IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 5 Issue 2, February 2018
ISSN (Online) 2348 – 7968
www.ijiset.com

Design of Compact Ultra Wide Band (UWB) Antenna using different feeding methods for various Wireless Applications

Maninder Pal Singh[1], Poonam Verma[2]

M.Tech Student, Electronics and Communications Deptt, SUS College of Engineering and Technology
Mohali, Punjab, India[1]
Assistant Professor, Electronics and Communications Deptt, SUS College of Engineering and Technology
Mohali, Punjab, India[2]

Abstract

The rapid growth in wireless communication systems created huge demands for wide band antennas to satisfy high gain and large bandwidth covering all frequency ranges for these systems. UWB patch antennas could be designed with different geometries; i.e. triangular, circular disk, strip loop and square several methods are used to enhance its bandwidth (BW) by using parasitic structures and other different arrangements, The proposed ultra wide band antenna is going to be designed by introducing radiating patch of the antenna and different shaped slots in order to attain a ultra wide band operating frequencies. The proposed microstrip patch antenna is designed by using two different feeding techniques and a comparison will be made between their results. This ultra wide band patch antenna is made to operate for WLAN application from 2.9 GHz to 10 GHz frequency range. The antenna is designed from perfect electic conductor (PEC) radiating patch which mounts above substrate of the Flame Retardant 4 (FR4) dielectric material and this substrate is a medium that connects the top radiating patch to the ground plane. This proposed simulated using user friendly software CST Microwave studio 2010.In this dissertation work a defected substrate with slots has been used which improves the bandwidth and return loss of the antenna at great extent.

Keywords: **Perfect Electric Conductor (PEC), Ultra Wideband(UWB),Co-axial feed, CST Software.**

1. Introduction

Ultra Wide Band (UWB) technology is the basis of different methods of wireless communications. According to the Shannon Hartley theorem, the main benefit of the UWB system is that it is channel capacity corresponds to the bandwidth. The rapid growth in wireless communication systems created huge demands for wide band antennas to satisfy high gain and large bandwidth covering all frequency ranges for these systems. In 2002, FCC approved the Ultra Wide Band (UWB) technology in the frequency range of 3.1–10.6 GHz with maximum radiated power 41.3 dBm/MHz and data rate between 110–200 Mbps within 10 m distance (FCC, 2002). The advantages of the UWB technology are high data rate, less interference, secure, low cost and low complexity. It is used in different applications such as radar, imaging in medicine and military communication. UWB patch antennas could be designed with different geometries; i.e. triangular, circular disk, strip loop and square several methods are used to enhance its bandwidth (BW) by using parasitic structures and other different arrangements recently, researches focus on designing UWB antenna with band rejection characteristics to eliminate any interference from narrowband wireless applications. This is achieved by adding slots with different shapes in the patch, feed and ground plane or in Substrate.

Ultra Wide Band (UWB) technology is the basis of different methods of wireless communications. According to the Shannon Hartley theorem, the main benefit of the UWB system is that it is channel capacity corresponds to the bandwidth. The rapid growth in wireless communication systems created huge demands for wide band antennas to satisfy high gain and large bandwidth covering all frequency ranges for these systems. In 2002, FCC approved the Ultra Wide Band (UWB) technology in the frequency range of 3.1–10.6 GHz with maximum radiated power 41.3 dBm/MHz and data rate between 110–200 Mbps within 10 m distance (FCC, 2002). The advantages of the UWB technology are high data rate, less interference, secure, low cost and low complexity. It is used in different applications such as radar, imaging in medicine and military communication. UWB patch antennas could be designed with different geometries; i.e. triangular, circular disk, strip loop and square several methods are used to enhance its bandwidth (BW) by using parasitic structures and other different arrangements Recently, researches focus on designing UWB antenna with band rejection characteristics to eliminate any interference from narrowband wireless applications. This is achieved by adding slots with different shapes in the patch, feed and ground plane or in Substrate.

IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 5 Issue 2, February 2018
ISSN (Online) 2348 – 7968
www.ijiset.com

2. Microstrip Patch Antenna Design

The three essential parameters for the design of a rectangular microstrip patch antenna using traditional method are:

(i) Frequency of operation (f_o):

The resonant frequency of the antenna must be selected appropriately. The resonant frequency selected for design is at 3.0 GHz.

(ii) Dielectric constant of the substrate (ε_r):

The dielectric material selected for the design is FR4-epoxy which has a dielectric constant of 4.3. A substrate with a high dielectric constant reduces the dimensions of the antenna.

(iii) Height of dielectric substrate (h):

For the microstrip patch antenna it is essential that the antenna is not bulky. Hence, the height of the dielectric substrate is selected as 1.574mm.

The design parameters that are assumed and evaluated are shown in Fig.1 as below:

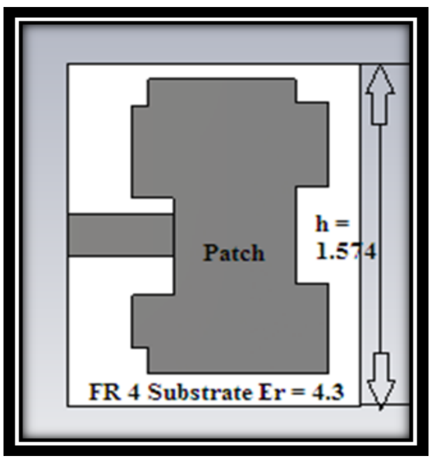

Figure : 1 : Front view of Ultra wide Band antenna using line feed

3. Antenna Design Specifications

After following the design procedure explained in 1.3.2 values shown in table 5.1 are calculated. Figure 3.2 shows geometry of the proposed antenna for dual band operation. First a rectangle patch having the dimensions of 14 mm by 16 mm is taken. Then, two U slots are cut in the patch. These slots have significant effect on the results which has been shown in figure 3.2. The proposed antenna using both techniques produces wide impedance bandwidth with Omni-directional radiation pattern. Length (Ls) and Width (Ws) of substrate have great effect on the resonant frequencies of the designed dual band antenna.By optimizing the dimensions of substrate desired dual band frequency response of the antenna can be achieved. Novel design includes slots in order to improve the return loss of ultra wide bands and also make antenna to operate at wireless frequency bands by eliminating other undesired frequencies.

Table 1 : Geometrical Dimensions of Patch Antenna

Sr. No.	Antenna specifications	Dimensions of antenna design using line feed	Dimensions of antenna design using coaxial feed
1.	Length of Patch (Lp)	38 mm	34 mm
2.	Width of Patch (Wp)	24 mm	34 mm
3.	Length of Substrate (Ls)	46mm	60 mm
4.	Width of Substrate (Ws)	36 mm	50 mm
5	Subsrate height (h)	1.544	1.544
6.	Dielectric Constant (Er)	4.3	4.3
7.	Feed to Patch	Line feed	Co-axial Feed

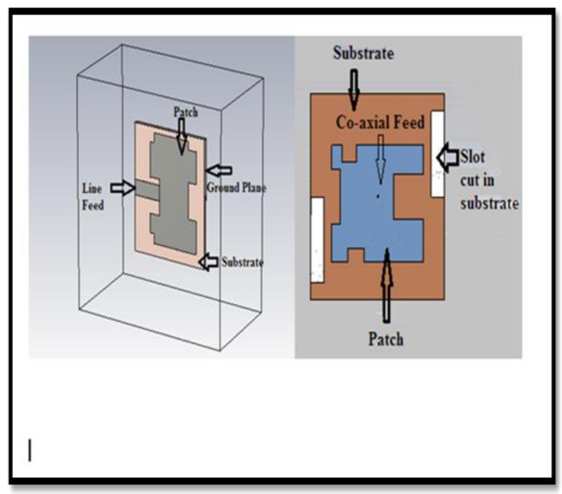

Figure: 2 (a) and (b): Geometrical view of Ultra wide Band antenna using line feed and using co-axial feed respectively

The CST microwave studio simulation software is used to design and optimize the antenna parameters of ultra wide band antenna using line feed and co-axial feed. The proposed dissertation work includes two techniques of designing ultra wide band anteena.In first technique ultra wide band antenna is designed using line feed as shown in figure 2 (a).In this technique various slots have been cut in order to tune antenna work on various frequencies.

In the second technique, ultra wide band antenna is designed using co-axial feed. Here a concept of defected substrate structure is also used in order to achieve high return loss.

4. Results and Discussions

The proposed antenna was fabricated on FR4 substrate with dielectric constant 4.3, loss tangent 0.02, and thickness 1.574 mm. Figure 2 shows the photographs of the proposed antenna designed using two different techniques. The optimized geometrical dimensions of both patch antenna designs have been shown in table 3.1. As can be observed in Figure 4.1 (a) Ultra wide band antenna designed using co-axial feed operates at four distnict frequency bands centered at 4 GHz,5.1 GHz,7.6 GHz and 9 GHz with impedance bandwidths of 40 MHz (3.7 GHz- 4.1 GHz), 30 MHz (4.9 GHz – 5.2 GHz), and 35 MHZ (7.4 GHz -7.8 GHz), 70 MHz (9.2 GHz- 9.9 GHz) respectively. These frequency bands can cover the desired WLAN and WiMAX applications. Figure 4.1 (b) Ultra wide band antenna designed using line feed operates at five distnict frequency bands centered at 3.1 GHz, 5.6 GHz, 6.4 GHz ,7.4 and 7.8 GHz with accepatable and optimum impedance bandwidths at each frequency bands. These frequency bands can also cover the desired WLAN and WiMAX applications. When we compare return loss versus resonant frequencies plot for both the microstrip patch designs, we observe that patch antenna designed using co-axial feed gives better and lower return loss as compare to patch antenna designed using line feed

.

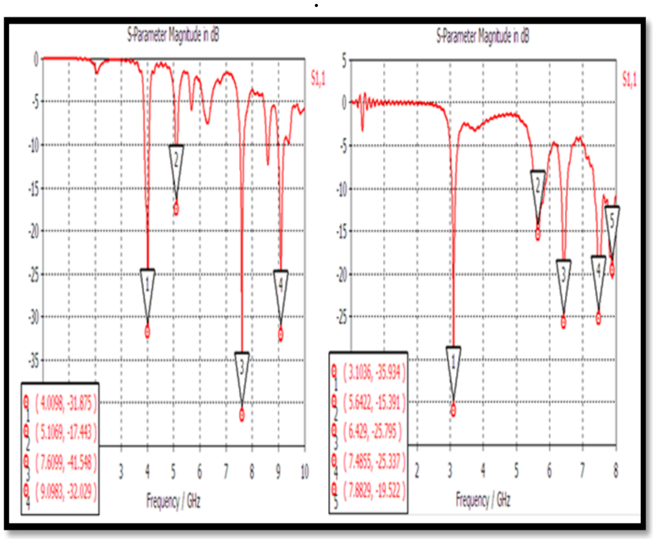

Figure: 3: Retun loss versus Resonant frequency Plot (a) using coaxial feed (b) using line feed

The radiation patterns of the proposed antenna were measured in anechoic chamber. Figure 4 shows the normalized radiation pattern for co- and cross polarizations in the *E*-plane (*xz*-plane) and *H*-plane (*yz*-plane) at the frequencies of 4 GHz, 5.1 GHz, 7.6 GHz and 9 GHz, respectively. As shown in Figure 4, the antenna exhibits a bidirectional radiation pattern in *E*-plane and a stable omnidirectional radiation pattern in *H*-plane. The measured peak gains at the frequencies of 4 GHz, 5.1 GHz, 7.6 GHz and 9 GHz are 6.8 dBi, 5.5 dBi, 3.75 dBi, and 6.17 dBi respectively. Patch antennas designed using line feed also exhibits almost similar gains/directivity at each frequency band. Therefore, the proposed antenna can provide sufficient gain and stable omnidirectional radiation patterns to receive or transmit signals for the WLAN frequency bands and WiMAX frequency band.

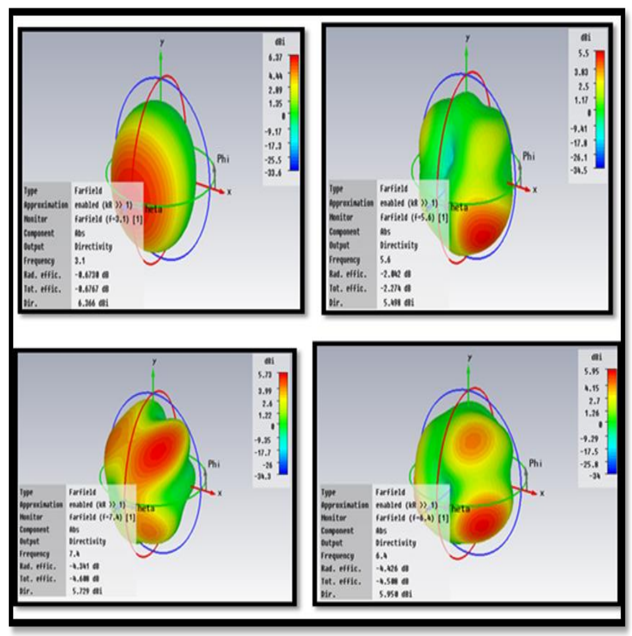

Figure: 4 : 3D Pattern of Directivity of Ultra wide band patch antenna at Various frequency bands

The radiation pattern or directivity of antenna is depends on the shape of the radiating patch and the slot which is cut away from the radiating patch, so by the changing the shape of the radiating patch or the slot of the radiating patch the radiation pattern of antenna can be changed. The radiation pattern of antenna can also be changed by changing the dielectric loss of the FR-4 substrate and changing the distance between the ground plane and the substrate. As in proposed desertation work one patch antenna is excited using co-axial feed and another one is excited using line feed.The position of co-axial feeding method is choosen in such a way to match impedance of the proposed antenna. In another method,

IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 5 Issue 2, February 2018
ISSN (Online) 2348 – 7968
www.ijiset.com

dimensions of the line feed optimized in order to achieve matched characteristic impedance. So in both the designs we get perfectly matched impedance. Fig. 5 shows the smith chart of the designed antenna which clearly depicts the impedance of patch antenna is approximate equals to characteristics impedance i.e. 50 Ohms

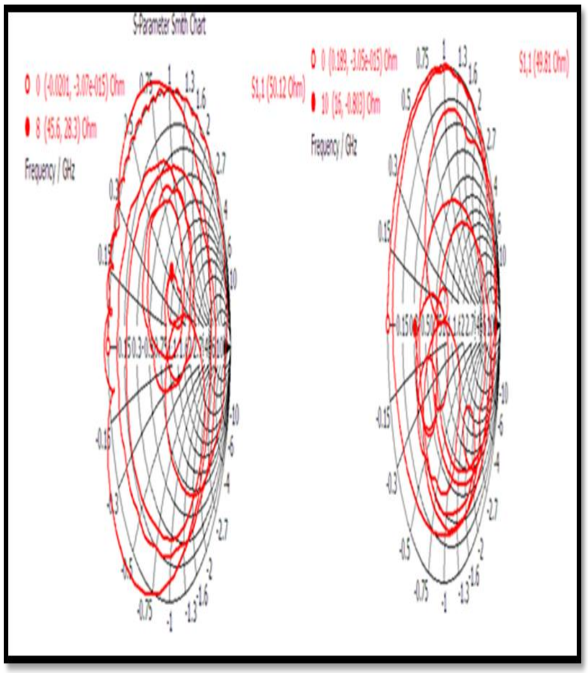

Figure: 5 Smith Chart for ultra wide band antenna using (a) Line feed (b) Co-axial feed

The value of VSWR depends on the value of reflection coefficient and it explains the power that reflected from the antenna. Fig.6 (a,b,c,d) and 4.5 (a,b,c,d) show the simulated results of VSWR for ultra wide patch antenna designed using line feed and co-axial feed at various frequency bands. It can be stated that, the VSWR for both the the designs at all the frequency bands are about 1.1 which is less than 2 and it is proved that the antenna impedance matching for ultra wide band MSPA is considered very good. It is because, only 0.8 % power is reflected back from the antenna and the value of mismatch loss is only about 0.04 dB for VSWR=1. When we compare the VSWR results for ultra wide band antenna designs using line feed and co-axial feed,it has been realized that patch designed using co-axial feed shows better results than the design using line feed. Figure 4.5 shows the VSWR plot for ultra wide band patch design using co-axial feed,here at some frequency band patch antenna even gives ideal value of VSWR that is equals to 1.

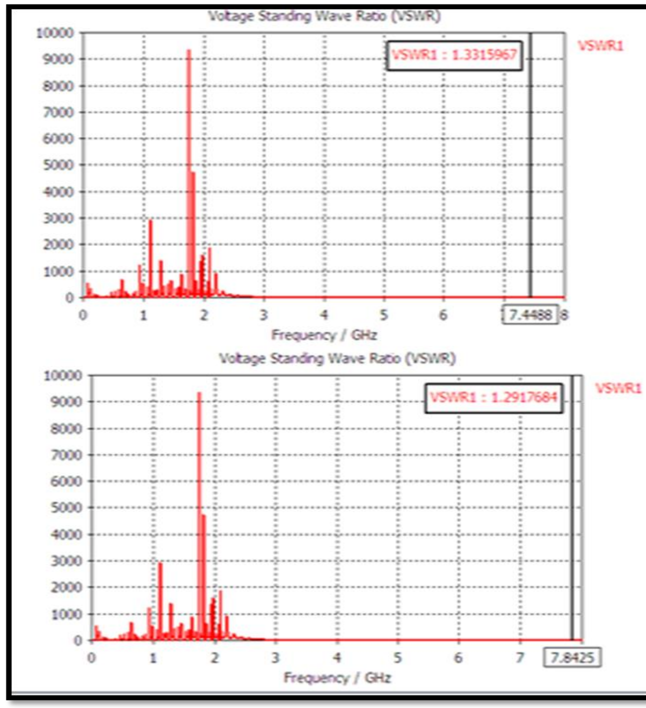

Figure 6 (a,b)-VSWR Plot for Ultra wide band patch antenna design using Line feed

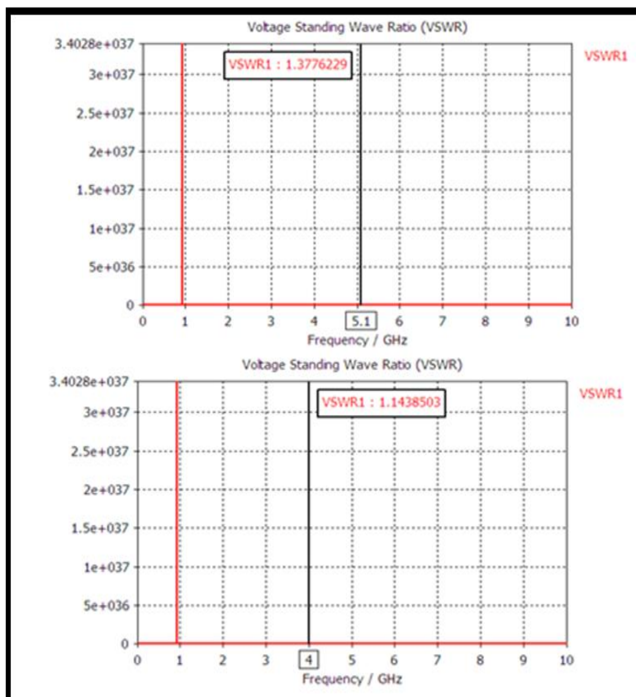

Figure 6 (c,d)-VSWR Plot for Ultra wide band patch antenna design using Co-axial feed

IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 5 Issue 2, February 2018
ISSN (Online) 2348 – 7968
www.ijiset.com

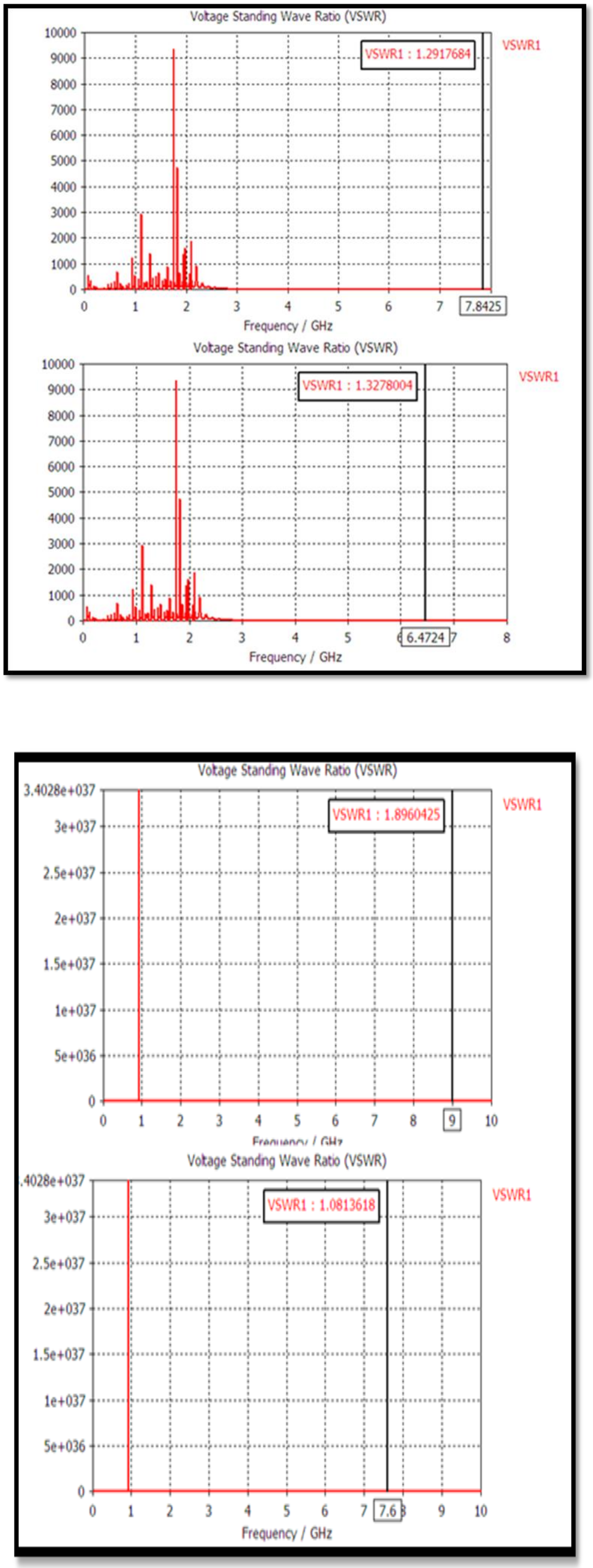

Figure 7 (a,b,c,d)-VSWR Plot for Ultra wide band patch antenna design using Co-axial feed

5. Conclusion

In present dissertation work,we presented a planar multiband antenna with a pair of rectangular slits. By using the pairs of rectangular slits and the defected substrate with different slots, the multiband resonance frequency and bandwidth can be tuned and controlled.As can be observed in Figure 3 (a) Ultra wide band antenna designed using co-axial feed operates at four distinct frequency bands centered at 4 GHz,5.1 GHz,7.6 GHz and 9 GHz with impedance bandwidths of 40 MHz (3.7 GHz-4.1 GHz), 30 MHz (4.9 GHz – 5.2 GHz), and 35 MHZ (7.4 GHz -7.8 GHz), 70 MHz (9.2 GHz- 9.9 GHz) respectively. The measured peak gains at the frequencies of 4 GHz, 5.1 GHz, 7.6 GHz and 9 GHz are 6.8 dBi, 5.5 dBi, 3.75 dBi, and 6.17 dBi respectively. Patch antennas designed using line feed also exhibits almost similar gains/directivity at each frequency band. Therefore, the proposed antenna can provide sufficient gain and stable omnidirectional radiation patterns to receive or transmit signals for the WLAN frequency bands and WiMAX frequency band.
So in this dissertation work, ultra wideband antenna for WLAN and Wi-Max applications has been designed using two different feeding techniques and also comparison has been made beteen resulting parameters.

6. Future Scope

As ultra wide band antenna using line feed exhibits lower bandwidth and somewhat high return loss as compare to co-axil feed excited patch anteena. It can be improved further by applying defected ground structure also.Futher by using this single on chip designed structure an phase array can also designed with improved chacterstics and enhanced radiation patterns using CST microwave studio 2010 .

REFERENCES

[1] C. A. Balanis, “Antenna Theory” John Wiley & Sons, 3rd edition, 2005 chp-4 pp.722-784
[2] H Singh, “Electromagnetics and Antennas”, Katson publication, New Delhi, 2nd edition.
[3] Asrokin A., M. K. A. Rahim, M. Z. A. Abd. Aziz,” Dual Band Microstrip Antenna for Wireless LAN Application”, Asia-Pacific Conference on Applied Electromagnetics, Johor, Malaysia, pp: 26-29, 2005
[4] Ramadan Ali, Al-Husseini Mohammed, Tawky Youssef, Kabalan Karim Y., El-Hajj Ali, “A Novel Frequency/Pattern-reconfigurable Microstrip Antenna for WLAN Applications” 2010 Proceedings of the Fourth European Conference on Antennas and Propagation (EuCAP), pp No-1-3, 2010.
[5] Malisuwan S., Charoen wattanapom M., Huvanandana S., Rosesukon K., “Design of Microstrip Antenna for Bluetooth and WAN Applications by Applying Modified Smithchart Representation”, APACE 2003. Asia-Pacific Conference on Applied Electromagnetics, pp: 38 – 41, 2003.
[6] Guang-ming Zhang,Hong-jing Song,Bing-zhong Wang, Qin-ying Qin,” A Novel dual-band microstrip antenna for

WLAN Applications", IET International Communication Conference on Wireless Mobile and Computing, pp:269-271, 2010.

[7] Raghava N.S. De A., Arora P. , Malhotra S. ,Bazaz, R. ; Kapur S. , Manocha R.,"A Novel Patch Antenna for Ultra Wideband Applications", International Conference on Communications and Signal Processing (ICCSP), pp:276-279, 2011.

[8] Taheri M.M.S., Hassani H.R., Nezhad S.M.A., "UWB Printed Slot Antenna With Bluetooth and Dual Notch Bands", IEEE Antennas and Wireless Propagation Letters, Vol-10, pp: 255-258, 2010,

[9] Parmar Kapil and Kumari Runa and Behera S K, "M-Shaped dielectric resonator antenna for WLAN applications", International Conference on Devices and Communications (ICDeCom), pp-1-4, 2011.

[10] Nguyen T. D., Lee D. H., Park H. C., "Design and Analysis of Compact Printed Triple Band-Notched UWB Antenna" IEEE Antennas and Wireless Propagation Letters, pp-403, 2011.

[11] Natarajamani.S, S K Behera& S K Patra, "A compact wide band patch antenna for WLAN aaplications", Second International conference on Computing, Communication and Networking Technologies, pp: 1-4 ,2010.

[12] Mahender.P, Natarajamani.S and S K Behera , "Inverted U-Shaped Dielectric Resonator Antenna for WLAN" IEEE International Conference on Communication Control and Computing Technologies (ICCCCT) pp:9-11, 2010

[13] Sobhan Saravani*, Chandan K. Chakrabarty, and Norashidah M. Din"Compact Bandwidth-Enhanced Center-Fed CPW Zeroth-Order" Progress In Electromagnetics Research Letters, Vol. 66, 1–8, 2017

[14] Gui Liu, Mengli Fang, Ruixing Zhi, Jin Bai, and Zhe Zeng "Compact CPW-Fed Multiband Antenna for TD-LTE/WLAN/WiMAX Applications" Vol. 65, 9–14, 2017

[15] Abdullah M. Zobilah, Noor A. Shairi, and Zahriladha Zakaria" Fixed and Selectable Multiband Isolation of Double Pole Double Throw Switch Using Transmission Line Stub Resonators for WiMAX and LTE" Vol. 72, 95–110, 2017

[16] Azadeh Pirooj1, Mohammad Naser-Moghadasi1, Ferdows B. Zarrab and Alireza Sharifi1"A Dual Band Slot Antenna for Wireless Applications with Circular Polarization" Vol. 71, 69–77, 2017.

[17] Mohammad El Ghabzouri1,Abdenacer Es Salhi,Pedro Anacleto and Paulo M. Mendes" Enhanced Low Profile, Dual-Band Antenna via Novel Electromagnetic Band Gap Structure", 71, 79–89, 2017

[18] Josiel do Nascimento Cruz, Raimundo Carlos Silvério Freire, Alexandre Jean René Serres"Parametric Study of Printed Monopole Antenna Bioinspired on the Inga Marginata Leaves for UWB Applications" Vol. 16, No. 1 March 2017

[19] M. Abdollahvand, G. Dadashzadeh, and D. Mostafa ,"Compact Dual Band-Notched Printed Monopole Antenna for UWB Application", IEEE Antennas and Wireless Propagation Letters, Vol. 9, pp:1148-1151, 2010.

[20] Eun-Seok Jang,Che-Young Kim,Dae-Geun Yan and Sung-Su Hong"Suppressed Band Characteristics of an UWB Conical Monopole Antenna with Split Loops Based on the Equivalent Circuit" Vol-29 , pp: 2 – 24, 2017.

[21] Xiaoang Li, Chao Li ,"Design of High Gain Multiple U-Slot Microstrip Patch Antenna for Wireless System", International Conference on Computational Problem-Solving (ICCP), pp:256-259, 2010.

[22] M. Abdollahvand, G. Dadashzadeh, and D. Mostafa ,"Compact Dual Band-Notched Printed Monopole Antenna for UWB Application", IEEE Antennas and Wireless Propagation Letters, Vol. 9, pp:1148-1151, 2010