A Compact CPW Fed Dielectric Resonator Antenna for WLAN Applications

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***Abstract*— A new rectangular dielectric resonator antenna (DRA) design with CPW feeding is presented for wireless local area network (WLAN) applications. In this proposed antenna, Coplanar Waveguide (CPW) inductive slot feeding is used as an effective radiator as well as the feeding structure for the DR. The result shows that the proposed antenna achieves an impedance bandwidth from 5.45 GHz to 6.22 GHz covering 5.8 GHz WLAN band. Parametric studies of the antenna carried out by varying the length of the horizontal slot and simulated results for 5.8 GHz WLAN application are presented here.**

Keywords- Dielectric Resonator Antenna (DRA), CPW feed, WLAN.

I. INTRODUCTION

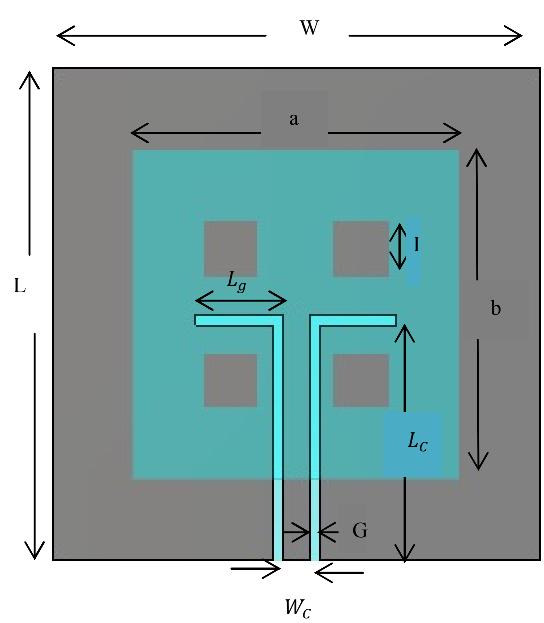
Dielectric Resonator Antennas (DRA) possesses some peculiar properties which are making them very attractive, especially for millimeter wave applications [1]. Due to the flexibility in DRAs, they can be designed with different shapes as per our requirements depending upon the applications in the wireless world [2-3]. DRAs can also be excited with different feeding methods, such as probes, microstrip lines, slots, and co-planar lines [4-5]. The DRAs are good replacement for the Microstrip antenna, because the DRA has much wider impedance bandwidth due to their many advantageous features. These include their compact size, light weight, the versatility in their shape and feeding mechanism, simple structure, easy fabrication and wide impedance bandwidth.

Among the different shapes DRA, the rectangular shaped DRA offers greater design flexibility, where the slots length controls the resonant frequency [5-7]. Various modes can be easily excited within the rectangular DRA, which results in either broadside or Omni-directional radiation pattern.

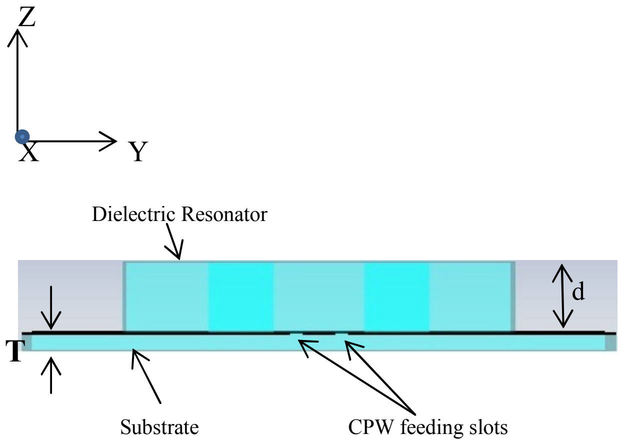
In this paper, a new rectangular shape DRA designed for narrowband WLAN applications by removing the four square shaped identical portions from the dielectric resonator of the DRA. As a result of which a new type of rectangular DRA is obtained. The DRA is excited by using CPW feeding. The coplanar waveguide (CPW) inductive slot simultaneously acts as an effective radiator as well as the feeding structure of the DR. The major advantages of CPW feeding provide the lower radiation leakage and less dispersion than microstrip lines. With these features, this design of rectangular DRA is suitable for wireless communication systems and especially for WLAN applications at 5.8 GHz frequency.

II. ANTENNA DESIGN

The proposed narrowband rectangular DRA structure is shown in Fig. 1. This antenna consists of a rectangular DR with a center-fed CPW inductive slot which is etched on a Teflon substrate (ε_s = 2.1, T = 1.25mm), with L and W denote the length and the width of the substrate, respectively.
DR is placed above the inductive slot with an offset L_c from the slot to the lower edge of the DR. The 50Ω CPW line is designed with the center metal strip width W_c = 2.5 mm and a gap width = 1.0 mm. The resonator material used is RT/duroid 6010LM laminate has a dielectric constant of 10.2. The rectangular DR has dimensions a, b and d with dielectric constant ε_{dr} = 10.2 and the four square shaped identical holes on the DR have dimension I. The center-fed CPW inductive slot has two arms of equal length L_g. The slot resonates at approximately one guided wave length $\lambda_g \approx 2L_g+W_c$ where λ_g is the guided wavelength of the slot. On the other hand, the optimal slot length for DR excitation is dependent on the resonant frequency of DR, thus the slot length should be optimized so as to achieve narrowband resonant for WLAN applications.



(a)



(b)

Fig. 1 (a) Top View and **(b)** Front view of the proposed antenna structure

III. RESULTS AND DISCUSSION

As discussed in the previous section, that a narrow band can be achieved by modifying the basic shape of the dielectric resonators. So the first design step was to modify the shape of rectangular DRA. A parametric study has been performed to investigate the characteristics of the proposed antenna to achieve optimal performance. The antenna parameters are $a = b = 30mm$, $d = 5mm$, $\varepsilon_{dr} = 10.2$, $L = W = 45mm$, $L_C = 21.5mm$, $L_g = 10.15mm$ and $I = 5.0mm$. The simulated resonant frequency of proposed DRA is approximately 5.8 GHz. For the case $L_g = 10.15mm$, a narrow bandwidth with less $\mathbf{S_{11}}$ $(-34.5dB)$ has been observed.

A. Parametric Results

The simulated S parameter of the rectangular DRA plotted against frequency is shown in Fig. 2. By varying the slot length L_g , we can easily change the resonant frequencies. The proposed antenna achieves an impedance bandwidth from 5.45 GHz to 6.22 GHz covering 5.8 GHz WLAN band for L_g=10.15mm. Based on the information gathered from the parametric study, a prototype antenna for 5.8GHz 802.11a WLAN applications is designed.

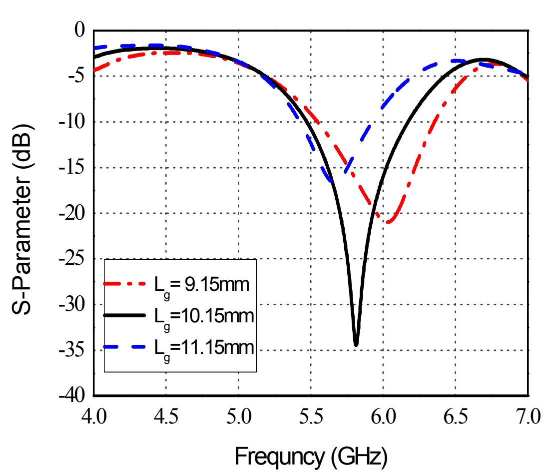


Fig. 2 Simulated S-parameter of the Rectangular DRA versus Frequency

B. Gain and Directivity

The Peak Gain of antenna is 7.27 dBi at 5.8 GHz. It is observed from Fig. 3 that the simulated peak directivity is 7.82 dBi at 5.8 GHz frequency range. The Gain curve follows the directivity curve over the entire frequency range which has been observed from 5.5 GHz to 6.2 GHz range.

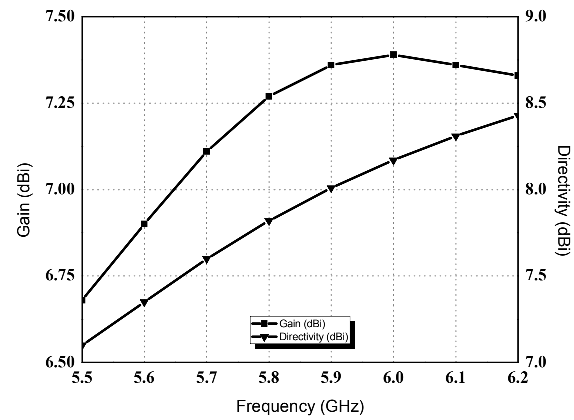
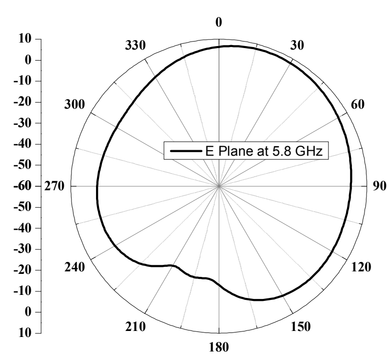


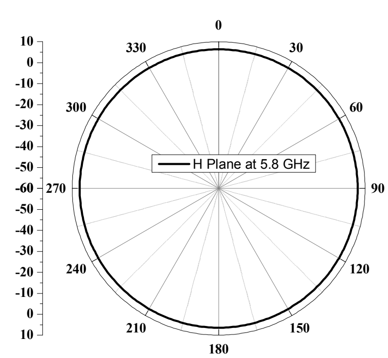
Fig. 3 Simulated Gain and Directivity of the Rectangular DRA versus Frequency

C. Radiation Pattern Characteristics

The simulated far field radiation patterns of E-Plane and H-Plane of the proposed rectangular shaped DRA are shown in Fig. 4. The simulated radiation patterns at resonant frequency (5.8GHz) show that the E-Plane radiation pattern is in broadside direction against frequency and H-Plane in Omni-directional.



(a)



(b)

Fig. 4 Simulated radiation patterns of proposed DRA at 5.8 GHz **(a)** E-Plane and **(b)** H-Plane

However, in the proposed configuration, DR works as a dielectric loading at the resonant frequency of the inductive slot.

IV. CONCLUSION

A new rectangular dielectric resonator antenna is realized by drilling off four square shaped identical slices on the DR. The resonance of a CPW inductive feeding slot is merged with that of a rectangular DR so as to achieve desired band for WLAN operation. The simulated results show that the designed antenna offered desired resonant frequency at 5.8 GHz, which covers the WLAN applications band. This antenna provides maximum Gain of 7.4 dBi. The proposed compact rectangular DRA design is overall suitable for wireless local area networks (WLAN). Fabrication of the proposed antenna will be carried out in future.

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