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Stepped Rectangular Dielectric Resonating ANENNA for 5.0 Ghz Wireless LAN Applications

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***Abstract*— This paper presents an approach which combines the two Dielectric Resonating Antennas together as if one resonator is loading the other one. A stepped DRA is presented here which produces enhanced bandwidth in micro and millimeter region of spectrum. A new design of compact and stacked DRA is presented which gives a bandwidth of 34% and a return loss of -39 db .This design uses two materials one is Rogers RT 5880 as a thin dielectric having a ε_r = 2.2 and the other one is Rogers TMM10 having a ε_r =9.2. The software used for the simulation is the CST Microwave Studio which is an analytical tool that provides an accurate 3D EM simulation results for high frequency design.**

Keywords*— Microstrip Antenna, VSWR, DRA, Stacked, Broadband.

I. INTRODUCTION

MODERN communication systems require wide bandwidth to support the demand of high data rate transfer for various multimedia applications. To fulfil this requirement, most wireless mobile systems have to be operated at the millimetre wave frequencies [1]-[2]. For ease of space allocation, it is highly desirable to have small size, low profile equipment. Hence, the antennas for modern wireless communication system should be low in profile and efficient in high frequencies. Dielectric resonator antennas (DRAs) have attracted broad attentions in various applications due to their attractive features in terms of high radiation efficiency, light weight, small size and low profile [3]-[6]. Dielectric resonator (DR) antennas are attractive due to their advantages of low loss and high efficiency and research to broaden its bandwidth is being conducted. Over last decades, various bandwidth enhancement techniques have been developed for DRAs. An overview on these techniques has also reported in [6], where these techniques were classified into three broad categories: Lowering the inherent Q -factor of the resonator; using external matching networks; and combine multiple dielectric resonators

Dielectric resonator antennas (DRA) have been the interest of research and investigation due to its highly desirable characteristics such as small size, light weight, highly efficient in microwave and mm wave spectrum. The most popular shape studied for practical antennas applications have been the cylindrical dielectric resonator antennas, rectangular dielectric resonator antennas, spherical dielectric resonator antennas and many more different structure are reported. The stacked DRA has also been tested [7]-[12] with a resulting increase in bandwidth that is much wider than the bandwidth of the micro strip antennas. Two or multi- resonators are defined as those having different sizes with the same or different dielectric materials, they may be loaded or separated from each other. The excited modes in the resonators may be the same or not. For the same modes, the corresponding radiation performances have a good agreement. For the different modes, similar patterns can also be obtained after choosing suitable parameters.With the above approach, an earlier design is a pair of slot coupled-DRAs [13]. The proposed structure consists of two rectangular dielectric resonators that are displaced near the two edges of a single slot on a ground plane. Since the two DRAs have the same shape and material but the different sizes, it may be possible to get the same resonance modes but with the different resonance frequencies. The advantage of this approach is that each resonator can be tuned more or less-independently, allowing for a great deal of design flexibility, this reduces the complexity in a trial design. The disadvantage lies in the added real-state required, which increases the size of antenna and may preclude some of these configurations from being used in an array environment.

There is also one alternative approach proposed for the combination of two dielectric resonators together as if one resonator is loading the other one. For example, a dielectric resonator is stacked on the top of the other [14]-[18], or a smaller size dielectric resonator is inserted into another lager size dielectric resonator [19], [20] In this approach, the combined two dielectric resonators can usually operate at the same modes or at the different modes.

II. ANTENNA GEOMETRY AND DESIGN

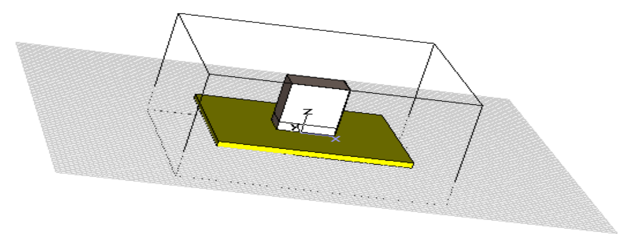

Fig.1 Geometry of the antenna (W=40mm, L=40mm, h=15.2)

Geometry of the proposed antenna is illustrated in Fig.1. As shown initially, the dimensions of the slot are 40x40x14.8 mm^3. Dielectric resonating antenna is simulated both at CST and HFSS software. DRA which was simulated on CST has the following specifications:-

1) It is a stacked DRA which is made up of two dielectric materials
   First is Rogers 5880 with dielectric constant of 2.Second is Rogers TMM 10 with dielectric constant of 9.8
2) Dimensions of Ground are Width = 40mm, length= 40 mm, and height =1.6 m
1) Dimensions of Ground are Width = 12mm, length= 8 mm, and height =2.4 mm
2) Dimensions of Ground are Width = 12 mm ,length= 8 mm, and height =12 mm

Fig. 2 shows the surface current distribution of the proposed antenna for center frequency of 5.818 GHz.

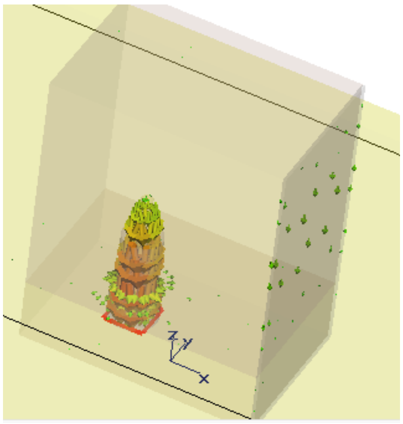

Fig 2 Surface current distribution of simulated antenna.

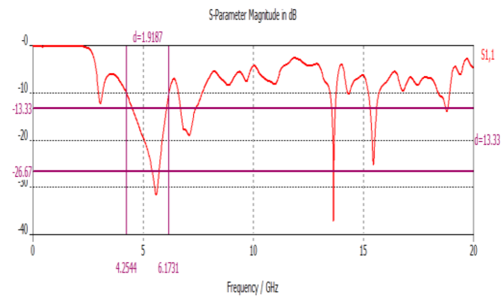

Fig 3 S11 parameters /Return loss of the Dielectric Resonating antenna

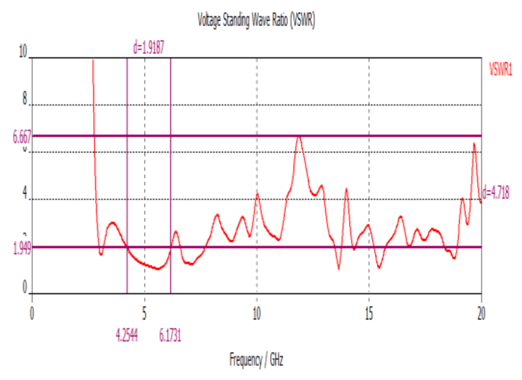

Fig 4. VSWR v/s FREQUENCY curve.

As shown in Fig. 3 and 4, the antenna shows S11 and VSWR curve

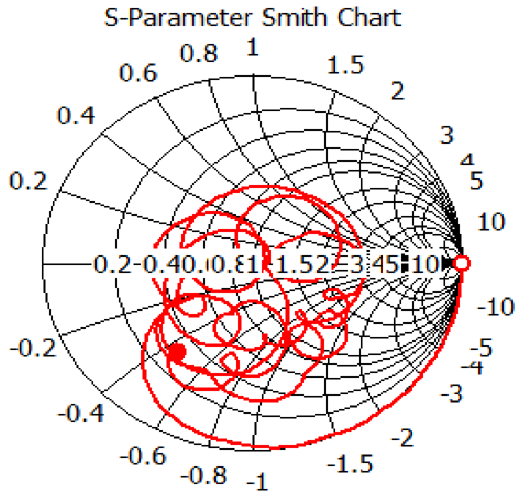

Fig 5 Smith Chart

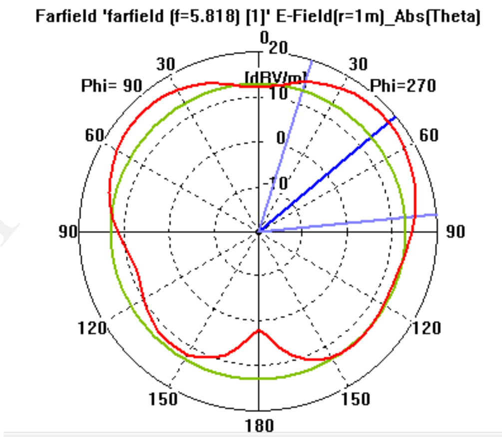

Fig 6 Electric field

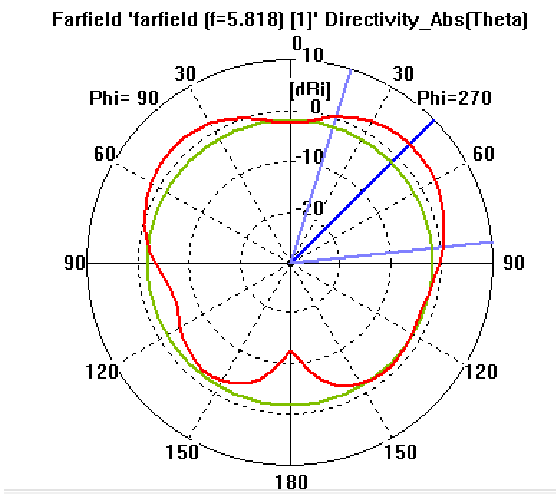

Fig 7 Directivity

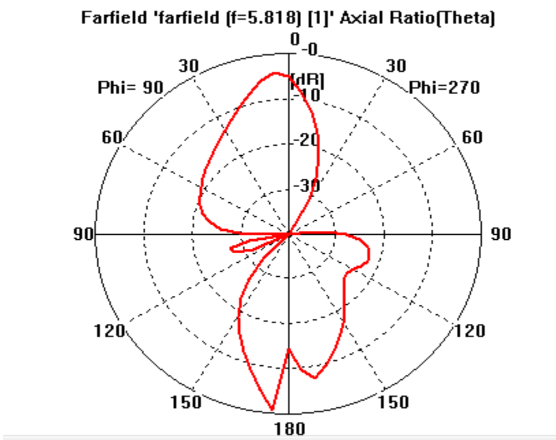

Fig 8 Axial Ratio

Fig. 5, 6, and 7 shows the electrical characteristics of the antenna .fig. 8 shows the axial ratio which indicates the polarization of the antenna.

III. RESULTS AND DISCUSSION

Proposed antenna is simulated by taking ε_r=2.2 and 9.2.Antenna is resonating for frequency ranging from 4.2544-6.1731 GHz. By taking S11≤- 10 db and VSWR= 2:1 the bandwidth calculated for every resonating frequency comes out to be ≥ 34%. Another frequency range obtained from 13.452-13.806 using the same parameters Simulated DRA is showing 34%bandwidth at a range of 4.19 GHz to 6.13 GHz, which is a very useful band in hand phone, and Bluetooth applications.

IV. CONCLUSION

DRA is the device which provides high gain, better return losses more bandwidth, polarization agility as compare to the microstrip patch antenna. MSA is regarded as one of the narrow impedance device until and unless some active device is not attached with that, but by using DRA better frequency range can be obtained .In this design the obtained frequency is 5.1 GHz and the bandwidth obtained is 34%which is quite good as compare to MSA.

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