Wideband Printed Rectangular Monopole Antenna for Circularly Polarization

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***Abstract* –In this paper, a printed monopole antenna for circular polarization has been proposed. The relationship between the geometry of the antenna and the axial ratio is investigated. A wideband circularly polarized antenna is designed according to the parametric studies. The simulated bandwidth of 3dB-axial ratio is from 2.06GHz to 6.04GHz (98%).**

***Index Terms* — Printed rectangular monopole antenna, Wide bandwidth, Circular polarization.**

1. Introduction

Printed monopole antenna is known as wideband antenna. So far, many printed monopole antennas for linearly polarized wave have been proposed [1]-[3]. Their impedance bandwidth is over 100%. However, the reports of the wideband printed monopole antenna for circular polarization is a few [4]-[6].

Authors have proposed a wideband rectangular printed monopole antenna for circular polarization [7]. The simulated bandwidth of 3dB-axial ratio is approximately 65.8%. In [7], the microstrip line is connected the long side of the rectangular patch. The length of one side of the top edge of the ground plane is similar to the length of the short side of the rectangular patch. Therefore, the size of the ground plane is small compared with the wavelength. As the ground plane operates as the radiation element, it is difficult to enhance the bandwidth using the small ground plane.

In this paper, by changing the shape of the ground plane and the position of the connection of the microstrip line to the rectangular patch, the further enhancement of the bandwidth of the 3dB-axial ratio is examined.

For the calculations of axial ratio and radiation pattern, the simulation software package FEKO is used [8].

2. Antenna Design

Fig.1 shows the printed rectangular monopole antenna for circular polarization. The microstrip line is connected to the short side of the rectangular patch. The shape of the ground is also rectangle. However, the section of the ground plane overlapped with the rectangular patch is removed. The short side of the rectangle patch is t_1 and long side of it is t_2. The center of the rectangular patch is located at (x_0, y_0). There is gap between the rectangular patch and the ground plane. The size of gap along the short side of the rectangle is g_1 and the that of the long side is g_2. The relative dielectric constant, the thickness and the loss tangent of the dielectric substrate are ε_r = 2.6, h = 1.6mm and tanδ = 0.001, respectively. The size of the dielectric substrate is fixed to $W_1 \times W_2$ = 50mm×60mm. The dimension of the ground plane $d_1 \times d_2$. The angle between x axis and the long side of the rectangular patch α = 50°. The SMA receptacle is connected behind the dielectric substrate. The feed point is set to S_d = 3mm.

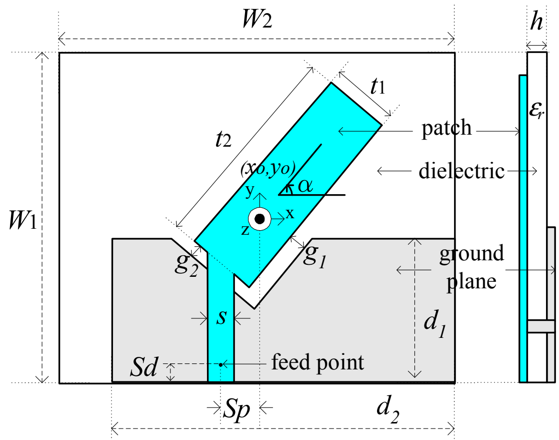


Fig. 1 Geometry of a printed rectangular monopole antenna

3. Parametric Studies

The relationships between the geometric parameters and the simulated axial ratio at θ = 0° are investigated.

Figs. 2(a) and (b) show the axial ratio for change of the lengths of the rectangular patch t_1 and t_2, respectively. In order to discuss the effects of the lengths t_1 and t_2 on axial ratio, the geometry of the antenna doesn't change except for these lengths. As the length t_1 becomes short, the axial ratio is improved around 4.5GHz. On the other hand, the axial ratio is worsened around 2.5GHz. It is observed that the length of the short side of the rectangular patch significantly influences the axial ratio. However, the influence of the length of the long side of the rectangular patch on the axial ratio is small. This is due to the following reason. The electric current concentrates at the top edge of the ground plane and the bottom edge of the rectangular patch [7]. Although most parts of the edge in the short side overlaps with the edge of the ground plane, only a part of the edge in the long side overlaps the edge of the ground plane.

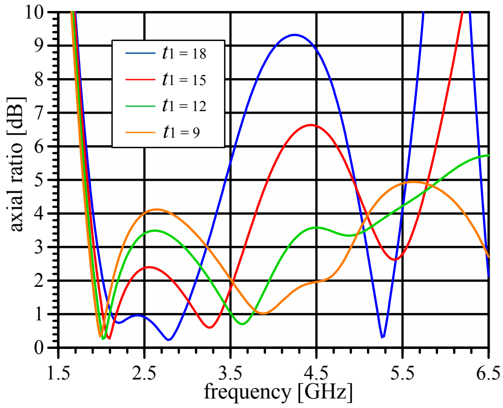
Fig. 2(c) shows the axial ratio for change of the width d_2 of the ground plane. The ground plane operates as the radiation element [7]. The length and the angle of the diagonal of the ground plane influence the axial ratio. Therefore, the axial ratio is adjusted by the width d_2.

4. Antenna Characteristics

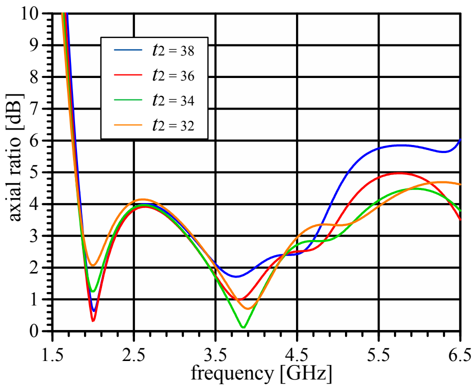
A wideband printed rectangular monopole antenna for circularly polarized wave is designed according to the parametric studies. The optimal dimensions of the proposed antenna are follows: $x_0 = y_0 = 4.3$, $t_1 = 10$, $t_2 = 38$, g = 4, $S = 5$, $Sp = 7$, $Sd = 3$, $d_1 = 21.5$, $d_2 = 52$ (unit : mm), and $\alpha = 50°$.

Fig. 3 shows the simulated axial ratio of the designed antenna. The simulated bandwidth of 3dB-axial ratio is from 2.06GHz to 6.04GHz (98%).

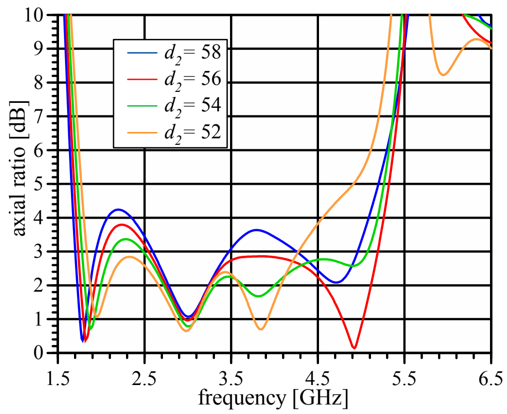
Fig. 4 shows the simulated radiation patterns. It is observed that the RHCP is radiated at $\theta = 0°$ and that the LHCP is radiated at $\theta = 180°$. The beamwidth of the circular polarization is wide at 2.5GHz. However, the radiation pattern deteriorate at 4.5GHz.



(a) the length of t_1 (t_2 = 38mm)



(b) the length of t_2 (t_1 is 10mm)



(c) the length of d_2

Fig. 2 Simulated axial ratio for changes of geometric parameters

5. Conclusion

A wideband printed rectangular monopole antenna for circularly polarized wave has been proposed. The relationships between axial ratio and the geometrical parameters is investigated. The future task is improvement of the return loss.

References

[1] K. P. Ray and Y. Ranga, *IEEE Trans. Antennas Propag.*, vol. 55, no. 4, pp. 1189-1192, April 2007.

[2] A. M. Abbosh and M. E. Bialkowski, *IEEE Trans. Antennas Propag.*, vol. 56, no. 1, pp. 17–23, Jan. 2008.

[3] M. Ojaroudi, Sh. Yazdanifard, N. Ojaroudi, and M. Naser-Moghaddasi, *IEEE Trans. Antennas Propag.*, vol. 59, no. 2, pp. 670–674, Feb. 2011.

[4] T. N. Chang and J. M. Lin, Electronics Letters, vol. 48, no. 14, pp. 818-819, July 2012.

[5] K. Ding, C. Gao, T. Yu, and D. Qu, IEEE Trans. Antennas Propagation, vol. 63, no. 2, pp. 785-790, Feb. 2015.

[6] K. G. Thomas and Praveen G, IEEE Trans. Antennas Propagation, vol. 60, no. 12, pp. 5564-5570, Dec. 2012.

[7] T. Fujimoto and K. Jono, *IET Microwave, Antennas Propagation*, vol. 8, pp. 649–656, 2014.

[8] http://www.feko.info/

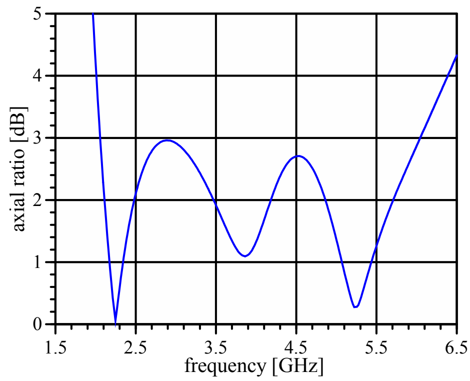
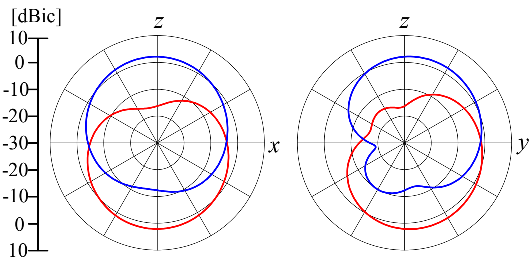
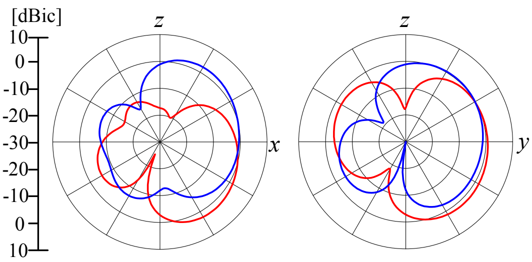


Fig. 3 Simulated axial ratio of the optimized antenna



(a) 2.5GHz



(b) 4.5GHz

Fig. 4 Simulated radiation patterns