# CSRR slotted CPW-Fed Compact Antenna for UWB Applications

Dr. Praveen Kumar Kancherla, Amulya Boyina

***ABSTRACT--****A compact monopole antenna having CPW-Fed provided with CSRR slots which produce dual notch band characteristics are presented and its results are analyzed. To obtain dual notch band characteristics in UWB against neighbourhood interfering bands, the CSRRs are used. The architecture contains CSRRs etched on patch and ground. Rogers RT/duroid 5880 material with a stature of 0.8mm of surface area 30x30mm$^2$ is used. The proposed antenna shows its impedance bandwidth that covers the ultra-wide band which is spread across 3.1GHz to 10.6 GHz for VSWR $\leq 2$ and exist dual band notches of 3.3GHz to 3.7 GHz and 5.15GHz to 5.825GHz to mitigate the interference from existing Wi-MAX and WLAN bands. The designs of antenna, geometrical parameters and simulations have been carried out by using the HFSS tool. Design procedure, parametric studies and obtained results were presented.*

***Keywords--****characteristics of band-notched, slotted complementary split ring resonators (CSRRs), UWB.*

## I. INTRODUCTION

Ultra-wide band technology is growing rapidly in the field of communication systems due to its high speed data rate, increased communication security, simple hardware configuration and low power consumption characteristics. It has huge applications such as WSN, tracking of radar location, cancer sensing and other commercial applications. As per the guidelines of US-FCC the UWB spectrum is ranging from 3.1GHz to 10.6GHz with a -10 dB bandwidth greater than 500MHz that is unlicensed in Feb 2002 for commercial communication purposes [1-2]. The UWB range contains IEEE 802.16, Wi-MAX (3.3GHz to 3.7GHz) and IEEE 802.11a WLAN (5.15GHz to 5.85GHz) [3-5]; So UWB system create interference with above discussed other wireless communication systems.

To avoid the interference in UWB, the antennas should exhibit characteristics of band-notch. Numerous antenna design techniques were developed and presented to mitigate the interference[6-10].Among these methods, slots in feeding line [11-12], slotted patch or slotted ground are popularized [13-18]. Some other methods also studied, for example parasitic elements, folded strips and resonated cells to the antennas. SRR, CSRR as shaped-slot and/or shaped-conductor to produce notches at desired frequencies. In our current study, slotted CSRRs are introduced in monopole antenna feed by CPW. The CSRRs are etched on patch as well as on ground to achieve dual notch band characteristics. The structure of CSRRs contains two rectangular split-ring slots resembles like metamaterials.

## II.ANTENNA DESIGN

Figure-1(a) showing a compact 30x30mm$^2$, with stature 0.8mm antenna is designed substrate material. In current design, both semi-circular radiating patch and an edge-curved ground plane are imprinted on substrate’s single face. CSRRs are etched on patch as well as ground surfaces. Optimized antenna parameters are presented in table-1(a) and table 1(b) contains CSRRs design values.

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**Received: 22 Feb 2019 | Revised: 13Mar 2019 | Accepted: 05 Apr 2020**

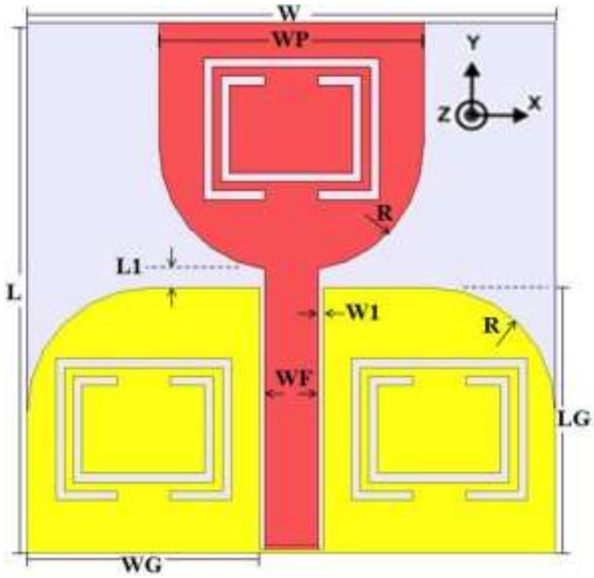


**Figure-1(a).** Shape of CPW-fed UWB antenna

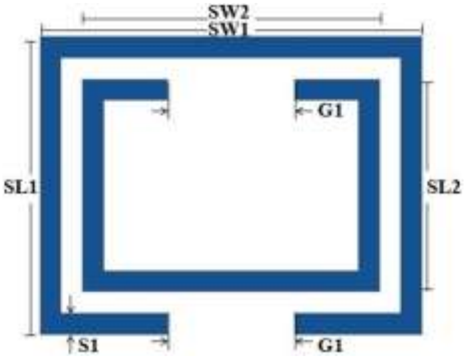


**Figure-1**(b). Shape of CSRRs slots

**Table-1(a).** Parameters of Antenna

| Parameter | L | W | WP | L1 | W1 | WF | R | LG | WG |
|---|---|---|---|---|---|---|---|---|---|
| Dimensions (mm) | 30 | 30 | 15 | 1 | 0.3 | 3 | 7 | 15 | 13.2 |

Table 1(b): CSRR design parameters

| Parameter | SL1 | SW1 | SL2 | SW2 | S1 | G1 |
|---|---|---|---|---|---|---|
| Dimensions (mm) | 8 | 10 | 6 | 8 | 0.5 | 3 |

Evolution of proposed antenna contains following steps: Ant#1, shown in blue color, contains semi-circular edged rectangular patch with curved edge ground plane. This structure resonating at 12.9GHz with impedance bandwidth ranging from 2.4 to 14.4 GHz. Ant#2, shown in pink color, CSRRs slot cut are provided on ground to achieve single band notch that ranges from 3.3 to 3.7 GHz helps to minimize interference due to Wi-MAX.



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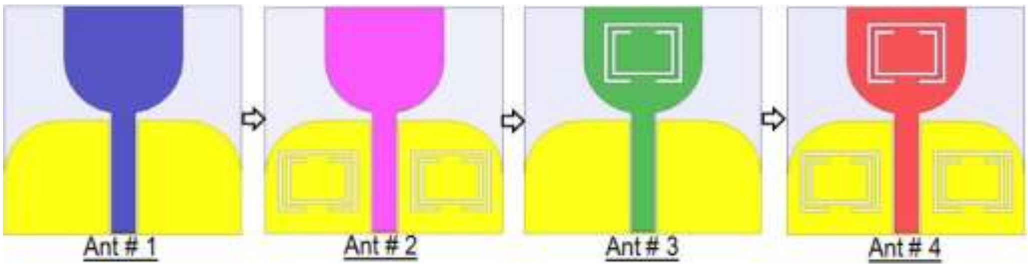


**Figure-2.** Progress of development of antenna

Ant#3 shown in green color, where CSRR is etched on patch then UWB ranging from 5.1 to 6.4 GHz is achieved. In Ant#4, shown in solid red color CSRRs are etched on patch and ground so the desired characteristics are achieved. The resultant antenna working from 2.23GHz to 14.95GHz, with two notched bands(i.e Wi-MAX and WLAN). Comparative VSWR characteristics are presented in Figure-4.

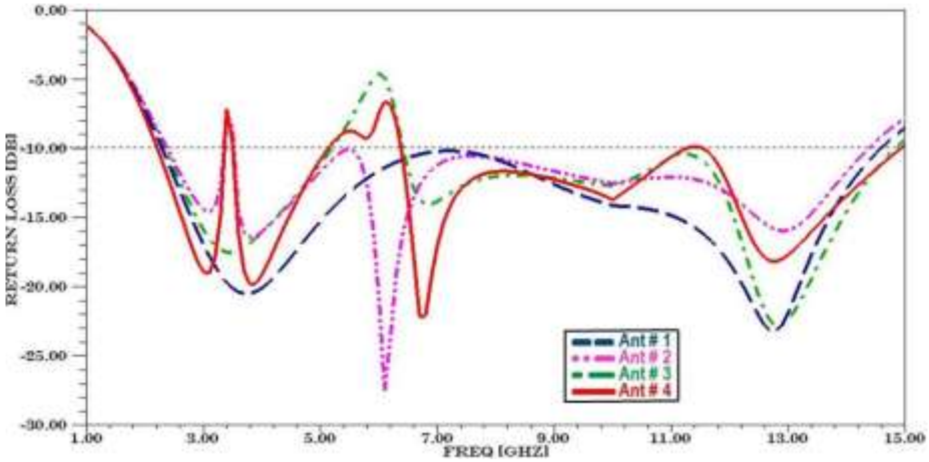


**Figure-3.** Comparative analysis of return loss characteristics.

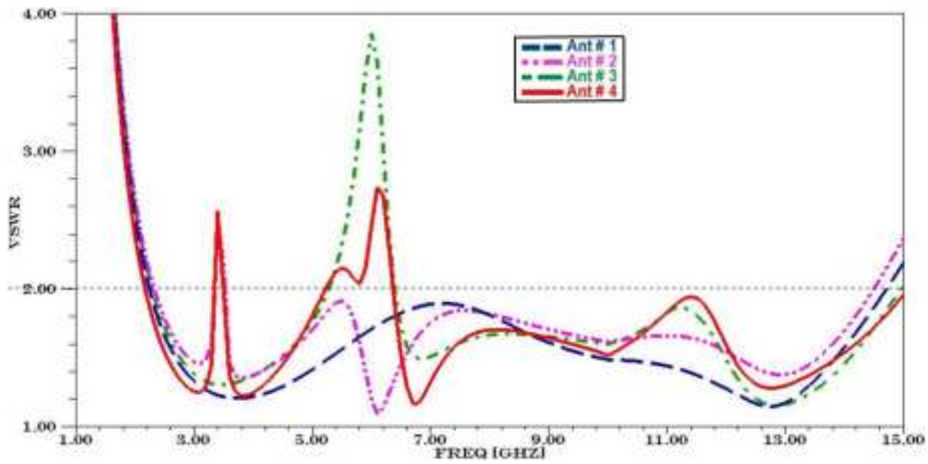


**Figure-4.** VSWR characteristics at all evolution stages.

To obtain optimized design parameters parametric analysis was performed and obtained results were presented in Figure-5(a). When external ring length SL1 was varied, an improvement in bandwidth was achieved. Radiating antenna and corresponding CSRR parameters are altered and obtained results were verified, observed shift in notch band to right presented in Figure 5(b).



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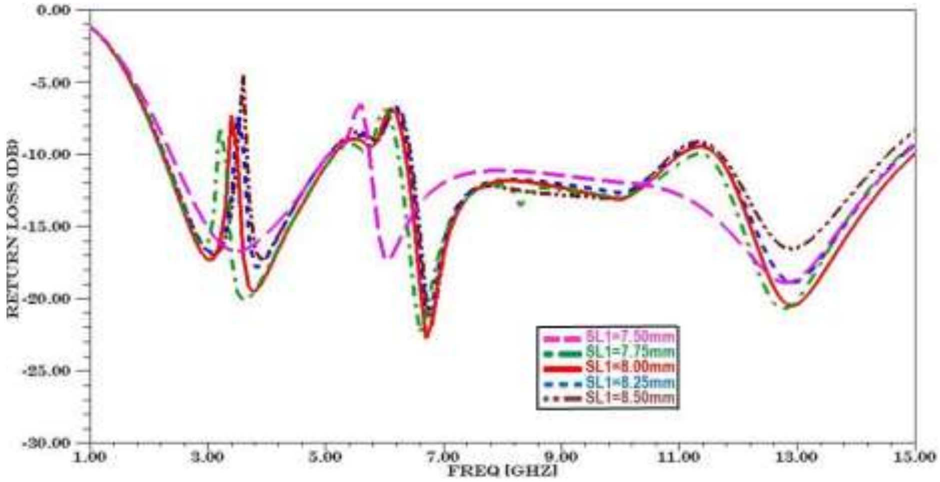


**Figure-5(a).** Analysis of SL1 parametric effect.

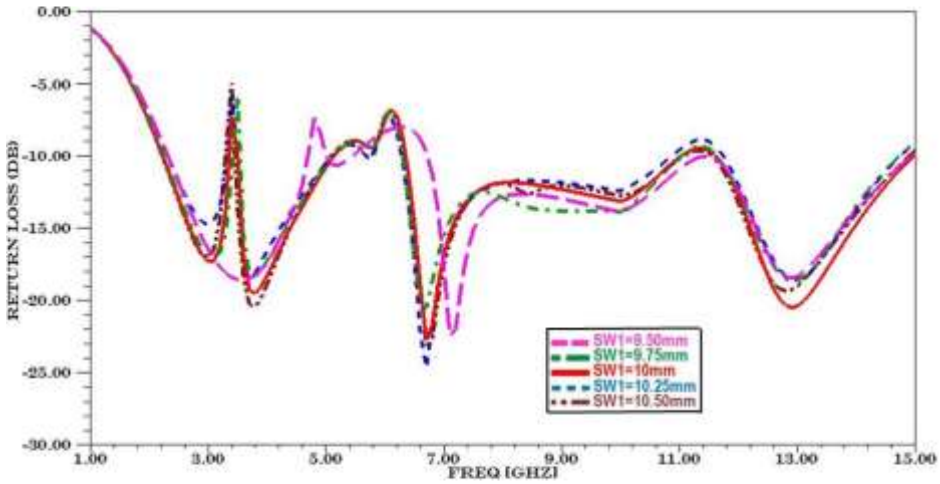


**Figure-5(b).** Analysis of SW1 parametric effect

The return loss characteristics for different G1 values is plotted and presented in Figure-5(c). The raise in G1 value, obtained switch in eliminated bands and achieved optimum value at 3mm.

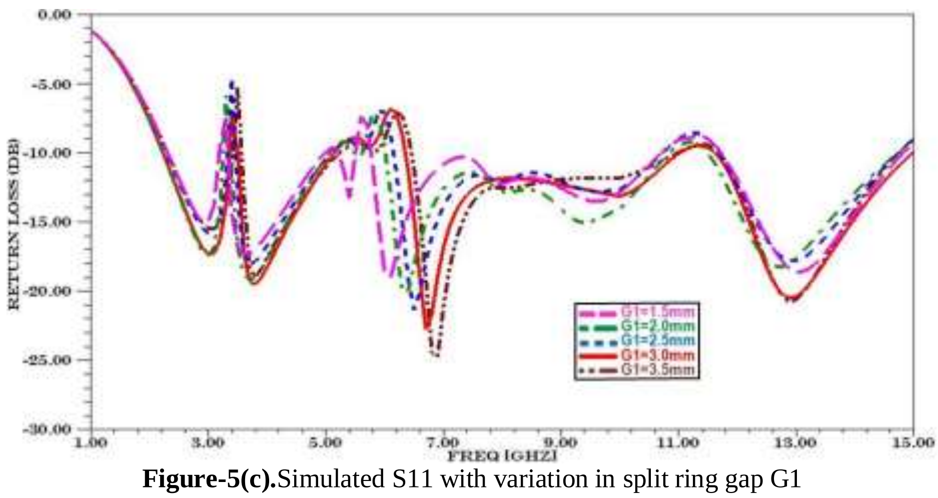


**Figure-5(c).**Simulated S11 with variation in split ring gap G1

Thickness of CSRR (S1) is varied results shift in band notch towards left, is presented in Figure-5(d). To get better performance characteristics S1 value is set to 0.5mm.



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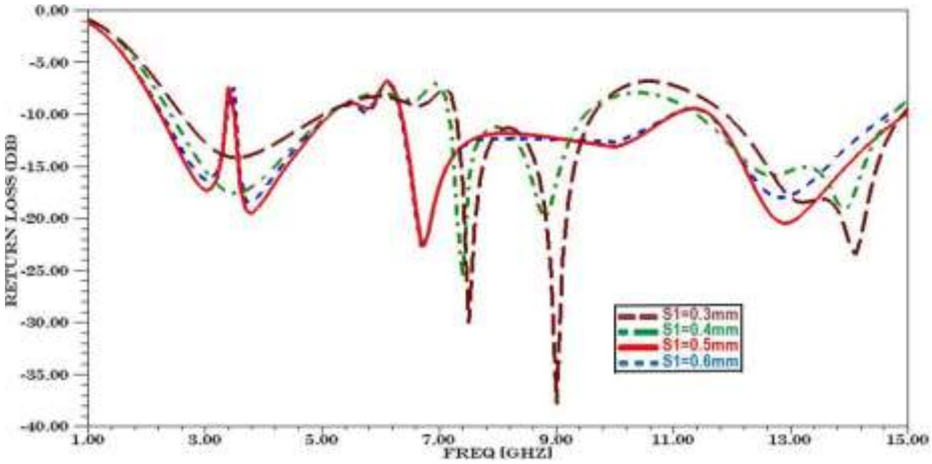


**Figure-5(d).**Simulated S11 with variation in S1

Final simulated results such as coefficient of reflection for different feed line widths (Wf) are presented in Figure-5(e). For optimum value of 3mm, notched Wi-MAX and WLAN bands are acquired.

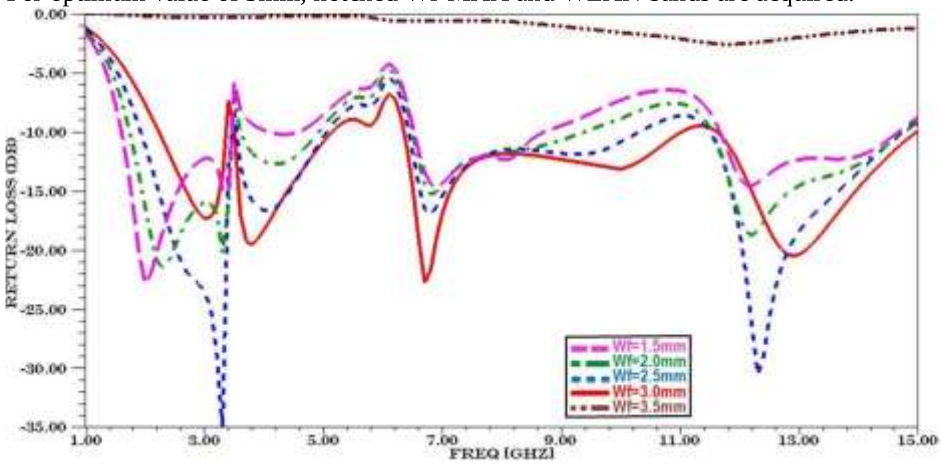


**Figure-5(e).** Analysis of coefficient of reflection at different Wf values

The distribution of surface currents at 3.4 GHz and 5.6 GHz is depicted in Figure-6. High concentration of current is indicated by red color while low concentration is indicated with blue color. At 3.4GHz, high concentration of surface currents on and around the CSRRs slots etched on metal ground while weaker flow of current at CSRRs slot etched on the radiating patch is observed. So the influence of this slot on radiating characteristics is very less. At 5.6 GHz the current flow is more concentric at feed line as well as slotted CSRRs on radiating patch, which indicates clear effects of slots on dual band-notched characteristics.

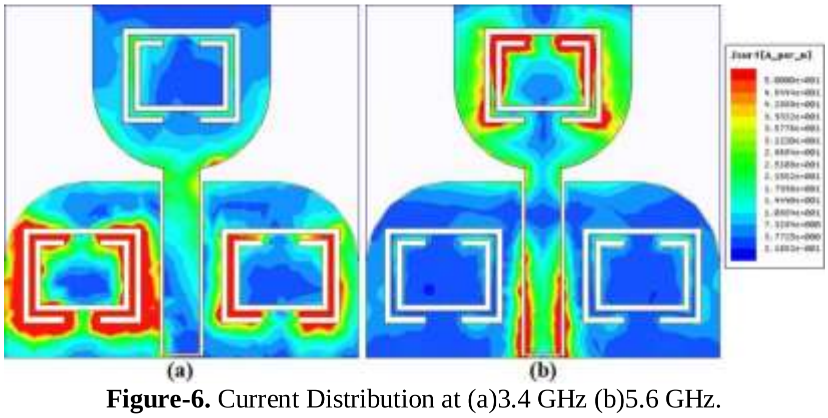


**Figure-6.** Current Distribution at (a)3.4 GHz (b)5.6 GHz.



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International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 06, 2019
ISSN: 1475-7192

## III.RESULTS AND DISCUSSION

Top and rare view of fabricated antenna is depicted in Figure-7. Its results are measured using R&S ZNB 20 Vector Network Analyzer. Measured and simulated results are achieved good agreement where rejection and pass bands as per the specifications.

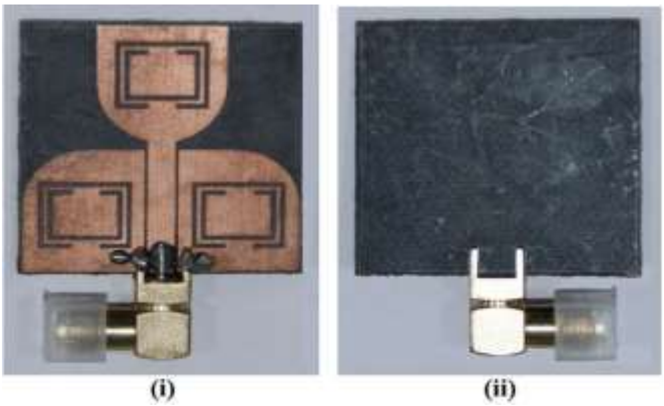


**Figure-7(a).** Prototype of antenna (i) front view (ii) back view

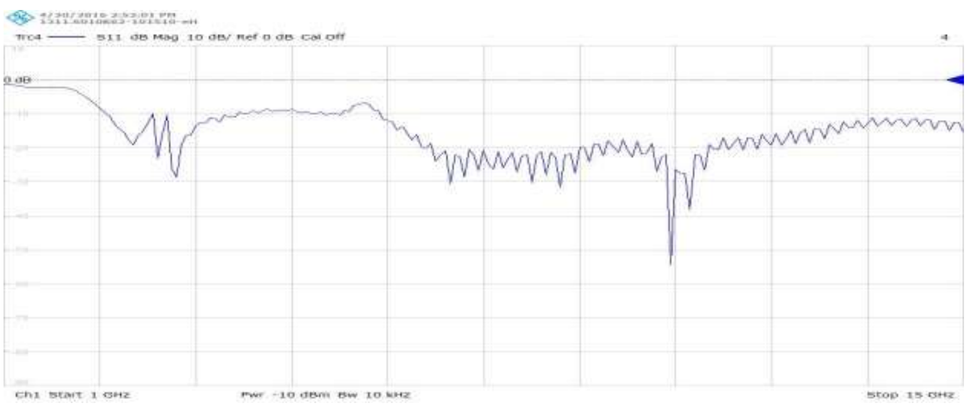


**Figure-7(b).** Measured results on ZNB 20 VNA

The 2D E-plane and H-plane radiation patterns at 3.0GHz, 3.7GHz, 6.7GHz & 10GHz of antenna is depicted in Figure-8. During lower frequencies, H plane pattern are appear to be Omni directional while at higher frequencies same H plane pattern is appeared nearly Omni directional. At both lower and higher frequencies E plane pattern are appear to bidirectional. Constant and stable gain characteristics are achieved during frequency sweep except at notch band is presented in Figure-10.



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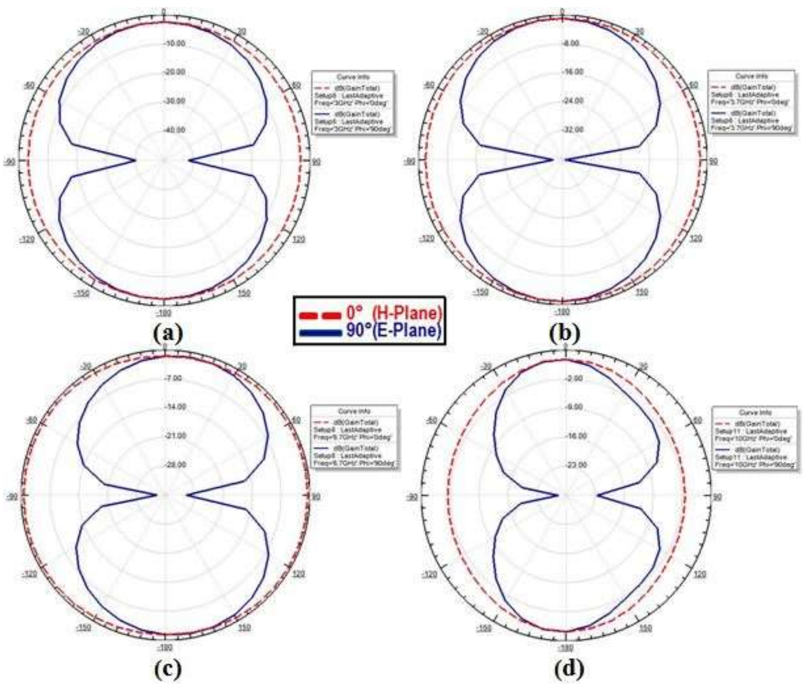


**Figure-8.** 2D Radiation patterns at: (a) 3.0 GHz (b) 3.7GHz (c) 6.7GHz (d) 10 GHz.

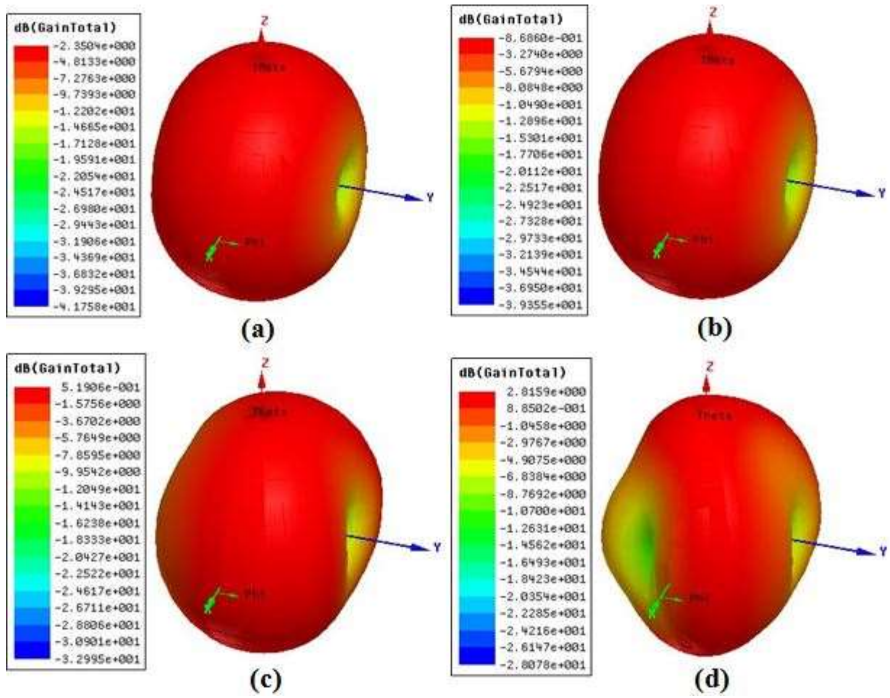


**Figure-9.** 3D Polar plots at: (a) 3.0 GHz (b) 3.7 GHz (c) 6.7 GHz (d) 10.0 GHz.



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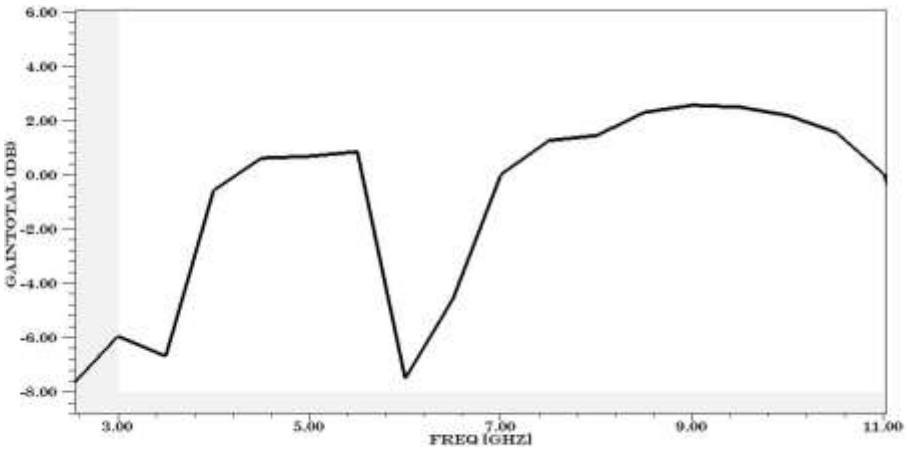


**Figure-10.** Gain vs Frequency plot.

## IV.CONCLUTION

In current article, minimized CPW monopole antenna inserted by CSRRs slots for double notch band UWB attributes is planned and introduced. Its deliberate outcomes are demonstrating great concurrence with simulated results. Consequently current design is best reasonable for wireless communication applications.

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**Received: 22 Feb 2019 | Revised: 13Mar 2019 | Accepted: 05 Apr 2020**