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Design of aCompact Dual Band Notched Hexagonal Monopole Antenna for UWB Applications

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ABSTRACT

Design of a dual band notched hexagonal monopole antenna with a band rejection characteristics at WLAN andWiMAXhas been presented. The proposed antenna has a compact size of 26 x 35x 1.6 $mm^3$with an impedance bandwidth of 2.6-12 GHz for VSWR<2 except at two frequency bands. The notched bands are achieved by using two different types of slots. Design involving hexagonalshape slot and quarterly cut rhombic slot to obtain the notched band for WiMAX(3.3-3.7GHz) and WLAN(5.725-5.825GHz) respectively.The designed antenna has a sharp reduction in the gain at twonotched band.

KEYWORDS

Dual band notched, band rejection, hexagonal patch, UWB antenna.

INTRODUCTION

In 2002, the allocation of 3.1- 10.6 GHz band for ultra wide band applications by FCC(Federal Communication Commission) has attracted increasing interest because of its low complexity, low cost and high data rate for short ranges[1]. With the advantages like high data rate and unlicensed bandwidth there is a major challenge in UWB technology to avoid interferences due to existing narrowband wireless technologies such as WiMAX(3.3-3.7GHz) and WLAN (5.725-5.825GHz).To avoid interference a UWB antenna with compact size and dual band notched characteristics is desirable. There are various ways to achieve the band notched characteristics such as using several band stop filters connected to UWB antenna, but this will increase the complexity and cost of the system.A easier way to solve the problem of interference with the existing wireless networking technologies is by embedding different types of slots such as U- shaped Slot[10], arc shaped slot[11], square shaped slot [12] and H- shaped slot [13] to design antenna with band notched characteristics.Several antenna designs have been proposed with different shape patch and one, two or three notched-frequency bands[2-9]. Hexagonal monopole antenna for UWB applications is proposed[14-16].In this paper,a compact hexagonal monopole antenna with dual band- notched characteristics is proposed. Dualnotched characteristics is obtained by one hexagonalslot and one quarterly cut rhombic slot etched on hexagonal patch of the antenna.

DESIGN ANALYSIS OF ANTENNA

The geometry of proposed compacthexagonal monopole dual notched band UWB antenna is shown in Fig. 1. Antenna is designed using FR4 substrate with size of 26X35 mm^2 and thickness of 1.6 mm. It is composed of micro strip line fed, a hexagonal patch, a rectangular ground plane and two slots. Dual notched characteristics is obtain by one hexagonal slot and one quarterly cut rhombic slot etched on hexagonal patch of the antenna. In this design, each slot creates notch at different frequency band. The antenna is optimized using HFSS.

The length and width of a proposed antenna[15] are calculated using equations (1) and(2).

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$S_L = \frac{c}{2f\sqrt{\frac{\varepsilon_r+1}{2}}}$ (1)

And $S_W = \sqrt{3} S_L$ (2)

The lower band edge frequency(f) is calculated using formula[15], [16]given in equation (3)

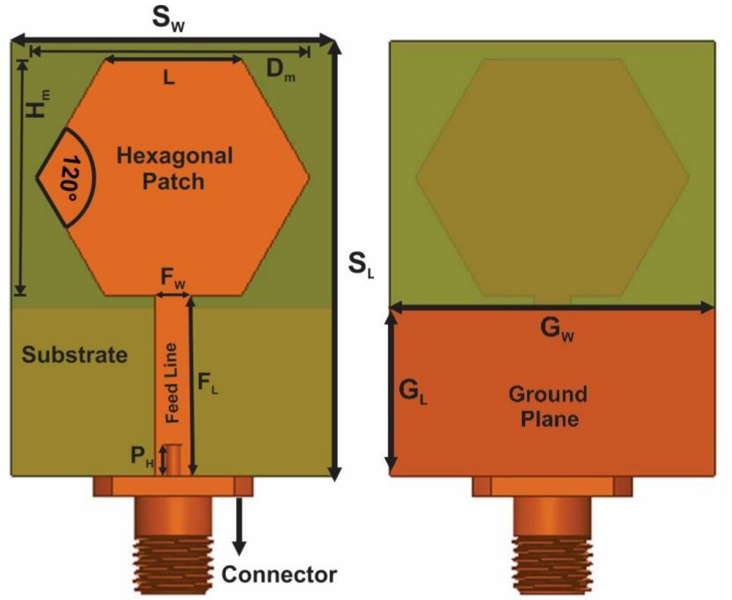
$f = \frac{C}{\lambda} = \frac{7.2}{H_m + r + F_L}$ (3)

Where H_m is the height from ground plane edge to the top of the hexagon and r is the radius of an equivalent cylindrical monopole antenna and $F_L$is the length of feed line. With the side length L, the H_m and r of cylindrical monopole antenna is calculated by equating their areas as follows.

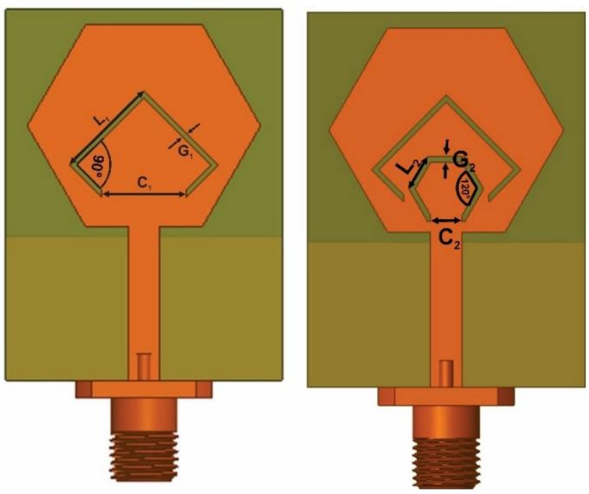
$r = \frac{3L}{4\Pi}$(4)

$H_m = \sqrt{3}L$ (5)

Fig.1. shows the evolution steps of the proposed hexagonal monopole antenna with dual band notch characteristics.The proposed antenna has a compact size of 26x35x1.6 mm^3. It is fed by a microstrip linewidth of 3mm.



(a) (b)



(c) (d)

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Fig.1.(a) A hexagonal monopole UWB antenna, (b) Back view of hexagonal monopole UWB antenna, (c) Hexagonal monopole antenna with slot S_1(quarterly cut rhombic shape) (d) Proposed Antenna with slot S_1 and S_2 (hexagonal shape).

TABLE1. ANTENNA DIMENSIONS

Abbrivation	Expansion	Value(mm)
G_W	Ground width	26
G_L	Ground length	13.5
S_W	Substrate width	26
S_L	Substrate length	35
H_m	Height of monopole patch	19
D_m	Diameter of monopole patch	22
L	Length of monopole patch	11
F_W	Feed line width	3
F_L	Feed line length	14.4
P_H	Pin height	2.5
L_1	Rhombic slot length	9.8
G_1	Rhombic slot gap	0.7
$C_{1`}$	Cut length in rhombic slot	8
L_2	Hexagonal slot length	3.5
G_2	Hexagonal slot gap	0.6
C_2	Cut length of Hexagonal slot	3

Fig.2. show the variation of the length of the hexagonal patch denoted with “L” in Fig.1.and ultra-wide band (2.6GHz-12.4GHz) for VSWR <2 was achieved at L=11mm. Fig.3 shows the variation of the width G_1 of the slot S_1 and width G_2 of the slot S_2. It is observed that as the width of the slot $S_1$and S_2 increases then the width of notched band become wider and peak rejection goes higher. It was also noticed that as the width G_1 and G_2 vary, rejecting frequency also vary, and the final optimized values for WiMAX(3.3-3.7GHz) and WLAN (5.725-5.825GHz) was acquired at G_1 = 0.7mm and G_2 = 0.6mm respectively.

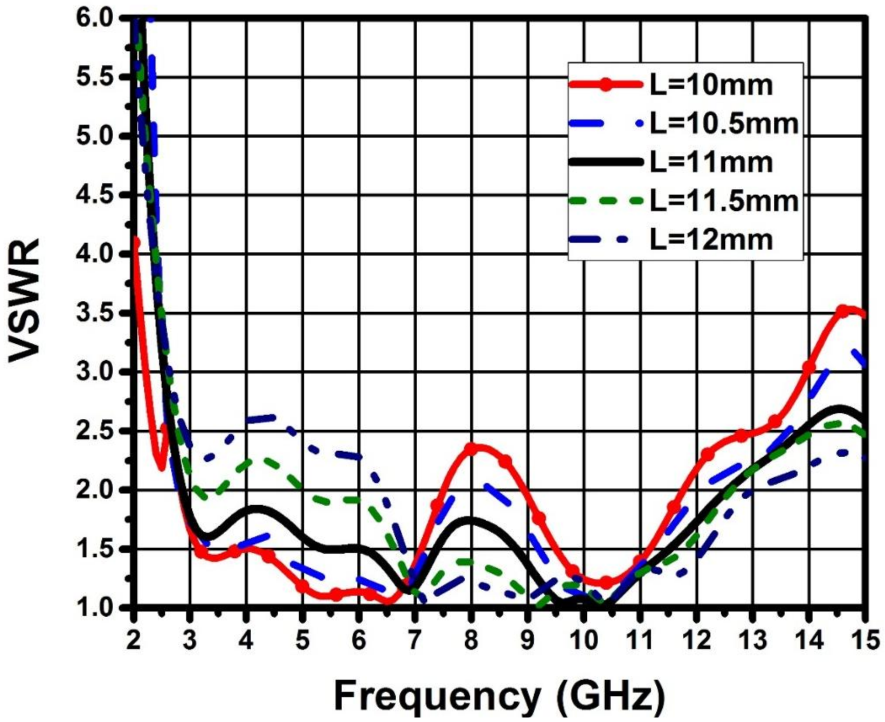
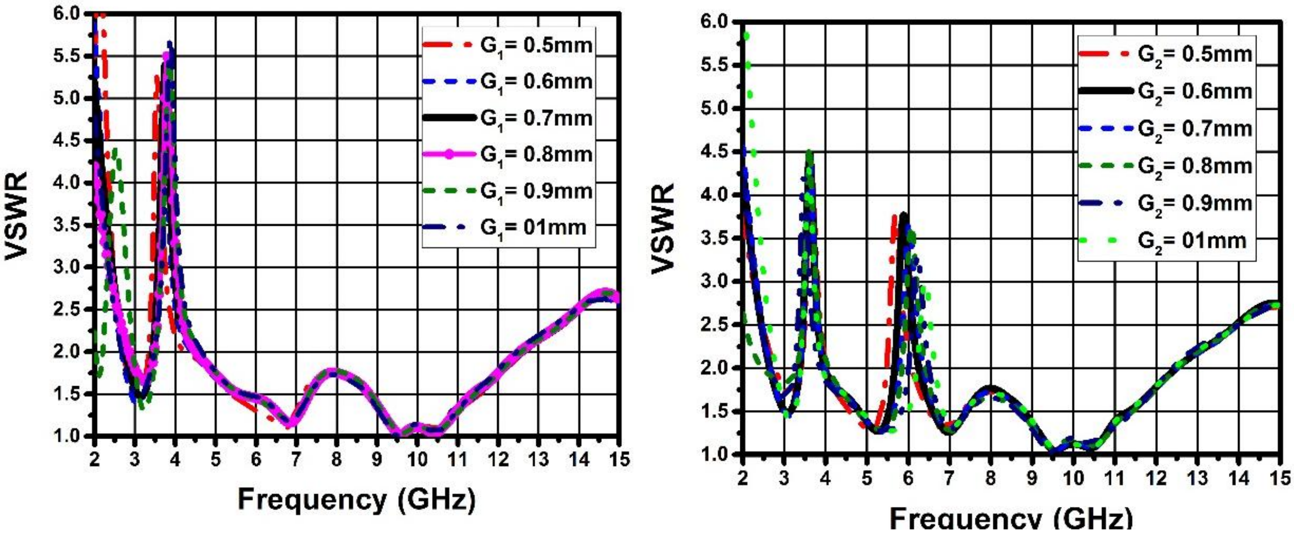


Fig.2. Hexagonal patch length variation.



(a) (b)

Fig.3. (a) Variation of width of Slot gap of quaterly cut rhombic Slot, (b) Variation of width of slot gap of hexagonal slot.

RESULTS AND DISCUSSION

Fig .4 shows the simulated VSWR of the proposed antenna.Where VSWR of the antenna having individual slots compare with the VSWR of the proposed antenna without slot.It is observed that each slot is responsible to create corresponding notched band so by combining each slot we get a dual notched proposed antenna.

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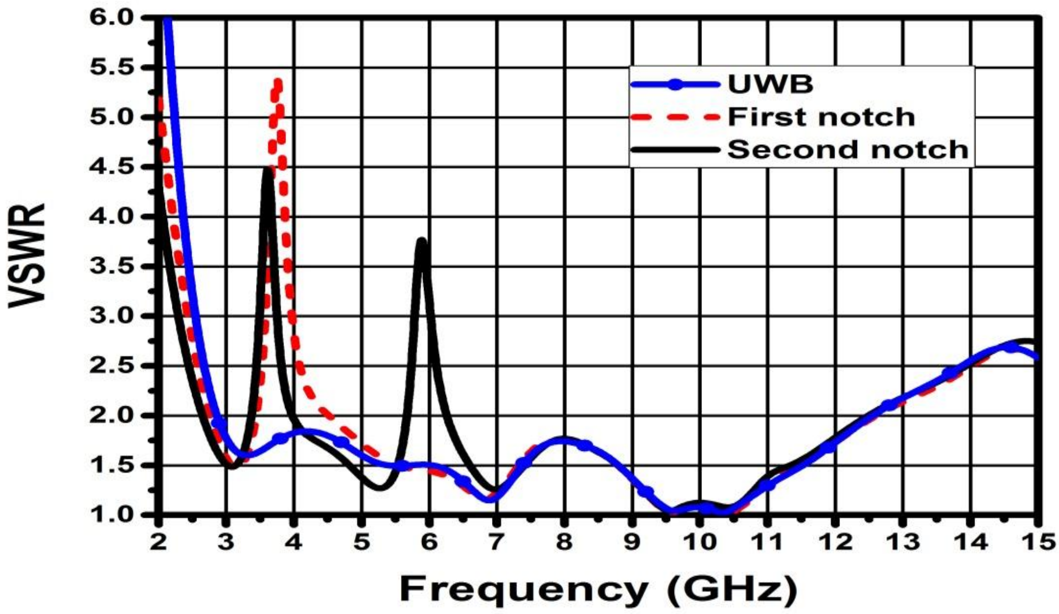
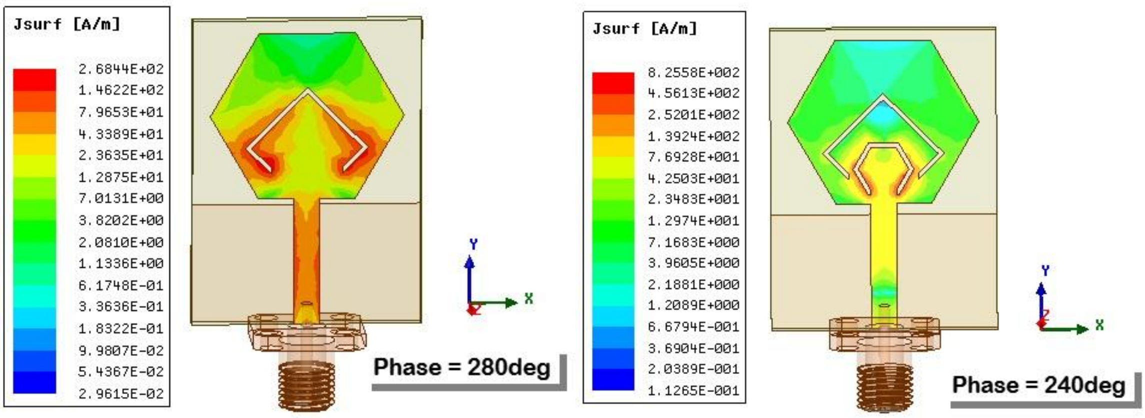


Fig.4Simulated VSWR of the proposed antenna

Fig.5 shows the simulation of surface current distribution at two notched band of the proposed antenna. It shows that at 3.6 GHz there is stronger current distribution coupled to slot S_1that means large portion of energy of antenna has been stored as a non-radiating energy at slot S_1 hence, radiation efficiency become lower at this notched band. The current distribution at 5.8 GHz flows along the slot S_2, while very small current flows along slot S_1.The current concentration around slots shows high attenuation and impedance mismatch at the notched frequency.



(a) (b)

Fig.5 Surface current distribution of the proposed antenna at(a) 3.6 GHz (b) 5.8 GHz

The radiation pattern of the E- plane and H-plane for 3.6 and 5.8 GHz frequency of the proposed antenna is shown in fig.6.It shows the co-polar and cross-polar radiation pattern of the proposed antenna at 3.6 and 5.8 GHz.

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E-Plane H-Plane

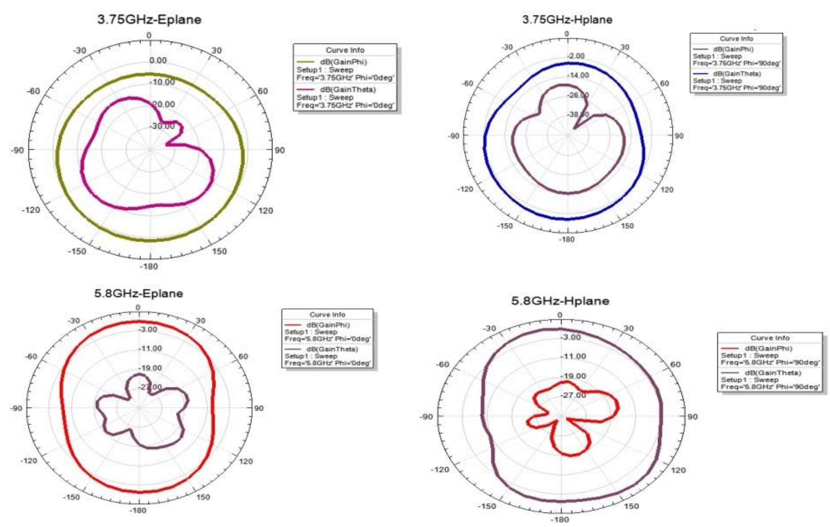

Fig.6. Simulated Radiation pattern of antenna at 3.6 GHz and at 5.8GHz

The simulated results for gain versus frequency of the proposed antenna is shown in fig.7.The gain is constant in the entire UWB range except drops drastically at notched bands so the antenna could not work properly at these notched bands.As the gain decreases at two notch bands.

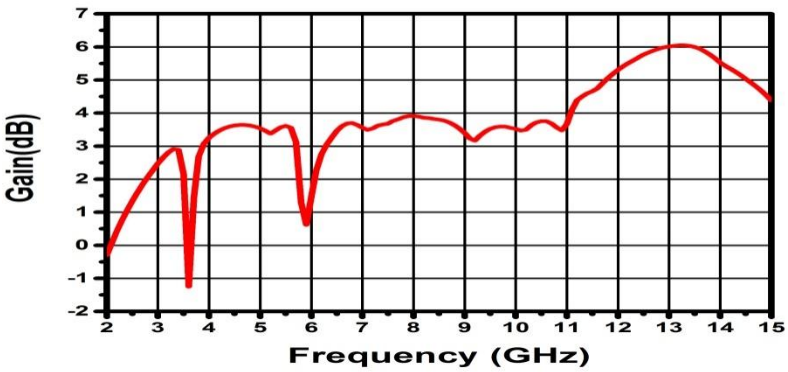

Fig.7.Simulated gain of the proposed antenna with dual band- notched characteristics

CONCLUSION

A compact dual notched band hexagonal monopoleUWB antenna with micro strip fed has been designed. The designed antenna has a compact size of 26x35x1.6 $mm^3$and covers a wide band from 2.6-12GHz. Dual notched bands are achieved around WiMAX(3.3-3.7GHz) and WLAN(5.725-5.825-6GHz) by etching a hexagonal slot and a quarterly cut rhombic slot on a hexagonal patch.The designed antenna shows omnidirectional radiation pattern over the entire band.Hencedesigned approach solves the problem of interference with existing wireless technologies in ultra-wide band.

REFERENCES-

[1] FCC Fist Report and Order on the Ultra-wideband Technology, 2002.
[2] Kumar.G and K.P. Ray, Broadband Microstrip Antennas, Norwood, MA, Artech House, 2003.
[2] J.Y. Siddiqui, C.Saha, Y.M.M. Antar, 2014, "Compact SRR Loaded UWB Circular Monopole Antenna with Frequency Notch Characteristics", IEEE transactions on antennas and propagation, Vol. 62, No. 8, pp. 4015-4020.

[3] W. T. Li, Y.. Q. Hei, W. Feng, and X. W. Shi, “Planar antenna for 3G/Bluetooth/WiMAX and UWB applications with dual band-notched characteristics,” IEEE Antennas Wireless Propagation Lett., vol. 11, pp. 61-64, 2012.

[4] L. Li, Z.L.Zhou, J.S.Hong, and B.Z.Wang, Y.H. Sun, “Compact dual band-notched UWB plannar monopole antenna with modified SRR,” Electron Lett, vol. 47, pp. 950-951, 2011.

[5] B.C. Reddy, E.S.Shajahan, M.S. Bhatt, 2014, “Design of a Triple band-notched circular monopole antenna for UWB Applications,” International conference on wireless and optical communications networks(WOCN), Vol. 47, No. 12, pp.1-5.

[6] M.C. Tang, S. Xiao, T. Deng, D. Wang, J. Guan, B. Wang, and G.-D. Ge, 2011 “Compact UWB antenna with multiple band-notches for WiMAX and WLAN,” IEEE Trans. Antennas Propagation., vol. 59,no. 4, pp. 1372-1376.

[7] LIU, J., ESSELLE, K.P., HAY, S.G., ZHONG, S.S., “Study of an extremely wideband monopole antenna with triple band-notched characteristics. Progress In Electromagnetics Research, 2012, vol. 123, p. 143-158.

[8] P. Wang, G.J. Wen, Y.J.Huang and Y.H. Sun, “Compact CPW fed planar monopole antenna with distinct triple bands for WiFi/WiMAX applications,” Electron.Lett, vol. 48, pp. 357-359, 2012.

[9] L. Peng and C.L. Ruan, “ UWB band- notched monopole antenna design using electromagnetic band structures, “IEEE trans. Microw. Theory Tech. vol. 59, no. 4, pp. 1074-1081, 2011

[10] W.S Lee, D.Z. Kim, K.J. Kim, and J.W. Lu, “ Widebandplannar monopole antennas with dual band notched characteristics,” IEEE Trans. Microw. Theory Tech, vol. 54, pp. 2800-2806, 2006.

[11] S.J. Hong, J.W. Shin H. Park, and J.H. Choi, “Analysis of the band stop techniques for ultra wideband antenna,” Microw. Opt. Technol. Lett., vol.49, pp. 1058-1062, 2007.

[12] S. Hu, H.Chen, C.L. Law, Z. Shen, L.Zui, W. Zhang, and W. Dou, “Backscattering cross section of ultra wideband antennas,” IEEE Antennas Wireless Propag. Lett., vol.6, pp.70-73, 2007.

[13] J.-Y.Deng, Y.Z. Yin, S.-G.Zhou, and Q.Z. Liu, “Compact ultra wideband antenna with tri band notched characteristics, Electron.Lett., vol.44, no.21, oct 2008.

[14] M. R. Ghaderi, and F. Mohajei, “ A Compact hexagonal wide slot with microstip fed monopole for UWB applications,” IEEE Antennas and Wireless Propagation Letters, vol.10, 2011.

[15] K.P. Ray and S. Tiwari, “Ultrawideband printed hexagonal monopole antennas,” IET Microw. Antennas Propag., vol.4, pp. 437-445, 2010.

[16] Kumar.G and K.P. Ray, Broadband Microstrip Antennas, Norwood, MA, Artech House, 2003.