Dual Band Notch, Compact, Low profile, Hybrid Ultra Wideband RDRA

Taruna Sharma, Parikshit Vasisht, Munish Vashishath, R. S. Yaduvanshi

Abstract- This paper presents a novel, compact Ultra Wide Band, Asymmetric Ring Rectangular Dielectric Resonator Antenna (ARRDRA), which is a unique combination of Thin Dielectric Resonator (DR), Fork shape patch and defective ground structure. The base of the proposed antenna is its Hybrid structure, which generates fundamental TM, TE and higher order modes that yields an impedance bandwidth of 119%. Proposed antenna provides a frequency range from 4.2 to 16.6 GHz with a stable radiation pattern and low cross polarization levels. Peak gain of 5.5 dB and average efficiency of 90% is obtained by the design. Antenna is elongated on a FR4 substrate of dimension 20 x 24x 2.168 mm3 and is particularly suitable for C band INSAT, Radio Altimeter, WLAN, Wi-Fi for high frequencies. Ease in fabrication due to simplicity, compactness, stable radiation pattern throughout the entire bandwidth are the key features of the presented design. Inclusion of Defective ground structure and asymmetric ring not only increases the bandwidth but also stabilize the gain and efficiency due to less surface current. Presented design launch an Ultra Wide Band antenna with sufficient band rejection at 4.48-5.34 and 5.64-8.33 GHz with stable radiation pattern and high gain.

Keywords—Asymmetric Ring Rectangular Dielectric Resonator Antenna (ARRDRA), Microstrip Patch Antenna (MPA), Ultra Wideband, Multimode Resonance, Microstrip feed.

I. INTRODUCTION

In this era of technological advancement, when 6G is ready to knock the door of wireless communication, every antenna designer is trying to render ultra wide bandwidth with high data transfer rate that too with ease in size allocation. In last 25 years, Dielectric Resonator Antenna (DRA) is evolving as a prolific, ultra wideband , low profile and efficient radiator. DRA is a lossless radiator, educing various merits like wideband nature, compactness in size, light weight offering high temperature stability, low cost and ease of fabrication [1]. DRA displays high radiating efficiencies due to absence of any kind of conductors in the radiator. Moreover, these dielectric radiators are highly compatible with every kind of transmission lines such as coaxial probe, micro-strip line, micro-strip slot, coupled or aperture coupled, coplanar waveguide and dielectric image guide method [2].Array formation is the best way to increase bandwidth and maintain high gain at the same time but if we consider only single element bandwidth enhancement methods includes lowering Q-factor, modifying feed mechanisms and multi segmentation of the DRA's .Bandwidth of the DRA can be enhanced with the reformed geometries. L-shape [3] and Asymmetrical T-shape[4] DRA's have been proposed to enhance the bandwidth from usual 10% to 38% and 75.1% respectively. Combination of shape modification along with restructured feed is proposed in[5] where L shape probe is applied in the groove space created between DRA and the ground plane hence yields an impedance bandwidth of 32%. Conformal inverted trapezoidal patch and microstrip integration with renewed L Shape of DRA is proposed in [6] that not only gives 70% bandwidth with stable bidirectional radiation pattern but also yields high gain ranging from (5-8.5 dBi). Compact and low profile antennas in combination with Ultra wide band characteristics are not lesser than any boon in today's swift communication era. A- shape compact antenna with stair shape feed [7] with ultra wide bandwidth and high efficiency and a CPW fed antenna[8] which is compacted by 50% is proposed with steady gain. Modified feed mechanisms like U-shaped stair shape microstrip feed[9] is applied to a multi segment DRA, which is another way of achieving UWB. Annular shape [10] microstrip feed in conjunction with ring DRA is presented. Other Techniques of obtaining UWB Antennas include using pairs of compact DRA placed adjacently and asymmetrically , fed by single rectangular Aperture [11] also same arrangement fed by two rectangular adjacent slots[12].Multiple slab structures or multisegment antenna with different permittivity are placed side by side provides wide band width also inclusion of Defective Ground Structure provide high gain with stable radiation pattern. Adjustment in positions of two low profile DRA's, microstrip feed sandwich between them provides UWB of 88.2%[13]. Latest effective technique of Sandwiching micro strip feed between two low profile DRA's is also proposed in[14] to achieve UWB DRA Many techniques have been devised to suppress unwanted signal interference in WLAN and Wi-Fi and ITU bands of UWB system provided by FCC in the frequency range 3-10 GHz. Insertion of stubs and parasitic strips[15] and using modified DRA geometries [16] with altered feed mechanism is serving the purpose. In this paper, a detail investigation on Fork shape feed, low profile DRA is carried out. A compact, miniaturized, antenna is proposed which not only solve the space constraint of the UWB systems but also can be fitted into any hand held device for 4.2-16.6 GHz range.

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DGS technique of bandwidth enhancement is applied in the design. Partial ground structure with a slot in center and use of conducting strip not only increases the bandwidth but also increases gain of the antenna. Incorporation of the asymmetric ring in DRA reduces the quality factor of DRA, which in turn improve cross and co polarization of the design. In this paper, section II describes geometry and designing concepts of the antenna. Section III demonstrates results obtained and discusses various aspects of the resulting graphs. Section IV delineates the conclusion part of the article.

II. ANTENNA GEOMETRY AND DESIGN

Fig. 1. Shows the geometric configuration of a ARDRA (Asymmetric Rectangular Dielectric Resonator Antenna). A compact RDRA is designed having a red ground of 10 x 24 mm^2 and a substrate material of FR4 epoxy, permittivity of 4.4 with dimensions of 20 x 24 x 1.6 mm^3. Rectangular DRA is made of TMM13i with permittivity of 12.8. Feeding mechanism used here is microstrip plus conjunction with fork shape feed coupling method.

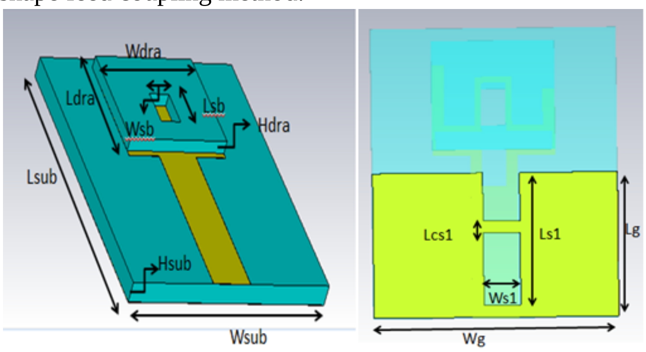

Fig. 1(a) Fig.1(b)
Geometrical configuaration of proposed design

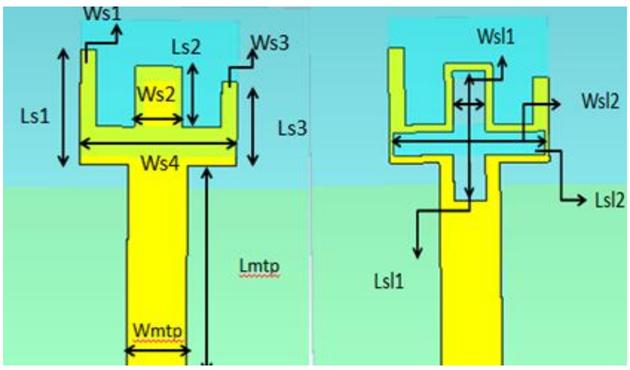

Fig. 1(c) Fig. 1(d)
Fig. 1. Geometrical configuration of proposed design .

S.no.	Antenna Part	Dimensions(mm)	Material used
1.	Substrate	WsubxLsubXHsub = 20x24x1.6	FR4(εr =4.4)
2.	Fork shape feed	Ws1xLs1 =1x7.5	Copper
		Ws2xLs2 =1x5.5	
		Ws3xLs3 =3x4	
		Ws4 =1.5	
3.	Ground	WgxLg =20x10	
		Ws1xLs1 =3.5x11	
		Lcs1=1	
4.	DRA	WdraxLdraXHdra =10x9x1	TMM13 i(εr =12.8)
		WsbxLsb =2x3	
5.	Slots in fork	Wsl1xLsl1 = 2x8.5	
		Wsl2xLsl2 = 1.5x9.5	

III. RESULTS AND DISCUSSION

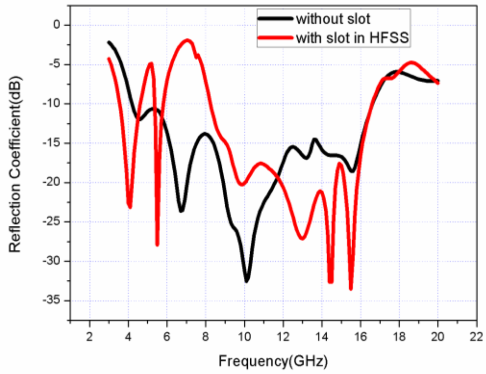

Fig.(2) S11 with and without slot in HFSS.

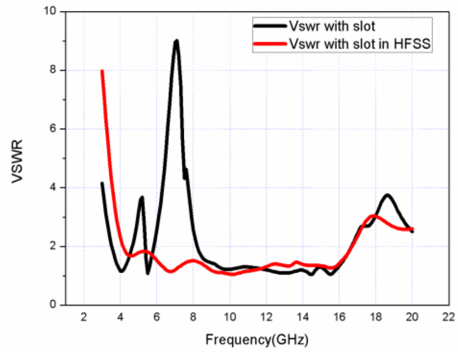

Fig.(3) VSWR with and without slot in HFSS.

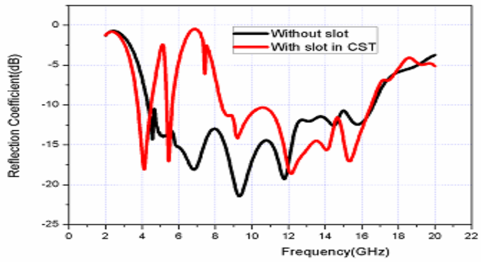

Fig.(4) S11 with and without slot in CST.

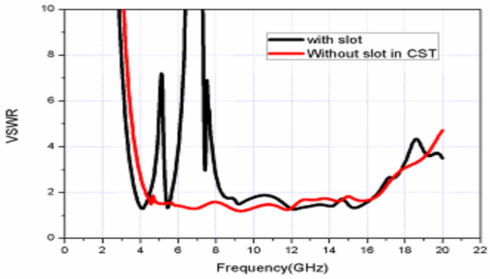

Fig.(5) S11 with and without slot in CST.

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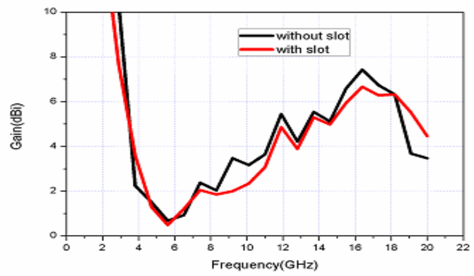


Fig.(6) Gain drop in DRA with and without slot

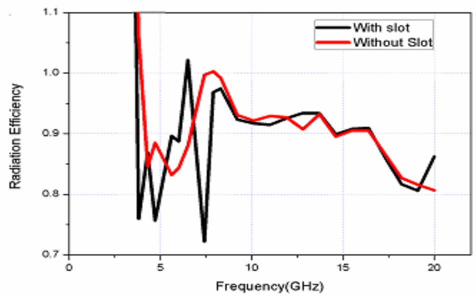
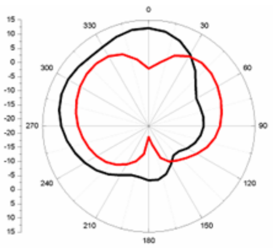
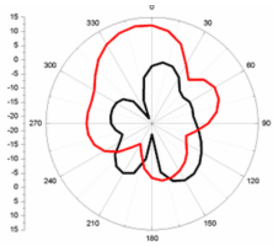


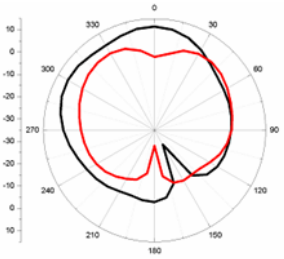
Fig (7) depicts drop in efficiency at band rejection frequencies.



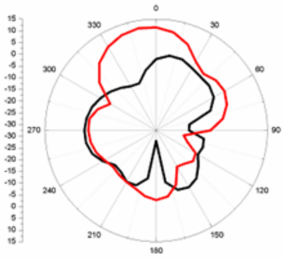
E-plane at 4.5 GHz at phi=0



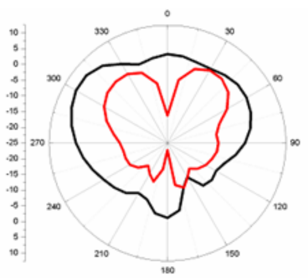
H-plane at 4.5 GHz at phi=90



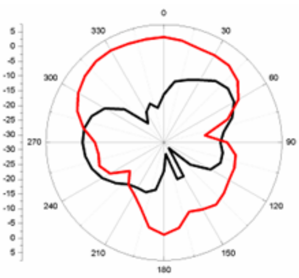
E-plane at 5.5 GHz at phi=0



H-plane at 5.5 GHz at phi=90



E-plane at 7.5 GHz at phi=90



H-plane at 7.5 GHz at phi=90

Fig (8) Radiation Pattern at various frequencies.

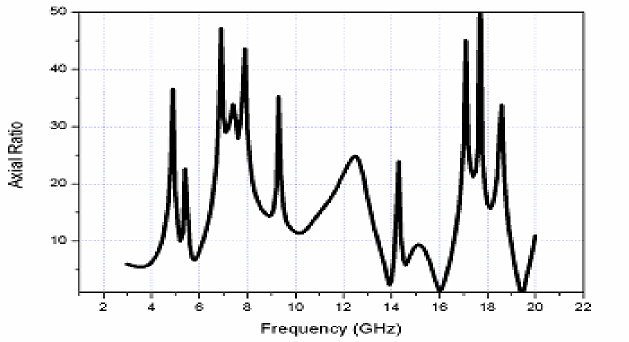


Fig. (9) Axial ratio of the antenna

IV. CONCLUSION

Presented antenna is a compact and low profile solution of the space constraint of Ultra wide band technology of the wireless communication. This design provides high peak gain of 6.4 dB and a high bandwidth of 12.24 GHz ranging from 4.2-16.6 GHz. Average radiation efficiency is above 90% and group delay provided is also <1.2 ns. At the same time noise interference is also avoided by creating a notch for Wi-Fi and ITU band. Antenna is simulated in both ANSOFT HFSS and CST MWS software. A high degree of coherence is achieved in the results obtained from both software.

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