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Delta Shaped Planar Monopole Antenna for Super Wide Band Applications

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Abstract*—Delta shaped planar monopole antenna employing a triangular slot in the ground plane is proposed. The impedance bandwidth of the proposed antenna is from 2.8603 to 30 GHz for reflection coefficient less than -10 dB. Since the antenna manifests a bandwidth ratio of 10:1, it can be assess as a super wide band antenna and it also cover the frequency range of ultra wide band antenna. Better impedance matching and enhanced bandwidth is achieved by the use of triangular slot on the ground plane. Simulation is done by ANSOFT High Frequency Structure Simulator (ANSOFT HFSS 13.0) which is based on Finite Element Method.

***Index Terms*— Impedance Bandwidth, Monopole Antenna, Reflection Coefficient, Ultra Wideband/super wide band.**

I. INTRODUCTION

Due to useful features such as very large impedance bandwidth, high data transmission rates, low power consumption, multi-path propagation immunity, easy hardware configuration and low complexity architectures [1] of ultra wide band antenna various research has been taken place these days.

For ultra wide band applications (UWB), FCC (Federal Communication Commission) has allocated the frequency band from 3.1 to 10.6 GHz in 2002[2].

Apart from ultra wide band antenna, there are such antennas, which work at both short and long-range transmission for ubiquitous services. The requirement of such an antenna can be fulfilled by a super wide band antenna, which can operate over a bandwidth of at least 10:1[3]. Long distance and space based applications of super wide band antenna are radars, satellite communication, weather monitoring and forecasting, air traffic control.

In recent years, both ultra wideband and super wideband can be achieved by the use of planar monopole antennas. A monopole antenna consists of a conductive surface called ground plane over which a straight rod-shaped conductor is mounted perpendicularly.

Integration with other MMIC devices, easily fabrication, less weight and Omni-directional radiation characteristics these are the few useful characteristics of planar monopole antennas. Applications of monopole antenna are radio broadcasting, aircraft communication and handheld radios etc.

Various research on UWB antennas of rectangular, circular, elliptical shapes exist in literature [4-5] and only a few studies on triangular Shaped Planar Monopole Antenna for Super Wide Band And Ultra Wide Band Applications have been taken place [6-7].

In this paper, a delta shaped planar monopole antenna with a triangular slot on the ground plane has been designed for SWB as well as UWB application. This antenna is designed by the formula, which is given in [8], .The proposed design shows a bandwidth ratio of 10:1. ANSOFT HFSS 13.0 software is used for the simulations.

II. DESIGN AND ANALYSIS OF THE PROPOSED ANTENNA

A. Design of Proposed Antenna

The delta shaped monopole antenna has been designed using high-frequency structure simulator (HFSS) which is based on Finite Element Method.

The volume of the designed antenna is 80x70.75x1.6 mm^3. The antenna has been designed on 1.6 mm thick FR-4 substrate with a relative permittivity of 4.4 with a dielectric loss tangent of 0.02 (tan δ = 0.02) as shown in fig 1. The detailed parameters of the antenna are given in Table 1.

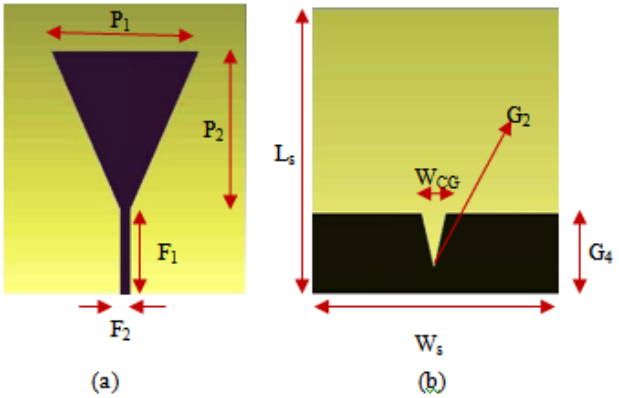

Fig.1. The Geometry of the proposed antenna (a)Top View, (b) Bottom View

The shape of the patch of the proposed antenna is a delta like structure. The addition of triangular slot on the ground plane improved the S11, voltage standing wave ratio and also the gain of the proposed antenna.

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TABLE 1: PARAMETERS OF ANTENNA

Symbol	Dimension (mm)	Description
W_s	80	Antenna width
L_s	70.75	Antenna length
F_2	3	Feed line width
F_1	20.75	Feed line length
W_{CG}	8.1	Ground slot width
G_2	14	Ground slot length
G_4	19.75	Ground length
P_2	41.76	Patch length
P_1	48.22	Patch width

B. Development of Antenna

The performance of the antenna typically depends on the microstrip feed line at lower frequencies. The Lower band edge frequency of the antenna is determined by the microstrip feed line length and consequently defines its lateral size.

In the proposed antenna, the radiating element is in the form of equilateral triangle designed by using the standard formula given in[8].

The monopole antenna is an equilateral triangle with edges 48.22 mm, feed length 20.75 mm and height of ground 19.75.

By the use of triangular slot in the ground plane, impedance bandwidth is increased which are optimized in ANSOFT HFSS 13.0.The effect of ground plane is reduced by the use of triangular slot as the electric current on the ground plane is suppressed at lower end operating frequency. Since the radiation from the ground plane is unavoidable as electric current is distributed on both the radiating elements and the ground plane. Fig. 1 shows the final design of the proposed antenna. Fig 1(a) shows the top views of the proposed antenna and fig. 1(b) shows the bottom view of the proposed antenna.

III. RESULTS AND DISCUSSION

A. Antenna S_{11}

S11 versus frequency graph has been shown in fig 2. The frequency range of the simulated antenna is from 2.8603 to 30 GHZ with an impedance bandwidth of 10:1 GHZ which makes it suitable for ultra wideband, wireless access/ radio local area networks (WAS/RLANS), Radio Determination applications, radio astronomy etc. applications. Maximum return loss (or minimum reflection coefficient) is obtained at 18GHz which is equal to -40. Also as per the need, the super wideband antenna can be converted into multiband antenna by employing notch in mid-band using various existing techniques.

B. Antenna VSWR

Fig 3 shows the graph between VSWR versus frequency. Graph clearly indicates that VSWR is less than 2 in the entire frequency band.

C. Antenna Input Impedance

The real and imaginary parts of antenna impedance versus frequency curve is shown in fig 4.The graph clearly indicates that the real part of impedance is 50 ohm which means that feed line characteristic impedance is matched with the load impedance and the imaginary part of the impedance is 0 means reactance is zero.

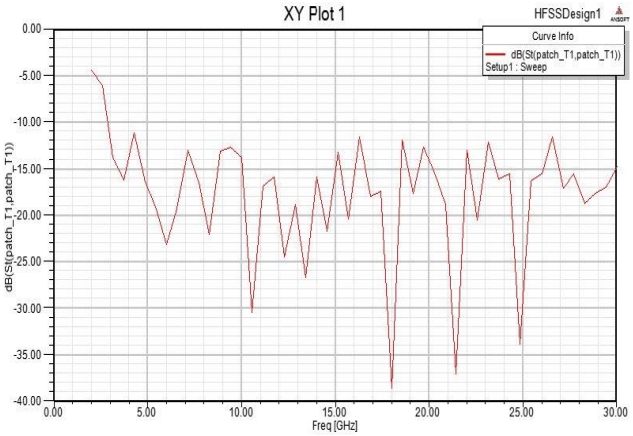

Fig.2. S_{11} of proposed delta shaped monopole antenna

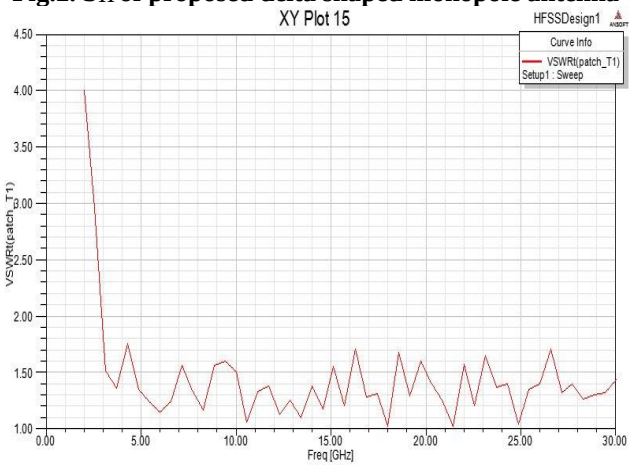

Fig.3. VSWR of proposed antenna

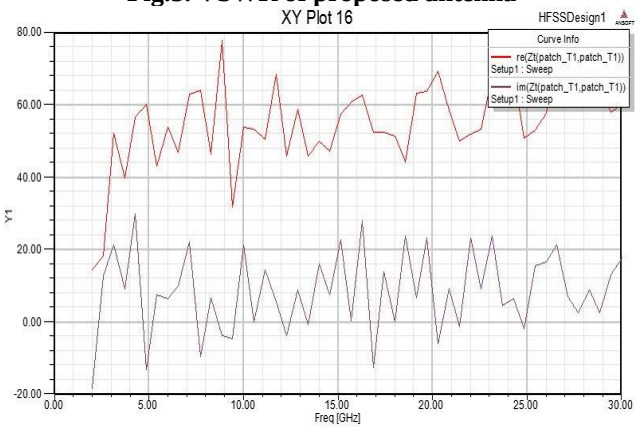

Fig.4. Input impedance of proposed antenna

D. Antenna Gain

Antenna gain versus frequency curve has been shown in Fig 5. By seeing the graph we can estimate that the gain is continuously increasing from 2.8603 to 10GHZ and also maximum gain of 8dB has been achieved at 8.1 GHZ.

E. Radiation Efficiency

Radiation efficiency was observed to be 93%, 90%,85%, and 80.4% at frequencies 3GHz,5.75 GHz,8 GHz,10.45GHz respectively.

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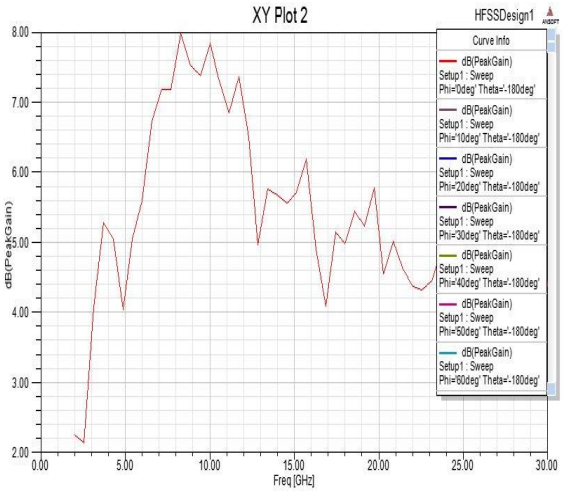

Fig.5. Peak gain of proposed antenna

IV. CONCLUSION

A delta shaped planar monopole antenna is developed for Super wide band operation employing modification in the ground plane to exert a bandwidth ratio of 10:1 in this paper. This antenna is suitable for both short and long range transmission like ultra wideband, WLAN , high resolution RADAR, medical imaging, WAS/RLANS, Radio Determination ,radio astronomy etc. applications. This paper presents the SWB performance of proposed delta shaped monopole antenna. In future, band specific performance can be achieved by introducing band notches or by making it reconfigurable.

REFERENCES

1. Azannanesh, M., Soltani, S., Lotfi , P.: "Design of an ultra-wideband monopole antenna with WiMAX, C and wireless local area network",IET Microw. Antennas Propag., 2011 , 5, pp. 728-733
2. First Report and Order, Revision of Part 15 of the commission's Rules Regarding Ultra-Wideband Transmission Systems FCC, 2002, FCC02-48
3. Sarthak Singhal* and Amit K. Singh, "CPW-Fed Phi-Shaped Monopole Antenna for Super-Wideband Applications", Progress In Electromagnetics Research C, Vol. 64, 105–116, 2016.
4. Liang, J., C. C. Chiau, X. Chen, and C. G. Parini, "Study of a printed circular disc monopole antenna for UWB systems," IEEE Trans. Antennas Propagat., Vol. 53, 3500–3504, Nov. 2005.
5. Ammann, M. J., "Square planar monopole antenna," Inst. Elect. Eng. NCAP, No. 461, 37–40, IEE Publication, York, U.K., 1999.
6. Wong, K.-L. and Y.-F. Lin, "Stripline-fed printed triangular monopole," Electron. Lett., Vol. 33, 1428–1429, August 1997
7. C.-C. Lin, H.-R. Chuang and Y.-C. Kan ,"A 3–12GHz UWB PLANAR TRIANGULAR MONOPOLE ANTENNA WITH RIDGED GROUND-PLANE", Progress In Electromagnetics Research, PIER 83, 307–321, 2008.
8. Debatosh Guha and Jawad Y. Siddiqui," Resonant Frequency of Equilateral Triangular Microstrip Antenna With and Without Air Gap", IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. 52, NO. 8, AUGUST 2004.

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