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# CIRCULARLY POLARIZED SLOT ANTENNA WITH COMPACT SIZE FOR WLAN/WIMAX APPLICATION

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## *Abstract*

In this letter a circle patch that have two slots in ground and patch is presented. The antenna is operated in WLAN/WiMAX at 4.7~6 GHz. The 3dB axial ratio bandwidth is 0.5GHz at 5.3~5.8GHz. Comparison results between measured and simulated of antenna are acceptable.

## Introduction

Microstrip-fed slot antennas have found many applications in various radar and satellite communication systems because of their desirable features. Compared to microstrip patch antennas fed by a strip line or a coaxial probe, microstrip-fed slot antennas exhibit advantages such as wider bandwidth, less interaction via surface waves, better isolation and negligible radiation from feeding network, while maintaining the similar properties of low-profile, light weight and ease integration with other parts of MMIC transceivers. A number of experimental and theoretical studies [l], [2] and [3] were carried out in the past for narrow- and wide-slot antennas fed by an open-ended microstrip line. Various numerical techniques including the method of moments and the equivalent circuit model were employed to investigate the input impedance and radiation characteristics of microstrip-fed slot antennas of rectangular shape.

It is noted that most of the previous studies were mainly focusing on narrow and wide rectangular slot antennas fed by a microstrip open line, and these slot radiators only produce radiation of linear polarization. However, in many engineering applications including satellite communications, circular polarization is usually preferred.

For the purpose of more flexibly deploying a transmitter and a receiver without causing a severe polarization mismatch between them, circular polarization (CP) is getting more and more popular in wireless communications. On the other hand, a communication standard with a higher data-rate capability tends to survive or even prevail over others. The high data-rate capability has to be supported by antennas having a large operating bandwidth. In view of these perspectives, the need for broadband CP antennas is inevitable. Because of their high-Q nature, CP microstrip patch antennas with a low-profile feature usually have small impedance bandwidths and 3-dB axial-ratio (AR) bandwidths (ARBWs) [4], [5].

In this communication, our goal is to design a CP slot antenna with a fractional CP bandwidth (FCPBW) of larger than 23.6%, where the CP bandwidth refers to the frequency range in which 4.7~6 GHz is met. The 3-dB ARBW achieved for the proposed antenna is about 23.6%, which is also the FCPBW because the 3-dB AR band is completely enclosed by the 5.3~5.7GHz impedance band. If scaled to the same CP-band center frequency, the antenna proposed here, inclusive of the slot and ground plane, is smaller than most antennas in [6]–[7].

## Antenna Design and Configuration

In order to generate CP a configurations with a single feed as shown in figure 1 has been used. As a prototype a ring with outer radius $R_2$= 8.5 mm and an inner radius $R_1$ = 4mm was used, then two notches are cut along the outer periphery of the ring patch at diametrically opposite points with a width of $w_1$ = 5mm and a depth of $l_1$ = 2.12mm, and then two small stubs are added as shown in Figure 1 along the inner periphery of the ring at diametrically opposite points, with a 90° rotation of the two cut notches, which have a width of $w_2$ = 3mm and a thickness of $l_2$ = 1.2mm. The single feed line is introduced (placed) at an angle of 45° from the stub-axis or notch-axis, which excites the two orthogonal modes with equal amplitude and a 90° phase difference.

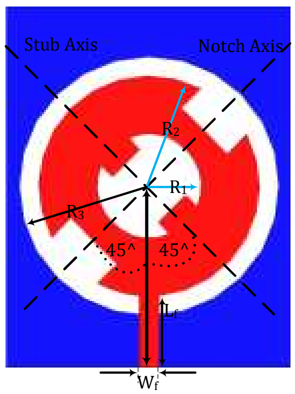


Figure 1 Antenna configurations.

By embedding a circular slot of radius $R_3$ in the bottom of ground plane antenna will help to increase the bandwidth. The antenna uses FR4 substrate with a dimension of 28 x 22 x 0.8 mm$^3$, $\varepsilon_r$ = 4.4 and a loss tangent of 0.02. A group of the antenna parameters obtained in simulation are g = .8 mm, $W_f$ =1.5 mm, $L_f$ =5.5 mm, respectively.

## Result and Discussion

To compare the improvement in the antenna bandwidth and circular polarization, the parameters of the proposed antenna are obtained using Ansoft High-frequency Structure Simulator (HFSS) simulation software. The simulated curves for two states of antenna are plotted in Figure 2. From the simulation results in Figure 2, it is observed that the impedance bandwidth increases as a circular slot is created in the ground plane antenna is improved, thus we have impedance bandwidth for the antenna when we have a circular slot in the ground.

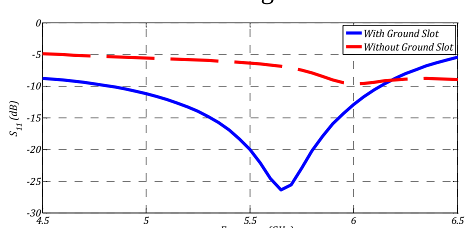


Figure 1. The simulated curves for two states of antenna

Figure 3 shows the simulated and measured return loss of the proposed antenna. As can be observed from this figure, the measured center frequency and -10 dB $S_{11}$ bandwidth is 1.32 GHz (23.7 %), whereas the center frequency and simulated bandwidth is 1.3 GHz (23.6 %).

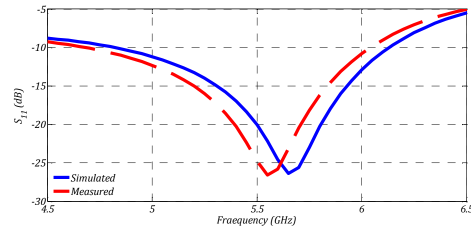


Figure 2. the simulated and measured return loss of the proposed antenna

The slight discrepancy between the simulation and measurement results can be attributed to the finiteness of the ground plane, which causes a shift in the resonant frequency and to the fact that the response of the antennas is sensitive to the exact location of the microstrip feed, which is subject to alignment errors in the fabrication process.

The simulated and measured results of AR of the proposed antenna, where the geometric parameters are parametrically optimized, are presented in Fig. 3. The measured AR bandwidth of the proposed antenna is about 600 MHz (5.3‘5.8 GHz), which is much larger than the bandwidth specification for WLAN/WiMAX operation at 5.5 GHz. The measured radiation patterns of the $\phi$=0° and $\phi$=90° planes of the proposed antenna at 5.5 GHz is presented in Fig. 4. The $\phi$=0° patterns are Omni-directional and the $\phi$=90° patterns are 8-like. Due to the quasi-loop structure, the electric field on the horizontal segment of the antenna is strong and the magnitudes of the cross-polarized patterns are similar to the magnitude of the co-polarized patterns.

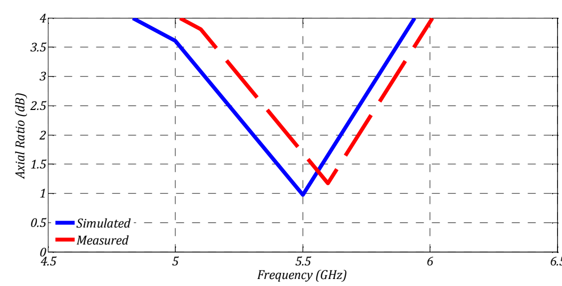


Figure 3. The measured AR bandwidth of the proposed antenna

Fig. 5 shows the measured peak gain for the proposed antenna at (4.5~6.5 GHz). The measured peak gain with frequency among all φ and all Ө is selected for the proposed antenna. The average gain for the antenna is about 3.1 dBic.

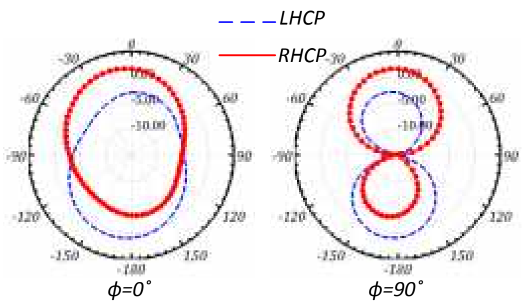


Figure 4. The measured radiation patterns of the ϕ=0˚ and ϕ=90˚ planes of the proposed antenna at 5.5 GHz

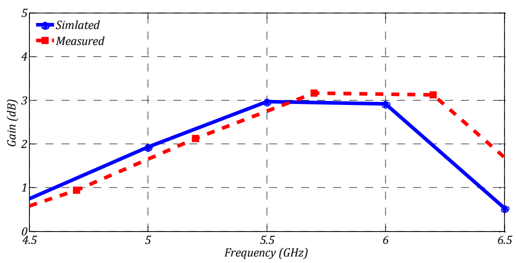


Figure 5. The measured peak gain

## Conclusion

A slot antenna with operation in WLAN/WiMAX was presented. The antenna with using a slot in patch that is embedded in tow side at opposite corner that provide circular polarization, and a circle slot in ground that provide broadband operation condition in antenna. This antenna with 3dB Gain can be used in array antenna with circular polarization.

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