Wideband Printed Elliptical Monopole Antenna for Circularly Polarization

Takafumi Fujimoto[1], and Masaya Takamura[2]
[1, 2] GRADUATE SCHOOL OF ENGINEERING, NAGASAKI UNIVERSITY, 1-14 Bunkyo Nagasaki, Japan

***Abstract* - In authors' previous studies, a printed rectangular monopole antenna for circular polarization has been proposed. The radiation characteristics of the wideband circular polarization are achieved by designing the antenna asymmetrically to microstrip line. The simulated bandwidth of 3dB-axial ratio with 10dB-return loss is approximately 56%. In this paper, a printed elliptical monopole antenna is proposed to enhance the bandwidth further. The bandwidth of the proposed antenna is approximately 84%. The gain at high elevation angle is stable within the frequency range compared with the rectangular monopole antenna.**

***Index Terms* —Elliptical printed monopole antenna, Wide bandwidth, Circular polarization.**

I. INTRODUCTION

Printed monopole antennas are useful for wide band operation [1][2]. Many printed monopole antennas have been proposed because of simple structure, small size, low profile and low cost. Most of these antennas are for linearly polarized wave.

Authors have proposed a wideband rectangular monopole antenna for circular polarization [3]. The radiation characteristics of the wideband circular polarization are achieved by designing the antenna asymmetrically to microstrip line. The simulated and measured bandwidths of 3dB axial ratio with 10 dB return loss are 56.2% and 51.4%, respectively.

In this paper, to design a printed monopole antenna with a further wide bandwidth, a printed elliptical monopole antenna is proposed. Similarly to the printed rectangular monopole antenna [3], the elliptical monopole antenna is designed asymmetrically to microstrip line. For the calculations, in this paper, the simulation software package FEKO [4], which is based on the method of moment, is used.

II. ANTENNA DESIGN

Fig. 1 shows a printed elliptical monopole antenna for circular polarization. The elliptical patch is connected to a microstrip line. The semimajor of the ellipse is t_1 and its semiminor axis is t_2. The center of the elliptical patch is located at (x_0, y_0). There are gaps in between the elliptical patch and the ground plane. The sizes of the gaps along the semimajor and semiminor axes are g_1 and g_2, respectively. The relative dielectric constant, the thickness and the loss tangent of the dielectric substrate are ε_r=2.6, h=1.6mm and $\tan\delta$= 0.001, respectively. The size of the dielectric substrate is $W_1 \times W_2$=50mm×60mm. The width of the ground plane is fixed at d=23mm. An SMA receptacle is connected from behind the dielectric substrate. To guarantee that the whole SMA receptacle is placed on the ground place, the feed point is set to S_d=3mm.

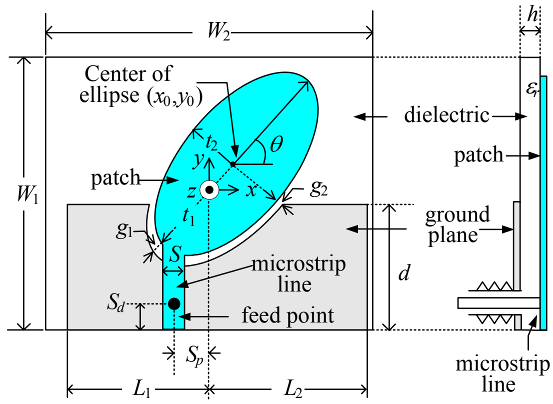
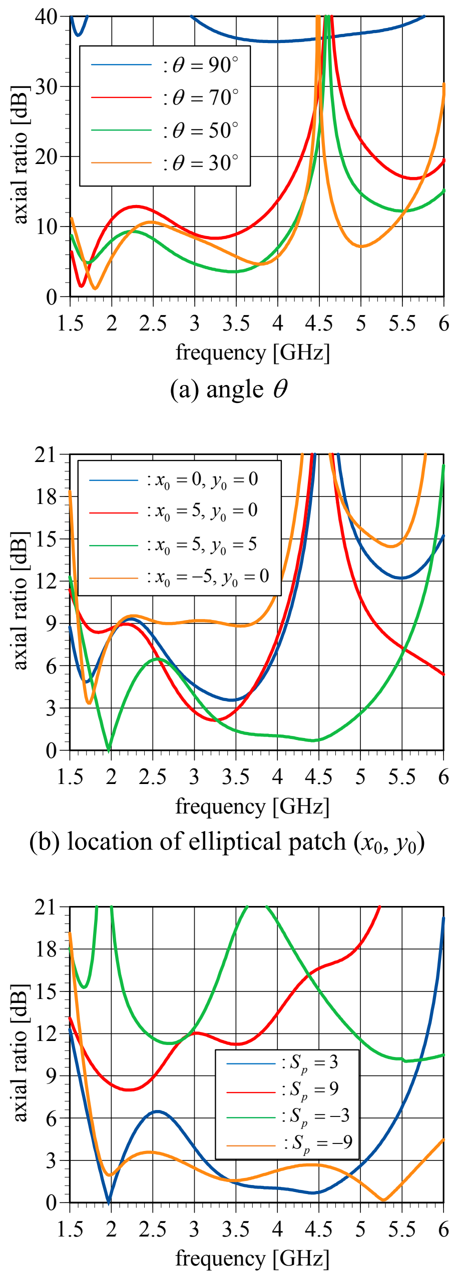


Fig. 1 Geometry of a printed elliptical monopole antenna for circular polarization

III. RESULTS AND DISCUSSION

The relationships between the geometric parameters and the simulated axial ratio in +z direction are investigated.

Fig. 2 (a) shows the axial ratio for change of angle between the x axis and the semimajor axis. In order to discuss the effects of the angle on the axial ratio, the geometry of the antenna is symmetric to the y-axis. The geometry of the patch is ellipse (t_1=20mm, t_2=10mm). The ground plane has the same size in the both directions from the y axis (L_1=L_2=30mm). When $\theta = 50^\circ$, the axial ratio is less than 10dB in the wide frequency range (approximately 1.5GHz-4.2GHz). Fig. 2 (b) shows the axial ratio for change of the position of the elliptical patch. The angle between the x axis and the semimajor axis is set to $\theta = 50^\circ$. In the printed monopole antenna, the electric currents concentrate at the bottom edge of the patch and the top edge of the ground plane [3]. By changing the position of the patch, the electric current distributions at their edges also change. Therefore, the axial ratio greatly depends on the position of the elliptical patch. Fig. 2 (c) shows the axial ratio for change of the position of the microstrip line S_p. Using the width S_p, the axial ratio can be reduced further.



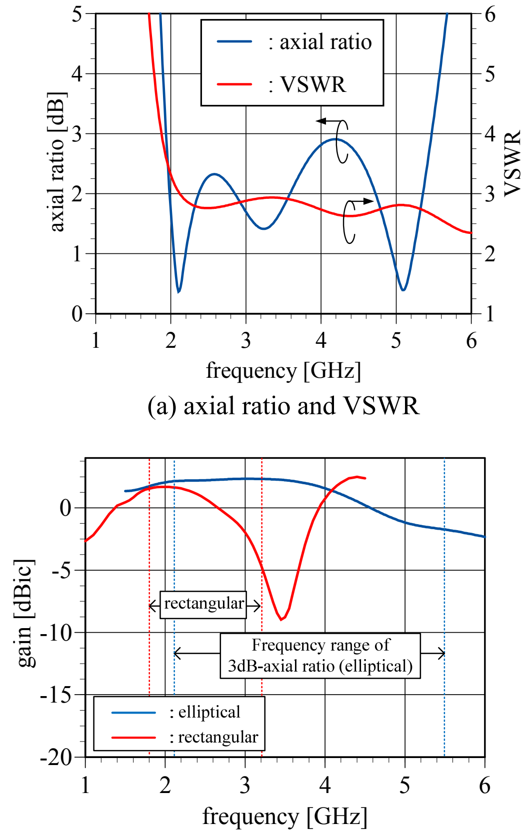
(a) angle θ

(b) location of elliptical patch (x_0, y_0)

(c) location of microstrip line S_p

Fig. 2 Simulated axial ratio for changes of geometric parameters

A wideband circularly polarized antenna is designed according to the parametric studies. The optimal dimensions of the proposed antenna are follows: x_0= y_0=5, t_1=20, t_2=10, g_1=0.6, g_2=0.4, S=4, S_p=-7.5, L_1=26, L_2=29 (unit:mm), and $\theta = 50^\circ$. Fig. 3 (a) shows the simulated axial ratio and VSWR of the designed antenna. The simulated bandwidths (2-VSWR with 3dB-axial ratio) are from 2.12GHz to 5.47GHz (86.4%), respectively. The simulated bandwidth of the designed antenna is wider than that of the rectangular monopole antenna [3]. Fig. 3(b) shows the simulated gain. The gain of the antenna is over -2dBic in the z direction in the frequency band (2-VSWR and 3dB-axial ratio). The gain of the designed antenna is greater than that of the reference [3] in the frequency range.



(a) axial ratio and VSWR

(b) gain

Fig. 3 Simulated antenna characteristics

IV. Conclusion

A wideband printed elliptical monopole antenna for circularly polarized wave has been proposed. The relationships between axial ratio and the geometrical parameters were investigated. The elliptical monopole antenna has a wider bandwidth compared with the rectangular monopole antenna.

References

[1] M. Ojaroudi et. al. "Small square monopole antenna with enhanced bandwidth by using inverted T-shaped slot and conductor-backed plane," *IEEE Trans. Antennas Propagation*, vol. 59, pp. 670–674, 2011.

[2] A.M. Abbosh and M.E. Bialkowski, "Design of ultrawideband planar monopole antennas of circular and elliptical shape," *IEEE Trans. Antennas and Propagation*, vol. 56, pp. 17–23, 2008.

[3] T. Fujimoto and K. Jono, "Wideband rectangular printed monopole antenna for circular polarization," *IET Microwave, Antennas Propagation*, vol. 8, pp. 1–8, 2014.

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