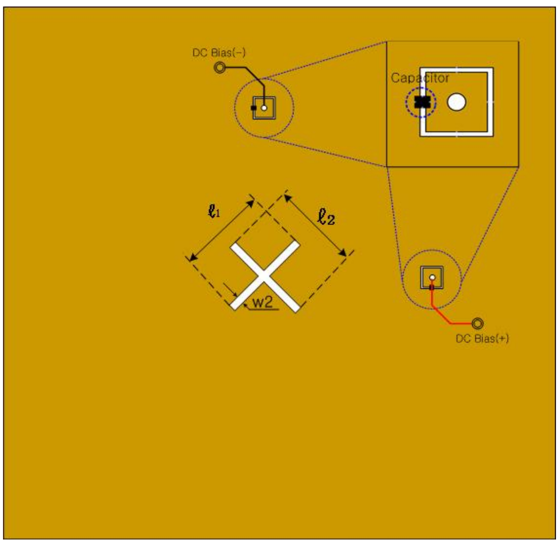
4. Conclusion

A switchable circular polarization antenna of cross slot structure with microstrip single feed is presented. It is obtained that the polarization can be switched between RHCP and LHCP by using two pin-diodes. The axial ratio is relatively as good as less than 1 dB. Since the proposed antenna is simple to switch a polarization, the antenna can be applicable for a polarization diversity system.

5. Figure

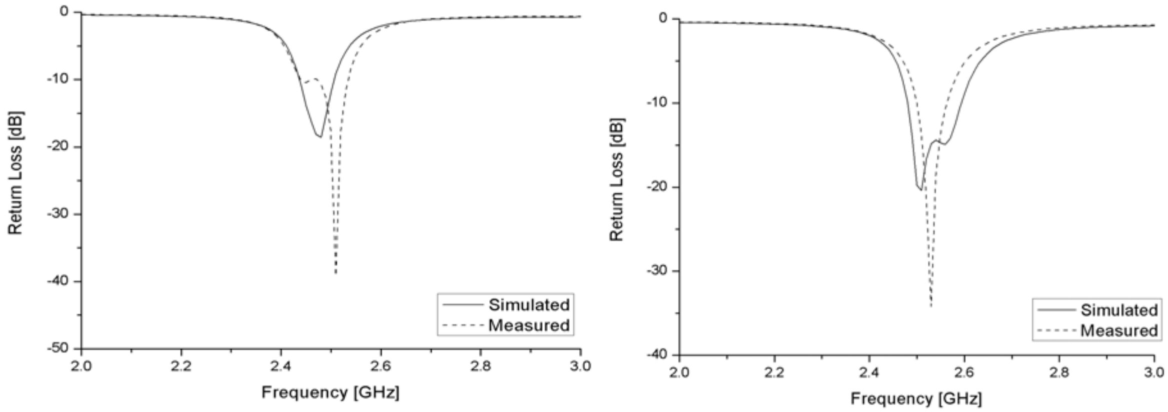


(a) Patch side



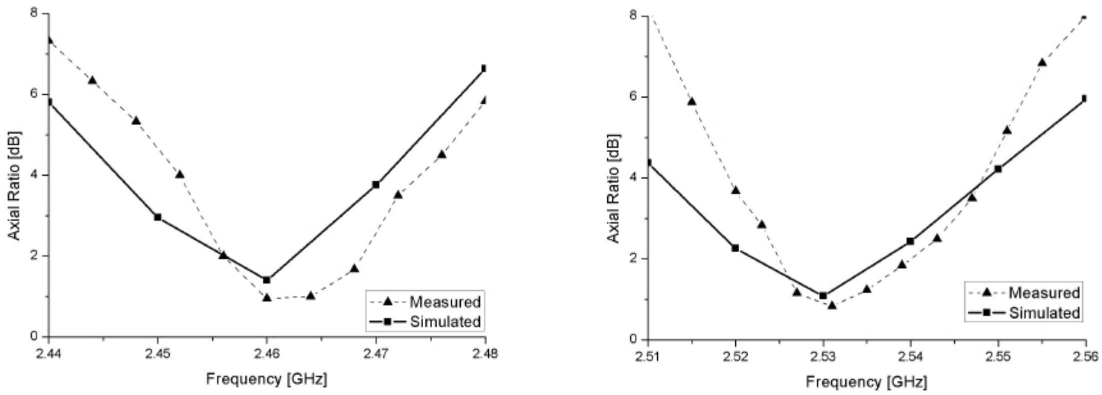
(b) Bottom side

Fig. 1. Geometry of the proposed antenna



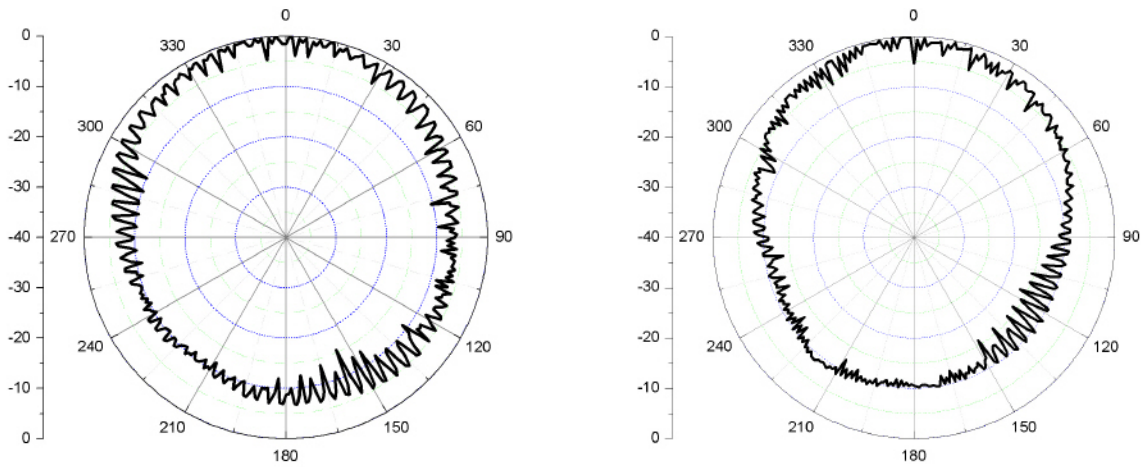
(a) diode-off state (b) diode –on state

Fig. 2. Simulated and measured results of return loss



(a) diode-off state (b) diode –on state

Fig. 3. Simulated and measured results of axial ratio



(a) diode-off state at 2.46GHz (RHCP) (b) diode –on state at 2.531GHz (LHCP)

Fig. 4. Measured spinning radiation pattern

References

[1] R. Garg, P. Bhartia, I. Bahl, and A. Ittipiboon, Microstrip Antenna Design Handbook. Norwood, MA: Artech House, 1995.

[2] W-. S-. Chen, C-. K-. Wu, and K-. L-. Wong, "Novel Compact Circularly Polarized Square Microstrip Antenna, " Antenna and Propagation, *IEEE Transaction*, vol. 49, No. 3, pp. 340-342, 2001.

[3] Y. J. Sung, B. Y. Kim, T. U. Jang, and Y. -S. Kim, "Switchable Triangular Microstrip Patch Antenna for Dual-Frequency Operation," Antenna and Propagaiton Society International Symposium, vol. 1, pp. 265-268, 2004.

[4] H. Iwasaki, K. Kawabata, and K. Yasukawa, "A circularly polarized microstrip antenna using a cross-slot feed," Antenna and Propagation Society International Symposium, vol. 2, pp. 807–810, 1990

[5] J. –S. Row and C. –Y. Ai, "Compact design of single-feed circularly polarised microstrip antenna," Electron. Lett., vol. 40, No. 18, pp. 1093-1094, 2004.