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Modified Rectangular UWB Planar Monopole Antenna

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Abstract – *In the proposed paper, a Ultra wide band (UWB) planar monopole antenna presented that has Impedance bandwidth from 3.15GHz to 18.8GHz for reflection co-efficient less than -10dB. The antenna consists of modified rectangular patch with round steps on lower and upper corners of patch along a notched partial-circular ground plane. Better Impedance matching and enhanced bandwidth is achieved by the use of round cut on ground plane. The simulation is done by ANSOFT High Frequency Structure Simulator (ANSOFT HFSS 13.0) which is based on finite Element method.*

Key Words: *Planar Monopole Antenna, Ultra wideband (UWB), Microstrip feed-line.*

1. INTRODUCTION

The Ultra-Wideband (UWB) technology provides promising solutions for future communication systems due to excellent immunity to multi-path interference, large bandwidth and high speed data rate. The Federal Communications Commission (FCC) allocated the frequency band 3.1 to 10.6 GHz for ultra wideband (UWB) systems, which provides an excellent opportunity for short-range high-speed indoor data communication applications. However, there are more challenges for designing a UWB antenna than a narrow band one. A suitable UWB antenna should be capable for impedance match over an ultra-wide bandwidth. UWB main advantages are omnidirectional radiation pattern, constant group delay, high data rate, secure, low cost and low complexity and antennas are to be operated with wide band characteristics. Researchers have examined the different structures that can achieve an UWB, such as A Novel Rectangular Ring Planar Monopole Antennas for Ultra-Wideband Applications [1], Compact UWB Planar Monopole Antenna [2], Bandwidth Enhancement of Rectangular Monopole Antenna using modified semi-elliptical ground plane and slots [3], Multislot Microstrip Antenna For Ultra-Wide band Applications[4], Compact Low-Profile Planar Elliptical Antenna for UWB Applications [7], Ultra-Wideband square planar monopole Antenna[8].There are numerous patterns that can be used as feed to m9icrostrip antenna like co-axial feed, Line feed, aperture coupling and proximity coupling etc. Two analyzing techniques are mainly employed for any patch antenna. They are namely the cavity model and transmission line model. Application of monopole antenna are radio broadcasting, aircraft communication and handheld radios etc.

This paper presents the design of rectangular patch with round steps on lower and upper corners of patch along with round cut ground corners. The designed UWB antenna operates from frequency range 3.15GHz to 18.8GHz.

2. PROPOSED ANTENNA DESIGN

The proposed modified rectangular monopole antenna design which include multislot at four corners of rectangle and a notched partial-circular ground plane shown in figure 1, is built on 1.6 mm thick FR4 substrate with ε_r=4.4 and tanδ=0.02. The volume of the designed antenna is 30×35×1.6 mm^3. It is designed using high-frequency structure simulator (HFSS) which is based on finite element method.

The length and width of the micro-strip antenna is calculated by formula given below [5]. Width of patch is given by-

$$\mathbf{W} = \frac{C}{2f_r} \times \sqrt{\frac{2}{\varepsilon_r+1}}$$

Where C is speed of light in free space.

Similarly, the effective dielectric constant $\varepsilon_r$eff, effective length (Leff), the length extension (ΔL) and the length of the patch (L) can also be calculated using the formulas given below.

Effective Dielectric Constant-

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2\sqrt{1+\frac{12h}{wp}}}$$

Length Extension: Extended distance ΔL along the dimensions of patch length and the normalized extension of the length is given by equation-

$$\frac{\Delta L}{h} = \frac{0.412(\varepsilon_r+0.3)\left(\frac{wp}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left(\frac{wp}{h}+0.8\right)}$$

Effective Length:

$$L_{reff} = \frac{c}{4f_r\sqrt{\varepsilon_{reff}}}$$

Length of Patch: Actual length of patch is L and it is calculated by formula given below

$$L = L_{reff} - 2\,\Delta L$$

Dimensions of the proposed antenna has been mention given in **table 1.**

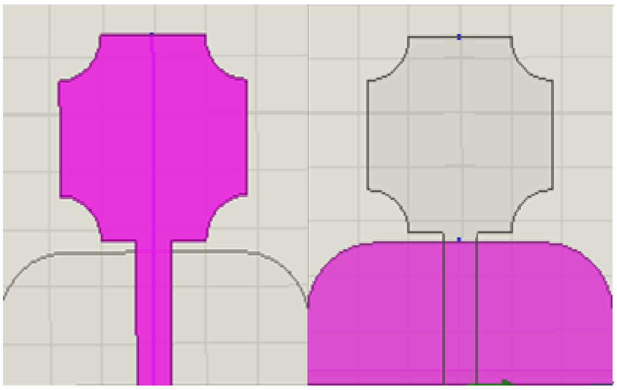
TABLE 1: PARAMETERS OF ANTENNA

Symbol	Dimensions(mm)	Description
W	30	Antenna width
L	35	Antenna length
L_G	13	Ground length
W_P	18	Patch width
L_P	17.5	Patch length
W_F	3.4	Feed line width
L_F	14	Feed line length
R_G	6.5	Ground cut Radius
R_P	4	Patch cut Radius

The round steps are made to the lower and upper corners of the patch after adding a notched partial-circular ground plane which improve the antenna bandwidth and matching of antenna with device.

3. SIMULATION AND RESULT

Since the performance of the proposed antenna is affected by its geometry, it was therefore necessary to carry out a parametric study to obtain a better insight of its behavior for design purposes. For parametric study of R_P other parameters were kept fixed. The proposed antenna's structure was analyzed using HFSS. The simulated returns-loss performance for different values of R_P defined in Table 1. It is observed that variation of R_P from 2.3 to 4 mm the antenna's impedance bandwidth increases and at 4 mm the optimized result found shown in **figure 2.**



(a) (b)

Figure 1: proposed antenna design (a) Top view (b) Bottom view.

Return loss performance for R_P=2.3 to 4 mm

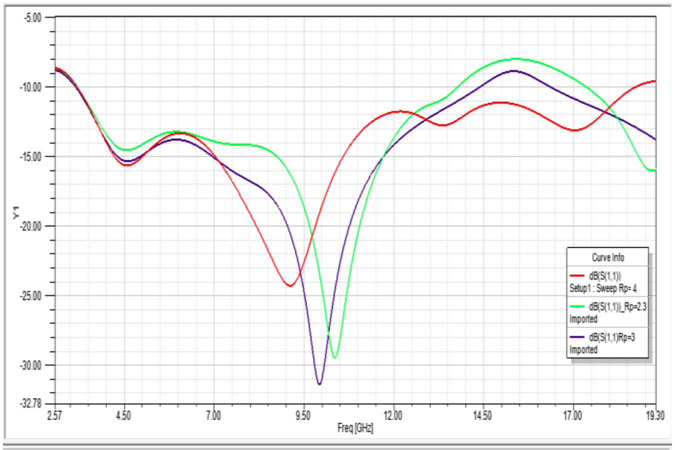


Figure 2: variation of Return loss with R_P from 2.3 to 4 mm.

The S_{11} versus frequency graph has been shown in **Fig 3**. The frequency range of the simulated antenna is from 3.15GHz to 18.8GHz for $|S_{11}|$< -10dB which make suitable for ultra wideband applications.

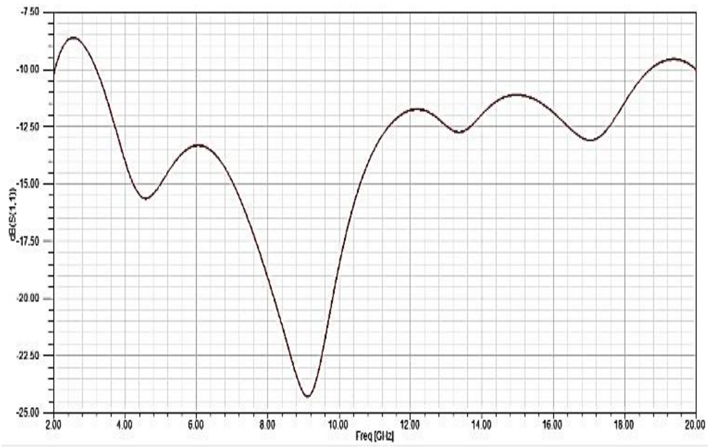


Figure 3: S_{11} vs frequency in GHz for proposed antenna

Fig 4 Shows the graph between VSWR versus frequency. Graph clearly shows that VSWR is less than 2 in the entire frequency band.

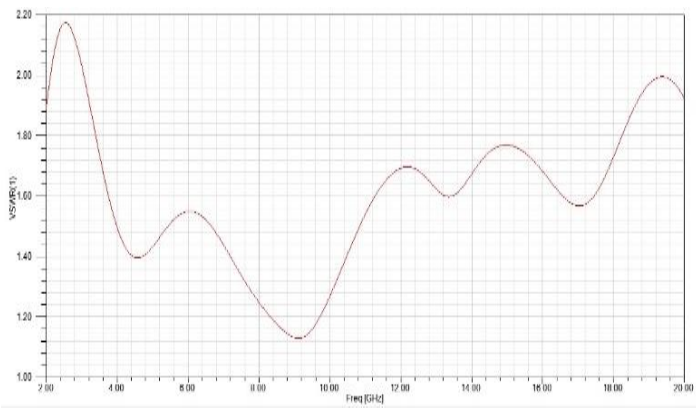


Figure 4: VSWR versus frequency in GHz

The antenna impedance versus frequency curve is shown in **Fig 5**.

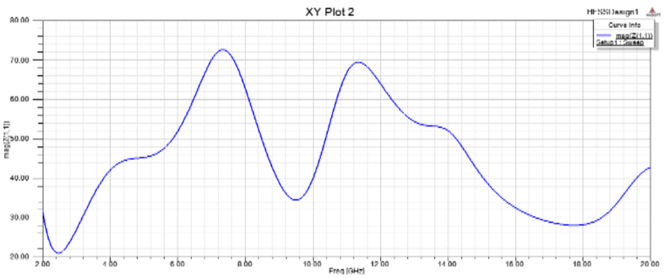


Figure 5 : Z_{mag} vs frequency in GHz

4. CONCLUSION

A Modified Rectangular UWB Planar Monopole Antenna is proposed for UWB applications. The proposed antenna having approximate omnidirectional radiation pattern. Therefore the proposed antenna is useful for low profile, low-cost and supporting the S,C,X and Ku band.

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BIOGRAPHIES

Sunil Kumar Singh was born in Chitrakoot district of Uttar Pradesh, India, in 1979. He completed his B. Engineering from Govind Vallabh Pant Engineering College Pauri Garhwal, Uttarakhand in year 2000. He received his Masters degree in Microwave Engineering with gold medal from Government Engineering College, Jabalpur, in 2005. In 2007 he joined Jabalpur Engineering College, Jabalpur, India, as an Assistant Professor. He coauthored more than 50 research papers and got published in various national and international journals and conferences on micro strip antennas and Electronic Band Gap (EBG) Substrates. Along with them his current research interest is Ultra Wide Band (UWB) Monopoles and MIMO/Diversity antennas. Currently he is a reviewing member of various reputed journals including MOTL and IET.

Birendra Kumar received his B.E degree in Electronics & Communication Engineering From BIT MESRA RANCHI, INDIA in 2013. He started his Master in Engineering in Microwave Engineering from JEC Jabalpur, India in 2016. Currently he is working on Ultra Wide Band(UWB) Monopole antennas.