Stub loaded UWB Antenna for Dual Notch Bands

Ch.RamaKrishna, G.A.E. SatishKumar, P. Chandra Sekhar Reddy

Abstract*: A Dual Notch ultra wideband antenna (UWB) is presented in this communication. The dual notch bands covers the WLAN and WiMAX frequencies. The Ultra wideband is achieved by introducing multiple techniques into a basic antenna. The basic radiating element is a rectangular patch with a pentagonal slot at the center for which the bottom two edges of the patch are truncated in steps. A ground with a rectangular slot at the middle is considered. The cumulative effect of edge truncated slotted patch and partial defective ground plane will generate ultra wideband. To generate notch bands two stubs are loaded into the pentagonal slot there by enabling isolation in the WLAN and WiMAX frequencies. Proposed antenna is having a bandwidth of 10.37GHz ranging from 3.08GHz to 13.45GHz with isolation ranging from 3.66GHz to 3.86GHz and 4.9GHz to 5.6GHz.

***Keywords* : Dual Notch, Partial ground, Slotted Patch, Ultra wideband.**

I. INTRODUCTION

With the increase of innovations in the field of telecommunications many new application in the area of public safety and ease of access is coming forward which also include medicine and inter modular communications. All most every application stated above use the ultra wideband frequency range because of its high spectrum bandwidth which can support high data rate. Proper care has to be taken in using these devices so as to avoid any interference with the WLAN and WiMAX frequencies. The best option for this is making the antenna itself non resonating at these frequencies instead of adding filters and making the system heavy.

Many researchers proposed techniques to produce notch bands in ultra wideband. In [1] a dual notch UWB with micro strip feed is proposed which use two complementary split ring resonators (CSRR) in the patch to develop two notch bands. Here the position of the CSRR structure with respective to patch is very important as it will determine the performance of the notch bands. In [2] a stop band filter has been proposed which use a slotted ground and a cylindrical resonator to develop filtering characteristics. The placement of the resonator and its dimensions will determine the notch characteristics. In [3] multiple techniques of corner truncation, slotted patch and defective ground structures are used to develop triple notch bands. Multiple slots are been etched in the patch to generate triple notch bands. In [4] a antenna with filtering characteristics is been designed using a T slot which can minimize the levels of higher order modes. In [5] a dual symmetrical semi circular slotted circular patch antenna has been proposed to develop triple frequency of operation. Similarly many techniques were reported to develop ultra wideband and notch bands [6-10].

All the techniques reported above have one or the other problem like accurate placement of split ring resonator structures, Inserting the cylindrical resonators into the antenna and the complexity in fabricating the antennas, etching multiple slots or placing filtering structures in the patch to develop notch bands which involves a lot of effort in designing the antenna and also in optimizing the positions of the structures which may lead to low accuracy.

Proposed antenna is a dual notch UWB. UWB is achieved by introducing multiple techniques into a basic antenna which lead to development of dual notch bands at lower frequencies.

II. DEVELOPMENT OF ANTENNA

The simulated structure of the antenna is presented in the figures below. Figure 1(a) shows the model of the patch of the ultra wideband antenna where as figure 1(b) shows the model of the ground plane of the ultra wideband antenna. Similarly Figure 2(a) shows the model of the patch of the dual notch ultra wideband antenna where as figure 2(b) depicts the schematic model of the ground plane of the dual notch ultra wideband antenna. Table 1 below gives the optimized values of both the antennas.

For the construction of ultra wideband antenna initially we have taken a rectangular patch with a 50Ω strip feed to provide excitation. At the center of the rectangular patch a pentagonal slot has been etched. The lower two corners of the rectangular patch are been truncated in a step structure. Both the center slot and the corner truncation in the patch will enhance the bandwidth of the antenna. For further development of the bandwidth we have taken a partial ground plane at the bottom of the patch and a rectangular slot has been etched in the ground inline with the stripfeed to further enhance the bandwidth of antenna.

For the development of the ultra wideband antenna with dual notch bands we have inserted two stubs inside the center polygon slot which will act as a filtering structure and will produce the notch bands. The length of the stubs will decide the frequency of the notch band produced. The width of the stubs will determine the bandwidth of the notch band.

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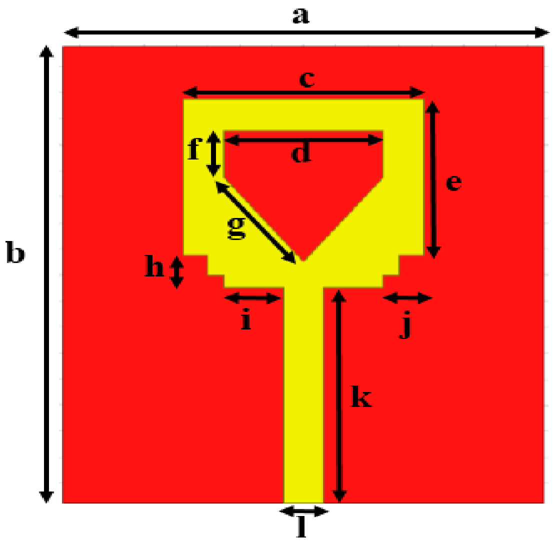
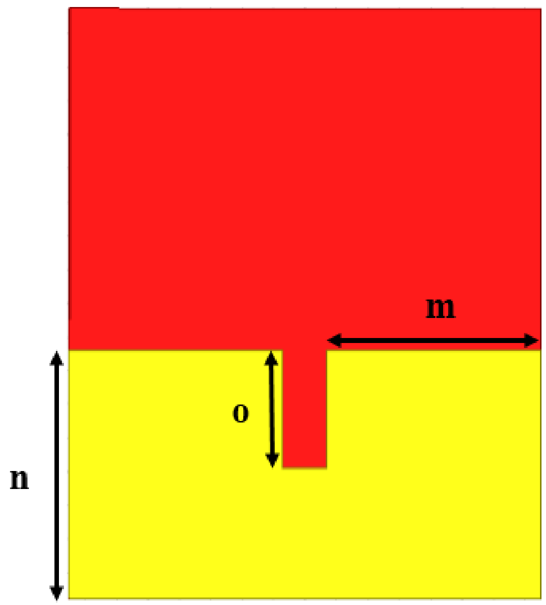
* Correspondence Author
Ch.RamaKrishna*, Electronics and Communication Engineering, Scholar JNTU Hyderabad, Assistant Professor in ECE ,Vardhaman college of Engineering , India. Email: rahulvar434@gmail.com
Dr.G.A.E. Satish Kumar, Professor in ECE, Vardhaman College of Engineering, Hyderabad, India. Email: gaesathi@gmail.com
Dr.P. Chandra Sekhar Reddy, Professor in ECE, JNTU H college of Engineering, Hyderabad, India. Email: drpcsreddy@gmail.com

So by varying the length and width of the stubs one can tune the notch bands produced to any required frequency. The length of the stubs in the patch is in the order of the wavelength of the frequency at which the notch band is required. Whenever the antenna is excited both the antenna and the stub will generate the currents which will produce a same frequency of resonance but the direction of the currents will be in opposite directions and the net current at that particular frequency will be zero and the result will be a development of a notch band.



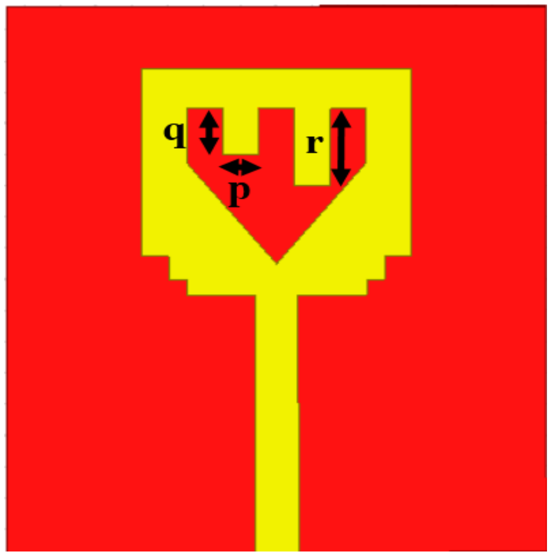
(a) Top View



(b) Rare View
Fig. 1. Proposed UWB antenna

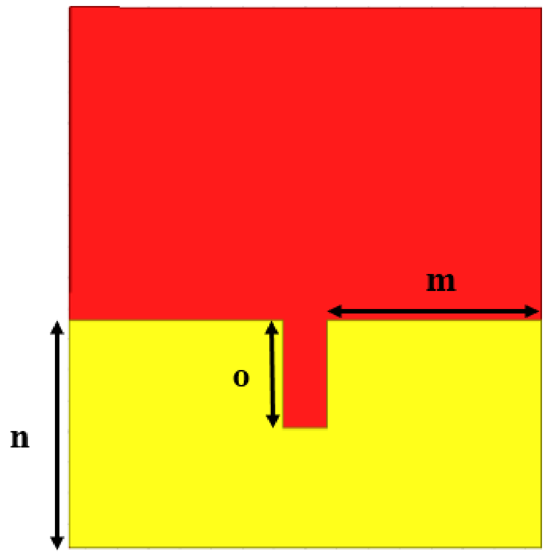
TABLE 1 OPTIMIZED VALUES OF THE ANTENNA GOMETRY

Label	a	b	c	d	e	f
Value(mm)	30	35	15	10	12	3.51
Label	g	h	i	j	k	l
Value(mm)	8.19	2.5	3.8	2.5	16.5	2.4
Label	m	n	o	p	q	r
Value(mm)	13.6	14.7	12	2	3	5



(a) Front View

Proposed antenna is modeled in HFSS software using a FR4 substrate with a height of 62mils and a dimension of 30mm×35mm which is fed with a 50Ω feed line. Two stubs are loaded into the pentagonal slot to develop notch bands.



(b) Rare View
Fig. 2. Proposed Notch band antenna

III. RESULTS

The impedance bandwidth plot of the ultra wideband antenna and dual notch band antennas are presented in figure 3(a) and figure 3(b). In Figure 3(c) we have the comparison of both the graphs. Proposed antenna is having a bandwidth of 10.37GHz ranging from 3.08GHz to 13.45GHz and to generate notch bands two stubs are loaded into the pentagonal slot there by enabling isolation in the WLAN and WiMAX frequencies with isolation ranging from 3.66GHz to 3.86GHz and 4.9GHz to 5.6GHz.

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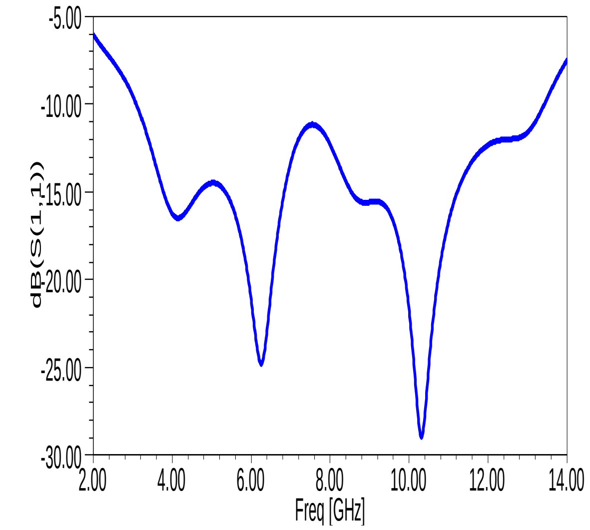
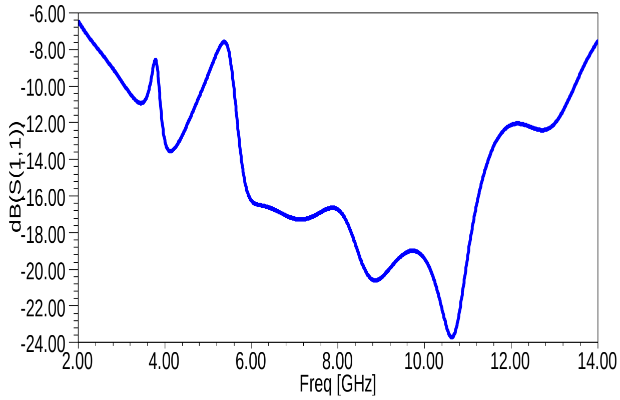
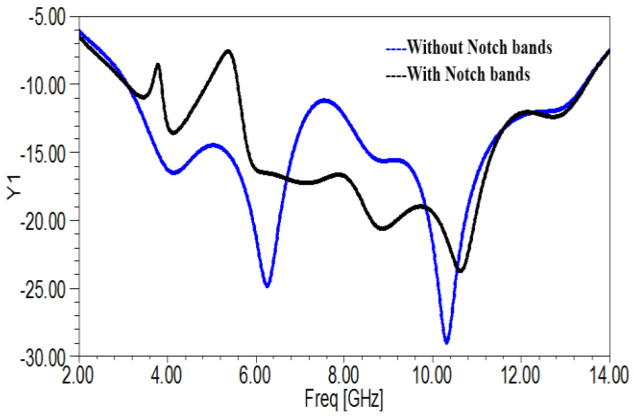


(a) ultra wideband antenna



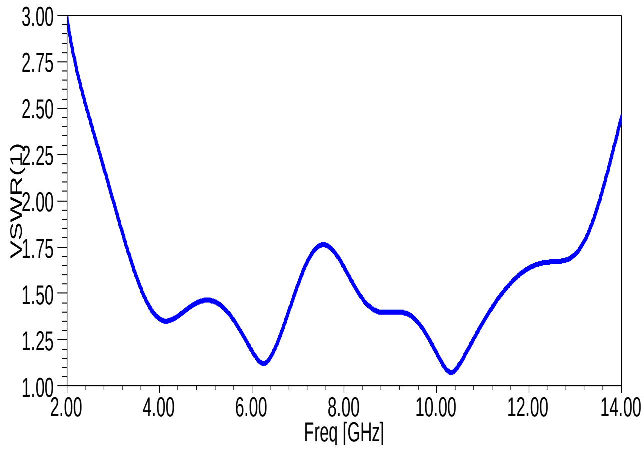
(b) Dual Notch ultra wideband antenna



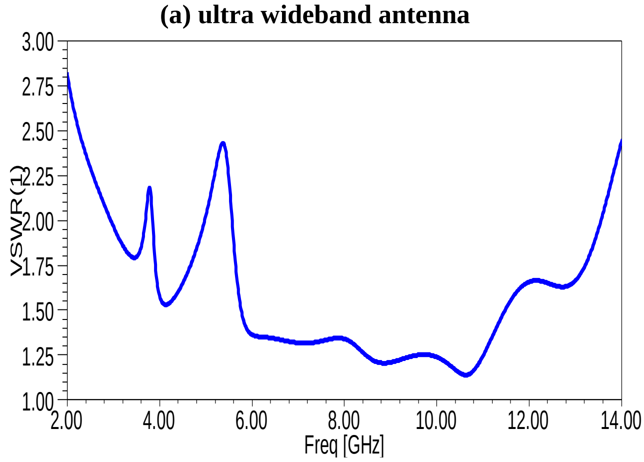
(c) Comparison

Fig. 3. Return loss plots

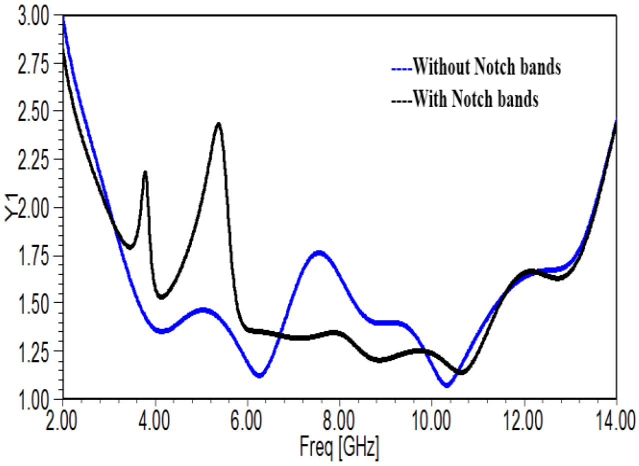
The VSWR bandwidth of the proposed ultra wideband antenna and dual notch band antennas are presented in the figure 4(a) and figure 4(b). In the Figure 4(c) we have the comparison of both the graphs. Proposed antenna is having a VSWR bandwidth of 10.37GHz ranging from 3.08GHz to 13.45GHz and to generate notch bands two stubs are loaded into the pentagonal slot there by enabling isolation in the WLAN and WiMAX frequencies with isolation ranging from 3.66GHz to 3.86GHz and 4.9GHz to 5.6GHz. We can observe that the VSWR value is less than 2 for the entire bandwidth except at the isolation ranging from 3.66GHz to 3.86GHz and 4.9GHz to 5.6GHz.



(a) ultra wideband antenna



(b) Dual Notch ultra wideband antenna



(c) Comparison of VSWR characteristics

Fig. 4. VSWR

The Gain for the proposed ultra wideband antenna and dual notch band antennas at four intermediate frequencies of 4GHz, 6.5GHz, 8GHz and 10GHz are presented in figures 5 and in figure 6. The proposed ultra wideband antenna is having a gain of 4.97dB, 3.09dB, 2.80dB, and 4.61dB at 4GHz, 6.5GHz, 8GHz and 10GHz respectively.

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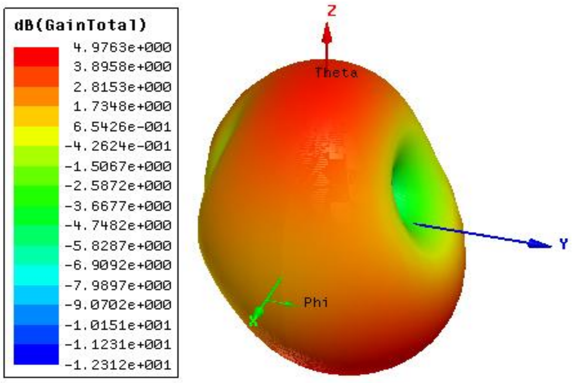
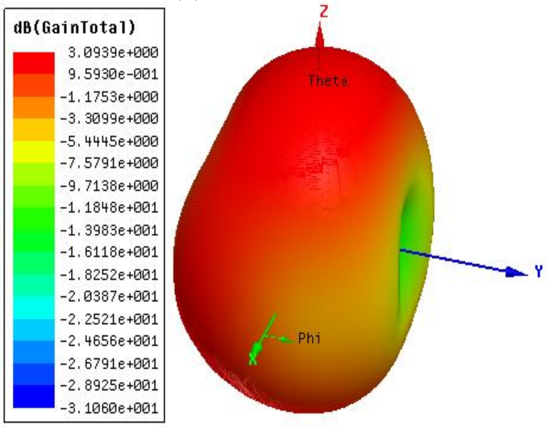
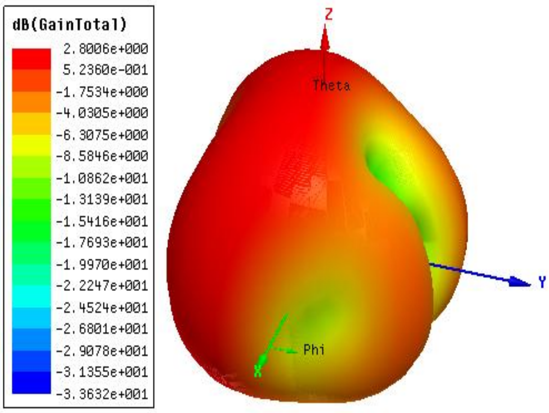


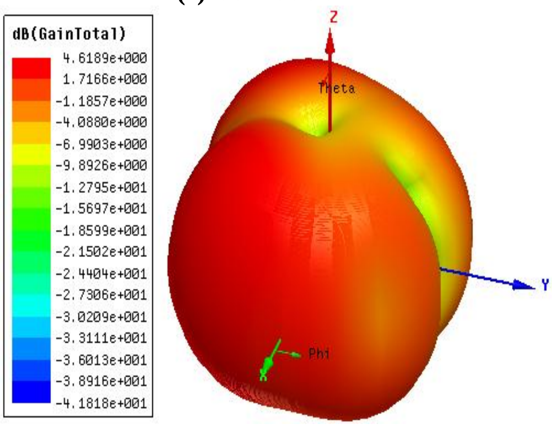
(a) Gain at 4GHz



(b) Gain at 6.5GHz

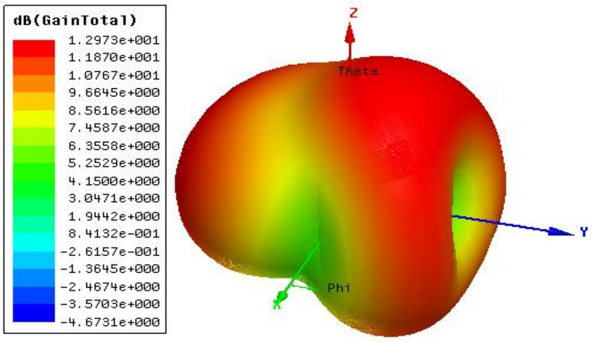


(c) Gain at 8GHz

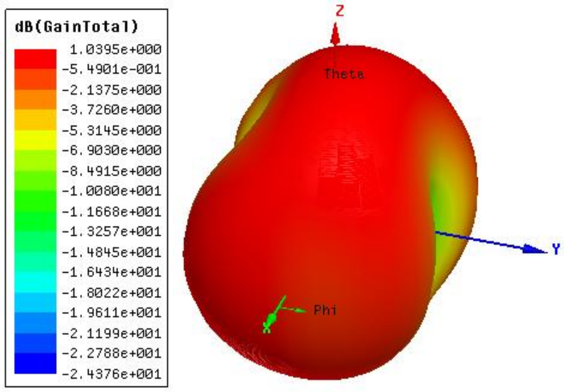


(d) Gain at 10GHz

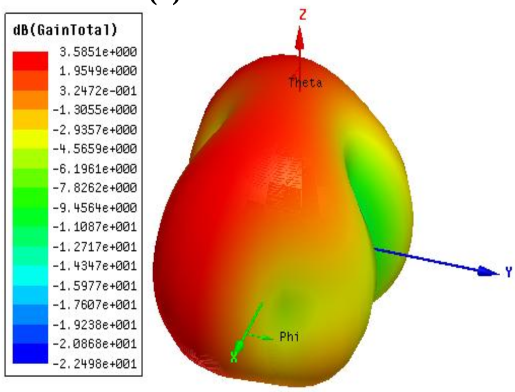
Fig. 5 Gain of Ultra Wideband antenna



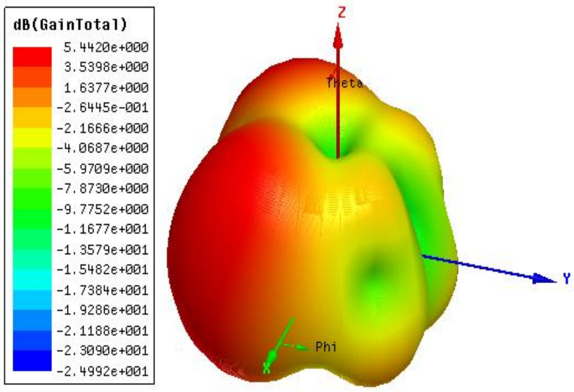
(a) Gain at 4GHz



(b) Gain at 6.5GHz



(c) Gain at 8GHz



(d) Gain at 10GHz

Fig. 6 Gain of Dual Notch band antenna

From the gain plots we can observe that the introduction of the two stubs for developing the notch bands is having a very less effect on the gain at the remaining frequencies.

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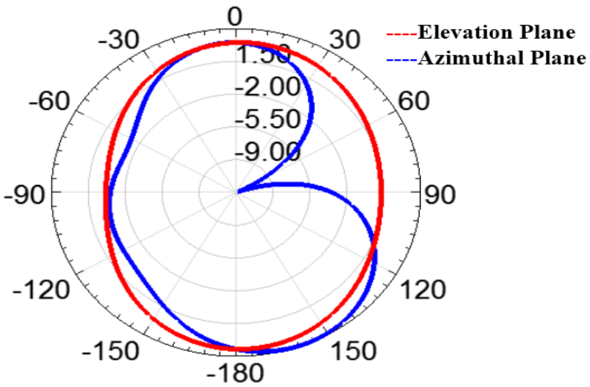
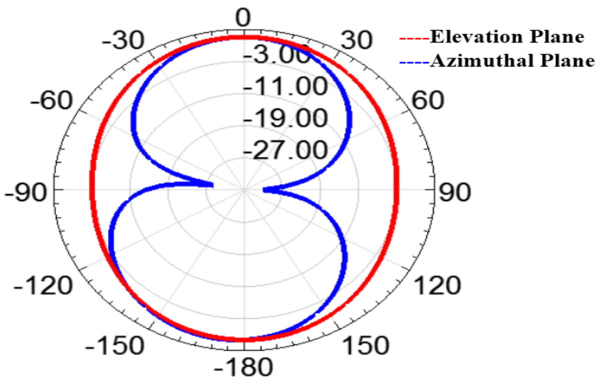
The proposed ultra wideband antenna with dual notchs is having a gain of 1.29dB, 1.03dB, 3.58dB, and 5.44dB at 4GHz, 6.5GHz, 8GHz and 10GHz respectively. Though a reduction of gain can be observed at the frequencies which are near to the notch bands but still the antenna is able to radiate the power and the gain of the antenna at these frequencies is considerably good for usage.

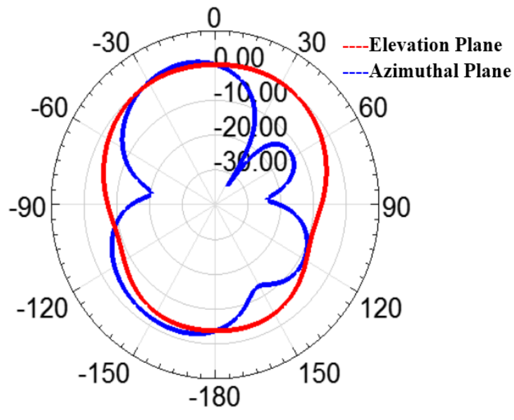
The radiation patterns for the proposed ultra wideband antenna and dual notch band antennas at four intermediate frequencies of 4GHz, 6.5GHz, 8GHz and 10GHz are depicted in figures 7 and 8 respectively. Both elevation plane and azimuthal plane of the antennas were presented in the figures. We can observe that for both the antenna models the radiation pattern is having a uniformity and is having a omni directional coverage. We can observe a null in the pattern at some frequencies which is quite normal in the ultra wideband antennas. Anyhow the nulls are not present at the bore side of the antenna so the antenna performance will not have a considerable effect because of these null.



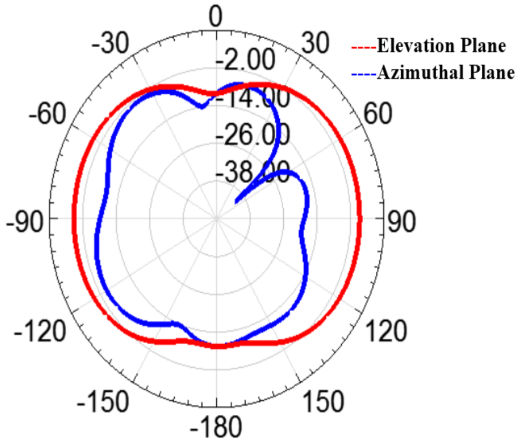
(a) at 4GHz



(b) at 6.5GHz

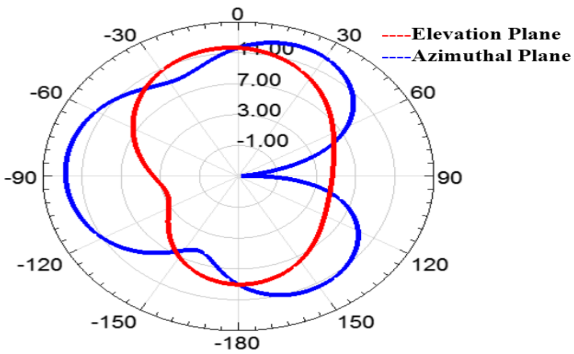


(c) at 8GHz

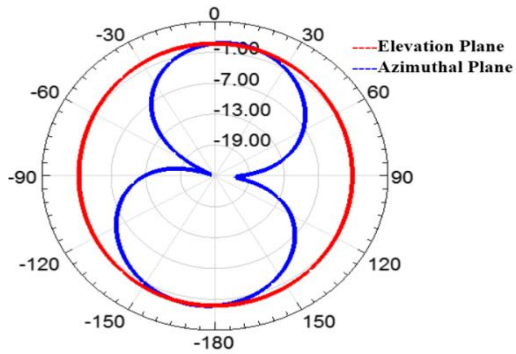


(d) at 10GHz

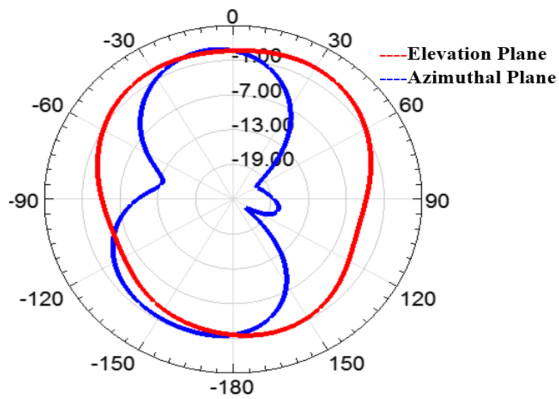
Fig. 7. Radiation pattern of Ultra Wideband antenna



(a) at 4GHz



(b) at 6.5GHz



(c) at 8GHz

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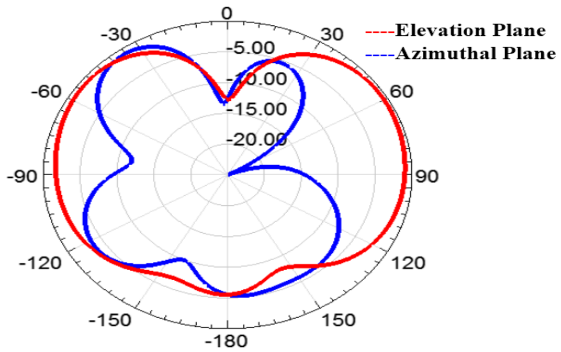
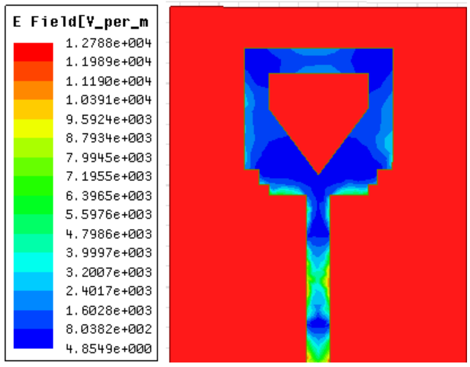


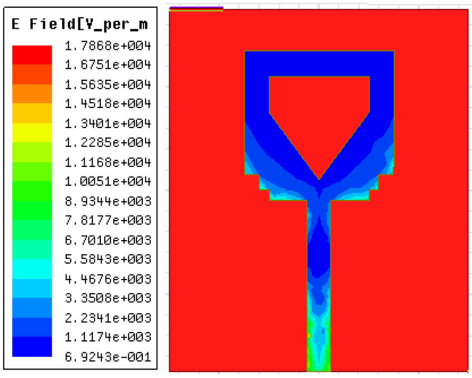
(d) at 10GHz

Fig. 8. Radiation pattern of Dual Notch band antenna

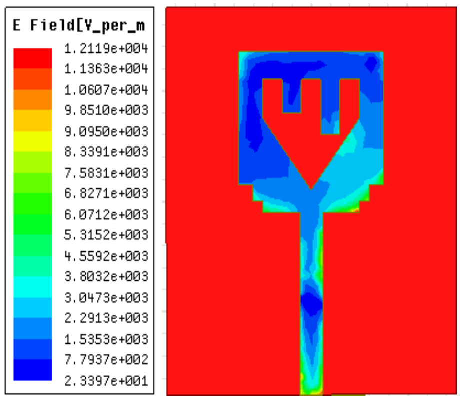


(d) at 10GHz

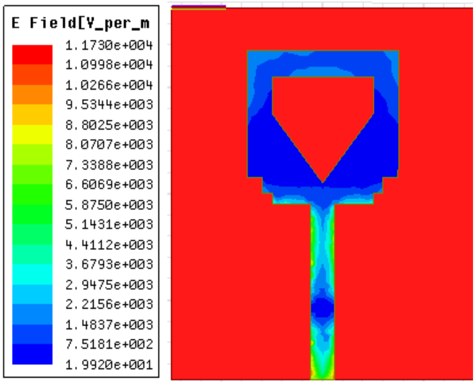
Fig. 9. Current distribution plots of Ultra Wideband antenna



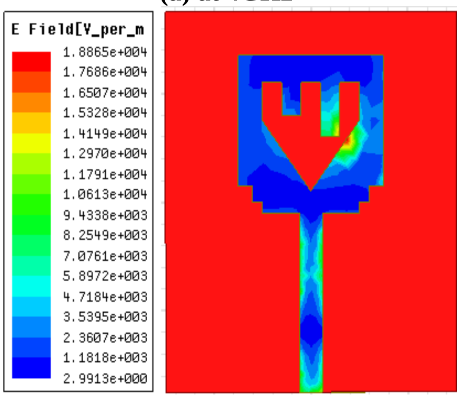
(a) at 4GHz



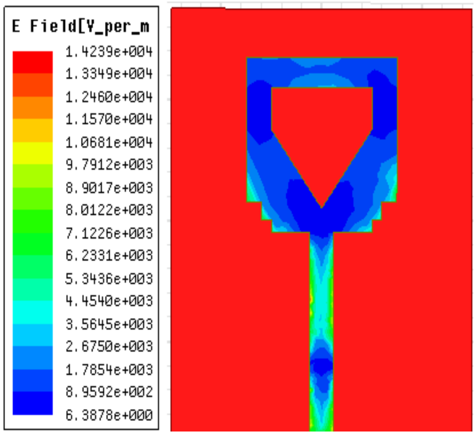
(a) at 4GHz



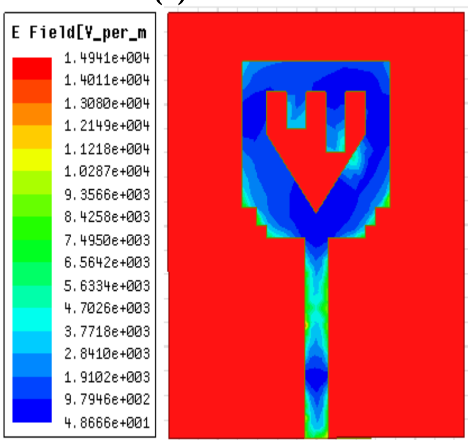
(b) at 6.5GHz



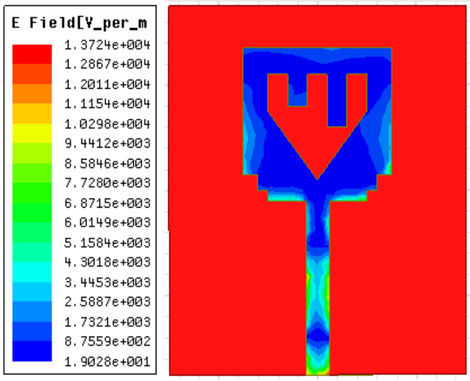
(b) at 6.5GHz



(c) at 9GHz



(c) at 9GHz



(d) at 10GHz

Fig. 10. Current distribution plots of Dual Notch band antenna

Current distributions for the proposed ultra wideband antenna and dual notch band antennas at four intermediate frequencies of 4GHz, 6.5GHz, 8GHz and 10GHz are depicted in the fgures 9 and 10 respectively. From the surface current distributions we can determine that different regions in the patch are responsible for radiation at different operating frequencies.

The figures 11 and 12 show the fabricated Dual band notch UWB antenna front and bottom views of the proposed antenna. Similarly figures 13 and 14 shows the measured return loss and Radiation pattern of the UWB band notch Antenna.

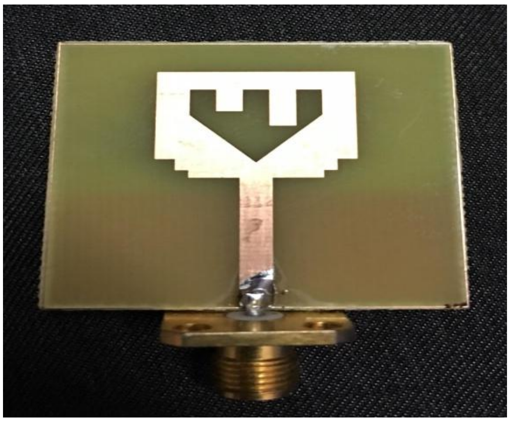


Fig.11. Front view of the Dual Notch band antenna

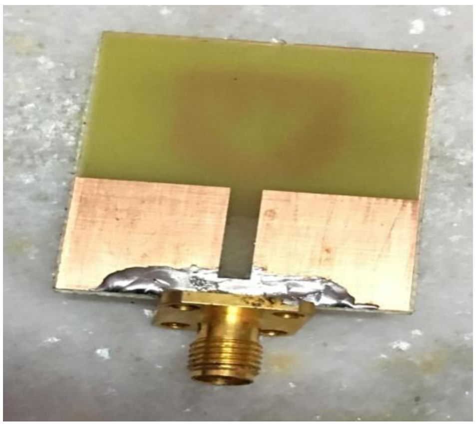


Fig.12. Bottom view of the Dual Notch band antenna

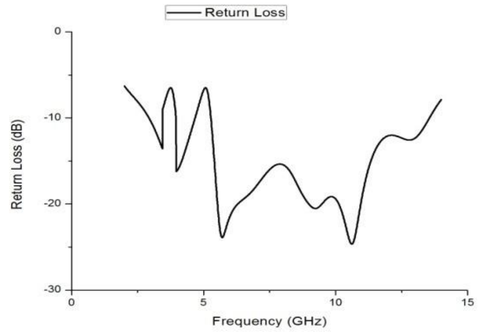


Fig.13. Measured Return Loss of the Dual Band Notch antenna

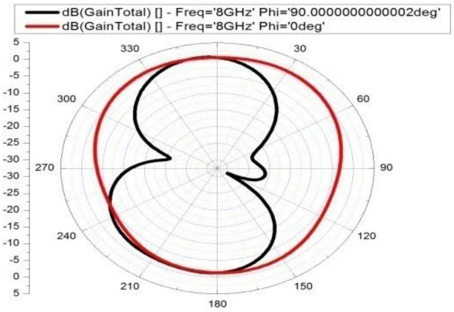


Fig.14. Measured Radiation Pattern of the Dual Band Notch antenna

IV. CONCLUSION

A Dual Notch UWB antenna is presented in this communication. The dual notch bands covers the WLAN and WiMAX frequencies. The Ultra wideband is achieved by introducing multiple techniques into a basic antenna. The basic radiating element is a rectangular patch with a pentagonal slot at the center for which the bottom two edges of the patch are truncated in steps. A ground with a rectangular slot at the middle is considered. The cumulative effect of edge truncated slotted patch and partial defective ground plane will generate ultra wideband. To generate notch bands two stubs are loaded into the pentagonal slot there by enabling isolation in the WLAN and WiMAX frequencies. Proposed antenna is having a bandwidth of 10.37GHz ranging from 3.08GHz to 13.45GHz with isolation ranging from 3.66GHz to 3.86GHz and 4.9GHz to 5.6GHz.

REFERENCES

1. E. Kusuma Kumari "Printed Monopole UWB Antenna with Dual Notch Bands" International Journal of Recent Technology and Engineering, Volume-7, Issue-5S4, February 2019.
2. Anil Kumar Karra, Arsavelli Janardhana "Design of a Novel Wide Stopband Common Mode Filter with Slotted Ground" International Journal of Recent Technology and Engineering, Volume-7, Issue-5S4, February 2019.
3. K.Leela Rani, K.Sowjanya, Sk.Khamuruddeen "Triple Frequency U-Slot Antenna for 5G and Satellite Communications" International Journal of Recent Technology and Engineering (IJRTE), Volume-7, Issue-5S4, February 2019.
4. Mohan Kumar D "Circular Polarized Ring Slot Antenna with Filtering Characteristics" International Journal of Recent Technology and Engineering, Volume-7, Issue-5S4, February 2019.
5. Sekhar M, Siddaiah P "Triple Frequency Circular Patch Antenna" 2014 IEEE International Conference on

Computational Intelligence And Computing Research, Park College Of Engineering And Tekhnology, ISBN: 978-1-4799-1594-1.

6. E. Kusuma Kumari, A.N.V.Ravi Kumar. (2017). Wideband High-Gain Circularly Polarized Planar Antenna Array for L Band Radar. IEEE International Conference on Computational Intelligence And Computing Research, Tamilnadu College of Engineering. Tamil Nadu.
7. Rao N.A, Kanapala S. (2018). Wideband Circular Polarized Binomial Antenna Array for L-Band Radar. Panda G., Satapathy S., Biswal B., Bansal R. (eds) Microelectronics, Electromagnetics and Telecommunications. Lecture Notes in Electrical Engineering, vol 521. Springer, Singapore.
8. T.V.Murali Krishna "Multi Band Slotted Planar Antenna for Maritime Applications" International Journal of Recent Technology and Engineering (IJRTE), Volume-7, Issue-5S4, February 2019.
9. Kanapala S, Rao N.A. (2018). Beam Steering Cuboid Antenna Array for L Band RADAR. Panda G., Satapathy S., Biswal B., Bansal R. (eds) Microelectronics, Electromagnetics and Telecommunications. Lecture Notes in Electrical Engineering, vol 521. Springer, Singapore.
10. E. Kusuma Kumari, A.N.V.Ravi Kumar "Development of an L Band Beam Steering Cuboid Antenna Array" 2017 IEEE International Conference on Computational Intelligence And Computing Research, Tamilnadu College of Engineering, ISBN: 978-1-5090-6620-9

AUTHORS PROFILE

Ch. Ramakrishna received the B.Tech and M.Tech degree in Electronics and Communication Engineering from Jntu Hyderabad in 2006 and 2010.From 2007 he is worked as a Assistant Professor in the Department of Electronics and Communication Engineering in different organizations. Presently he is working as a Assistant professor in the Vardhaman college of Engineering, Shamshabad, Telangana and pursuing Ph.D from Jntu Hyderabad. His research interests include the Electromagnetics, Micro strip Patch Antennas, UWB Antennas and Microwave resonators.He has authored over 2 research papers.

Dr. G.A.E. Satish Kumar was born on 23rd February,1971 at Jammalamadugu(AP,India).He received his B.Tech degree in Electronics and Communication Engineering from Sri Krishnadevaraya University in 1995.He then received his M.E degree in Communication Systems from Gulbarga University in 1999 and Ph.D in signal Processing from JNT University Hyderabad in 2009.He entered to teaching field in 1998 as a Lecturer and latter promoted as Assistant prof, Associative Professor and Professor. Presently he is working as Professor in Department of ECE, Vardhaman college of Engineering, Hyderabad(Telanaga,India).He has published 30 Research papers in National /International Journal/Conferences and guiding 8 research scholars under different Universities.

Dr. P. Chandra Sekhar Reddy, presently he is working as an Academic Coordinator & Professor of Coordination, in Jawaharlal Nehru Technological university Hyderabad. He received B.Tech Degree from JNTU from 1983-1987. And M.Tech Applied Electronics from Baratiar University.He did his Ph.D from Anantapur in the year 2000 on " Routing in Adhoc Networks". He is also worked as Head of the Department for the Electronics and Communication Engineering and computer science Engineering in JNTU Anantapur. He has published many Research papers in National /International Journal/Conferences and guiding 8 research scholars.