Mutual Coupling Reduction Using Dumbbell Defected Ground Structure for Multiband Microstrip Antenna Array

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Introduction

A novel design of multiband microstrip antenna array with dumbbell shape defected ground structure (DGS) is presented. The DGS is inserted into the ground plane between the two elements of the antenna array in order to suppress mutual coupling.

The proposed antenna configuration is shown Fig. 1. Fig. 1a shows the top view of the proposed antenna whereas Fig. 1b shows the exploded view of the proposed antenna design. The dashed line of the structures shown in Fig.1 indicates that the structure is located beneath the substrate; therefore it can not be seen directly from the front view. The dielectric material used has the thickness of 1.52 mm with dielectric permittivity (εr) of 2.2 and tangential loss (tanδ) of 0.0009.
Results and Discussion
Simulation and measurement results showed both antennas have multiband characteristics with three resonant frequencies at 2.3 GHz, 3.3 GHz and 5.8 GHz as shown in Fig. 2.

![Figure 2](image)

Fig. 4. Return Loss of proposed antenna

Both simulation and measured results verified that the DGS had improved the radiation properties of the antenna array. The measurement results show a mutual coupling reduction around 2 to 5 dB at the band 2.3 GHz. For the band 3.3 GHz, a mutual coupling reduction of 0.6 dB to 2.3 dB occurs. Meanwhile, for the band 5.8
GHz, the mutual coupling accomplished to be reduced to 2.9 dB. Therefore, the measured mutual coupling results show the DGS antenna can reduce the mutual coupling of around 0.6 dB to 5 dB for the three bands and the simulation result show the DGS antenna can reduce the mutual coupling of around 0.1 dB to 6.19 dB. These results show that there is a substantial mutual coupling reduction.

In addition, the antenna gain and radiation pattern of both antennas with and without DGS was also measured for all three bands. For the frequency band 2.3 GHz, there is a gain enhancement from the DGS antenna to 2.4 dB. As for frequency band 3.3 GHz and 5.8 GHz a gain enhancement to 2.4 dB and 3 dB is achieved, respectively.

**Conclusion**

Four dumbbell shape DGS unit have been implemented between two elements multiband microstrip antenna arrays. The antenna was simulated, designed and fabricated and shows that the DGS antenna can improve the mutual coupling reduction of the antenna without DGS. The simulation and measurement results showed a mutual coupling reduction to 6.19 dB and 5 dB is achieved, respectively.