MIMO 2-Ring Patch Antenna (2-RPA) for W-LAN Applications

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1. Introduction

It has been demonstrated by FEKO (German phrase FEldberechnung bei korpern mit beliebiger oberflache) simulation that orthogonal radiation pattern of mode 3 can be obtained with a circular patch antenna (CPA) stack. This pattern is applicable to W-LAN MIMO (multi-input multi-output) antenna[1,2]. As a result, about -20 dB of isolation was achieved from CPA by the simulation [1]. This good isolation is attributed to un-overlapped orthogonal radiations of the CPA stack. If overlapped, the isolation could be worse than the above simulated isolation. Furthermore, the size of CPA is still large to use in a MIMO system. Therefore, further reduction in the antenna size is desirable. In order to address this issue, we designed two types of ring patch antenna. One is a ferrite ring patch antenna (1-RPA) and the other two ring patch antenna (2-RPA) stack. The design of antenna is shown in Fig. 1(a) and Fig. 2(a). In this paper, we report a study of design of two types of ring patch antenna and simulation results for their antenna characteristics.

2. Design and simulation

The performance of 1-RPA and 2-RPA was simulated by the Ansoft HFSS (high frequency structure simulator) software. Radius and height of bottom 1-RPA are fixed to 3.19 cm and 0.65 cm, respectively, for our simulation. Fig 1(a) shows 1-RPA structure and the 2-RPA is illustrated in Fig. 2 (a), the total volume of which is 34.5 cm^3. This volume is about 1/3 of 2-CPA volume [1]. The 2-RPA has two separate feeding ports, which is detailed in Fig. 2(a). Permeability (2.2 ~ 2.3) and permittivity (4.5 ~ 7.0) were used for the simulation to characterize antenna performance.

3. Results and discussion

Fig. 1(b) shows well-defined orthogonal gain patterns of 1-RPA on x-y plane. As shown in Fig. 2(b), the central frequency was found to be 2.472 GHz for the bottom RPA and 2.517 GHz for the top RPA. The isolation between the top and the bottom RPAs was estimated to be -43.73 dB. To our best knowledge, this isolation is far better than any other MIMO CPAs. Our simulation results show that -1.92 dBi of peak gain and 71 MHz of bandwidth can be achieved. With regard to radiation pattern, we have simulated electric field distribution of 2-RPA. This electric field distribution verifies the existence of the mode 3 orthorgonal radiation pattern of the 2-RPA as shown in Fig. 3(a, b). The mode 3 radiation pattern for each RPA is easily realized by the observation of six electric field focused spots as shown in Fig. 3(a). It is noted that the mode 3 radiation pattern of the top RPA rotates 30 degree with respect to the bottom RPA. Accordingly, we can conclude that a high degree of isolation can be obtained from our proposed RPA stack as we described above. However, the gain pattern of 2-RPA shows 3 main robes rather 6 robes as shown in Fig. 3 (b). This is attributed to difference in the radiation efficiency between the top and bottom RPAs.

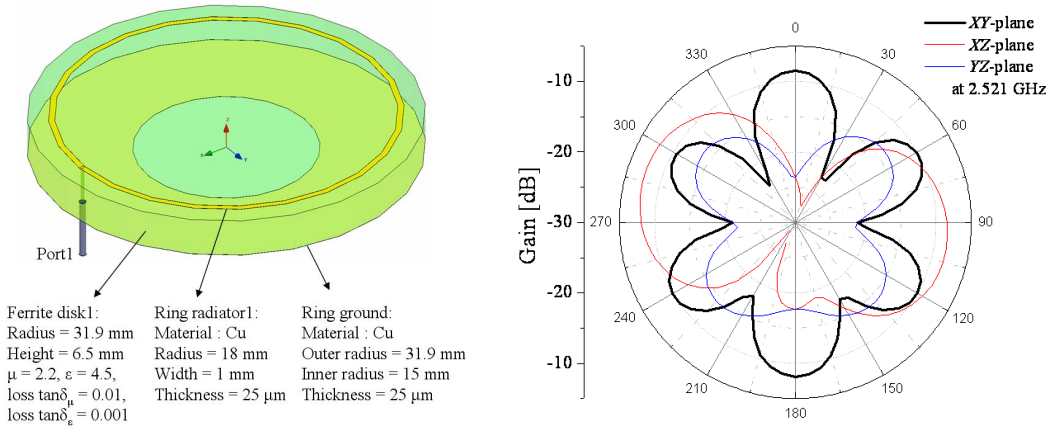
4. Conclusion

We have designed 34.5 cm^3 MIMO 2-RPA. The 2-RPA shows the mode 3 orthogonal radiation pattern and high isolation between RPAs. Both gain and bandwidth of 2-RPA are good enough for W-LAN applications.

5. Reference

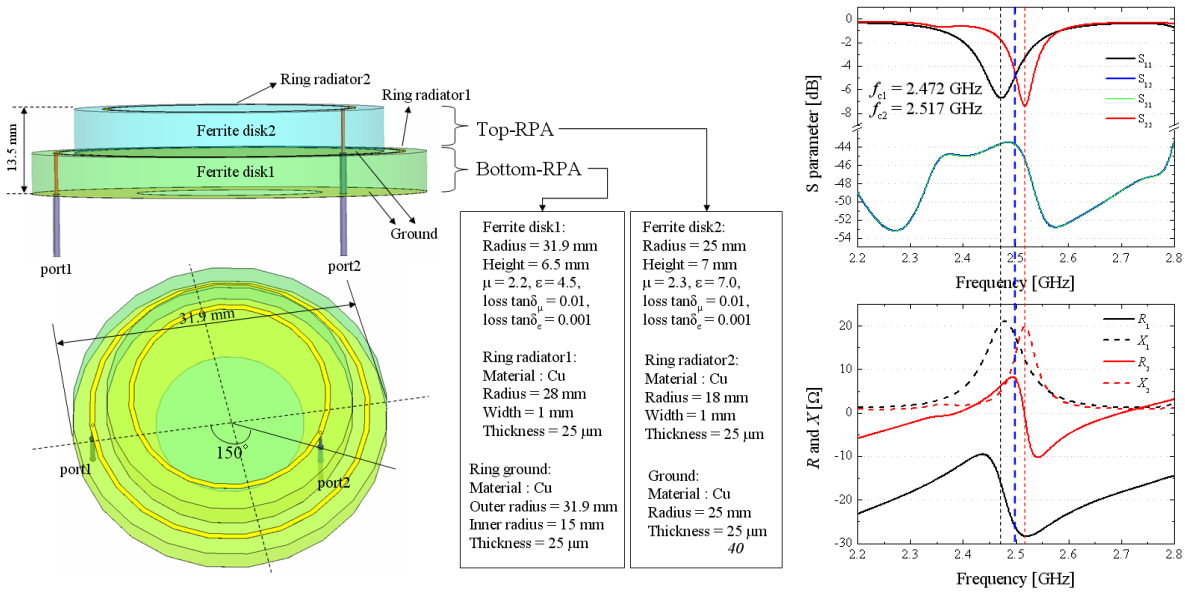
[1] A. Forenza and R. W. Heath Jr., "Benefit of pattern diversity via two-element array of circular patch antennas in indoor clustered MIMO channels", IEEE Trans. on Comm., vol. 54, pp. 943-954, May 2006.

[4] R. G. Vaughan, " Two-port higher mode circular microstrip antenna", IEEE Trans. Antennas Propagat., vol. 36, pp 309-321, Mar 1988.



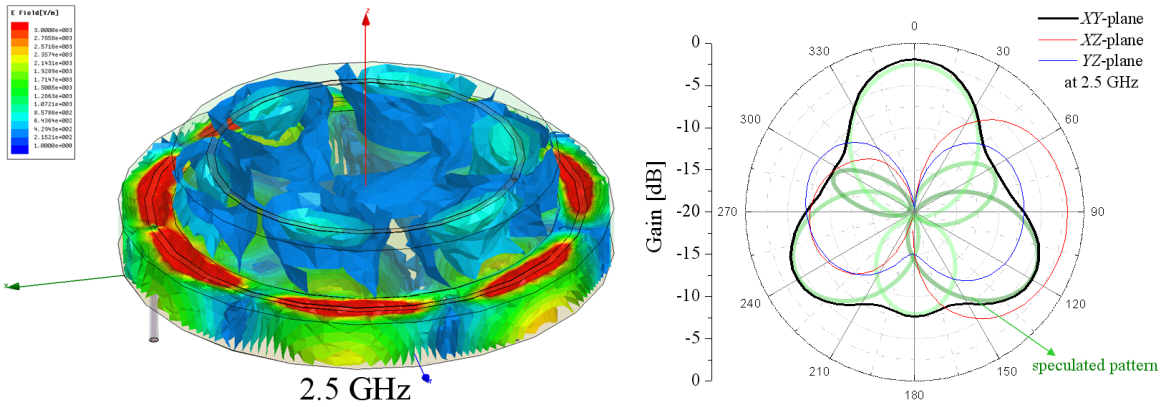
(a) (b)

Fig. 1 (a) Design of 1-RPA and (b) gain patterns of 1-RPA at 2.521 GHz.



(a) (b)

Fig. 2. (a) Design of 2-RPA and (b) antenna properties of 2-RPA as a function of frequency.



(a) (b)

Fig. 3. (a) Electric field distribution of 2-RPA at 2.5 GHz and (b) gain patterns of 2-RPA.