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Ring shape Dielectric Resonator Antenna for WLAN application

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Abstract: Wireless communication has significant role in modern communication systems. The antenna is very crucial component for any wireless communication devices. Planar Dielectric Resonator Antennas (DRAs) have attracted researchers' mind because of their inherent characteristics of low profile, compactness, light weight and radiation efficiency. In this paper, cylindrical ring shaped dielectric resonator antenna for WLAN communication is designed, fabricated and presented. The fabricated prototype shows extremely high correlation to simulation results. A ring shaped microstrip feed is engineered to optimize the reflection coefficient. The antenna is fabricated on FR4 substrate material for cost effectiveness and robust mechanical properties. Antenna has partial ground plane to improve the bandwidth. Overall Antenna dimensions is 48 x 75 mm2. The measured bandwidth is in order of 19.26% at 2.44 GHz.

Index terms - Dielectric resonator antenna, partial ground, micro-strip feed, cylindrical DRA, wideband antenna

I. Introduction

Dielectric resonator antennas (DRA) are quite useful type of antenna. It offers several advantages over conventional antennas like little size, easy to fabricate, high radiation proficiency. In recent decade, the research has been carried out to obtain the desire response from the antennas with other crucial parameters like increased efficiency, wide band application [1-3]. It has been observed that by selecting appropriate dielectric constant for an antenna, compact size could be achieved. Various feedings techniques can be adopted to energize the DRAs like coaxial feed, a micro strip line feed, a gap coupled source and a coplanar waveguide (CPW) [4-7]. Different DRA types could be utilized for multi-resonance frequencies which could be merged into a broad band [8]. It has been claimed that miniaturize structure, gain improvement and maximize coupling could be achieved by cylindrical dielectric resonator antenna using novel coupling scheme [9]. Micro strip patch antennas could be the other alternative for WLAN application [10].An extraordinary radiation examples are achieved by energizing distinctive modes. A variation of feed system is one of the most desired advantage of DRA. It has also other important advantages like wide bandwidth, low dissipation at high frequency and higher radiation efficiency due to negligible conduction loss [11-14, 17, 18].

There are many effective and interesting techniques are available for antennas miniaturization and bandwidth enhancement like negative refractive index materials [19-20], planar inverted antennas[21] and frequency selective surfaces. Dielectric Resonator antennas, however, without major fabrication stress can provide high gain and wide bandwidth. DRAs offer the benefits of high radiation proficiency, simplicity of excitation, little size, and wide data transmission [15-16]. Optimum designing of an antenna plays a major role in its application for wireless communication [22-30]. Electrically small antenna could be utilised for RFID, GPS and IEEE 802.11 a/b/g/s Applications. In this manner, DRAs could be the appropriate candidate for wireless communication applications. Fundamentally, the structure of DRA comprises of three essential parts; they are substrate, ground plane (coated on substrate) and dielectric material.
In the proposed work, a ring shape optimized microstrip feeding system is utilised to excite a cylindrical ring shaped dielectric resonator antenna. This antenna offers the simulated return loss of 34.12 at 2.44 GHz.

II. ANTENNA DESIGN

The geometry of the round shape small scale ring dielectric resonator (DR) is illustrated in figure 1. Figure 1(a) depicts the top perspective of the proposed ring DRA with the miniaturized scale strip sustaining structure. The bird view of proposed ring dielectric resonator antenna is appeared in Fig.1(b). In the proposed antenna, FR4 material is utilized as a substrate. The advantage of FR4 material is it’s easy fabrication on print board. The material has relative permittivity ε_r is 4.4 and a dielectric loss tangent δ of 0.02.The ring DRA is placed symmetrically at the center.

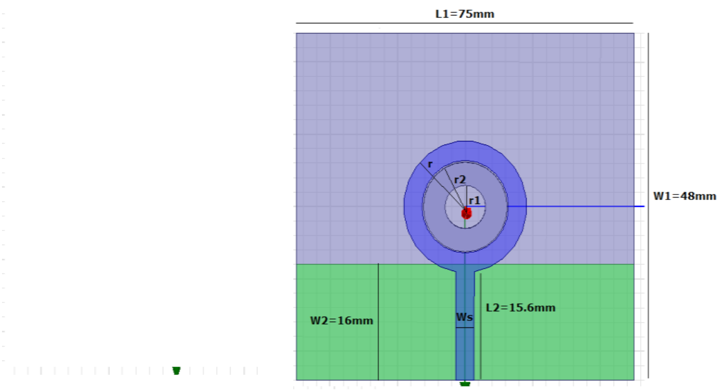


Figure 1(a): Top view of proposed antenna

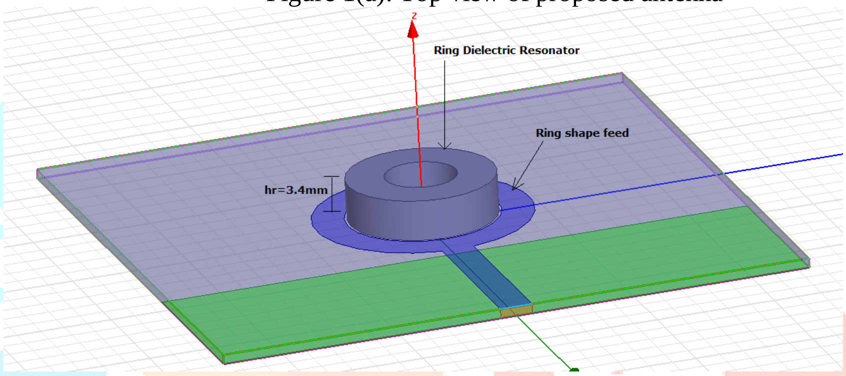


Figure 1(b): 3-D view of proposed antenna

Figure 1 Proposed Ring Dielectric Resonator Antenna

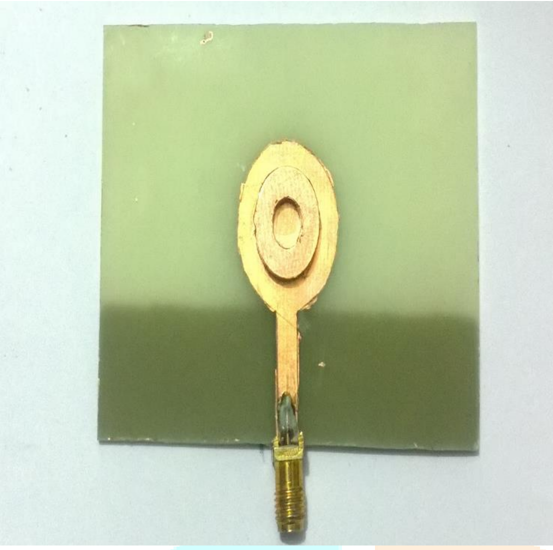
The table 1 shows parameters of the proposed antenna. The parameters have been carefuly optimized to get desire response. The High Frequency Structure Simulator (HFSS) has been used for DRA design and simulation.

Table 1: Parameters of proposed antenna

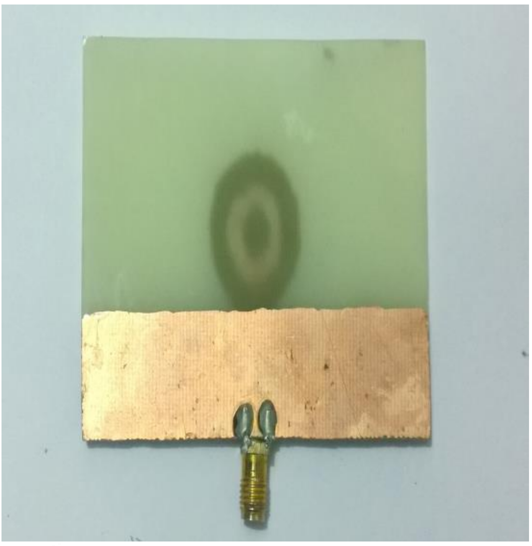
Parameters	Dimension (mm)	Parameters	Dimension (mm)
L1	75.0	g	0.2
L2	15.6	r	10.4
W1	48.0	r1	3.0
W2	16.0	r2	6.2
H	1.6	ε_r	4.4
hr	3.4	Ws	4.0

III. FABRICATED ANTENNA STRUCTURE AND MEASURED RESULT

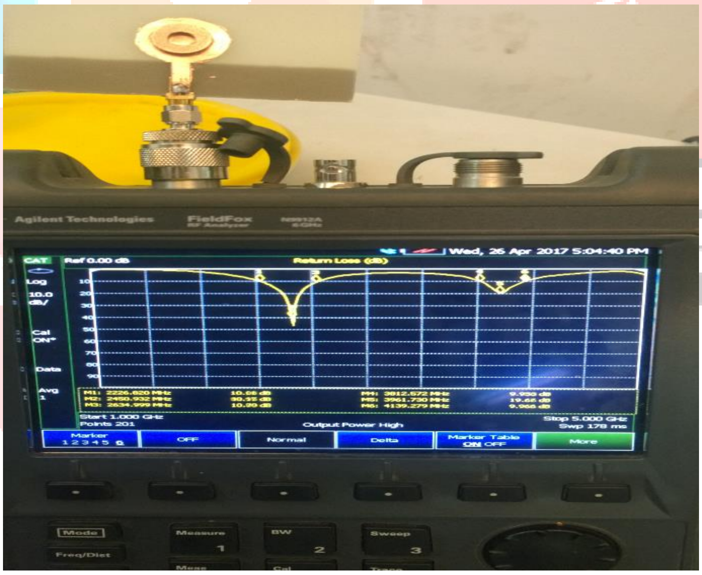
The actual fabricated antenna has been shown in fig 2(a) with connector and back view of same could be seen in fig 2(b). Fig 2(c) depicts the connection of antennas with network analyzer N9912A.



(a) Top view of fabricated antenna



(b) Back view of fabricated antenna



(c) Fabricated antenna mounted on network analyzer

Figure 2: Fabricated prototype of antenna

IV. RESULT AND DISCUSSION

The proposed dielectric resonator antenna has been simulated in High Frequency Structure Simulator (HFSS) software. Figure 3 shows the return loss for the proposed DRA. The return loss shows the part of an electromagnetic waves which is reflected back. It is very clear that return loss should be as minimum as possible because it is related with the radiation.

The simulated reflection coefficient of the proposed antenna is illustrated in fig.3 which claims that stable impedance resonance is between 2.23 GHz to 2.70 GHz with center frequency of 2.44 GHz. This gives impedance bandwidth of 19.20% which covers IEEE 802.11 Wireless LAN frequency spectrum. The fabricated antenna has been tested and analyzed using portable network analyzer in the laboratories. The actual return loss behavior measured in the said device is very close to the ideal response. The actual response is shown by fig. 4.

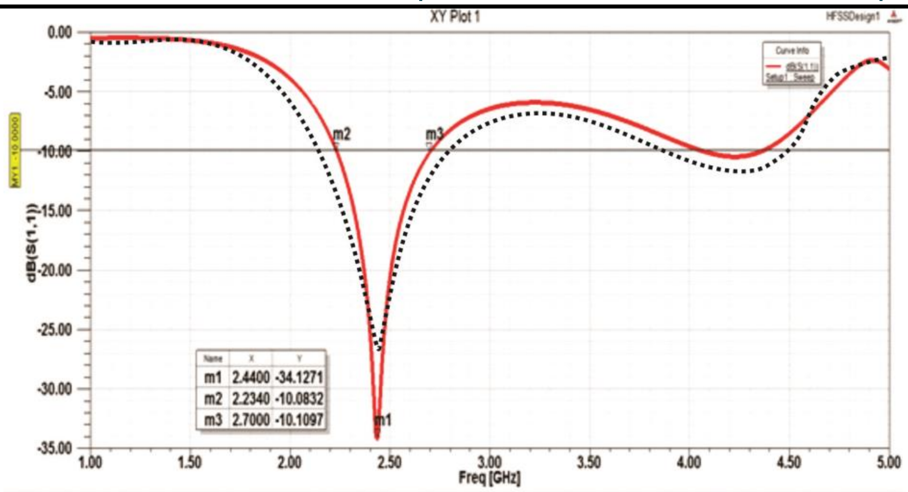


Figure 3. Simulated S_{11} of a ring dielectric resonator antenna

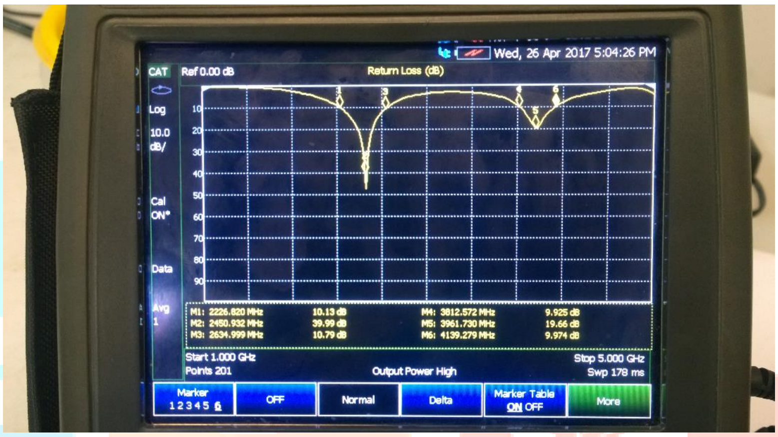


Figure 4. Actual S_{11} parameter response in network analyzer

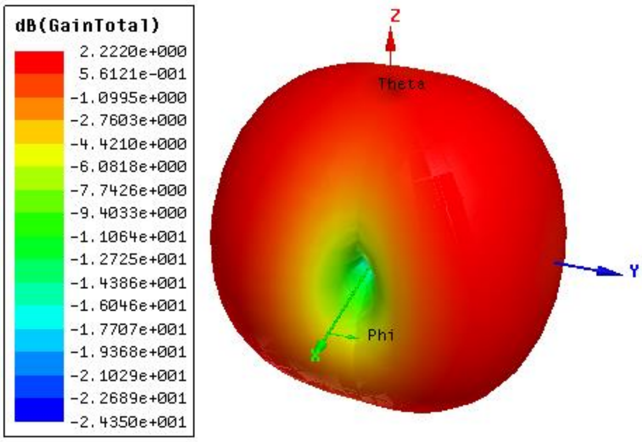


Figure 5. 3-D gain of a ring dielectric resonator antenna

An antenna gain is a key parameters which combines the antenna directivity and radiation losses. Higher gain implies higher transmission power of radio waves or low loss. Figure 5 demonstrates simulated gain of a ring dielectric antenna as 2.22 dBi. To build the return loss, one of the early recommendations was to expand the electrical thickness of the substrate. It had two noteworthy inconveniences: expanding the surface waves and Ohmic loss and along these lines lessening radiation efficiency. The simulated gain is illustrated in Figure 5.

V. CONCLUSION

A micro-strip feedline excited ring dielectric resonator antenna is presented for WLAN application. The proposed antenna illustrate resonance at 2.44 GHz frequency with gain of 2.22 dBi. The fabricated antenna has shown expected results. This antenna is viable option for wireless communication. The design can be further optimized by increasing the antenna gain through reduction of dielectric and conductive losses of antenna.

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