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A Novel Coaxial-fed Wide Band Circularly Polarised Patch Antenna for WLAN/ WiMax Applications

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Abstract

A simple and compact cross-slot wide-band patch antenna for circular polarization with a novel technique for enhancement of bandwidth and axial ratio is presented. By embedding three proper cross slots in radiating patch of the antenna, both impedance matching, and a good and desired axial ratio is achieved. Due to low thickness of the proposed antenna about (0.05λ0), the probe inductance is reduced and its effect on the impedance matching of the antenna can be ignored. Experimental results show that the designed antenna, with a compact size of 30×30×2 mm3, has a suitable impedance bandwidth of 5.4 to 6.5 GHz for voltage standing wave ratio (VSWR≤2), and the axial ratio less than 3 dB from 5.69 to 5.83GHz, which is suitable for WLAN (5.725-5.825 GHz) applications.

Keywords: Circular polarization, patch antenna and WLAN.

INTRODUCTION

Wireless communication developed rapidly in the past decade and has a great impact in our lives. The wireless local area network (WLAN) is one of the most applicable bands of wireless communications. Compactness, simplicity, and ease of integration, coupled with superior reflection efficiency and radiation performance are the challenges posed in designing antennas for WLAN applications [1], [2]. Therefore, patch antennas (PA) are frequently used in various wireless communication systems due to their low profile, light weight, easy to fabricate compared to other antenna structures [1]-[3]. Also, one of the serious disadvantages of patch antennas is narrow bandwidth. Therefore many researchers are utilizing methods and techniques for designing wideband patch antennas. Circularly polarized (CP) antennas are widely utilized to solve problems of polarization mismatch and multi-path interference in WLAN communications. Low profile circularly polarized antennas have been investigated by numerous researchers. CP antennas also provided better mobility and weather penetration than linearly polarized antennas. In addition, CP signals are not subject to the Faraday rotation effect [4]-[5].

In this study paper, we propose a novel single-feed wideband patch antenna (PA) using CP for 5.8 GHz WLAN technologies.

ANTENNA STRUCTURE

The geometry and dimensions of the proposed CP antenna is shown in Figs. 1and 2 that it fabricated on RT/Duroid 5880(εr=2.2) substrate. The patch of antenna consists of three cross rectangular slots. The thickness of substrate is critical factor for providing circular polarization in IEEE 802.11a standard (WLAN). In this antenna, value of this parameter by parametric analysis and designer experiment, is 2.37mm. The antenna fed by a 50Ω coaxial cable and the excitation point was optimized at (X=3.3, Y=2.3 cm) from the center of the patch for achieving a left hand CP operation (LHCP). When the feed is shifted to the other diagonal, then right hand circular polarization (RHCP) is obtained. The performance of the antenna can be described using the cavity model. For a normal square patch antenna, when the feeding point is located on its diagonal line, both the TM10 and TM01 modes are excited at the same frequency. After adding the slots, the resonant frequencies of both modes change [6]. On the other hands, the vertical slot (longest slot) is only affected on the TM01 mode and it does not affect on TM10 mode. Horizontal slot is affected on the TM10 mode and it does not affect on TM01 mode. Due to increasing the cross slot length, the main resonance frequency or the resonant frequencies of orthogonal modes decrease monotonically. To achieve deeper axial ratio about 0.66dB, the small cross slot is obtain 2×1.6mm² as shown in Fig. 1 and Fig. 2.

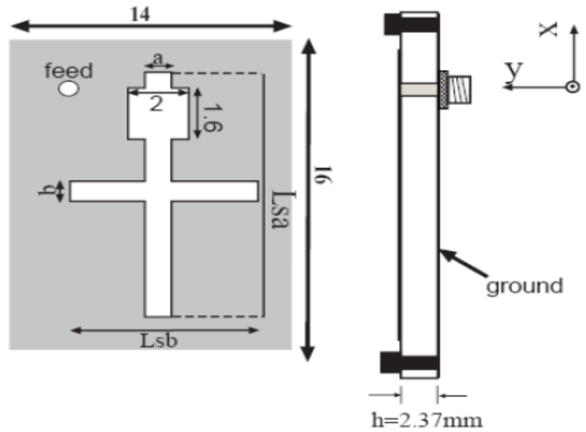


Fig. 1. Structure of proposed antenna :(mm)
$L_{sa} = 6.3, L_{sb} = 2.8, a = .3, b = .4$

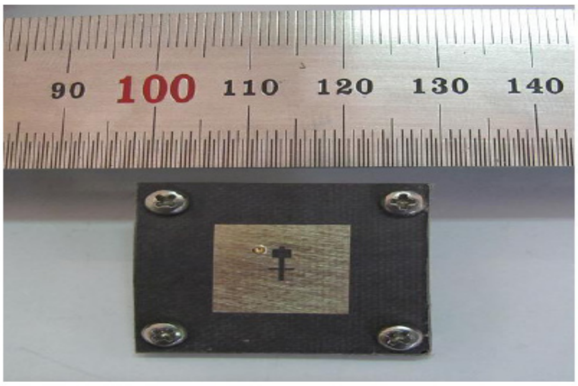
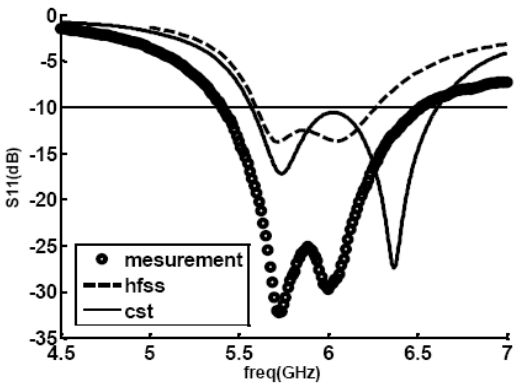
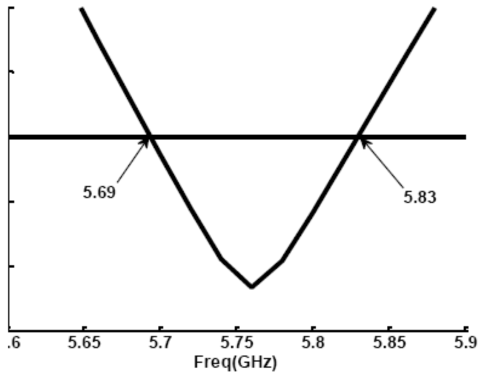


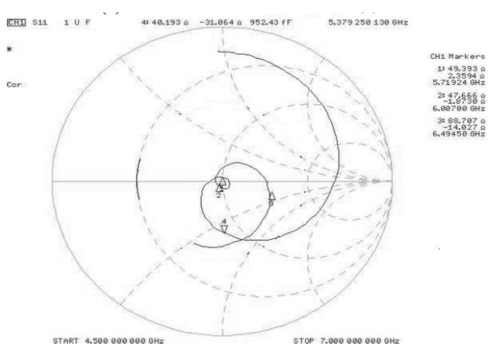
Fig 2. Photograph of fabricated antenna.



(a)

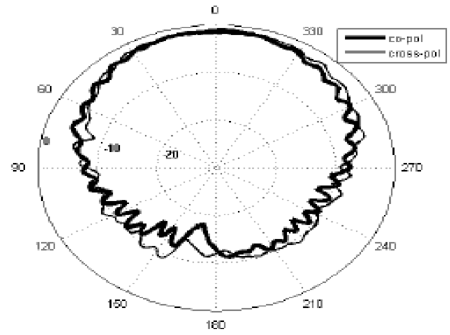


(b)

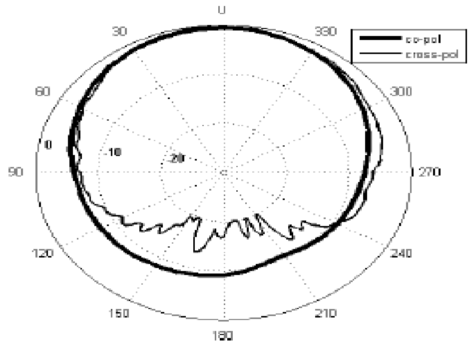


(c)

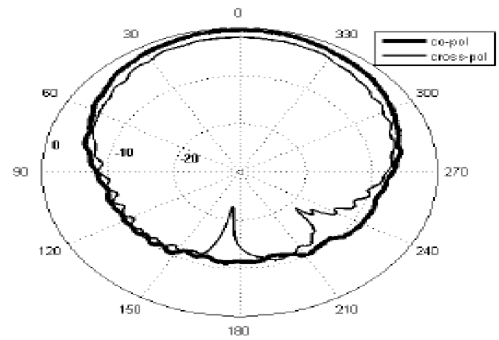
Fig 3. (a) Measured and simulated S_{11}. (b) Measured axial ratio (c) Smith chart measured by agilent 8722ES network analyzer



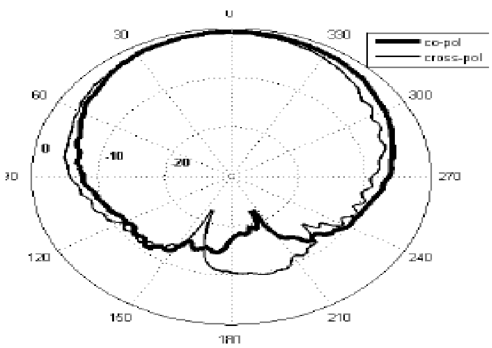
(a1)



(a2)



(b1)



(b2)

Fig 4. Measured radiation patterns for proposed antenna at (a) 5.7GHz (b) 6GHz (1)xz Plane (2)yz Plane

SIMULATION RESULTS and MEASUREMENTS

Full wave analysis of the proposed antenna configurations were performed using commercial Ansoft HFSS (ver10) software based on finite element method (FEM). In addition, the simulation results of CST Microwave Studio, based on finite integral technique, are provided to support our findings from HFSS software. This antenna measured by an Agilent 8722ES network analyzer. As the Fig. 3(a) depicted the first mode TM10 is excited in 5.7GHz and the second mode TM01 is excited in 6GHz between two frequencies the AR (≤3dB) occur and circular polarization obtained. To find the relation between radiation pattern and current distributions of the proposed antenna are presented. Fig. 3 (b) shows the measured input impedance. As shown in Fig. 3(c) a very small loop occurs close to the center of the smith chart. The small loop indicates that two resonant modes are excited at close frequencies which make CP radiation possible. Fig .4 shows the measured radiation patterns. including

CONCLUSIONS

A novel and simple wideband circular polarized patch antenna for covering WLAN (5.725-5.825GHz) was presented. By adjusting the length and position of the cross slots, we reached a good and desired axial ratio of 0.66 dB in frequency of 5.76 GHz. In other hand by using cavity model to optimizing the Location of the feed probe, the axial ratio was enhanced. The proposed antenna has no 900 hybrid coupler for circular polarization. Simplicity, easy to fabricate and small size are the advantage of this antenna. The performance of this antenna has been studied both by simulation and by experiment. Measured results shows that the antenna has a good axial ratio over WLAN band, and good radiation patterns.

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