

A Wideband Rotated Rectangular DRA With CPW Feed

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Abstract. A rectangular Dielectric Resonator Antenna with a co-planar waveguide fed inductive slot is proposed. A non-resonant inductive slot is used to couple energy from the CPW to the DRA. The rectangular DRA has been rotated by 45° to obtain two orthogonal modes. By selecting suitable dimensions of the DRA the two orthogonal modes has been brought close enough to yield wideband characteristic. The proposed antenna has been designed to operate in the IEEE 802.11a band.

Keywords: Dielectric Resonator Antenna, CPW feed, wideband antenna.

1. Introduction

The possibility of CPW as a potential feed mechanism for DRAs was studied by Kranenburg *et al.*[1]. In [2], a non-resonant CPW inductive slot fed DRA was investigated. This design would go on to the form the basis of hybrid antennas. In [3], planar feed topologies based on CPW feed were reported. A comparison of capacitive, inductive and square loop feed and their effects on impedance bandwidth and radiation pattern were examined. In [4], an inductive slot was used both as a radiator and a feed to the DRA. Parametric studies of the slot length, DR height and offset the antenna yielded a dual band characteristic which functioned independent of the other. A circularly polarized DRA using a single feed to excite two near degenerate modes with space-time quadrature is discussed in [5] by placing the antenna inclined at an angle of approximately 45° to the slot.

In this paper, a rectangular DRA for WLAN application is investigated. It consists of a CPW fed non-resonant inductive slot as the feed for the rectangular DRA. The DRA has been rotated by 45° along the z axis. The design allows two orthogonal modes to be excited which can be merged to obtain wide bandwidth. The proposed DR antennas are suitable for mounting on the system circuit board of mobile communication devices, and are suitable for application in wireless communication systems.

2. Antenna Design and Parametric Study

The proposed DRA consists of a rectangular DR placed on top of a centre fed CPW inductive slot printed on FR4 substrate of thickness $h = 1.59$ mm and relative permittivity $\epsilon_{\text{sub}} = 4.4$ having dimensions of $L \times W$ (58mm by 58mm) as shown in Fig. 1. The 50Ω CPW feed line is designed having a central conductor width of $S = 2.0$ mm and a slot width of $w = 0.25$ mm. The inductive slot has dimensions $s_l = 9.5$ mm and slot width of $s_w = 0.5$ mm. The rectangular DR has dimensions a , b and d as 25 mm, 25 mm and 5 mm respectively and a relative permittivity of $\epsilon_{\text{dr}} = 10$. The dimensions of the DRA are calculated using Marcanti's Dielectric Waveguide Model for a resonant frequency of 5.2 GHz. The length and width were kept fixed while the height was parametrically varied. A square base was preferred over a rectangular base to obtain nearly degenerate modes. The centre of the DRA is placed at the centre of the loop to maximize the energy being coupled to the DRA from the CPW loop. However, by offsetting the DRA from the loop centre by an amount O it is possible to obtain better impedance matching. Rigorous parametric studies were performed on the Euclidean design to obtain acceptable resonance characteristics. All simulations were performed using CST Microwave StudioTM.

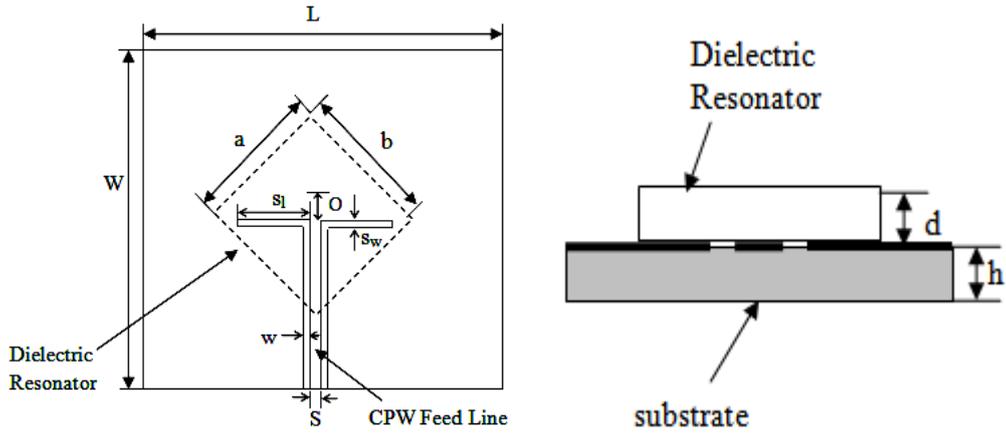


Fig. 1 Geometry of the rotated DRA

Figs. 2 to 4 show parametric variation of the DRA height, inductive slot width and the slot length. After completing the design of the inductive slot, parametric study of the offset distance between the centre of the loop antenna and centre of the DRA was studied to obtain better impedance match as shown in Fig. 5.

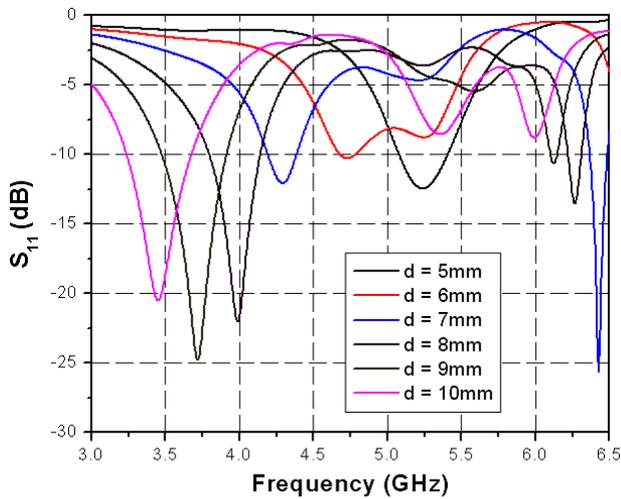


Fig. 2 Parametric Variation of DRA height

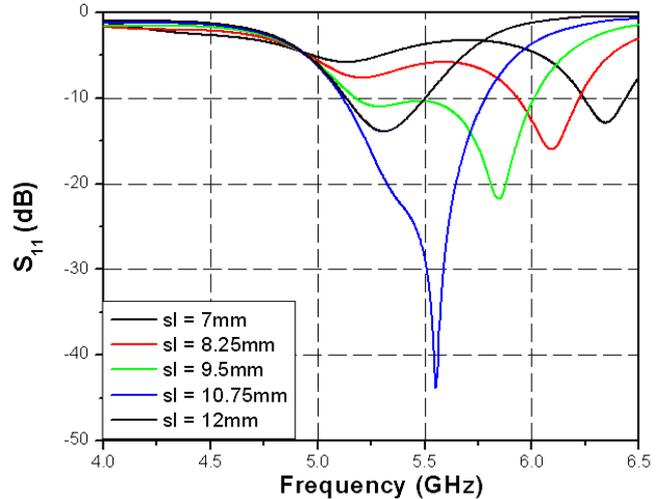


Fig. 3 Parametric Variation of inductive slot length

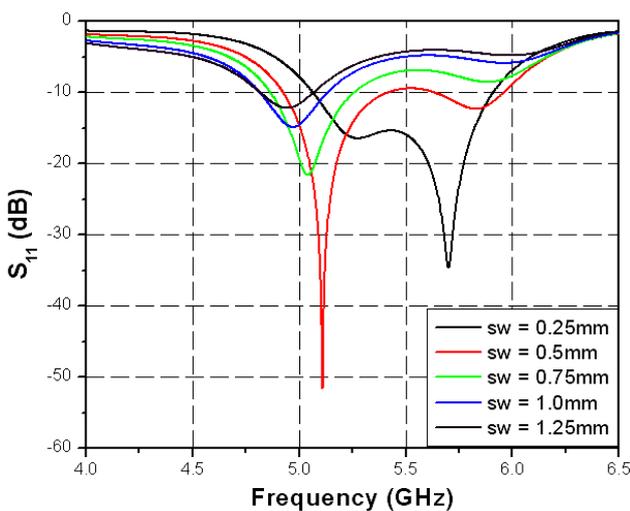


Fig. 4 Parametric Variation of inductive slot width

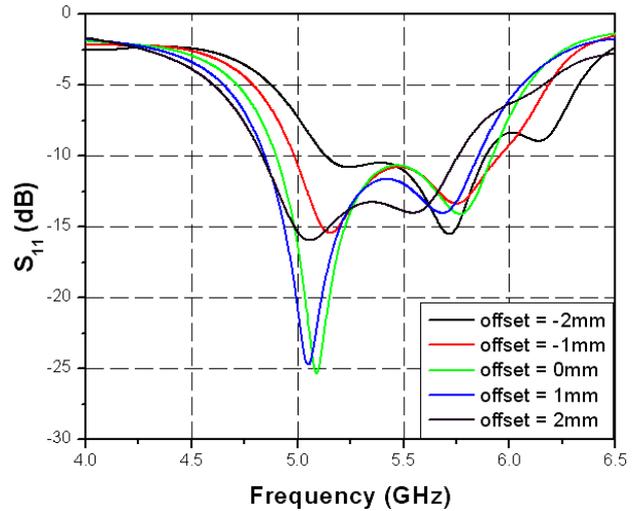


Fig. 5 Parametric Variation of offset distance

3. Results and Discussions

3.1 Resonance Characteristics

As depicted in Fig. 6, the rotated DRA exhibits dual resonance at 5.07 GHz and 5.77 GHz. It has a -10 dB impedance bandwidth of 1.0 GHz with a S_{11} of -24.71 dB at the resonant frequency. Rotation of the DRA results in the generation of two orthogonal modes which result in wideband characteristic.

3.2 Radiation Characteristics

The radiation pattern was simulated at frequencies of 5.05 GHz and 5.68 GHz. Fig. 7 shows the far-field radiation pattern polar plots. The DRA exhibits a gain of 5.61 dB in both x-z and y-z plane respectively at 5.05 GHz and 5.9 dB and 5.5 dB in the x-z and y-z plane at 5.68 GHz. The antenna radiates with a broadside pattern as expected and its gain at both the frequency bands are within acceptable limits for wireless communication.

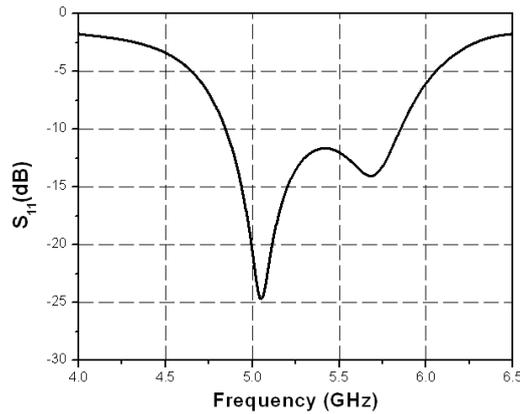


Fig. 6 S_{11} plot of the proposed antenna

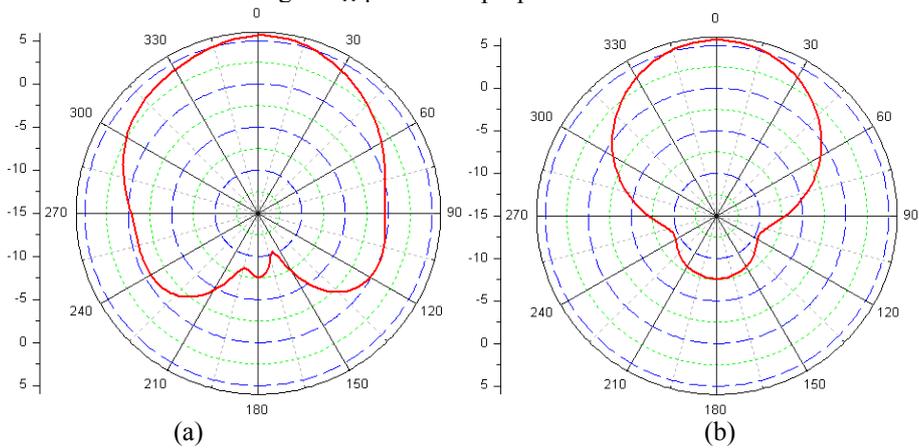


Fig. 7 Gain of the antenna at 5.05 GHz in the (a) x-z plane (b) y-z plane

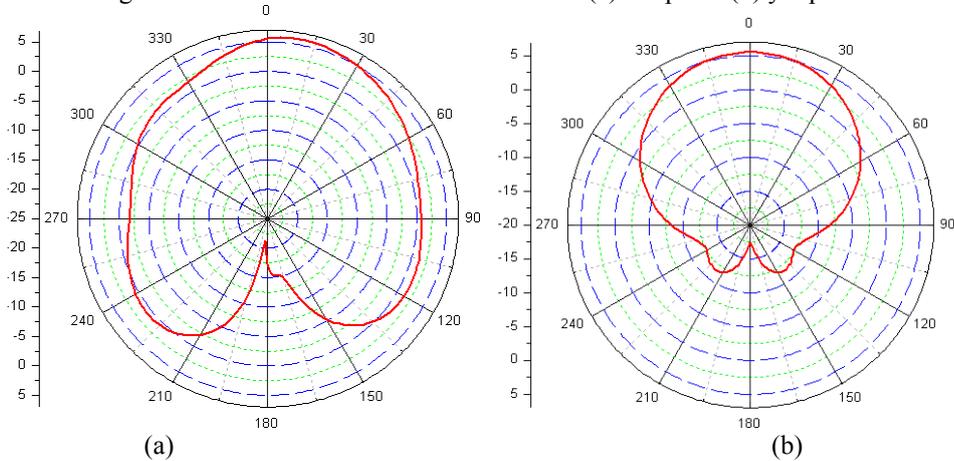


Fig. 8 Gain of the antenna at 5.68 GHz in the (a) x-z plane (b) y-z plane

4. Conclusions

In this paper a rectangular DRA for WLAN application is investigated. The DRA has been rotated by 45° to generate orthogonal modes to achieve wide impedance bandwidth. Parametric studies have been undertaken to design the inductive slot and also to maximize the coupling between the slot and DRA. The antenna has a -10 dB bandwidth of 4.85 – 5.85 GHz (14.3%) with a gain of 5.46 dBi. Thus it may eventually be concluded that the proposed antenna can be used for IEEE 802.11 a/b applications.

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5. References

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