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A Dual-Sense Circularly-Polarized Printed Monopole Antenna for GPS and Wireless Communications

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ABSTRACT

A printed monopole antenna with dual-sense circular polarization (CP) for GPS and wireless communications is presented in this paper. In order to generate the lower resonant GPS band, a rectangular slit is inserted in the patch which is fed asymmetrically by microstrip line. Without the slit, the antenna radiates RHCP wave for Wi-Fi and WiMAX bands only, whereas by introducing the slit it can produce both LHCP wave in GPS band and RHCP wave in Wi-Fi and WiMAX bands. Simulated bandwidths (satisfying 10 dB return loss and 3 dB axial ratio) of 1.27 % (1.563 GHz – 1.583 GHz) for the lower band and 57.86% (2.324 GHz – 4.216 GHz) for the higher band are achieved.

KEYWORDS: *dual-sense circular polarization, printed monopole antenna, GPS, Wi-Fi, WiMAX*

1. INTRODUCTION

Circularly-polarized (CP) antennas outperform linearly-polarized (LP) antennas because they can mitigate polarization mismatch losses independent of the antenna positions [1]. In terms of polarization, CP antennas may be categorized into three groups: the first one generating single-sense CP (only RHCP or LHCP) at a single band or multiband, the second one with polarization diversity property in which RHCP and LHCP can be generated by a single frequency at different instants, and the final one with dual-sense CP meaning LHCP at one frequency and RHCP at the other frequency simultaneously. In communications systems which demand better isolation between channels, dual-sense CP antennas are more suitable than co-polarized ones (single sense at multiple frequencies) [2].

Some research on dual-sense CP antennas has been conducted in [2]-[3]. Wideband single-sense CP performance was proposed in [4] by keeping the rectangular patch asymmetric with respect to the microstrip feed line. This paper proposes that dual-sense CP operation can be achieved by inserting a rectangular slit in the patch of [4]. Some dimensions of the antenna in [4] are modified to support GPS, Wi-Fi and Wi-MAX bands and to become more compact. Simulations in this paper are carried out using FEKO software.

2. ANTENNA STRUCTURE

The structure of the proposed antenna is shown in Fig 1. The rectangular patch is fed asymmetrically by microstrip line for circular polarization. The overall dimension is $D' = D'' = 54$ mm. The length L and the width W of the 45°-tilted patch are 38.26 mm and 21.86 mm respectively. The bottom corner of the patch is positioned at $X = 11.5$ mm away from the bottom edge of the substrate. The width w of microstrip feed is 3 mm and the feeding point is located at $U = 3$ mm and $V = 4.58$ mm. The ground plane's dimensions are $B_1 = 22.58$ mm, $B_2 = 31.6$ mm, $B_3 = 37.25$ mm and $B_4 = 8.5$ mm. The dielectric substrate has thickness of 1.6 mm, relative permittivity εr of 4.4 and loss tangent of 0.02. The length S_1 and the width S_2 of the rectangular slit are 28.68 mm and 3 mm respectively.

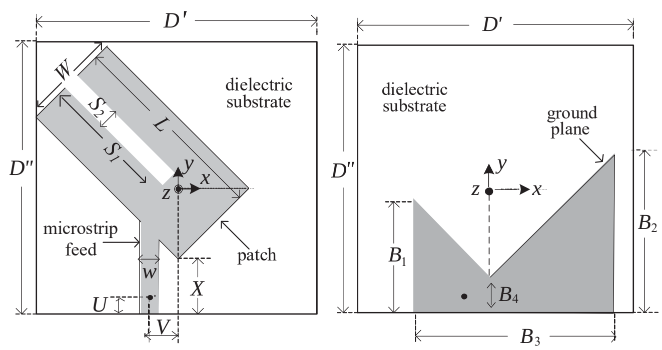
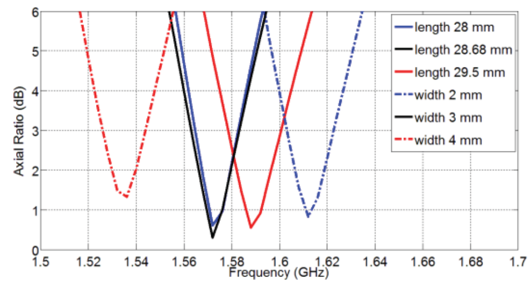


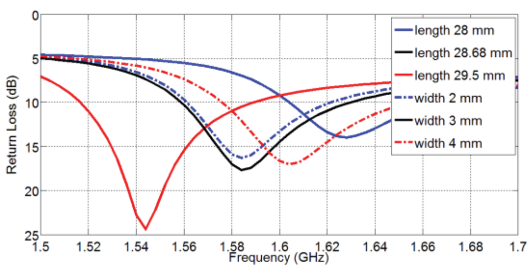
Fig 1. Proposed Antenna Structure: top view (left) and bottom view (right)

3. RESULTS AND DISCUSSIONS

In order to see the effect of the inserted slit on the antenna performance, the length and the width of the slit are varied. Simulated axial ratio and return loss for several slit lengths and widths are illustrated in Fig 2(a) and (b) respectively. The optimized dimension of the slit for GPS band is found to be 3mm x 28.68 mm.

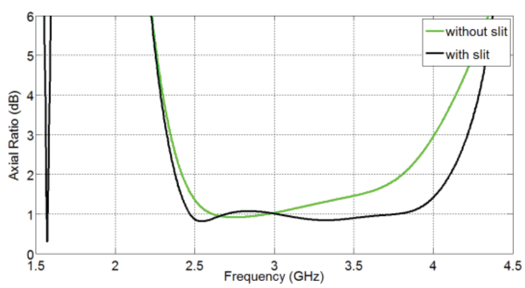


(a) axial ratio

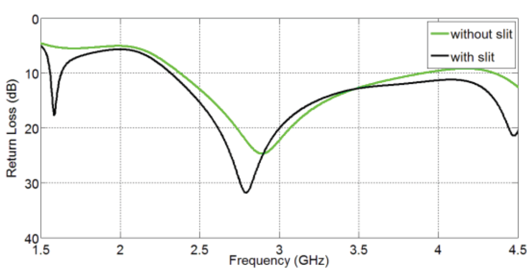


(b) return loss

Fig 2. Simulated axial ratio and return loss for different slit lengths and widths



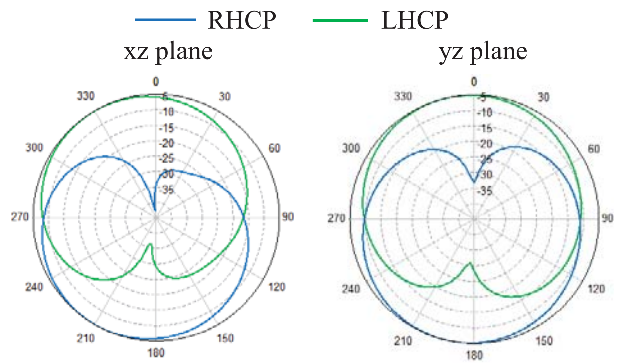
(a) axial ratio



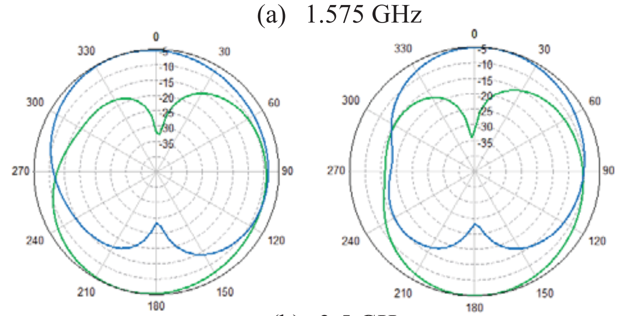
(b) return loss

Fig 3. Simulated axial ratio and return loss for the antenna with and without slit

Figure 3 depicts simulated return loss and axial ratio performance of the antenna with and without the slit. Inserting the slit in the patch enables the lower resonant band. Bandwidths (satisfying 10 dB return loss and 3 dB axial ratio) are 1.27 % (1.563 GHz – 1.583 GHz) for GPS L1 band and 57.86% (2.324 GHz – 4.216 GHz) for Wi-Fi and WiMAX. Normalized radiation patterns for 1.575 GHz (GPS) and 3.5 GHz (WiMAX) are shown in Fig 4(a) and (b) respectively. The LHCP wave is radiated in the positive z direction for the lower band, while RHCP is in the positive z direction for the higher band.



(a) 1.575 GHz



(b) 3.5 GHz

Fig 4. Normalized radiation patterns

4. CONCLUSIONS

A printed monopole antenna with dual-sense CP operation has been presented. Simulated results are shown to prove the effectiveness of the inserted slit. This antenna is suitable for GPS, Wi-Fi and WiMAX bands.

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