A circularly polarized printed monopole antenna for Radar application

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***Abstract*—A circularly polarized antenna for Radar in UWB high band (7.25GHz-10.25GHz) is proposed. As an antenna element, the printed monopole antenna is used. The proposed antenna for Radar consists of a transmitting antenna, a receiving antenna, and a reflector. The reflection coefficient less than -10dB, the transmitting coefficient lower than -30dB, the axial ratio less than 3dB, and the gain greater than 4dBi are achieved in the UWB high band.**

Keywords—Circularly polarized monopole antenna; Radar; UWB high band; Axial ratio; Transmitting coefficient

I. INTRODUCTION

Circularly polarized wave can overcome the multipath fading problem[1]. UWB high frequency has some great advantages such as low power consumption, low cost, high speed communication, and non-invasiveness to the human body and so on. Therefore, circularly polarized wave in UWB high band is suitable for Radar.

In this paper, circularly polarized antenna for Radar is proposed in UWB high band. So far, authors have proposed circularly polarized printed monopole antenna (CP-PMA) for wideband operation[2]. In the proposed antenna for Radar, the CP-PMA is used as an antenna element and a reflector is installed in the back side of the antenna to enhance the gain. Moreover, the approach for improvement of the isolation between the transmitting and receding antennas is proposed. For the simulation in this paper, the simulation software package Altair Hyper Works FEKO based on the method of moment, is used.

II. ANTENNA DESIGN

Fig. 1 shows the CP-PMA used as an antenna element. The geometry of the patch is ellipse. The ground plane behind the elliptical patch is removed. The elliptical patch is connected to a microstrip line. The relative dielectric constant, the thickness and the loss tangent of the dielectric substrate are ε_r =2.6, h=1.6mm, tanδ=0.001, respectively.

Fig. 2 shows the Radar system. The Radar system consists of two elliptical CP-PMAs and a reflector. The ground planes of the transmitting and the receiving antennas are connected by a convex conductor to improve the isolation between those antennas. The distance between the back surface of the antenna and the reflector is b. The geometrical parameters of the designed antenna for Radar are as follows; W_1= W_2=19.5, W_3=20.0, R_x=5, R_y=25, b=8.5, g_h=6, d_x=2, d_y=6, t_1=6.8, t_2=3.5, g_1= g_2=0, S=2.0, S_p=1.15, S_d=3.05, G_x=18.75, G_y=11.2 x_0=2.67, y_0=2.94, [mm], and α=50°.

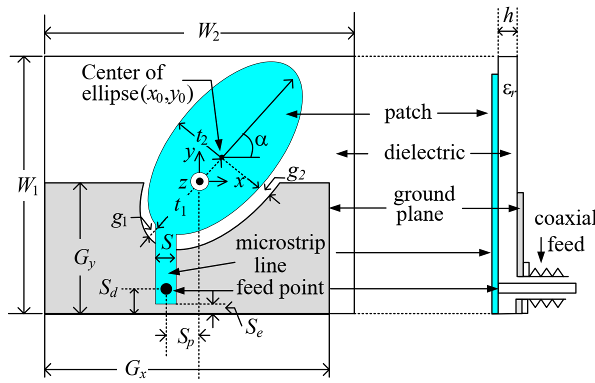


Fig. 1 Geometry of wideband PMA

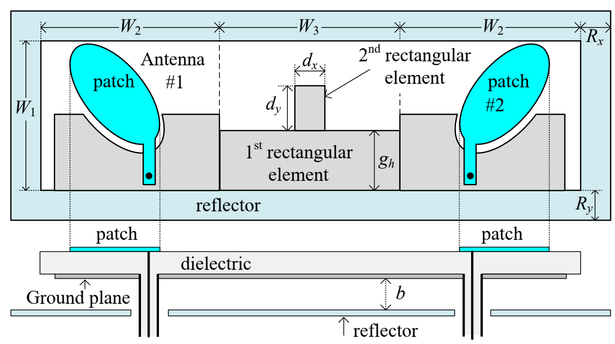


Fig. 2 Geometry of antenna for Radar

III. RESUTS AND DISCUSSION

A. Antenna Characteristics

Fig. 3 shows the reflection and transmitting coefficients |S11| and |S21|. In the UWB high band, |S11| is less than -10dB and |S21| is less than -30dB. Fig. 4 shows the axial ratio and the absolute gain at θ = 0° of the antenna #1. In the UWB high band, the axial ratio is less than 3dB and the absolute gain is greater than 4dBi. The frequency range of -10dB-|S11| with a 3dB axial ratio covers the UWB high band. Moreover, the high isolation between the transmitting and receiving antennas is achieved. However, as the frequency becomes high, the absolute gain decreases.

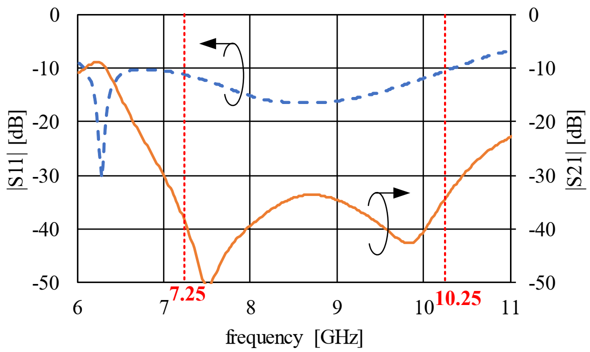


Fig. 3 Simulated reflection and transmitting coefficients

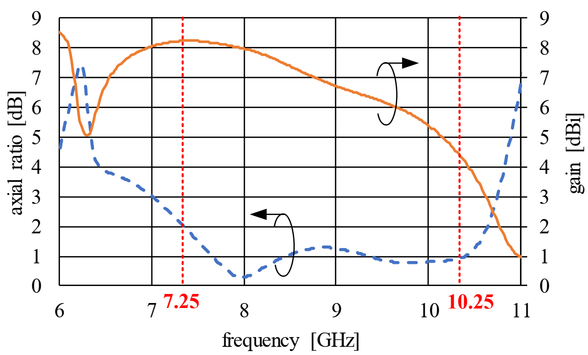


Fig. 4 Simulated axial ratio and absolute gain at $\theta = 0°$

B. *Parametric studies for improvement of isolaton*

Fig. 5 shows the transmitting coefficient |S21| for changes of the length g_h of the 1st rectangular element. The 2nd rectangular element isn't loaded. |S21| in the case that the two ground plane isn't connected is also shown. By adjusting the length g_h appropriately, |S21| can be significantly improved. When g_h=6mm, |S21| is less than -30dB around from 8.0GHz to 10GHz. Moreover, two peaks giving the minimum |S21| are observed around 8.4GHz and 9.6GHz.

Figs. 6(a) and (b) show |S21| and the axial ratio for change of the length d_y of the 2nd rectangular element. As the length d_y increases, the lower frequency giving the minimum peak shifts to lower frequency range. Moreover, the length d_y influences the axial ratio at the lower frequency giving the minimum peak. However, the influences of the length d_y on |S21| and the axial ratio are very small at the higher frequency giving the minimum peak.

By adjusting the lengths g_h and d_y, the isolation between the two antennas can be improved.

IV. Conclusion

A circularly polarized antenna for Radar in UWB high band has been proposed. As an antenna element, the printed monopole antenna is used. By installing the reflector, the gain is enhanced. Moreover, by connecting the two ground planes using the convex conductor, the transmitting coefficient is improved. The bandwidth of -10dB-reclection coefficient with a 3dB-axial ratio satisfies the UBW high band. The gain greater than 4dBi and the transmitting coefficient lower than -30dB are achieved in the UWB high band.

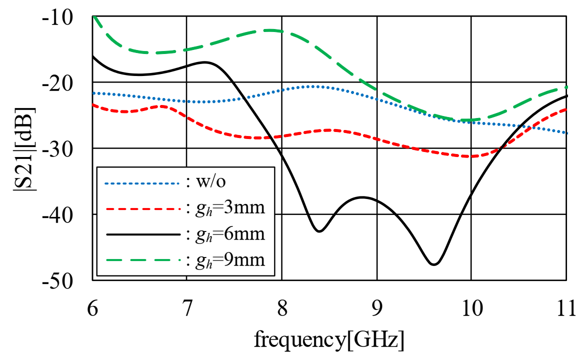
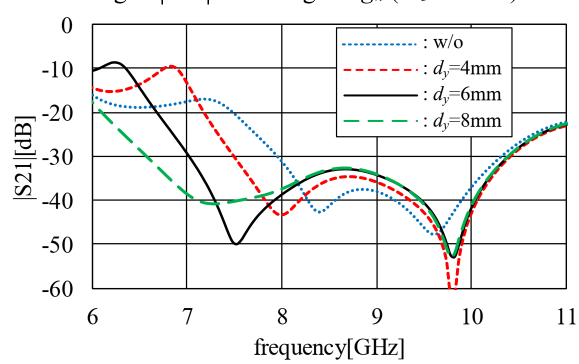
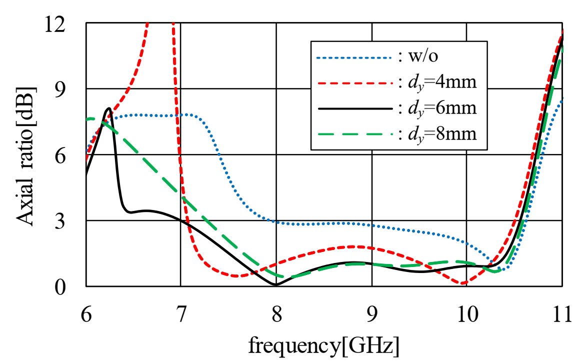


Fig. 5 |S21| for change of g_h (W_3=20mm)



(a) |S21| (W_3=20mm, g_h=6mm, d_x=2mm)



(b) Axial ratio (W_3=20mm, g_h=6mm, d_x=2mm)

Fig. 6 Antenna characteristics for change of d_y

References

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[2] T. Fujimoto, T. Ishikubo, and M. Takamura, "A wideband printed elliptical monopole antenna for circular polarization," IEICE Trans. Communi. vol. E100-B, no. 2. pp. 203-210, Feb. 2017.