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MULTIBAND DIELECTRIC RESONATOR ANTENNA FOR WIRELESS HOME ENVIRONMENT

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Abstract: A multiband cylindrical dielectric resonator antenna (CDRA) is proposed to access WLAN, WiMAX and Bluetooth application. The dielectric resonator antenna is fed by T-shaped microstrip line. The dielectric resonator with a dielectric constant of 12 is used and embedded with FR4 epoxy with relative permittivity 4.4. The partial ground plane produces wide impedance bandwidth and high efficiency on operating bands. The proposed antenna has three resonating bands of 1.44-2.66 GHz, 2.92-3.92GHz, 4.45-5.36GHz and corresponding impedance bandwidth is 59%,29% and 18% for WLAN, WiMAX and Bluetooth applications.

Keyword: -Cylindrical dielectric resonator antenna, multiband omnidirectional radiation, partial ground.

I INTRODUCTION

Wireless LAN (WLAN) has attracted a great deal of attention as a technology that enables short-range wireless communications between wide varieties of devices such mobile phones, and notebooks. The dielectric resonator antenna (DRA) is a resonant antenna, fabricated from low-loss dielectric material the resonant frequency of which is predominantly a function of size, shape and material permittivity. DRAs offer the advantages of small size, lightweight, low profile, low cost, and high radiation efficiency, making them attractive candidates for WLAN applications. DRAs frequently are available in rectangular, cylindrical and hemispherical geometries. Rectangular DRAs offer more design flexibility since two or three of its dimensions can be varied independently for a fixed resonant frequency and known dielectric constant of the material. DRA was first proposed in the early 1980's. After then various investigation offer significant enhancements to parameters such as bandwidth, gain, polarization, or power coupling. Over last decades, various bandwidth enhancement techniques have been developed for DRAs. An overview on these techniques has also reported, where these techniques were classified into three broad categories: Lowering the inherent Q-factor of the resonator; using external matching networks; and combined multiple dielectric resonators.

In this paper, we present multiband cylindrical dielectric resonator antenna. Modified microstrip line feed along with vertical strip act as a both magnetic and electric dipole (horizontally and vertically oriented) is used to stimulate two modes $HE_{11\delta}$ and $HE_{21\delta}$ modes. The proposed CDRA is operating in three frequency bands 1.44-2.66GHz, 2.92-3.92GHz and 4.45-5.36GHz.

II ANTENNA DESIGN AND CONFIGURATION

Geometry of proposed antenna structure is shown in Fig. 1. 3D view and feeding structure of antenna structure is shown in Fig. 1(a) and Fig. 1(b) respectively. The antenna consists of low-cost FR4 epoxy substrate (ε_r = 4.4, tan δ = 0.02) of thickness 1.6 mm. The dielectric with relative permittivity (ε_r)12 is embedded with FR4 epoxy substrate. Resonant frequency of CDRA is determined by using following equation

$$f = \frac{X_c}{(2\pi f\sqrt{\epsilon_{re}})} \qquad \text{………………} (1)$$

The electromagnetic solver HFSS is used to perform the modeling, simulation, and optimization of the designed antenna. Dimensions of proposed antenna design is given in Table-I.

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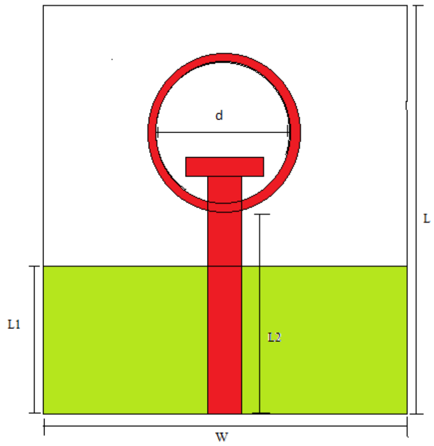

Fig 1a. feeding layout

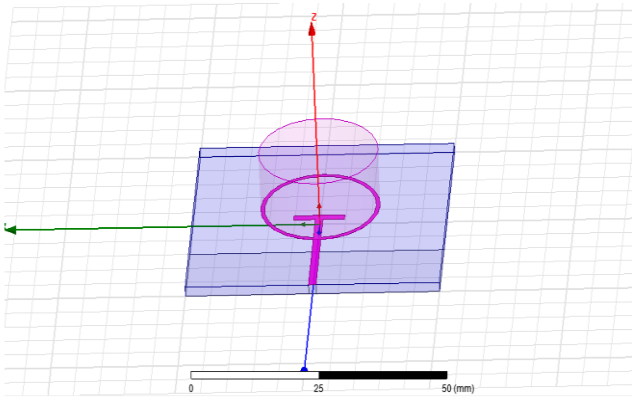

Fig 1b.3D view

S. No	Design Parameters	Dimensions	Material Used
1	Substrate	L x W x H 50x50x1.6mm	FR4 epoxy (ε_r=4.4)
2	Ground plane	L1 x W1 50x15.4mm	Copper
3	Cylindrical DRA	D=23.5mm Height(h1) =10mm	TCI ceramic (ε_r=12)
4	Outer ring path	d=23.5 b=22mm T=1.5mm	Copper
5	T-shaped microstrip line	L2=25mm	Copper

Table 1. Dimension of different parameters

III ANTENNA ANALYSIS

Parametric analysis of proposed antenna has been done on HFSS Electromagnetic solver. Fig. 2 shows the variation in return loss with frequency as the height of the CDRA (H) varies. It can be observed from Fig. 2 that as the height of the CDRA varies; Fig. 3 shows the variation in return loss with frequency as the length of the ground plane varies. It can be observed from Fig. 3 that as the length of the ground plane varies. Fig. 4 shows near field distribution within CDRA at 3.48 GHz and 5.43 GHz. Fig. 5 depicts that HE11and HE21mode are generated in CDRA at 3.48 GHz and 5.43 GHz respectively [9]. Fig .6 shows current distribution on feed line at 2.5 GHz and 5.0 GHz, which shows resonance at 2.5 GHz and 5.0 GHz is generated due to ring shape patch which is already verified from eqn. (6).) while the resonant peak of HE21 mode vanishes. Therefore, it can be said that annular shape microstrip line is responsible to cause HE21 mode in CDRA.

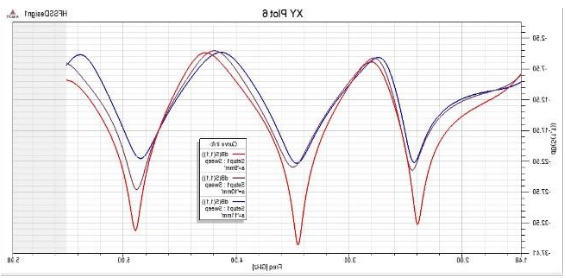

Fig 2. Return loss vs frequency curve Varies height of CDRA

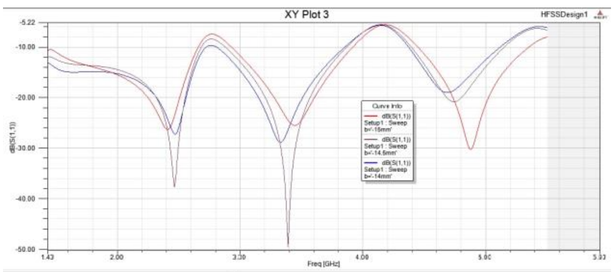

Fig 3. Return loss vs frequency curve varies length of ground plane

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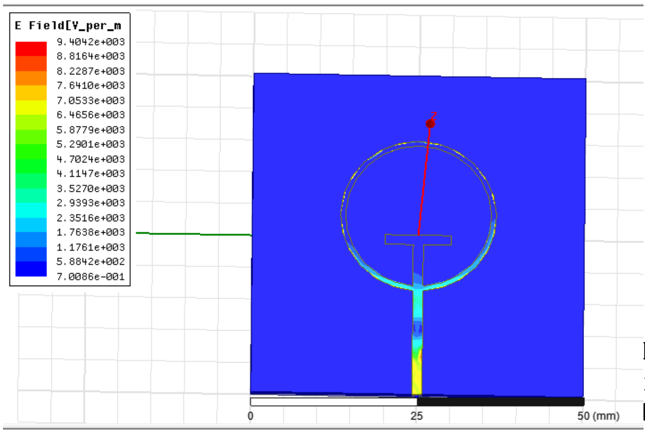

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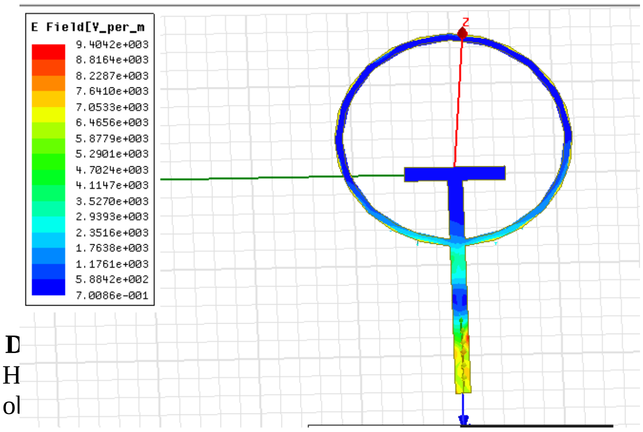

bands 2.4, 3.4 and 4.9 GHz with |S11| less than -10 dB, which are the candidate's bands for wireless communications systems. Another imperative parameter beside the reflection coefficient and input impedance, that reflects the antenna performance, is the VSWR (Voltage Standing Wave Ratio) (the antenna only can be able to operate at frequencies where the values of VSWR are inferior to 2). From fig 7, we can notice that the VSWR's value for the three bands of interest is less than 2, which reveals that there's a good adaptation between the feeding system and the proposed antenna. Additionally, good agreement has been achieved between results obtained by using HFSS. Simulated radiation efficiency and gain characteristics of the proposed antenna for the frequencies shown in Fig. 7. As it can be seen, the antenna's radiation pattern is almost stable and total efficiency 90.47%. Furthermore, as can be seen, a quasi-stable radiation pattern in terms of gain with a value of 6 dBi.

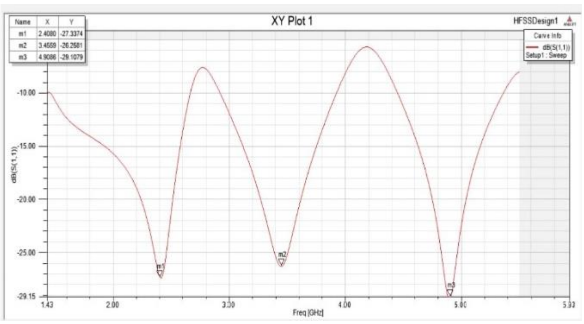

Fig.6 Return loss

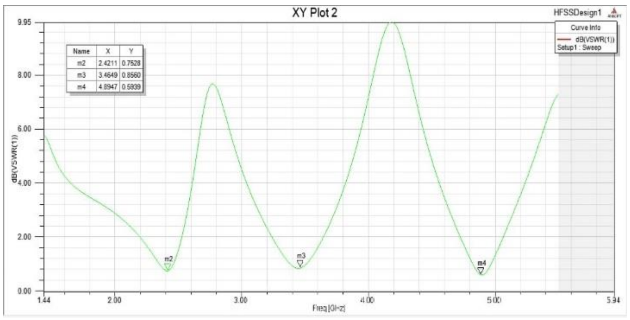

Fig 7. VSWR

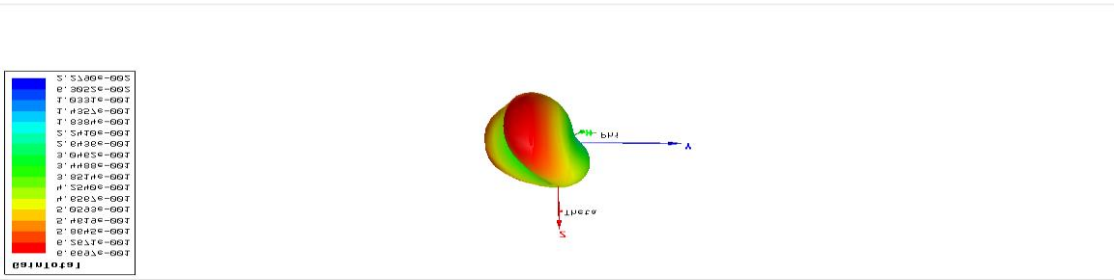

Fig 8. Gain

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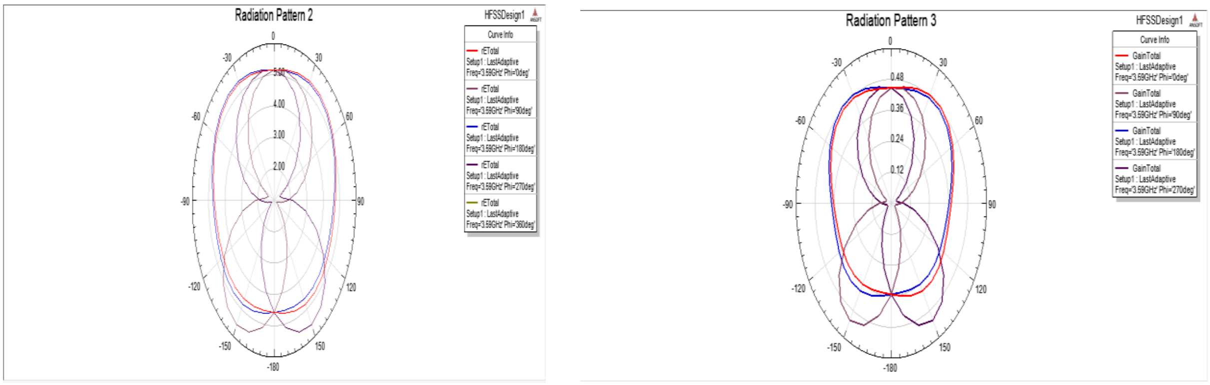

Fig 9. Radiation pattern on gain

CONCLUSION

In this paper a compact multiband cylindrical dielectric resonator antenna with a wide working band is presented. The proposed antenna is fed by modified feeding structure which has a conformal strip line and the partial ground plane. The antenna can operate at three frequency bands (1.44-2.66GHz, 2.92-3.92GHz, 4.45-5.36GHz) due to two modes HE_{11s} and HE_{21s} at a lower frequency. The proposed CDRA exhibits an omnidirectional radiation pattern at 3 operating frequency bands and relatively good gain and high total efficiency are obtained. In future we are going to fabricate CDRA antenna. To test and analyze CDRA antenna by using signal generator network analyzer.

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