Implementation of Octagonal and Hexagonal Microstrip Patch Antennas for UWB Applications

M.L.Naidu[1] Dr. B. Rama Rao[2] Dr.C.Dharamraj[3]

[1]*Asst.Professor, Dept of ECE, Aditya Institute of Technology and Management Tekkali, A.P.INDIA.*
[2]*Professor, Dept of ECE, Aditya Institute of Technology and Management Tekkali, A.P.INDIA.*
3Professor, Dept of ECE, GITAM Institute of Technology, GU Vizag, A.P.INDIA.

Abstract-

Ultra Wideband (UWB) communication systems have the advantages of very high bandwidth, fading minimization from multipath, and low power requirements. As per the standards of Fedaral Communications Commission (FCC), the UWB range is 3.1 GHz to 10.6 GHz.The Ultra Wideband (UWB) is rapidly advancing as a high data rate wireless communication technology.The Bandwidth of an antenna can be extended to high frequencies by adding an octagonal or hexagonal strip horizontally from the printed antenna and asymmetrically affix a conducting strip to the antenna.

The paper describes thedesign of antenna to enhance the bandwidth by increasing the size of the strip monopole by different geometries. Thegeometry of the wide Octagonal strip monopole is a Octagon of side 'a=9mm' where as for the wide Hexagon monopole is a Hexagon of side 'a=10mm'.The stripis designed with a length of 23mm and gap 'd=3mm' between ground planes and strip for both the antenna geometries to achieve matching. The two printed monopole antennas are designed are etched onto a FR-4 epoxy substrate with an overall size of 45mm × 60mm ×1.6 mm.The proposed antennas is simulated by using Ansoft HFSS and tested by Vector Network Analyzer (E5071C) to obtain the results . The Hexagonal strip monopole is resonating at 5.5 GHz and UWB impedance bandwidth (S11 <–10 dB) ranges from 1.54 to 9.41GHz, while the Octagonal strip monopole is resonating at 5.5GHz and UWB impedance bandwidth (S11 <–10 dB) ranges from 1.3 to 5.65 GHz. The VSWR values for Hexagonal is 1.52:1 at 2.09GHz & for Octagonal it is 1.53:1 at 1.78GHz .The Bandwidth for Hexagonal is 7.87GHz, while for Octagonal is 4.35GHz.

Keywords - *Bandwidth Octagonal, Hexagonal, UWB,HFSS.*

I. INTRODUCTION

The Federal Communications Commission (FCC) has declared that the Ultra-Wideband (UWB) frequencies (from 3.1 GHz to 10.6 GHz) by in 2002 [1], Design of antenna for this new communications accepted has admiring accretion interest. Commercial UWB systems crave baby bargain antennas with Omni directional radiation patterns, ample bandwidth and non-dispersive behaviour [2]. These requirements makes UWB antenna architecture added complicated than acceptable narrow-band designs.An antenna is a key element for wireless communication as it transmits and/or receives electromagnetic waves [3]. During a decade, several antenna designs have been developed and their application depends on the physical parameters of its output. Due to recent trends of the communication system requirements in portable devices, it is necessary to design a light, compact, portable and an efficient antenna [4]. Several researchers are still developing optimum designs to abate the admeasurements and weight of multiband antennas while befitting acceptable performances [5–7]. An integrated antenna is among the one that is being preferred due to several practical applications, because of its light weight, small size, easy to fabrication and cheap realization. A small integrated antenna, also called as microstrip antenna that has significant applications in the area of wireless communication and is used for several microwave applications. Small chip antenna technology came into affluence in the backward 1970s but was able-bodied accustomed in 1980s. The architecture of microstrip antenna is simple as it requires a attenuate application on one ancillary of a dielectric substrate. The added ancillary of substrate has a even to the arena [8].The application is about fabricated of administering actual like Copper or Gold and may be in any approximate shapes like rectangular, circular, triangular and egg-shaped or some added appearance [9]. For practical applications, the most common used microstrip patches are rectangular and circular patch antennas. In wireless communication, small integrated antennas are preferred than other radiating systems, due to their ablaze weight, bargain size, low cost, accord and affluence of affiliation with advice accessories [10].

II. ANTENNA DESIGN SPICIFICATONS

The geometry of the proposed dual-band antenna for UWB applications with its connected is depicted in Figure 1 and 2. The artifact of the proposed antenna is done application a accepted FR4 substrate, generally acclimated to accomplish printed ambit boards with array (h) of 1.6mmand about permittivity of 4.4, which makes it simple and bargain to manufacture. The three capital ambit for the architecture of a microstrip Antennas are :

Resonant abundance (fr): The beating abundance of the antenna accept to be called appropriately. The Ultrawideband (UWB) advice systems accept the abundance ambit from3.1GHz to 10.6 GHz , appropriately the antenna advised accept to be able to accomplish in this abundance range. The beating abundance called for architecture is 5.5 GHz,

Dielectric connected of the substrate (€r):The dielectric actual called for our architecture is FR4 adhesive which has a dielectric connected of 4.4. A substrate with a top dielectric connected has been called back it reduces the ambit of the antenna.

• Acme of dielectric substrate (h): For the microstrip Patch antenna to be acclimated in wireless applications, it is capital that the antenna is not bulky. Hence, the acme of the dielectric substrate is called as 1.6 mm. Hence, the capital ambit for the architecture are:

• fo = 5.5 GHz
• €r = 4.4
• h = 1.6 mm

Step 1: Calculation of the Able dielectric constant(€r):

Equation (1) gives the able dielectric constant as:

$$\in_{eff} = \frac{\in_r + 1}{2}(1 + 0.3 * h) \quad (1)$$

Step2: Calculation of the Length of Strip (Ls):

The length of the MicrostripAntenna given by the equation (2)

$$Ls = \frac{0.42 * c}{f_r * \sqrt{\in_{eff}}} \quad (2)$$

Step 3: Calculation of the Width of Ground plane(Wg):

The width of the ground plane can be calculated by the equation (3)

$$W_g = \frac{1.38 * c}{f_r * \sqrt{\in_{eff}}} \quad (3)$$

Step 4: Calculation of the Length of Ground plane(Lg):

Here the length of the ground plane is obtained by equation (4)

$$Lg = \frac{0.36 * c}{f_r * \sqrt{\in_{eff}}} \quad \mathbf{(4)}$$

Step 5: Calculation of the Resonant Frequency (fr):

Resonantfrequency (fr) is given by the equation (5),

$$f_r = 3 + \frac{2}{\sqrt{\in_{ref}}}\left[\frac{21}{Ls} + \frac{65}{Wg} + \frac{18}{Lg} - 3\right] (5)$$

By using theDesign Equations the dimensions of strip monopole antenna are having the values of a=10 mm for Hexagonal and a=9 mm for Octagonal antennas and Wg=45mm,Lg=20mm,D=3mm,H=9mm,A=1.6mm,ε_r= 4.44

A. Octagonal Microstrip Antenna Design Process

The geometry of proposed finite ground coplanar waveguide (CPW) fed dual-band Octagonal monopole antenna is Shown in Figure 1.The antenna structure is chosen to be a rectangular patch element with dimensions of width W and length L, and with a vertical spacing of ‘h’ away from the ground plane. A conventional CPW fed line designed with a gapof distancea ‘d’ between the signal strip and the coplanar ground plane is used for exciting the radiating patch element. Two finite ground planes with the same size of width Wg and length Lg, are situated symmetrically on each side of the CPW feeding line. The Table.1 shows the dimensions of the proposed Octagonal antenna

Configuration	Parameters	Dimensions
Substrate	W	60mm
	L	45mm
	h	1.6mm
	ε_r	4.38mm
Ground plane	W_g	45mm
	L_g	20mm
Antenna	D	3mm
	a	9mm

Table 1.Dimensions of the Proposed Octagonal Strip Monopole Antenna

B. Octagonal Microstrip Antenna Design Process

The geometry of the proposed bound arena coplanar beachcomber adviser (CPW) fed dual-band Hexagonal monopole antenna apparent in fig2.The proposed antenna was bogus on FR4 substrate with dielectric connected 4.4 and array 1.6 mm.

The Table.2 shows the ambit of the proposed Hexagonal antenna

Configuration	Parameters	Dimensions
Substrate	W	60mm
	L	45mm
	h	1.6mm
	ε_r	4.38mm
Ground plane	W_g	45mm
	L_g	20mm
Antenna	D	1mm
	a	10mm

Table 2.Dimensions of the Proposed Hexagonal Strip Antenna

III. RESULTS

Prototypes of the Octagonal and Hexagonal shape antennas aresimulated constructed and tested.The proposed antenna are simulated using HFSS, Fig.1,2shows the simulated antennas

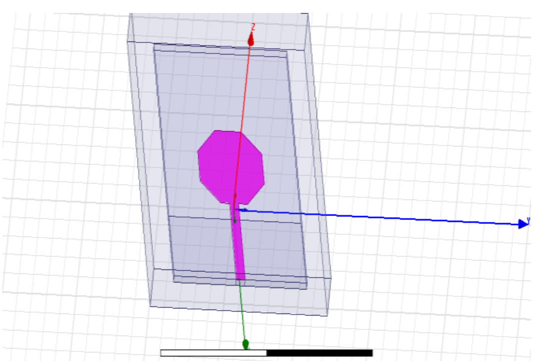


Figure1: HFSS Modal of Octagonal Antenna

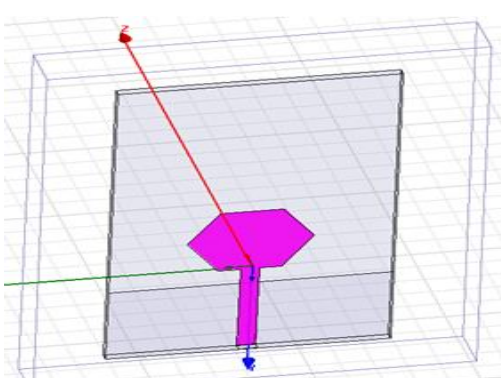


Figure2: HFSS Modal of Hexagonal Antenna

A. Octagonal strip Monopole Antenna

The performance of the Octagonal shape antenna has been investigated by using HFSS. The Figures3,4. shows the apish acknowledgment accident ,VSWR and Figure 5,6 shows the activated acknowledgment accident ,VSWR and the Figure 7 shows the radiation arrangement of the band monopole antenna from the frequency 1.9 GHz to 9.4 GHz.

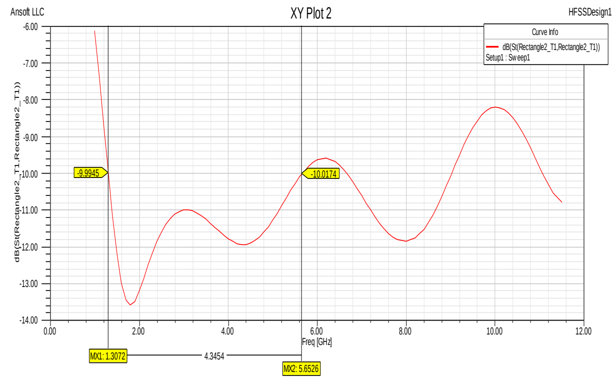


Fig3. Return Loss Curve for Wide Octagonal Strip Monopole Antenna using HFSS

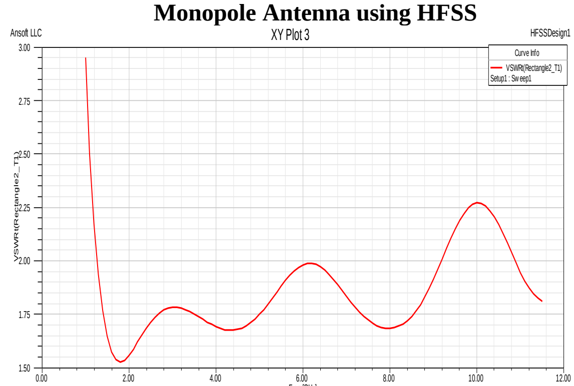


Fig4. VSWR Curve for Wide Octagonal Strip Monopole Antenna using HFSS

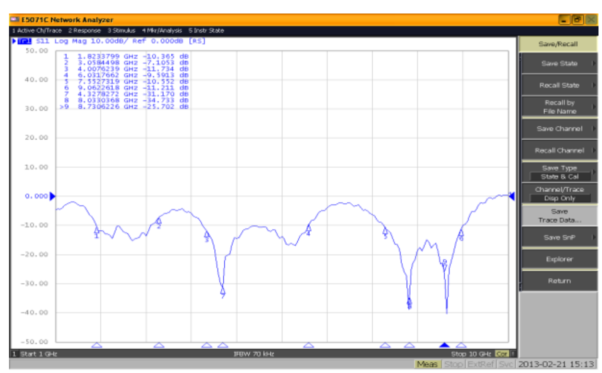


Figure 5: Return Loss Curve for Wide Octagonal Strip Monopole Antenna using Vector Network Analyzer Network

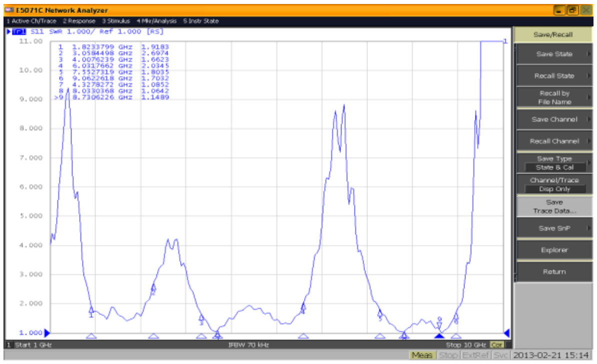
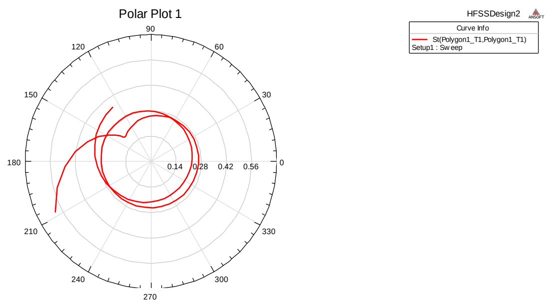
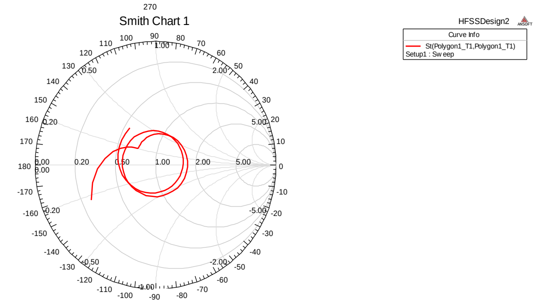
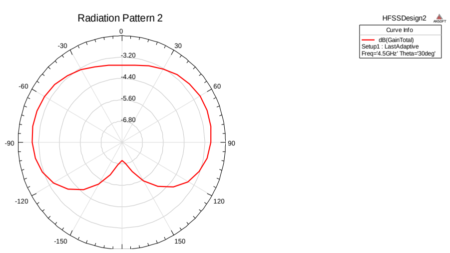
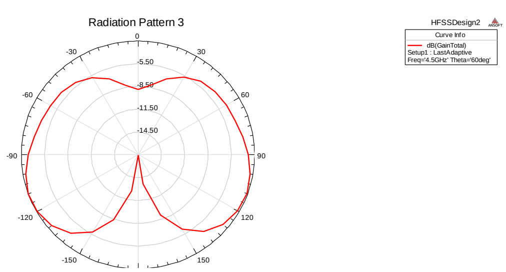


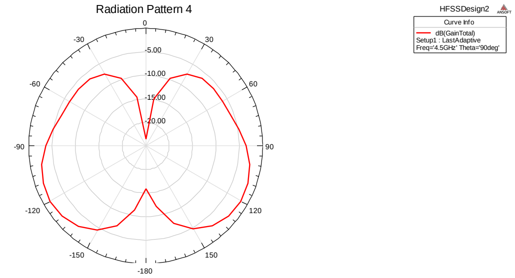
Figure 6. VSWR Curve for Wide Octagonal Strip Monopole Antenna using Vector Network Analyzer Network

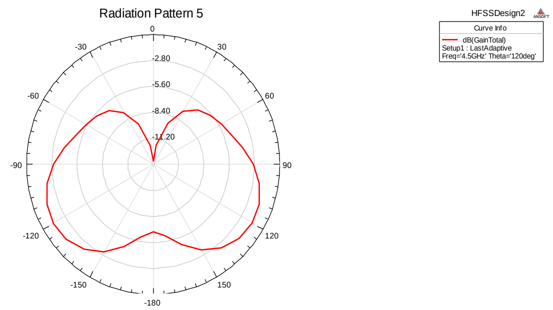


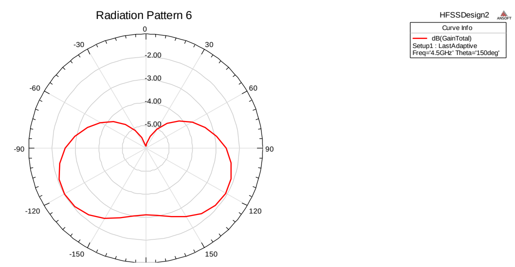


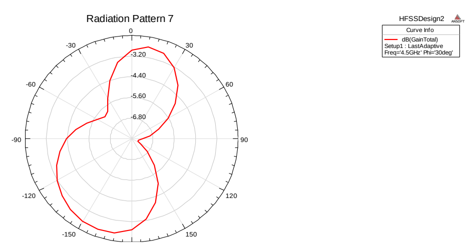


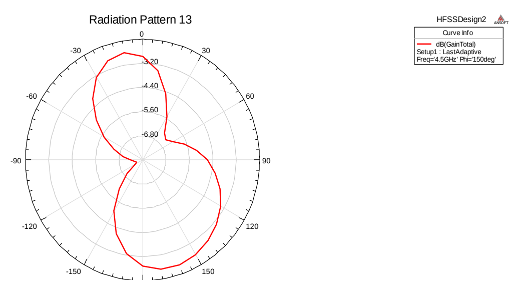












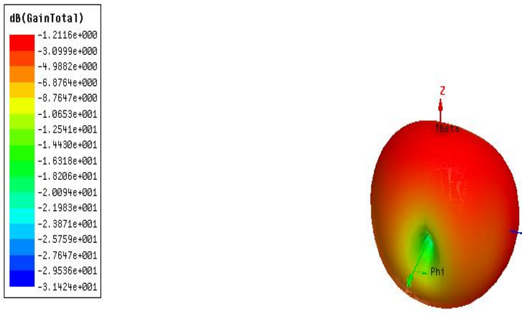


Fig.7.Mesured Radiation Patterns of Hexagonal Strip Monopole Antenna Using HFSS at Frequency Of 1.94 Ghz To 9.4 Ghz

B. Hexagonal strip Monopole Antenna

The performance of the Hexagonal shape antenna has been investigated by using HFSS. The figures8,9. shows the apish acknowledgment accident ,VSWR and Figure 10,11 shows the activated acknowledgment accident ,VSWR and the Figure 12 shows the radiation arrangement of the band monopole antenna from the abundance1.34 GHz to 5.65 GHz.

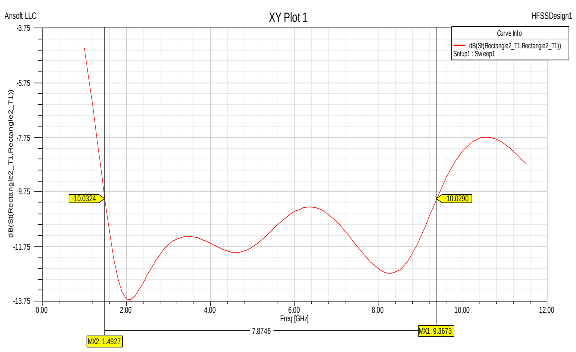


Fig.8.Return Loss Curve for Wide Hexagonal Strip Monopole Antenna using HFSS

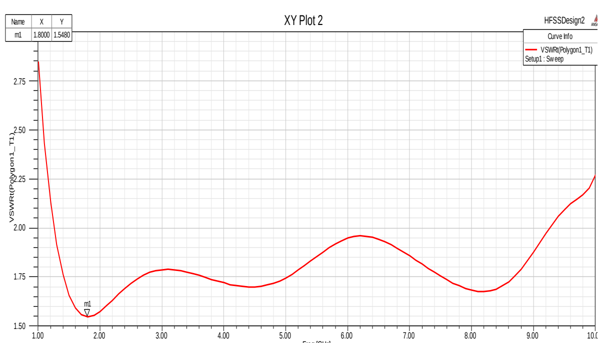


Fig.9.VSWR Curve for Wide Octagonal Strip Monopole Antenna using HFSS

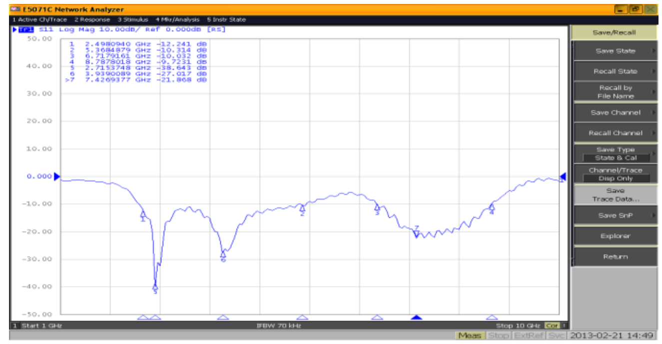
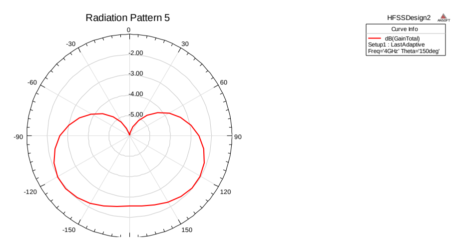
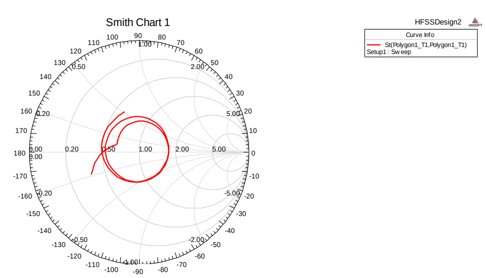
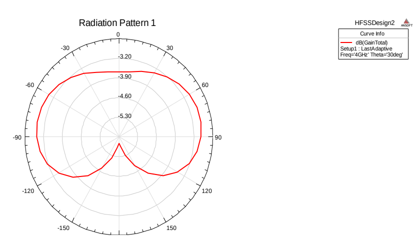


Fig.10.Return Loss Curve for Wide Hexagonal Strip Monopole Antenna

Fig.11.VSWR Curve for Wide Hexagonal Strip Monopole Antenna







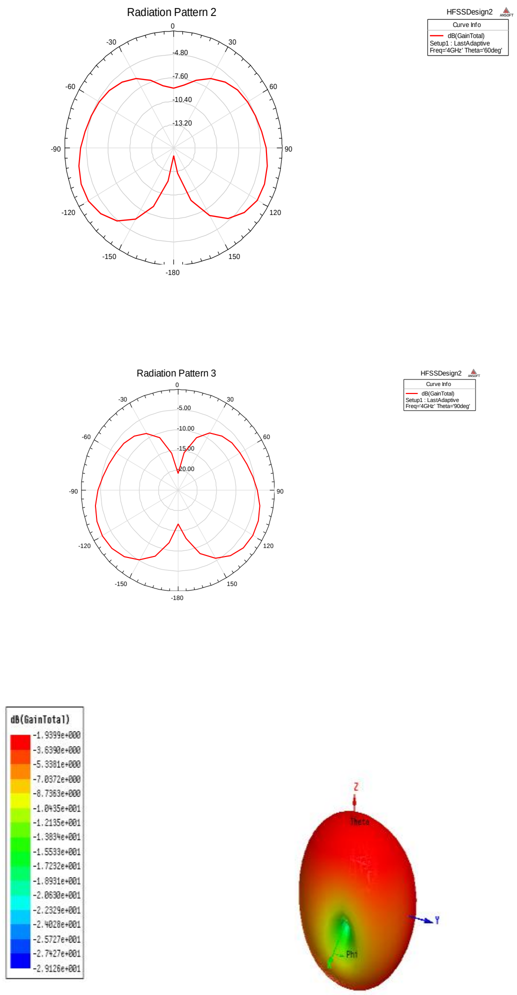


Fig12.Measured Radiation Patterns of Octagonal Strip Monopole Antenna using HFSS at Frequency of 1.3GHz to 5.65GHz

IV. CONCLUSION

The proposed work is mainly useful to operate the antenna at a particular band of frequencies. The Hexagonal and Octagonal shaped antennas has been built and simulated using the Ansoft HFSSand the practical results are obtained by testing the fabricated antennas on Vector Network Analyzer (E5071C). The Hexagonal band monopole is resonating at 5.5 GHz and UWB impedance bandwidth (S11 < –10 dB) ranges from1.54 to 9.41GHz,is observed in simulation result where as in practical results observed at 2.4 GHz to 8.7GHz. While the Octagonal band monopole is resonating at 5.5GHz and UWB impedance bandwidth (S11 < –10 dB) ranges from 1.3 to 5.65 GHz, is observed in simulation result whereas in practical results observed in steps of 3 bands 1.8GHz-3GHz ,4GHz-6GHz and 7GHz-9GHz.The VSWR values for Hexagonal is 1.52:1 at 2.09GHz & for Octagonal it is 1.53:1 at 1.78GHz .The Bandwidth for Hexagonal is 7.87GHz, while for Octagonal is 4.35GHz. The proposed antennas provide about Omni-directional radiation characteristics with abstinent accretion and ability which is acceptable for the next bearing ultra wide-band applications.

REFERENCES

[1] FCC 1st Report and Order on Ultra-Wideband Technology, Feb. 2002.

[2] Schantz H., The Art and Science of Ultra wideband antennas, Artech House 2005.

[3] A. Balanis, Antenna theory: analysis and design / Constantine, third edition, Hoboken, NJ: Wiley,2005, ISBN 047166782X (hbk.).

[4] Ross Kyprianou, Bobby Yau, and Aris, “Investigation into Novel Multi-band Antenna Design”,Defence science and Technology organization, Australia, 2006.

[5] C. I. Lin and K. L. Wong, “Printed monopole slot antenna for internal multiband mobile phoneantenna,” IEEE Trans. Antennas Propag., vol. 55, no. 12, pp. 3690–3697, Dec. 2007.

[6] A. Cabedo, J. Anguera, C. Picher, M. Ribo, and C. Puente, “Multiband handset antenna combining aPIFA, slots, and ground plane modes,” IEEE Trans. Antennas Propag., vol.57, no. 9, pp. 2526–2533,Sep. 2009.

[7] J. Anguera, I. Sanz, J. Mumbru, and C. Puente, “Multibandhandset antenna with a parallel excitationof PIFA and slot radiators,” IEEE Trans. Antennas Propag.,vol. 58, no. 2,pp. 348–356, Feb. 2010.

[8] L. H. Weng, Y. C. Guo, X.W. Shi , and X. Q. Chen,“ An overview on defected ground structure,”Progress in electromagnetic Research B, Vol.7, pp.173-189, July 2008.

[9] “Microstrip patch antenna,” www. electronicshome.com, Jan. 2007.

[10] D. M. Pozar, and D. H. Schaubert, “ Microstrip Antennas, the Analysis and Design of MicrostripAntennas and Arrays,” IEEE Press, New York, USA, 1995.