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Research paper



Study and analysis of single notched rectangular dielectric resonator antenna for cognitive radio applications

S Nagendram, B T P Madhav, K Sony, P Janaki, P Lakshmi Prasanna, S Swetha, M Venkateswara Rao

ALRC, Department of ECE, Koneru Lakshmaiah Education Foundation, Andhra Pradesh, India-522502
**Corresponding author E-mail: btpmadhav@kluniversity.in*

Abstract

In this article a single notched ultra-wideband antenna which is integrated with dielectric ring resonator is proposed for cognitive radio applications. The proposed antenna consists of elliptical base and a split ring resonator on either side of the feedline for bandwidth enhancement. The rectangular dielectric resonator which is proposed is a rectangular dielectric resonator which give good isolation between the two ports. The proposed antenna has single rejection at 5.7GHz-8.4GHz at ultrawideband region. The proposed antenna has a peak gain of 6dB and average gain of 3. 1dB.Commercially equipped tool ANSYS EM 17 is used to characterise the proposed antenna. The proposed antenna provides good isolation between the two antenna ports confirming efficient integration. The antenna is best suitable for candidate of radar applications, medical imaging and cognitive radio systems.

Keywords: *Cognitive Radio; Dielectric resonator antenna (DRA); Notch Band, Split Ring Resonator (SRR).*

1. Introduction

In many technologies, to get very moderate energy level for short-range, high bandwidth communications over a wide spectrum UWB is most prominently used. Microstrip patch antenna with UWB characteristics is a good alternative for wireless communication [1]. At a certain millimetric wave frequencies the technology of dielectric resonator antenna plays a prominent part as it has high Quality factor and when it excites properly it can be observed a very high radiation efficiency. It can be identified a large impedance bandwidth and dielectric constant when it is designed according to the required proportions. It has various features in which having enormous shapes (cylindrical, rectangular, hemispherical, linear, planar, spiral, conical, elliptical and stair stepped) are the interesting factor to get high gain and to enhance Q factor [2]. Coplanar wave guide is most appropriate for ultra-wide band communication. Between microstrip and CPW, to enlarge bandwidth of the broadband transition a short-ended parallel microstrip stub is included that reflects a return loss of 10db is obtained [3]. For UWB applications we use coplanar wave guide fed to MIMO antennas. It has an overall bandwidth ranging from 2.7 to 12 GHz. MIMO antennas are required to have good isolation between the ports, compact size [4-5]. CPW is more suitable for applications like WLAN 5.2(5.15-5.35 band)GHz, WiMAX 2.5/3.5(2.5-2.69)GHz. Having an agreeable feature like low radiation loss, less dispersion and ease of integration [6]. Dielectric resonator antennas (DRA) are more familiar antenna elements because of their various benefits when compared to the conventional antennas. DRA operates in the frequency range of 3.2 GHz-7.23 GHz[7].A dielectric resonator having two ports arouse using rectangular L-shaped slots lie on the ground plane that feeds the coplanar wave guide that gives a peek gain of 9.08db where it is more suitable for mill metric wave range applications[8].Depending on the size, shape and permittivity of the material the dielectric resonator with disk shape has interesting features like moderate size, ease of fabrication, high radiation efficiency, low production cost and bandwidth enlargement that is wireless applications[9-10].For the enhancement of rectangular microstrip patch antenna (RMPA),we introduced "Rectangular SRR" based Metamaterial structure. With the proposed Metamaterial structure, the impedance of RMPA is improved by 20.9 MHz and return loss is decreased by 33.8db [11]. Split ring resonator (SRR) mostly works on resonant frequencies of 2.4 GHz, 3.5 GHz and 5.2 GHz. As a resonator SRR applications include WIMAX, HYPERLAN/WLAN and Bluetooth applications. The applications of SRR provides high data rate over long distance communication with minimum interface [12]. SRR based band pass filter operates around a frequency of 2.4 GHz for wireless communications [13]. Array alignment of SRR that is inculcated into a square patch antenna to extract dual band frequency response which operates at two frequency bands for GPS and WLAN [14-15]. Research is going on in the field of microstrip antennas to enhance bandwidth and gain [16-20]. In this article a rectangular dielectric resonator having elliptical shaped patch has been proposed with CPW feed for ultrawideband applications the proposed modal has been characterized using ANSYS EM tool. The return loss, gain etc has been discussed in the subsequent sections.

2. Antenna Design

Ultra-Wide Band antenna is discerned for such applications having frequency range 3.1 to 10.6 GHz for commercial communication purpose. UWB as an advanced technology provides assurance for many reasons. But recently narrow band systems have been using for long time such as WLAN, X band. The proposed antenna constitutes of couple of U-shaped slot and inverted U-shaped slot at the CPW Transmission line are designed in such a way to get the dual band notch characteristics. To get low dispersion and

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low radiation loss Coplanar Waveguide Transmission line is used. U-shaped slot is used to perform antenna in band-reject mode. Proposed antenna constitutes of Rectangular monopole antenna with an elliptical base and Dielectric Resonator Antenna. Rectangular monopole antenna is printed on substrate Rogers TMM6 with relative permittivity εr = 6, loss tangent of 0.0023. The substrate dimensions are thickness of 0.8mm and area of 40 x 42 mm2.The combination of the rectangle and semi ellipse with Major radius of 20mm gives the geometry of proposed antenna. The designed patch is added with transmission line and the CPW Transmission line is responsible for the elevation of UWB Patch antenna is aroused from Port 1. The CPW Transmission line consists U-Shaped and inverted U-Shaped Slot that is attached above U slot in CPW Transmission line at Port1. The intersection of rectangle with ellipse results to quarter ellipse that further united with rectangle which results to ground. To provide CPW feed the ground planes are implanted from patch's both sides of Patch antenna on the same plane. The design of Proposed antenna includes Dielectric Resonator antenna is excited from port2 which is composed of material Rogers TMM10i with relative permittivity of εrd = 9.8 placed above the patch antenna. The Rectangular Dielectric A split ring resonator is designed having another split ring resonator i.e. is flipped inside at an angle of 1800 which is placed either sides of the feed line (left and right). The model and iteration model are carried out by using HFSS software.

Table 1: Dimensions of the proposed antenna.

Width	mm	Length	mm
W_s	3	L_s	12
W_a	6	L_a	1.5
Ws_1	2.4	Ls_1	4.6
W	40	Lp_1	15
W_c	1	Lp_2	13.8
W_{r1}	4	Lg_1	9
W_r	6	Lg_2	4
W_c	1	L_r	4
a	12.5	L_{r1}	2
g	0.2	b	12.5

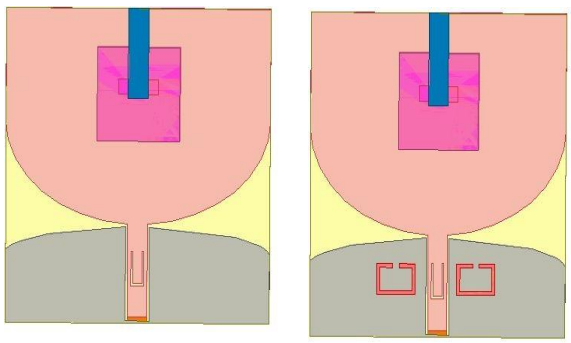


Fig 1: (a) model 1 and model 2

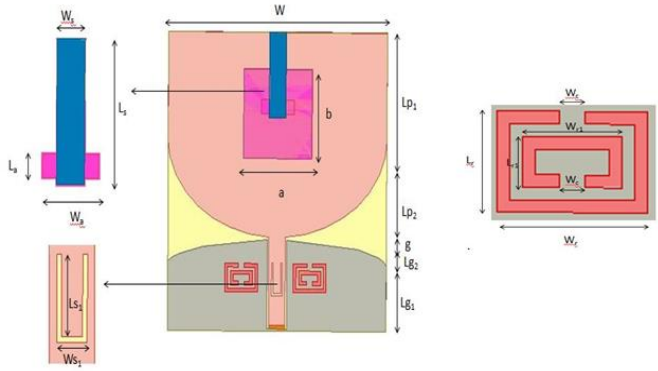


Fig 2: Design of Proposed Model with dimensions.

3. Result Analysis

In this paper three models were simulated using Ansoft HFSS. In base model UWB antenna is integrated with dielectric resonator excited by CPW transmission line. The simulated S parameters of the proposed structure are plotted versus frequency. From the results UWB patch antenna operating from 3 GHz to 8.6 GHz for return loss below -10 dB. The dielectric resonator antenna operates at 5.8 GHz and gives S22 < -10 in the range of 2.8 GHz to 8.6 GHz in HFSS simulation.

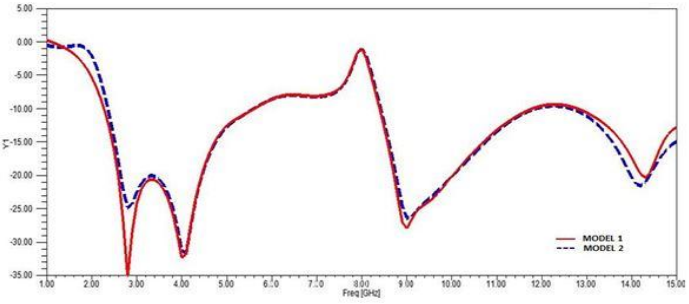


Fig 3: Return loss of model 1 and model 2

At a frequency of 8 GHz it can be observed the notch band systems whereas the frequency between 3GHz-8GHz the proposed antenna working used for the applications WLAN, WiMAX. From the simulation analysis, it is stated that transmission coefficient S parameters of port1 and port2 under -20db it provides very good isolation between two ports with which very useful in wireless systems. The radiation patterns for proposed antenna were plotted.

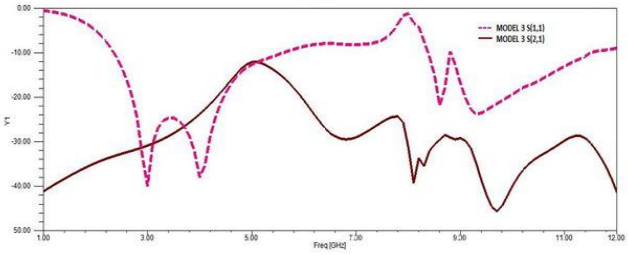
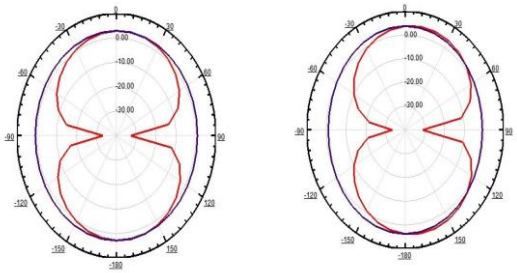
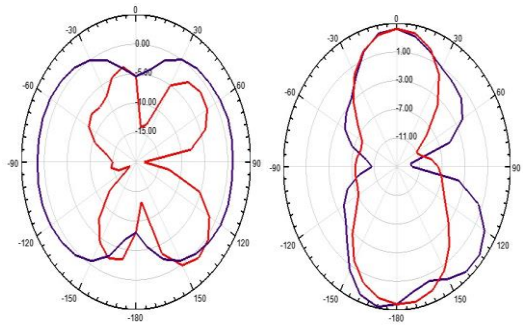


Fig 4: S Parameters of proposed model



(a) (b)



(c) (d)

Fig5: Radiation pattern at working bands that is 3GHz and 4GHz,8.6GHz and at notch band 8GHz

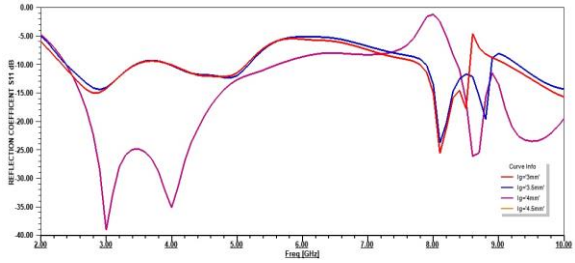


Fig 8: Parametric study based on length of the ground

4. Conclusion

In this paper, an integrated CPW-FED Ultra-Wide Band antenna, dielectric resonator and split ring resonator with single band notched characteristics have been proposed and simulated using Ansoft HFSS. The simulated results show that integrated ultra-wideband antenna operates at frequency range of 3 GHz to above 8 GHz (largely covering UWB range 3.1GHz to 8.6GHz). The dual band notched characteristics are provided by inserting U slot and inverted U slot in CPW Transmission line at Port 1 and split ring resonator at either sides of the feed. The proposed antenna provides good isolation between two ports (port1 and port 2 indicating that integration is done very efficiently. Due to band notched characteristics and good isolation the proposed design is used for many applications such as WLAN, WiMAX. With efficient integration of UWB and Dielectric Resonator it is mainly used for Cognitive radio, millimetric wave and medical applications.

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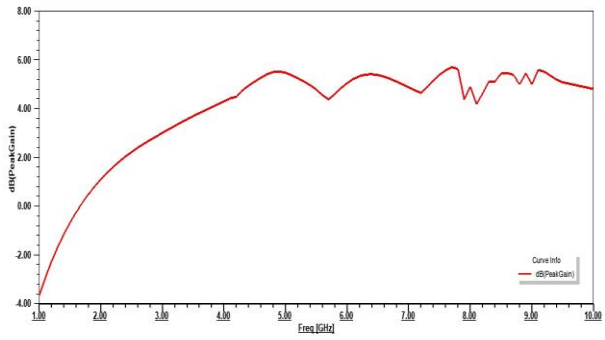

Fig 6: Gain vs frequency of the proposed antenna

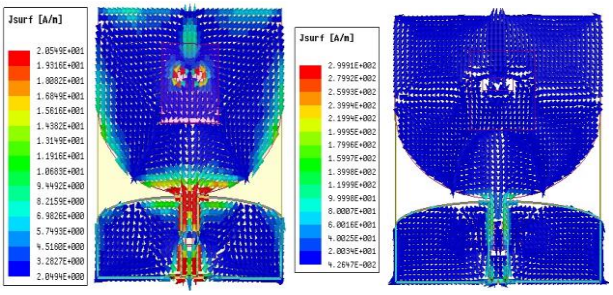

Fig 7: Current distribution of the proposed antenna at working band(4GHz) and notch band(8GHz)

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