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A Metallic WBAN Dielectric Resonator Antenna for ISM Band Applications

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Abstract*: *A compact cylindrical dielectric resonator antenna (CDRA) for Industrial, Scientific and Medical (ISM) applications is proposed in this article. The simple microstrip feeding system can be used to stimulate a certain CDRA. An implemented dielectric resonator delivers the functionalities for an efficient radiator with the feeding specifications. The permitted band can be accumulated by varying the design specifications. The standardized design comprises the resonator to attain frequency of 2.4 GHz. The ISM band is used in wireless body area networks (WBAN) technology for transmission of real time traffic such as video and information to monitor the health conditions. A U-shaped metal strip is located over the dielectric resonator material in order to miniaturize the size and enhance the resonator appearance. The consequences on antenna appearance for various radio wire specifications are explored. The intended model has competitive prices, lower volumes, and adequate containment. The evaluation of antenna illustrates the optimal bandwidth, coefficient of reflection (< -10 dB) as well as substantial gain across the specified bands. Coefficients of reflection, voltage standing wave ratio (VSWR) and radiation structure were discovered in each scenario. Architecture content and simulated results of Ansoft's HFSS are demonstrated. For ISM band implementations, the constructed antenna is sensible.

Index Terms*: *Dielectric resonator antenna, WBAN, ISM band, Microstrip feed line.

I. INTRODUCTION

Dielectric resonator antennas (DRAs) have a few favorable circumstances, for example, wideband execution, conservative size and high power abilities, high permittivity, light weight and simplicity of excitation. Moreover, the perceived features of DRAs are large network capacity, minimal absorption loss at high frequency, as well as high levels of radiation sustainability in view of the nonappearance of ground waves and conductors misfortunes. In recent decades, several research teams have revealed empirical and innovative research on cylindrical and hemispheric DRAs [1]. It needs sufficient understanding of the resonator-circuit attachment to use resonators in the sustaining element. A most effective approach of sustaining methods is microstrip line arrangement to replicate the resonator on the inclined element as well as stimulate the resonator in the optimal mode. Owing to their wideband facility, recently resonator antennas have attracted substantial exposure without expanding the volume of the structure.

The dielectric resonator has been typically utilized in the filters and oscillators in microwave structures however it is constrained in reverberant methods as well as narrowband. Currently the ability is to recognize how the antenna element of such device can accomplish. In recent decades, several research teams have revealed empirical and innovative research on cylindrical and hemispheric DRAs [2]-[3]. In order to use resonators in feed elements, it needs the best familiarity a feed line-resonator attachment. The desired approach of sustaining technique is microstrip line arrangement to replicate a resonator for the inclined line as well as for stimulate the resonator in optimal mode [4]. A desired frequency is accomplished by the implemented model. A miniaturized or adaptive recurrence antenna could be intended by organizing different location of a emitting resonators [5]-[7].

In this article, a microstrip line feed to DRA has been enacted to prevent the holes. It's only the easiest way to energize DRAs. The feed line is situated on the substrate in this work to energize a DR that can be set straightforwardly over the feed line. The features of microstrip feed being that assembling, modifying and planning is simpler [8]. Scientific, industrial, medical implementations have used the ISM ranges. Recently, there has been a dramatic increase in remote implementations in the ISM group, especially throughout the band across 2.4 GHz. The ISM band is utilized in WBAN technology for transmission of continuous traffic, for example, video and information to screen the health conditions [9].

In this work, the suggested DRA is intended for ISM band. The constructed antenna does have the optimum radiation in the ISM group for conveying this data to a surveillance system. This architecture has the benefit of compact design, easy arrangement and also the specified radiation structures can be accomplished. A resonator parametric examination is completed and the impact of execution of the different variables is analyzed.

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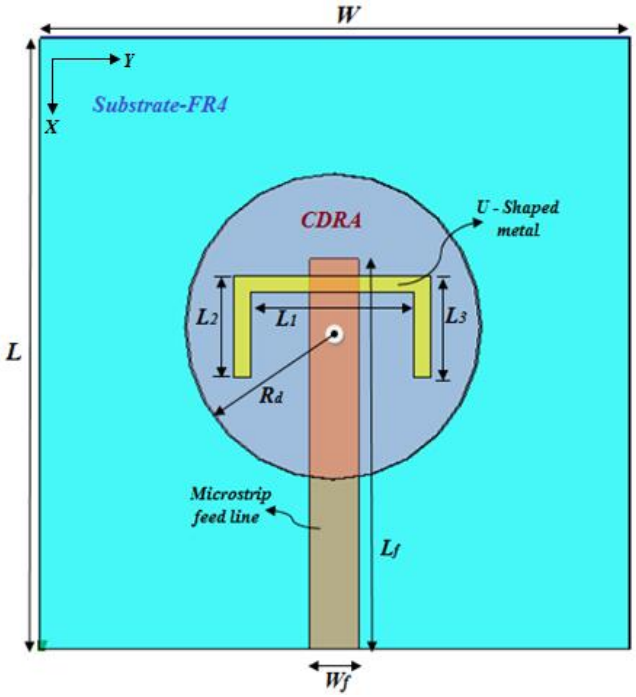
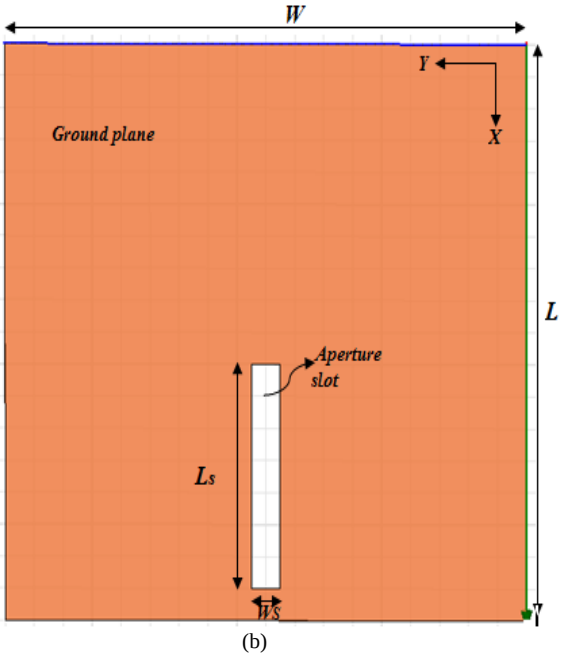
II. ANTENNA DESIGN

An investigated design is demonstrated in Fig. 1. The resonator antenna is comprises resonator, it is settled on the FR-4 substrate to attain a 2.4 GHz band. The feed segment is imprinted in the focal point of the substrate. The implemented resonator has the geometry of 38 mm × 36 mm × 9.75 mm, and a substrate, FR-4 with a dielectric property of $\varepsilon_r = 4.4$ and it has thickness as 1.6 mm. In addition to that a new metallic line has been located on the dielectric resonator to acquire the better characteristics.



(a)



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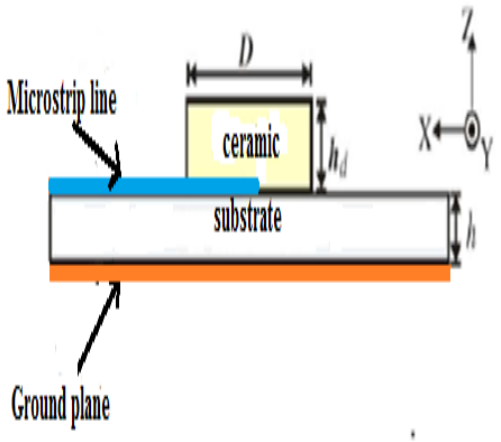

(c)

Fig.1 Designed antenna (a) Top view; (b) Bottom view; (c) Isometric view

The resonator does have a 9 mm radius, h_d=8 mm height, as depicted in Fig. 1. DR's convergence point is set on the ground plane centre line, which can be utilized for alter the connecting vitality between the transmission line as well as the radiating component. To demonstrate the simulation performance, HFSS is utilized. The envisaged transceiver can perform in ISM group by carefully adapting the antenna element, so it is easy to accomplish a decent impedance coordinating for the working recurrences.

III. PARAMETRIC STUDY

A cylindrical dielectric resonator antenna for ISM band is implemented in this work. A microstrip feeding method can be used to stimulate a CDRA. The recommended dielectric resonator delivers the functionalities for an optimal radiator with the feeding specifications. The allowed band can be amassed by shifting the structure dimensions. The suggested architecture includes the dielectric resonator to accomplish recurrence of 2.4 GHz. A U-shaped metal strip is settled on the dielectric resonator material in order to miniaturize the size and it improves the resonator appearance. Figure1 demonstrates the resonator antenna, there are various specifications that impact the reception apparatus qualities. To accomplish ideal reception apparatus execution, a parametric report is done to investigate the attributes of the DRA.

A cylindrical dielectric resonator is settled over the FR-4 (ε_r=4.4) substrate, dielectric property of the resonator is ε_d = 40, resonator height is h_d = 8 mm. A U-shaped metallic strip comprises 3 rectangular strips, specifications of rectangular strips are L_1=5mm, L_2=6mm and L_3= mm with same width W=0.5 mm. To enhance the impedance matching of a resonator, a aperture space on the ground section is created with the specifications of L_S=6mm and W_S=1mm. The 50-Ω inclined line has the geometry of a length, L_f =23 mm and a width, W_f =3 mm and it is situated at substrate center.

The DRA's quantitative evocative frequency has been computed by preceding equation and equivalent of 2.4 GHz, and it is adapted to ISM implementations [5].

$$f_r = \frac{c}{2\Pi R}\left(\frac{1.6 + 0.513x + 1.392x^2 - 0.575x^3 + 0.088x^4}{\varepsilon_d^{0.42}}\right)$$

Here, $x = R/2h_d$; c is the light speed; h_d, R and ε_d are height, radius and DRA dielectric property, subsequently.

IV. SIMULATED RESULTS AND DISCUSSIONS

Fig. 2 illustrates a reflection coefficient of the analysed cylindrical DR and desired band is attained because of DRA. The outlined resonator exhibits the return loss of -38db, it covers the ISM band (2380–2485 MHz). It is seen that a data transfer capacity of 5.1% for ISM band. The acquired optimal data transfer capacity is sensible. Note that without the subsistence of resonator, there are no frequencies to be energized, for example the DRA causes the resonant space mode.

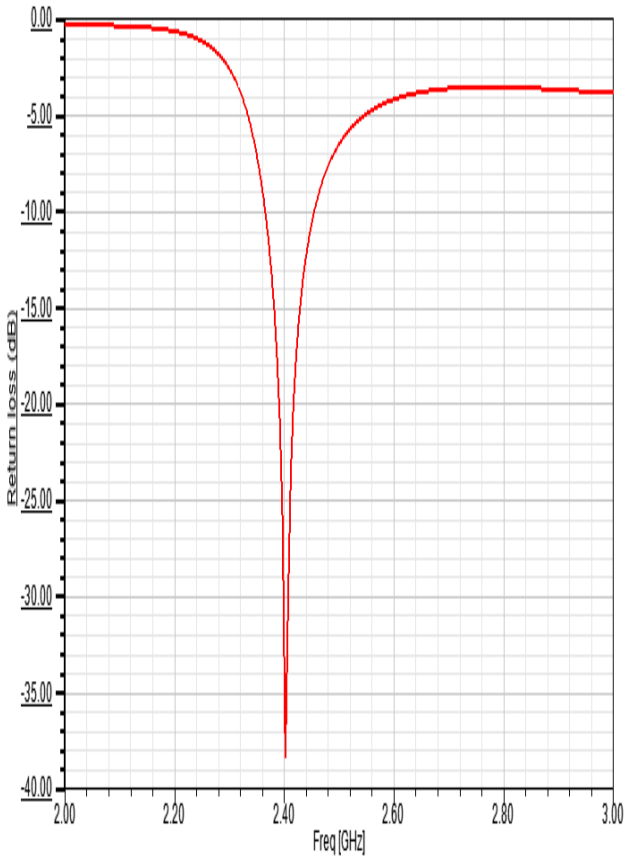

Fig.2. Simulated return loss at 2.4 GHz

Fig. 3 demonstrates the ISM (2.4 GHz) band simulated radio wire structure radiation designs. The receiving wire has 4.5 dBi gain at 2.4 GHz and transmits maximum at 2.4 GHz in the broadside direction.

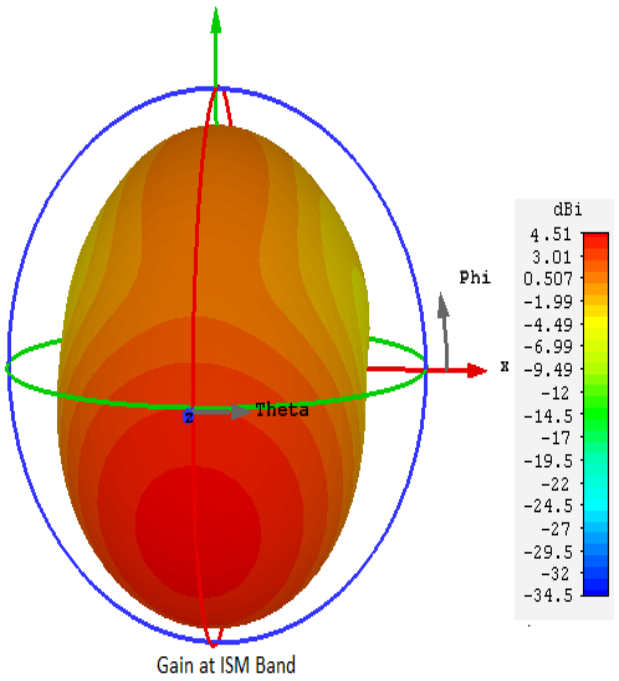

Fig.3. Simulated Gain at ISM band

The VSWR of the implemented model is demonstrated in Fig. 4. The analysed structure has VSWR around to 1.1 across the ISM band and it can be said to offer extraordinary impedance matching properties.

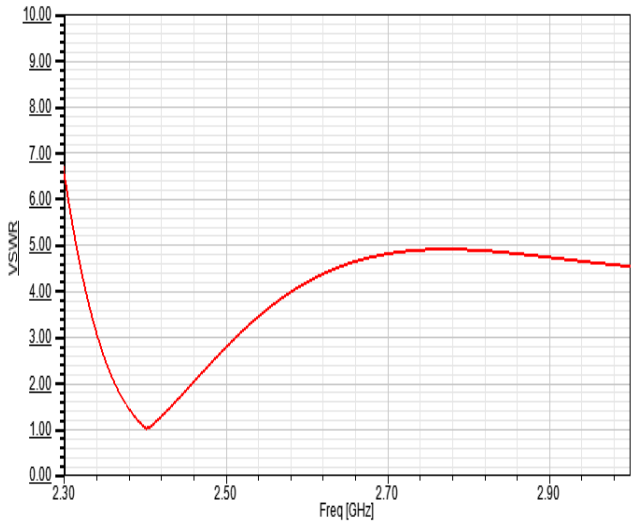

Fig.4. Simulated VSWR at 2.4 ISM Band

V. CONCLUSION

In this tasks, a compact dielectric resonator antenna is designed and analysed. To explore the responsive and structure parameters of the receive wire, the parametric analysis is operated. An intended resonator exhibits the return loss -38db, it covers the ISM band (2380–2485 MHz). It is seen that a data transfer capacity of 5.1% for ISM band. The implemented structure has gain of 4.5 dBi and VSWR around 1.1. An implemented framework brings a small volume, and simple to show. The intended structure has optimal operational band width and gain. For ISM band implementations, the configured structure is sensible.

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