

Bandwidth Enhancement of Tri-band Rectangular Dielectric Resonator Antenna using Novel Offset Feed for WLAN/WIMAX Applications



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Abstract: In this article, a novel offset microstrip line feed Rectangular Dielectric Resonator Antenna is used for bandwidth enhancement. The parameters such as Bandwidth, Return Loss and Radiation efficiency are improved in the proposed antenna. A comparison is also shown for the proposed feed structure with and without conformal strips. The improvement in the bandwidth is observed from 25% to 65% by optimizing the antenna design parameters. It works in three frequency bands, that is, 2.03-3.69 GHz, 3.86-7.26 GHz, and 7.32-9.26 GHz. The proposed antenna is appropriate for WIMAX/WLAN applications.

Keywords: Annular ring, Conformal strips, Microstrip line, Rectangular DRA.

I. INTRODUCTION

The dielectric resonator antenna (DRA) has been widely studied due to its several advantages, like the small size (since DRA is made of high dielectric constant), ease of fabrication, high radiation efficiency, Wide control over size and low production cost^[1]. The DRA is made up of non-conducting parts and has very small dissipation loss (So, it can handle high power)^[2] and offers more bandwidth^[3]. The rectangular DRA is preferred in this paper because it is characterized by three independent geometrical dimensions (length, breadth, height) this offers more design flexibility^[2] as compared to the cylindrical DRA. Degenerative mode in RDRA can be avoided by properly choosing the aspect ratios (length/height and width/height). It is easy to fabricate from raw dielectric material. Due to these, the Rectangular DRA is more popular and better choice other than cylindrical and hemispherical. The paper is organized as follows: In Section II, Parametric Analysis of different shapes of feed. In Section III, Stage 3 with conformal strips. In Section IV, Conclusion.

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II. PARAMETRIC ANALYSIS OF DIFFERENT SHAPES OF FEED

Here in proposed design, DRA is placed over Novel offset microstrip feed as DRA is made up of non-conducting material like alumina^[5], it does not suffer with conduction losses as Microstrip Patch Antenna does. Due to the hardness of the DRA material, it is difficult to drill a hole for co-axial probe feeding. So, microstrip line feed is preferred over co-axial probe feed because fabrication of microstrip linefeed is easy to fabricate and also provides good impedance matching to enhance the bandwidth of the proposed design, the feed shape is modified, which is explained as follows.

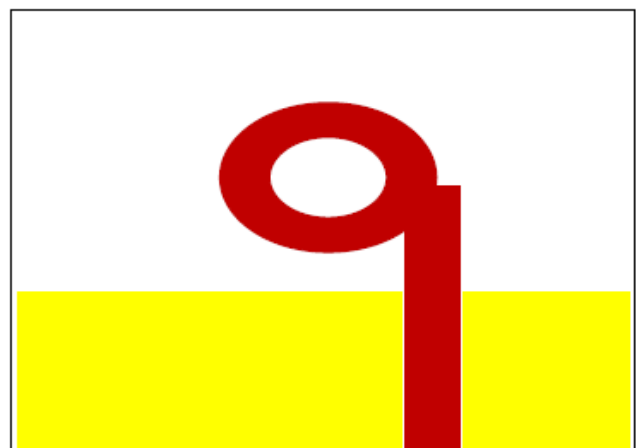


Fig1: Stage 1

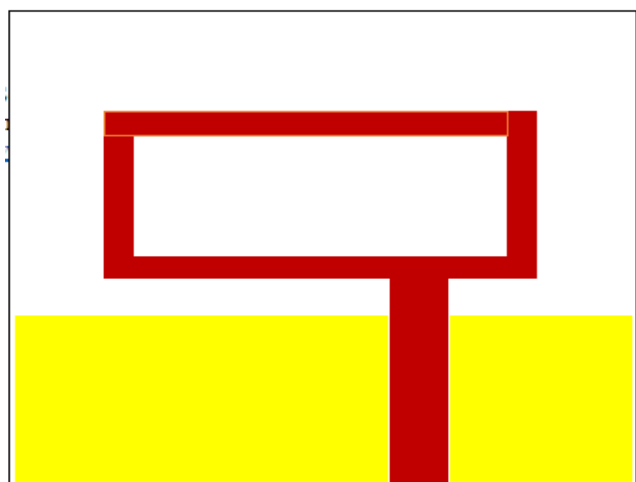


Fig2: Stage 2

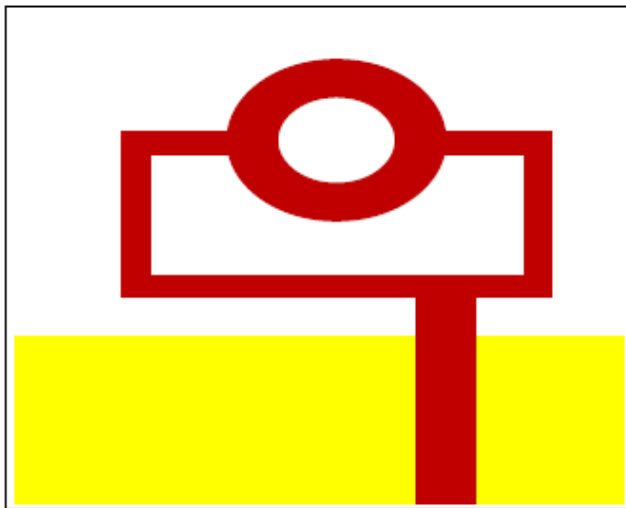


Fig3: Stage 3

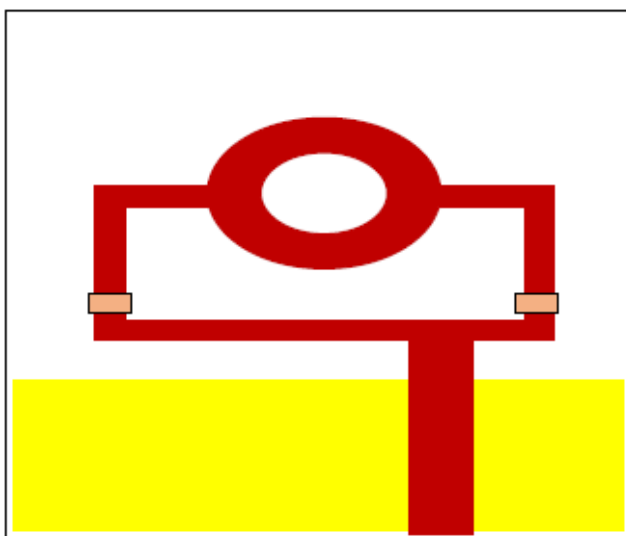


Fig4: Stage 4

In Stage 1(shown in Fig1), annular ring is added to the conventional Microstrip line feed .This offset annular ring feed enhances the bandwidth of the proposed radiator to 8.8%. It resonant at three frequency bands 3.41-3.73GHz 7.20-7.34GHz, 8.73-8.93GHz.This stage offers low gain, which needs some improvement VSWR value is less than 1. In stage 2(shown in Fig2), rectangular ring is added to conventional offset Microstrip feed ^[4]. For this feed, the DRA resonates at three frequency bands 4.28-5.25GHz, , 5.50-6.61GHz, 6.79-8.81GHz. The bandwidth is improved to 26% and Gain is 5.15dB at all the resonant frequencies the gain and bandwidth are enhanced. In stage 3(shown in Fig3), combination of stage 1 and stage 2 .There is a Slight shift in the resonant frequency .In this case bandwidth is improved to 65%. The parametric analysis of 3 stages is shown in Table 1. And the Return loss plot of 3 stages and proposed design is shown in Fig5.

Table 1: Parametric analysis

	Frequency band(GHz)	Bandwidth (%)	Resonant Frequency (f _r)	Gain
Stage 1	3.41-3.73	8.8	3.52	3.90
	7.20-7.34	1.9	7.27	4.03
	8.73-8.93	2.2	8.82	2.72
Stage 2	4.28-5.25	20	4.77	4.83
	5.50-6.61	18	6.04	5.07
	6.79-8.81	26	7.73	5.15
Stage 3	3.14-3.89	22	3.4	3.33
	4.16-5.36	25	4.56	4.72
	5.49-6.53	16	6.28	5.99
	6.67-7.89	15	7.67	4.46
	7.97-8.87	10	8.27	5.49
	9.02-9.59	6	9.29	6.77

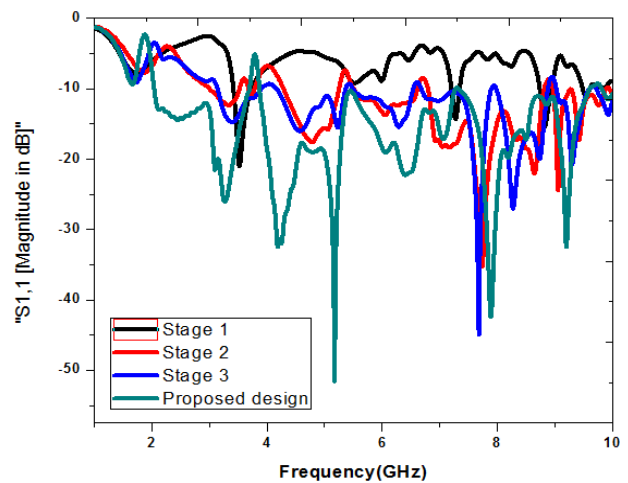
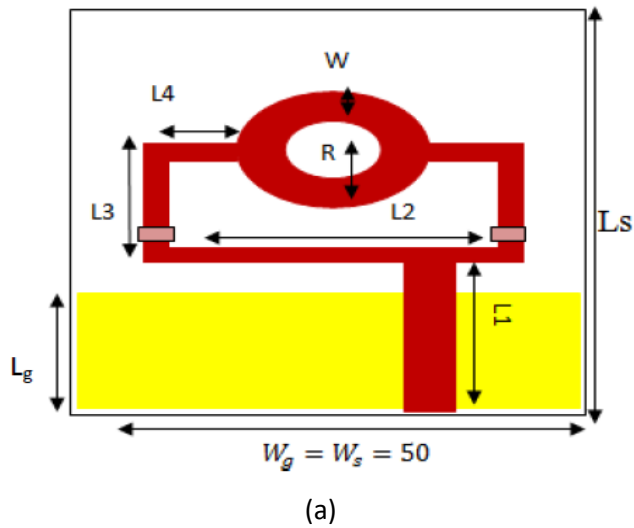


Fig 5: Return Loss (S₁₁) plot

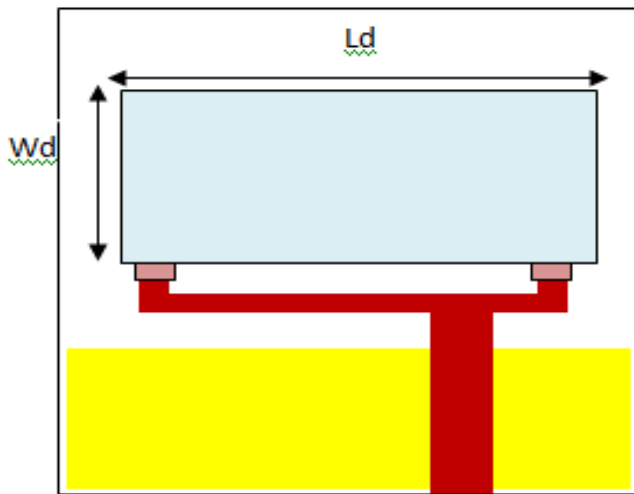
If the length of the ground plane is changed, there occurs variation in return loss characteristics^[6]. Better return loss is obtained when the length of the ground plane is changed from 50mm to 16mm.

III. STAGE 3 WITH CONFORMAL STRIPS

From the above results it is clear that Stage 3 gives better bandwidth enhancement. In this section conformal strip are added to Stage 3 as shown in Fig4.



(a)



(b)

Fig6: Proposed design (a) without DRA (B) with DRA

Parameters	Dimensions	Parameters	Dimensions
L(ground)	16mm	W	1.5mm
$W_g=W_s=L_s$	50mm	Length of strip	2mm
L1	17mm	Height of strip	8.4mm
L2	30mm	L_d	33mm
L3	10mm	W_d	8mm
L4	1.6mm	Height of DRA	12.5mm
R	6.5mm	W	1.5mm

The parametric analysis of proposed design (with and without conformal strips) is shown in Table II. The return loss plot of proposed design is shown in Fig7. Conformal strips are used for gain and bandwidth enhancement^[6-8].

IV. RESULTS

The proposed design produces multiple bands i.e. 2.03GHz-3.69 GHz, 3.86 GHz -7.26 GHz, 7.32 GHz -9.60 GHz. The bandwidth enhancement is increased from 8.8% to 65%. The simulated E-plane H-plane Far field radiation pattern at three resonant frequencies (3.27 GHz, 5.15 GHz, 7.86 GHz) as shown in Fig8.

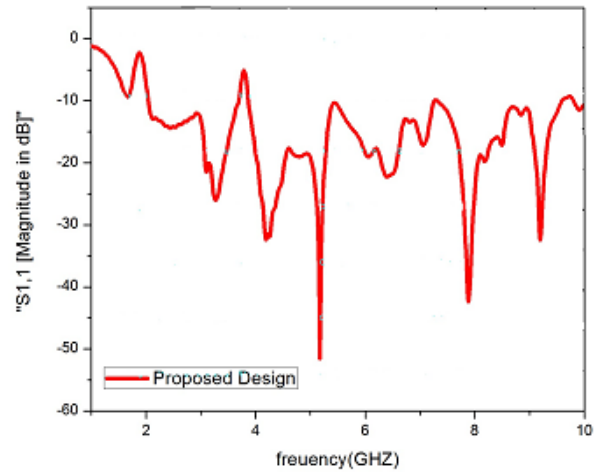
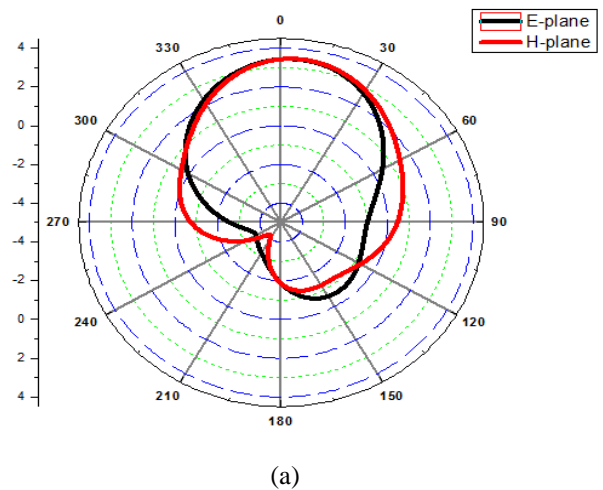
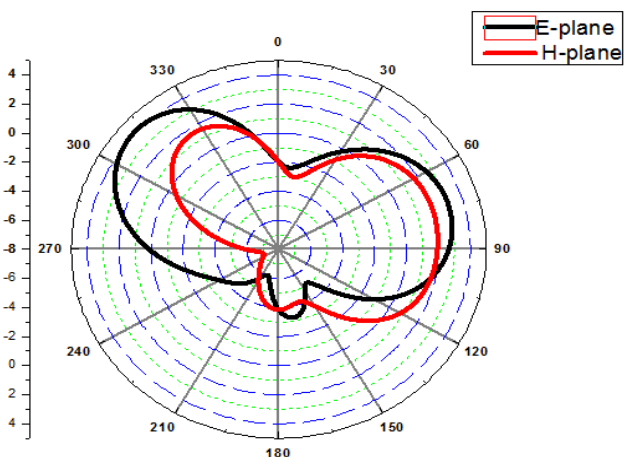


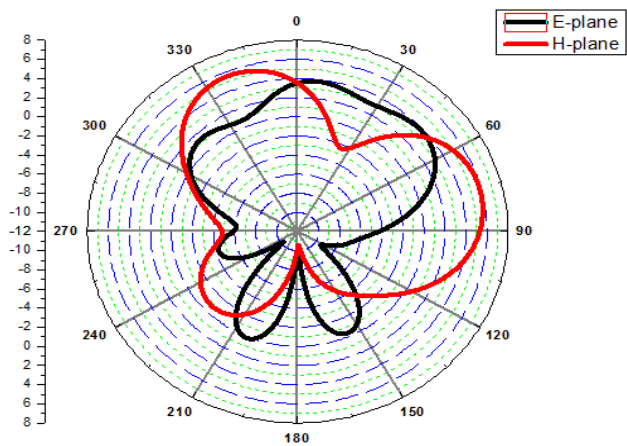
Fig7: Return loss plot of proposed design



(a)



(b)



(C)

Fig8: Radiation Pattern of proposed design at (a) 3.27GHz (b) 5.17GHz (c) 7.86GHz.

V. CONCLUSION

In this paper, a method for improving bandwidth and gain of Rectangular Dielectric Resonator Antenna has been proposed. A Novel offset feed, excitation method has been applied to the Rectangular DRA. The bandwidth enhancement is improved by the introduction of conformal strips, wide bandwidth is achieved. It resonates at three frequency bands 2.03-3.69 GHz, 3.86-7.26 GHz, 7.32-9.60 GHz which covers several important applications in WLAN and WIMAX.

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