Design and Optimize of Bow-Tie Patch Antenna with Shifting of Inner Width

Ravinder Singh[1], Surinder Kumar[2]

[1,2]Assistant Professor, MIMIT, MALOUT

ABSTRACT: In this paper we have proposed a design and optimize a bow-tie patch antenna with shifting of inner width with the help of HFSS simulator by variation of the patch arm length and the variation of outer width. The Analysis of the bow tie patch antenna is done with ANASOFT simulator. All results of the antenna are tested on High Frequency Structured Simulator software. The aim of this work is to study and observe the S parameter, operating frequency, directivity, gain and efficiency obtained by designing the bow-tie patch antenna with the help HFSS Simulator and optimize the operating frequency by variation of outer width and to determine which parameter gives the most effective result of the antenna. Optimum solutions of antenna parameters such as inner length and outer width are obtained by variation of the various parameter using the software computation techniques and these parameters are utilized to design the bow-tie antenna using the HFSS software. The design involves a bow-tie antenna being mounted on a patch. The patch can be taken with many configurations but the most popular are rectangular and circular configurations. Other configurations are complex in design and require heavy numerical computations. In this project a rectangular patch is used, Bow-tie patch is used because. They are physically small in size, low weight, low cost and they are highly reliable.

General Terms

Keywords: HFSS, Bow-tie antenna, VSWR

1. INTRODUCTION

An antenna is a metallic device which is used to radiate and receive ratio waves [5]. Antennas are installed in a system for communication. There are several parameter of antenna like radiation pattern, gain, VSWR, affected by the design of antenna. A bow-tie antenna consists of two triangular plates joined with each other to form, Bow-tie. The feed is given at the center of Bow-tie. Bow-tie antenna[2] is the form of by conical antenna whole is broadband antenna made of two cone objects touching at their center point, it is used to broadband application i.e. T. V, military application [3]. Bow-tie antenna has Omani directional [1]l radiation pattern. Operating frequency is about 10.6GHz. Bandwidth of Bow-tie about 10.6GHz. i.e. from to 10 to 12GHz antenna. According to the FCC regulation, ultra-wideband antenna which have -10dB relative bandwidth greater than 20% [1].so It has been applied for ultra wideband range for communication purpose [4]

2. ANTENNA DESIGN

The Design Sketch of antenna has been calculated by transmission line model in this geometry the radiating patch width is W is connected at the ends.

$$\mathbf{W} = \frac{\mathbf{c}}{\mathbf{2f_r}\sqrt{\frac{\varepsilon_r+1}{2}}} \qquad (\mathbf{1})$$

fr= frequency of operation

ε_r= dielectric constant

C= free space velocity of light, 3 x 10^8 m/s

Calculation of the effective dielectric constant (ε_r^{eff}): The effective dielectric constant can be determined by;

$$\varepsilon_r^{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-1/2} \qquad (\mathbf{2})$$

Where

ε_r= dielectric constant

h = height of dielectric substrate

W = width of the patch

(a) Calculation of the effective length (L^{eff}): The effective length can be determined by:

$$L^{eff} = \frac{c}{2f_r\sqrt{\varepsilon_r^{eff}}} (\mathbf{3})$$

Where;

C= free space velocity of light, 3 x 10^8 m/s

f_r= frequency of operation

ε_r= dielectric constant

(a) Calculation of the patch length extension (ΔL): The length extension can be determined by:

$$\Delta L = 0.412h\frac{(\varepsilon_r^{eff}+0.3)(\frac{W}{h}+0.264)}{(\varepsilon_r^{eff}-0.258)(\frac{W}{h}+0.8)} \quad (\mathbf{4})$$

(b) Calculation of actual length of patch (L): The actual length of patch can be determined by:

$$L = L^{eff} - 2\,\Delta L \qquad (\mathbf{5})$$

Λo is free space wavelength and effective dielectric constant

W = is width of patch

E = dielectric constant

The proposed antenna consists of bow-tie dipole with inset feed, the length of the arm of antenna is an important parameter which determined the operating frequency of the antenna. The schematic diagram of bow-tie antenna model is shown in Fig.1. Structure was design on HFSS simulator with following parameters.

Table1. Design Parameters

Sr No	Parameters	Value
1	Inner width	0.36mm
2	Outer width	6.42mm
3	Arm length	7.33mm
4	Port gap width	0.36mm
5	Feed offset	1.55mm
6	Sub H	62mm
7	Sub X	29mm
8	Sub Y	29mm

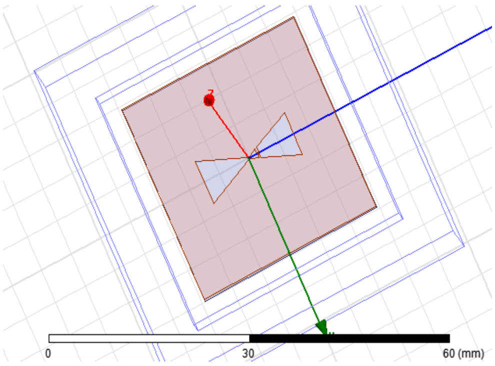

Fig 1 : Design of Bow Tie Antenna

In this paper we have found the various result by variation of inner width and optimize the result at the value of inner width.

3. MEASURED RESULTS

Based on the simulations, the fabrication is made on HFSS simulator and the return loss (S11) is measured by the variation of the inner width of the antenna shown in the fig.2.The result can be seen in the frequency range f_1 to f_2, the return loss at inner width 1.7mm is -18dB which is at 10.6Ghz frequency. The VSWR is less than 2 over the whole operating bandwidth in fig.3. the result for the variation of inner width is consistent in the voltage standing wave ratio (VSWR).

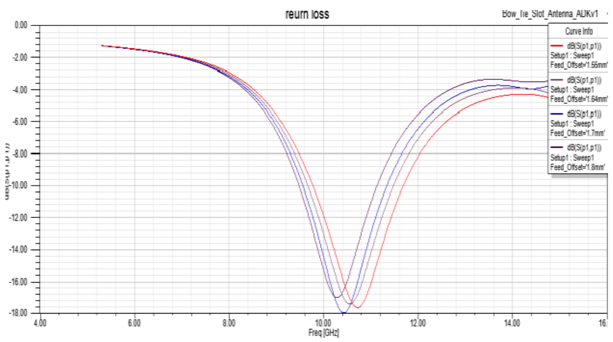

Fig 2: Return loss at different values of inner width

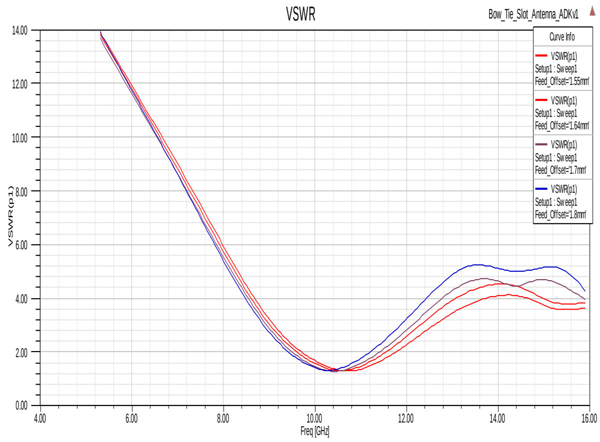

Fig.3 Simulated and measured VSWR of antenna

Radiation pattern characteristic

Figure 4 shows the radiation pattern for different angle for E and H Plane. The cross-polar isolation radiation pattern for 45^0 is maximum for E Plane while for the.It has a high bandwidth compared with the other inner width at 10.17mm .

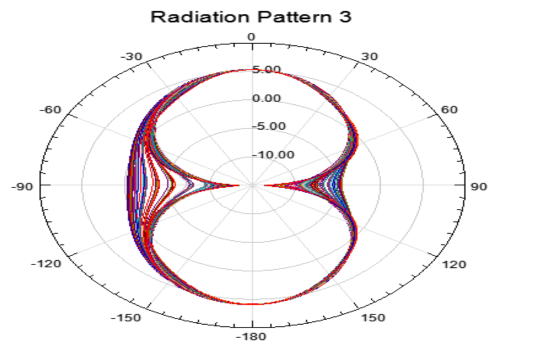

Fig.4 Radiation pattern of the proposed antenna

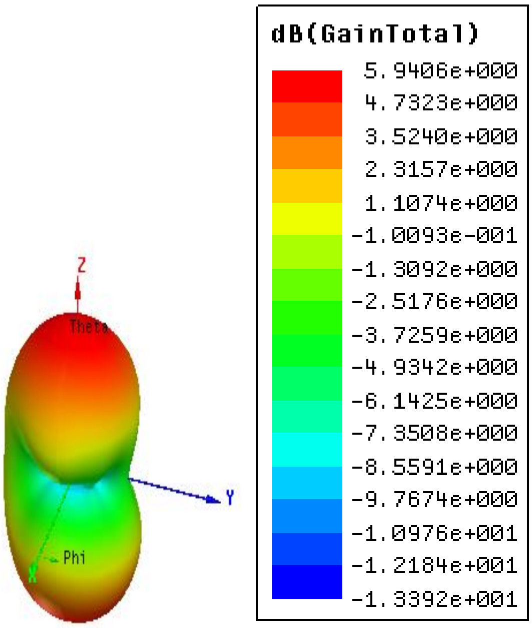

Fig. 5 Polar plot of proposed antenna

The bandwidth of an antenna is defined as the range of frequencies over which the antenna can properly radiate or receive energy Bandwidth. Effect of change of inner width shows following plots in the Fig. 6 the bandwidth is given at 10.17mm inner width of bow tie antenna which is maximum in term of range of frequencies.

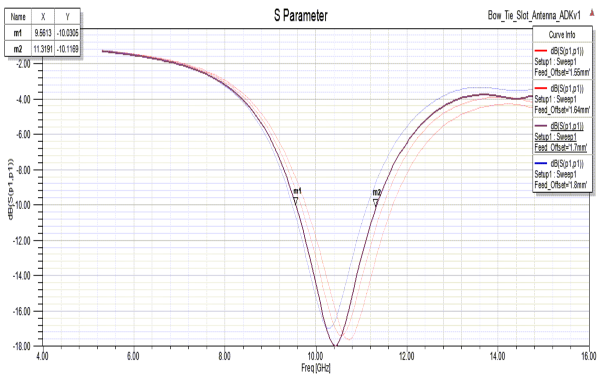

Fig 6: Bandwidth at inner width 1.7mm

4. CONCLUSION

This work presents bow-tie antenna for high frequency broadband antenna at operating frequency 10. 6Ghz.Thisband antenna is simulated using HFSS simulator tool which can be used for very high frequency application appliances and with small size and low profile. For military application it can help us high end transmissions.

5. REFERENCES

[1] S-W Choi, Y-B Jung and S-O Park, "Multiband and multi-polarized reconfigurable antenna for next generation mobile communication base-station applications," IET Microwaves, Antennas and Propagation., vol. 7, no. 10, pp. 819 – 824, 2013.
[2] R.J. Fontana, L. A, Foster, B. Fair and D. Wu, " Recent advances in ultra- wideband radar and ranging systems, IEEE Int. Ultra-Wideband Conf. Washington, DC: IUWC, pp. 19-25,2007.
[3] J. Powell, Antenna design for ultra-wideband radio[D]. Massachusetts: Massachusetts Institute of Technology,2004.
[4] A.A. Lestari,A.G. Yarovoy, and L.P. Lighthart, An Efficient Ultra-Wideband Bow-Tie Antenna. [C]. 31st European Microwave Conference, 2001.
[5] I. S. Jacobs and C. P. Bean, "Fine particles, thin films and exchange anisotropy," Magnetism, vol. 3 G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.