Compact Printed Dual-band Monopole Array with High Port Isolation

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***Abstract* - In this paper, a compact defected ground structure (DGS) with two circular split ring slots is presented to increase the port isolation of a compact dual-band antenna array. The proposed dual-band DGS is etched on the ground plane between two antenna elements. Each split ring slot corresponds to one resonant frequency of the antenna. The simulated results show that by using the proposed DGS structure the port isolation of the compact array can be obviously increased and the array is suitable for applications in multiple antenna communications.**

***Index Terms* — Dual-band array, port isolation, defected ground structure, compact antenna array.**

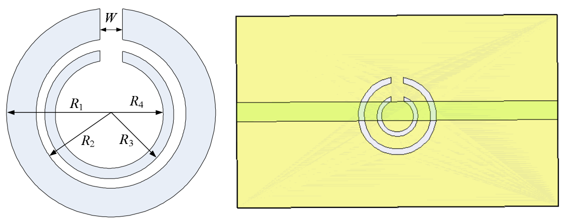
I. INTRODUCTION

To accommodate higher data rates and increase capacity, the multiple antennas are widely used in new generation of wireless communication systems. However, it is a challenge to implement multiple antennas in a small size wireless device while keeping a high level of isolation between antenna elements [1], especially for dual-frequency arrays. The severe mutual coupling effect between array elements can cause significant system performance degradation. Different techniques to remove or reduce the adverse effects of mutual coupling in compact antenna arrays have been frequently proposed in the literature, for example, the decoupling networks using reactive components [2] and hybrid couplers [3] and the defected ground structures (DGS) [4]. However, most of the designs in literature are for arrays with single operating frequency band. Along with the rapid development of wireless communications, dual-band and multi-band antennas are highly demanded. Improvement on dual-band isolation is achieved by using an array of printed capacitively loaded loops (CLLs) on the top side of the board and a complementary CLL structure on the ground plane [5]. However, this design is a bit complicated. Reference [6] describes a procedure to achieve simultaneous decoupling and matching at two frequencies using decoupling network with series and parallel combination of inductors and capacitors.

In this paper, a compact printed dual-band monopole array is proposed. The port isolation of the array is increased by utilizing a newly proposed defected ground structure. The proposed dual-band DGS consists two circular split ring slots, each of which corresponds to one resonant frequency of the array. The simulated results show that the port isolation between array elements has been obviously increased at the two operating frequencies.

II. DUAL-BAND DEFECTED GROUND STRUCTURE

Fig. 1(a) shows a double circular split ring slots etched on a ground plane. The larger split ring slot has an outer radius of R_1 and an inner radius of R_2, while the smaller one has an outer radius of R_3 and an inner radius of R_4. The two split ring slots resonant and create two stop bands, which can be observed from the characteristics of the microstrip filter model built in the EM simulator HFSS, as in Fig. 1(b). The FR4 substrate with dielectric constant of ε_r = 4.4 and thickness of 1.6 mm is used for all designs in this paper, while the 50 Ω microstrip line has a width of 3 mm. Fig. 2 shows the transmission coefficient, S_{12}, of the filter with variation of R_1. It can be seen that the lower stop band frequency decreases as the increase of R_1, while the upper stop band frequency remains stable.



(a) (b)

Fig. 1. (a) The DGS structure; (b) the microstip filter model in HFSS.

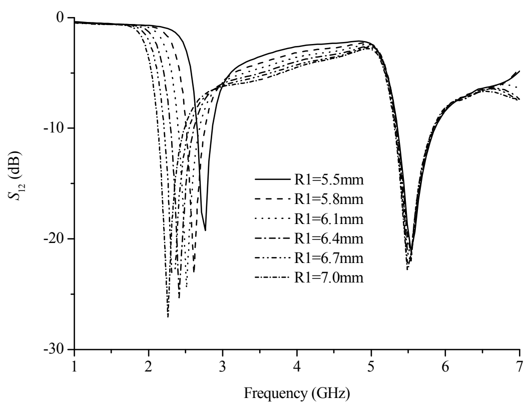


Fig. 2. The transmission coefficient of the filter with variation of R_1.

Similarly, the S_{12} of the filter with different R_3 are plotted in Fig. 3. It is obvious that as R_3 increases the upper stop band frequency decreases and the lower stop band frequency keeps unchanged. Accordingly, R_2 and R_4 have similar effects as R_1 and R_3, respectively. By properly tuning the dimensions of the DGS structure, the desired band rejection characteristic can be obtained. With R_1 = 6.1 mm, R_2 = 5.2 mm, R_3 = 3.2 mm, R_4 = 2.5 mm and W = 2 mm, two stop bands at 2.5 and 5.5 GHz can be achieved.

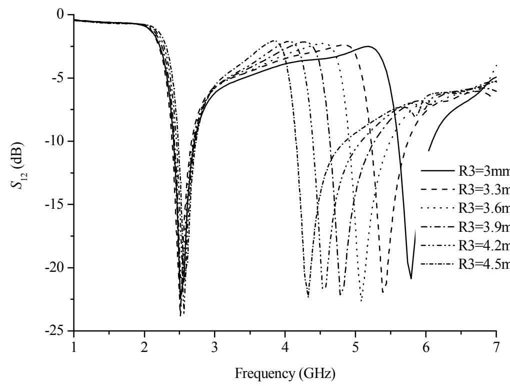


Fig. 3. The transmission coefficient of the filter with variation of R_3.

III. Printed Monopole Array With The Proposed DGS

To illustrate the effectiveness of the proposed DGS structure in increasing the port isolation of a compact antenna array, two printed 4-shaped dual-band monopole antennas operating at 2.5 and 5.5 GHz WLAN and WiMAX bands are designed, as shown in Fig. 4. The dimensions of the antennas are W_0 = 60 mm, L_0 = 50 mm, W_1 = 14 mm, L_1 = 24 mm, L_2 = 20.5 mm, L_3 = 4.5 mm, L_4 = 15 mm and H = 28 mm. As shown in Fig. 4, a double of the proposed DGS structure is etched on the extended L-shaped ground plane of the array for high port isolation.

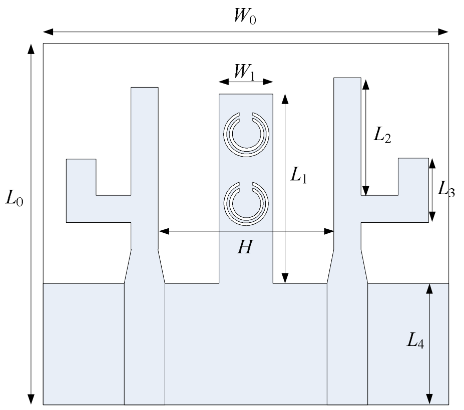


Fig. 4. The structure of the printed monopole array with DGS.

The S-parameters of the dual-band monopole array with and without the DGS are plotted in Fig. 5. Since the two antennas are symmetric, only the magnitudes of S_{11} and S_{12} are shown. It can be seen that the reflection coefficient of the monopole array with DGS etched in the ground plane remains below -20 dB at the two resonant frequencies of 2.5 and 5.5 GHz, while the coupling coefficient has been reduced from about -15 dB to -20 dB at 2.5 GHz and from -15 dB to about -40 dB at 5.5 GHz. The high port isolation of the monopole array makes it suitable for multiple antenna communications.

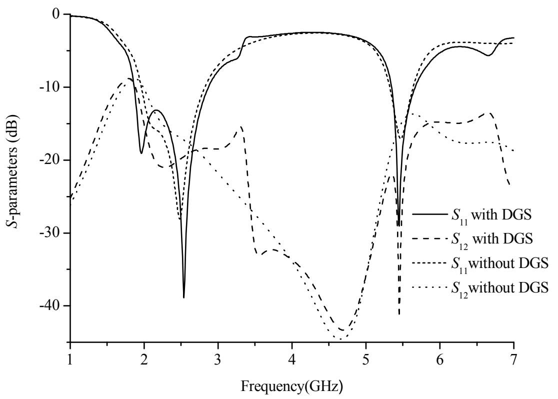


Fig. 5. The S-parameters of the monopole array with/without DGS.

IV. Conclusion

A printed dual-band monopole array with compact double circular split ring slot DGS has been described. The simulated results show that the mutual coupling effect between array elements has been obviously reduced. The resulted array has highly isolated ports and is suitable for applications in multiple antenna communications.

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