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Design of Stack Rectangular Dielectric Resonator Antenna for Wireless Application

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***Abstract**:*
This paper presents a stack rectangular dielectric resonator antenna for wireless local area network communication systems. The commercial 3D full wave electromagnetic simulation software CST microwave studio is used for this design optimization. The proposed antenna has a small size and low permittivity constant of 2.2 and 2.1 respectively. An impedance bandwidth about 33% from (3.5 to 5 GHz) was achieved making this antenna suitable for wireless application.

Key words: *Rectangular Dielectric Resonator Antenna (DRA), CST Microwave Studio*

1. Introduction

Dielectric Resonator Antenna (DRA) is a radio antenna mostly used at microwave frequencies and higher. DRA has increase interest because of their attractive features such as small size, high radiation efficiency (98%), considerable bandwidth, light weight and low profile [1]. One approach to enhancing bandwidth using multiple DRAs is to stack individual DRAs [2]. It consist of a rectangular DRA of low permittivity choose and each DRA is selected to response the same mode at a different frequency, such that the combined response increases the overall bandwidth [3].This technique also using parasitic DR elements [4], and utilizing special DR geometries [5]. In this paper a rectangular stack DRA is proposed using a simple DRA topology and the antenna is fed by a microstrip line [6].

2. Design Approach

First in an effort to verify the validity of CST microwave studio [7] simulator to simulate the kind of structures we have studied the DRA. Fig 4 shows the return loss results obtain for the antenna using CST and those obtained by measurement. It is seen that good result is obtained providing the efficiency and validity of CST to model DRAs.

The next is to optimize this antenna to have WLAN performances and well stacked. This has been achieved through a rectangular dielectric antenna printed on widely used Rogers Ultralam 3850 with dimensions 30 x 51 mm and 1.6 mm thickness with dielectric constant of 2.9 as shown in Figure 1. The dimension of the first DRA is 15 x 30.5 mm and 4 mm thickness with dielectric constant of 2.2 and the dimensions of the ground is 30 x 13.5 mm. The dimensions of the microstrip line is W = 1.525 mm and L = 24 mm. A stack of DRA is placed over the first DRA with the dimensions of 10 x 18 mm and thickness is 12.05 mm with the dielectric constant of 2.1 as shown in Figure 2.

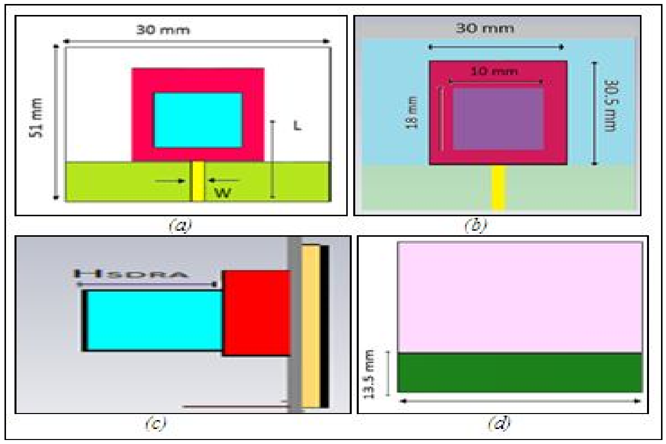


Figure 1: The structure of the DRA under consideration
(a) Front view, (b) Stack DRA configuration, (c) Side view, (d) Ground plane configuration

3. Parametric Study

Every geometrical parameter has different effect on the overall performance of proposed antenna. In the following section the effects of two parameter of the proposed antenna shown in Figure 2 will investigate by following namely (i) Length feed line effect and (ii) stacked DRA effect.

3.1. Length Feed line Effect

The size and position of the feed line are varied in order to improve matching and control resonance frequency. Microstrip line of varying is used to excite the rectangular DR. The variation of return loss as a function of frequency is observed for different position of DRA along the feed line. From this study we find that the bandwidth is 25% spanning the frequency band from 3.2 to 5.1 GHz.

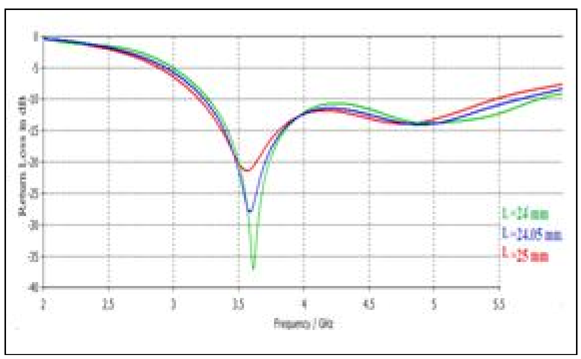


Figure 2: The effect of varying feed line length L

3.2. Stacked DRA Effect

To increase the bandwidth; a rectangular stack DRA is placed upon the first DRA. After several optimization tests, we found that the stack DRA length and width have to verify the following relationship in order to get a larger bandwidth. We have also investigated the stack DRA height effect. In figure 3, the return loss of the antenna is plotted considering a rectangular stack DRA for different values of its height.

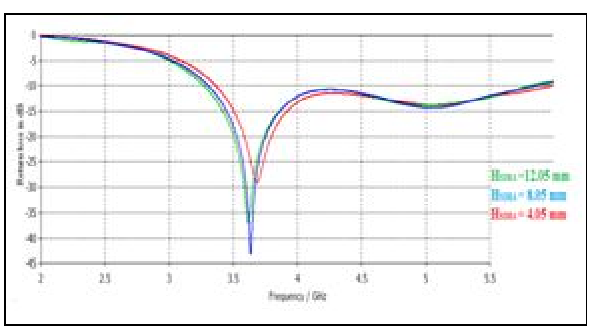


Figure 3: The effect of HSDRA

3.3. Optimal Structure

According to the above analysis; optimize result found that the stacking of DRA is the most important parameter allowing to increase the bandwidth of the proposed antenna. The optimum DRA parameters values cn be obtained by simulations are, $\in r$ = 2.9 for substrate, $\in r = 2.2$ for first DRA and $\in r =$ 2.1 for stacked DRA.

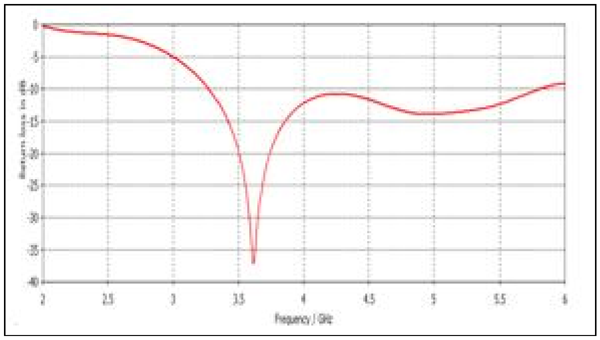


Figure 4: Return loss with optimum parameters

In Figure 4 the return loss with optimum antenna parameters is depicted with CST microwave studio verses frequency. The CST simulations result shows that the relative bandwidth achieved with optimum parameter is about 33% ranging from 3.5 to 5 GHz.

VSWR shows that how well the antenna impedance is matched to the transmission line it is connect to. The lesser is the VSWR better is the antenna matched and more is the power delivered to the antenna. VSWR is to be measured between 1 and 2 for efficient transmission as marked in the graph.

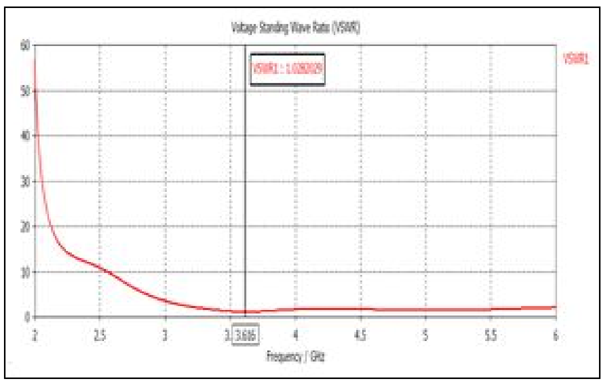
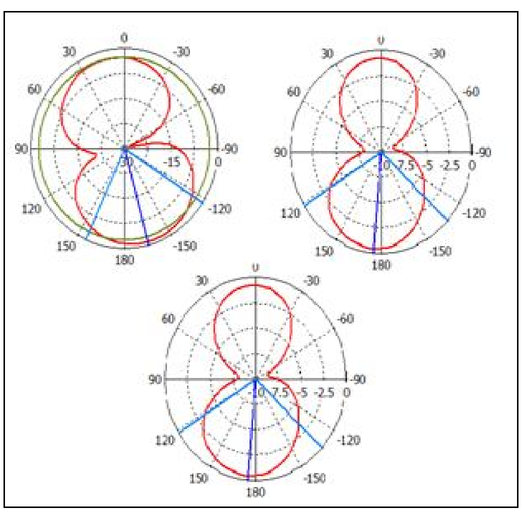


Figure 5: VSWR of the proposed antenna

Figure 6 and 7 illustrate the measured radiation pattern of the proposed antenna at 3.616 GHz, 4.23 GHz and 5.13 GHz.



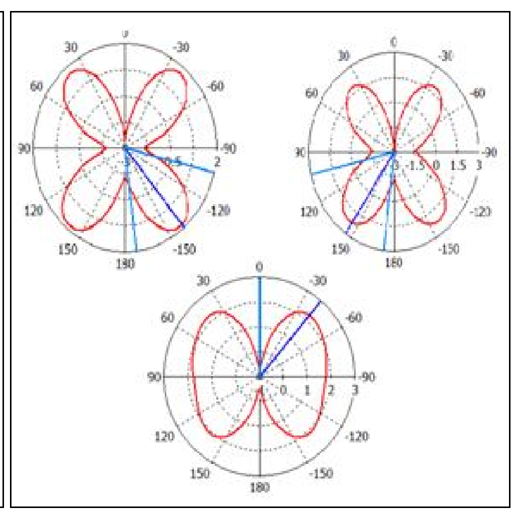


Figure 6: E-plane radiation pattern at 3.616, 4.23, 5.13 GHz

Figure 7: H-plane radiation pattern at 3.616, 4.23. 5.13 GHz

4. Conclusion

In this paper a rectangular DRA has been developed for WLAN communication. The introduction of the rectangular stack DRA allows achieving 33% bandwidth (from 3.5 to 5 GHz). The proposed antenna has a simple configuration and it also satisfies the -10 dB return loss requirement from 3.5 to 5 GHz which makes suitable for WLAN applications.

5. References

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