Coplanar Waveguide fed MIMO RDR Antenna for ISM Band Frequencies

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Abstract. A Multiple-Input-Multiple-Output (MIMO) Rectangular Dielectric Resonator Antenna (RDRA) is presented in this paper for industrial scientific and medical applications with 2.45 GHz. The geometry of proposed antenna is fabricated on low cost FR-4 substrate with dielectric constant of 4.4 with coplanar waveguide (CPW) inductive slot and its physical dimension is 69.3 X 73 X 1.6 mm³ (Length x Width x Height). In this work, RDRA uses two orthogonal modes with two different mechanisms and they are coplanar waveguide (CPW) and coaxial probe. The proposed MIMO RDR Antenna is expected to give various features such as isolation beyond 20 dBi range over the frequency of operation, positive gain, VSWR, Z-parameters display, 2-D current distribution using azimuthal and elevation patterns.

Index Terms— Rectangular Dielectric Resonator Antenna (RDRA), Multiple-Input–Multiple-Output (MIMO), Long Term Evolution (LTE).

1. Introduction

In human life wireless communications plays a prominent role which they can use anywhere at any time with high speed. Usage of internet became compulsory like downloading videos, software updating, uploading files and more usage of social media also. Our smartphone communications developed from 1G, 2G, 3G and 3.5G that is called as Long Term Evolution [1]. This gives perfect wide range of data services and also wireless communication services. The capacitance of the channel and data rates at high range for smart phones wireless networks had developed by Multiple Input-Multiple Output [2] –[3]. For representation of MIMO, micro strip antennas are viable for investigation on wireless communications.

It has pair of balanced inverted-L antennas builded on a rambled line, patch folding and having interlink capacitance strip linked to the patch folding [4] – [6]. Moreover for high frequencies, the efficiency of antenna decreases slowly and conductor loss becomes more. To solve this issue, an attractive feature is developed with ceramic material and applied on upper layer of the antenna radiating element [7]. These kind of antenna can be called as dielectric resonator antenna (DRA). The DRA’s exhibit many features that be utilized for proposal in wireless communication system because they are very small in size, light weight, conductive loss is small and easy to fabricate also having high radiation efficiency [8]. DRAs have feeding mechanisms and simplicity in shape and versatility [9] – [10]. The proposed antennas gives good isolation of above 20dB.
In this proposed work, an MIMO Rectangular Dielectric Resonator Antenna is designed to radiate at 2.45 GHz for ISM applications. To get more freedom in degree, Rectangular shape is taken than considering a cylindrical or a spherical DRAs that could be utilized for determining impedance and antenna bandwidth. Techniques which are used to excite the given antenna: coplanar waveguides for port1 which is inductive slot and coaxial probe for port2. To make it to tuning at 2.45 GHz, we proposed to extend the length of port2 with a small metallic strip. The detailed analysis of simulation and scaled results and its performance are stated in detail.

2. Antenna Geometry
The structure has CPW fed and slots are introduced for inductive nature, which is fabricated on the FR4, this has the size of $63.3 \times 70 \times 1.6$ mm$^3$ (length×width×height). In this structure, the dimensions of rectangular dielectric resonator antenna is taken as $a=37.8$ and $b=40$ and having loss tangent and permittivity. Dielectric resonator is placed at the Mid-point of the FR-4 Substrate as depicted in Figure 1. Thus, this antenna is leaded to 49.99 impedance matching by imposing CPW of port1 & co-axial probe of port2. In order to avoid the air gap, a coaxial probe has been used and it has been placed at the side of DRA. By achieved more than 20dB isolation. In direction to make the antenna radiate at 2.45 GHz DRA is coupled to the co-axial probe. The method ensure that the ground plane is connected to ground of port2.

![Figure 1(a) Top view.](image)

![Figure 1(b) Bottom view.](image)

![Figure 1(c) Fabricated Structure](image)

To obtain the performance and parametric study of the dielectric resonator thickness, length of the strip and position of slot are vital.

3. Results and Discussion
To estimates the proposed antenna structure performances characteristics IE3D simulator is used to simulate first. By changing antenna parameters various investigation were carried out, to examine wide
bang coverage. The initial design of MIMO antenna is simulated and s-parameters value is shown in Figure.2. where S11 is -85dB at 2.45GHz. The antenna design is optimized with varying length, width and its characteristics were validated. After the antenna designing, it has been fabricated and tested in anechoic chamber. As per simulation results, in comparison with fabricated antenna fall within estimated band. The measured gain varies between 1 and 4 dB.

![Figure 2 Return loss](image1)

Performance of patch antenna is good with respect to polarization, well in spite of the angles created in textile substrate. For θ=0 and φ=0 the propose antenna gain is 1dBi and it is shown in Figure.5 and Figure.6. The gain of the proposed structure is very high and good as the compatible materials used for the fabrication. At the frequency of 2.45 GHz, the surface field distribution & the radiation pattern of the structure is shown in Figure.4.

![Figure 3 Z-Parameter](image2)
Figure 3. shows Z-parameter of proposed structure has 50Ω impedance matching at 2.45GHz for square loop antenna. Figure 5 and 6 shows positive gain value for elevation and azimuth pattern. For wearable applications, the proposed structure is one of perfect solution for embedded in textile fabrics. Figure 7 shows current distribution of the structure were maximum at 2.45GHz.

**Figure 4** Gain vs frequency

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**Figure 5** Elevation pattern
4. Conclusion
A MIMO RDRA is radiating at 2.45 GHz, with good S11, perfect impedance matching of 50Ω, VSWR at 1.2 and positive gain. The proposed structure show enough impression comparing results of measured and simulated. The antenna shows us uni-directional radiation pattern along broad side, through an operating frequency of gain for antennas. The given results shows that the antenna structure we proposed has good efficiency, gives agreeable contender for 4G applications. The investigation should be
prolonged by decreasing the dielectric resonator height by improvising dielectric material with more thickness to satisfy utilization of smaller antennas in portable communication devices.

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