# BANDWIDTH ENHANCEMENT OF MICROSTRIP ANTENNA USING NUMBER SEVEN SHAPED SLOT ON RECTANGULAR PATCH

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***Abstract:***In this paper, microstrip antenna with numerical number seven shaped slot for c-band and x-band applications is presented.Proposed antenna consists of numerical number seven shaped slot on radiating patch.By doing this the antenna's reflection coefficient bandwidth achieved over the frequency range from 6.2GHz to 11.7GHz**.**Which covers most of the C band and X band applications. The dimensions of the proposed antenna issemi ground size 12mm×5mm,size of antenna is 12mm×16mm×1.6mm and radiating patch size 10mm×8mm.Proposed antenna uses line feeding of size 2mm×7mm and FR4 material used as a substrate.It covers around 45% of C –band range and 88% of X-band range of frequencies for the VSWR<2 and simulated antenna gain is 2.59 dB at 6 GHZ.

***IndexTerms - 7 shaped slot, feed, VSWR, HFSS***

## I. INTRODUCTION

The fast expansion of now a days Wireless Communication Technology, microstrip antennas are used many researchers [9]. Though printed Microstrip antennas are having advantages of simple geometry, ease of manufacture and little expensive, they suffer from drawbacks of narrow bandwidth and low gain [1].c band is used for long distance radio telecommunication , satellite communication[10]. X band is used in radar applications like single polarization, synthetic aperture dual polarization radar and phased arrays and X band radar frequency sub-bands are used in civil, militaryand government organizations for weather monitoring, maritime vessel traffic control, air traffic control, defence tracking and vehicle speed revealing for law enforcement. Many techniques are there in the literature to provide X band microstrip antennas which include bow tie antenna [1], using circular patch [2], using nine element quasi yagi antenna [3], using dielectric resonator [4], having two slots on the ground plane [5], using fractal patterned iris loaded cross dipole slot [6], having two dielectric resonators coupled to an S-shaped slot [7] and extended stepped side inverted U slot [11].
The aim of this paper is to suggest a rectangular microstrip antenna with numerical number seven shaped slot simulating with software tool Ansoft High-Frequency Structure Simulator (HFSS) software [8]. To cover the applications of communication engineering ranging from 6.2 to 11.7 GHz inC band & X band, radar applications from 8 to 12 GHz in X band, and to cover X band uplink frequency band from 7.9 to 8.4 GHz as assigned by the International Telecommunications Union (ITU). The microstrip antenna that suggested is miniaturized shape and covering C band and X band applications.

## II. ANTENNA DESIGN

The schematic diagram of the suggested microstrip antenna is shown in Fig. 1. Proposed antenna uses a substrate FR4 of dielectric permittivity $\varepsilon r=4.4$, and thickness h=1.6 mm having dimensions of 12x16x1.6 $mm^3$. A rectangular patch of dimensions 10x8 $mm^2$ is printed on one side and partial ground on other side. Numerical number seven shaped slot on the patch. Microstrip line feeding is used with dimensions of width 2 mm and length 7mm to achieve 50Ω impedance. Dimensions of slots and ground were optimized at initial stage to get a wider bandwidth using HFSS software simulation.Length of the ground Lg is 5 mm and width is same as of the substrate (12mm). The structure is simulated in HFSS based on FEM (Finite Element Method). All the dimensions are given in Table 1.
The type of feed is microstrip line feed as it is one of the easier methods to fabricate and can be considered as an extension of patch. The position of the strip is normally at the half of the width of patch in the direction of X axis.

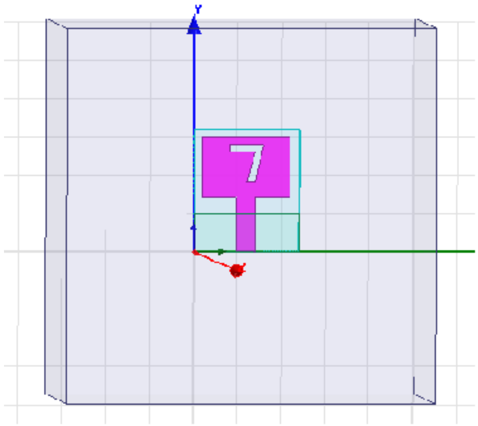
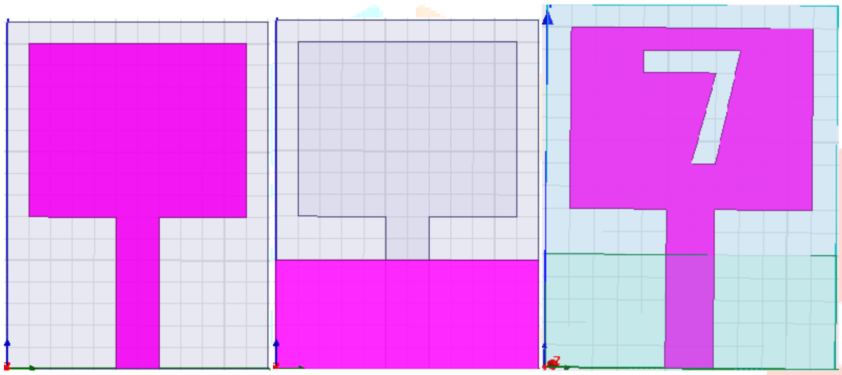


Figure 1: schematic diagram of proposed antenna

The width and length of the patch are calculated at fr = 6 GHz. Initially optimization is in the dimensions of slot, patch and partial ground to obtain better output for wide band frequency characteristics.
Design process of the suggested antenna is shown in Fig. 2.



(a) (b)(c)

Fig:2 Design of suggested antenna

First design patch as per theoretical calculations which equations are available in literature survey using those equations to calculate patch width and length.
Choosing the consideration of w/h>1

Width $W = \frac{c}{2fr}\frac{1}{\sqrt{\left(\frac{\epsilon r+1}{2}\right)}}$

Effective dielectric constant=

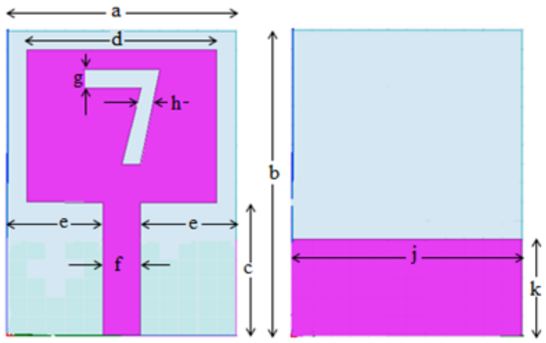
$$\in eff = \frac{\in r + 1}{2} + \frac{\in r - 1}{2}\left(1 + \frac{12h}{w}\right)^{\frac{-1}{2}}$$

Length $L = \frac{c}{2fr\sqrt{\epsilon r}} - 2\Delta l$

$$\Delta l = 0.412h\left(\frac{\in eff + 0.3}{\in eff - 0.258}\right)\left(\frac{\frac{w}{h} + 0.264}{\frac{w}{h} + 0.8}\right)$$

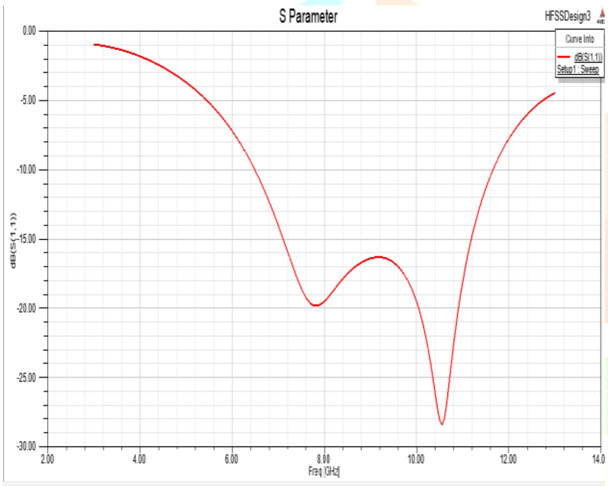
By the above equations length and width of patch are calculated.From figure 2(a) observe patch and feed of antenna. In literature survey have many feeding techniques in that line feeding technique choose has a feed for the proposed antenna. From figure 2(b) make a partially ground and size 12mm×5mm.at this stage did not found any frequency response at 10 GHz. whenever make a numerical number seven as a slot on the radiating patch then found that operating frequency range 6.2GHz to 11.7GHz at center frequency 6GHz.
The specifications of the slot numerical number seven have length 4mm; width 1mm and height 5mm.

| | | | | | |
|---|---|---|---|---|---|
| Parameter | a | b | c | d | e |
| Value(mm) | 12 | 16 | 7 | 10 | 5 |
| Parameter | f | g | h | j | k |
| Value(mm) | 2 | 1 | 1 | 12 | 5 |




## III. RESULTS AND DISCUSSIONS

Fig. 4 shows the simulated reflection coefficient of the proposed antenna. The frequency of proposed antenna have the bandwidth measured at -10dB ranges from 6.2 GHz – 11.7 GHz. This range is used for C-band and X- band applications.



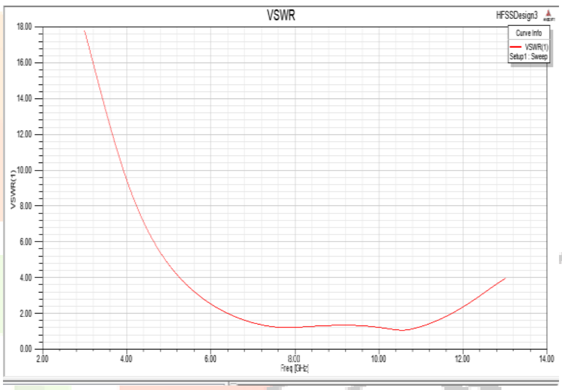




Figure.4. Simulated reflection coefficient $S_{11}$ against frequencyFigure.5. Simulated variation of VSWR

Fig. 5 shows voltage standing wave ratio of the antenna according to the frequency. It shows that the value of VSWR is less than 2, which is sufficient to cover the band allocated by the FCC.

The simulated Gain of the proposed antenna at 6 GHz is shown in Fig. 6 as 2.59dB.

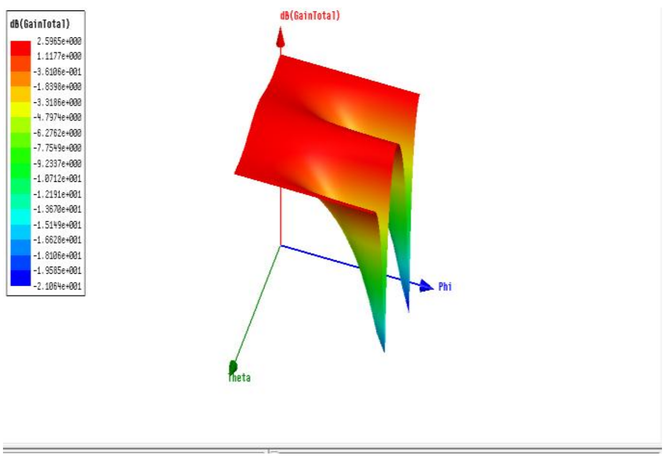
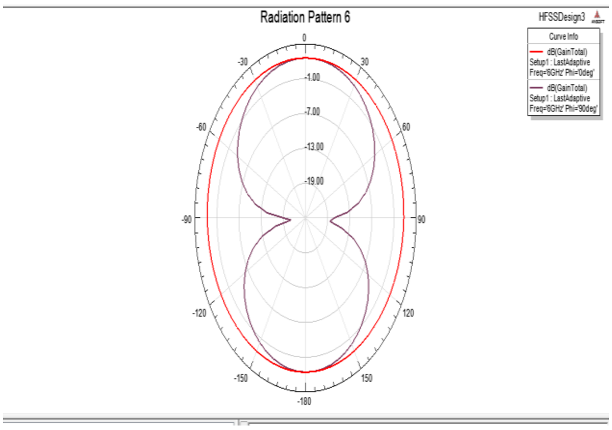



Figure.6. Simulated dB (Gain Total) at 6 GHz

E-plane is the x-z plane (elevation plane) with some particular azimuth angle and the primary sweep will be theta. H-plane is the x-y plane (azimuth plane) with some particular elevation angle and the primary sweep will be Phi. Fig. 7 and Fig. 8 show the simulated two dimensional radiation patterns (E-plane, H-plane) of the antenna at 10 GHz. In the E-plane, the value of azimuth angle (Phi angle) φ of 0° and 90° with all theta values. In the H-plane, the value of elevation angle θ of 0° and 90° are taken into consideration.



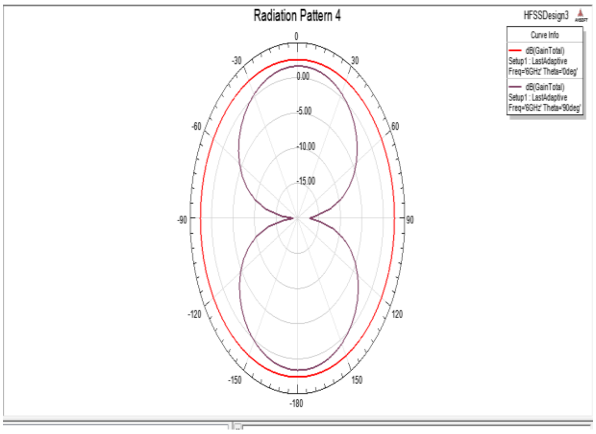




Figure.7. Simulated E- plane radiation patterns at 6 GHzFigure.8. Simulated E- plane radiation patterns at 6 GHz

## IV. CONCLUSION

In this paper, it is proposed that a rectangular printed microstrip antenna having operating frequency range in C-band and X-band from 6.2 to 11.7 GHz below -10dB. The suggested antenna is simulated by using HFSS with good performance for the allocated X-band. Itis shown in this paper that the frequency parameters are changed with the numerical number seven shaped slot and also with the partially ground. The radiation pattern of this antenna was analyzed. It has good stability over the entire frequency band required and that in the two principal planes E and H. The simulated gain is found to be a maximum of 2.59 dB at 6 GHz.

## REFERENCES

**[1]** Abdelnasser A. Eldek, Atef Z. Elsherbeni, and Charles E. Smith, "Wide-band modified printed bow-tie antenna with single and dual polarization for C– and X-band applications," *IEEE Trans. On Antennas and Propagation,* vol. 53, no. 9, pp. 3067 - 3072, Sep. 2005

[2] Andrey S. Andrenko, , Igor V. Ivanchenko, Denis I. Ivanchenko, Sergey Y. Karelin, Alexey M. Korolev, Evgeniy P. Laz'ko, and Nina A. Popenko, "Active broad X-band circular patch antenna," *IEEE Antennas Wireless Propag. Lett.*, vol.5, pp. 529-533, 2006.

[3]Frank Weinmann, "Design, optimization, and validation of a planar nine-element quasi-yagi antenna array for X-band applications*," IEEE Antennas and Propagation Magazine,* vol. 50, no. 1, pp.141-145, Feb. 2008.

[4] YacoubaCoulibaly, Tayeb A. Denidni, and Halim Boutaye, "Broadband microstrip-fed dielectric resonator antenna for X-band applications," *IEEE Antennas Wireless Propag. Lett.*, vol.7, pp. 341-345, 2008

[5] N. Ghassemi, J. RashedMohassel, M. H. Neshati and M. Ghassemi, "Slot coupled microstrip antenna for ultrawide band applications in C and X bands," *Progress In Electromagnetics Research M*, vol. 3, pp.15–25, 2008.

[6] R. Ghatak, S. Chatterjee and D.R. Poddar, "Wideband fractal shaped slot antenna for X-band application*," Electronics Letters*, vol. 48, no. 4, Feb. 2012.

[7] Asmaa H. Majeed, Abdulkareem S. Abdullah, FauziElmegri, Khalil Hassan Sayidmarie, Raed A. Abd-Alhameed, and James M. Noras, "Dual-segment S-shaped aperture-coupled cylindrical dielectric resonator antenna for X-band applications," *IET Microw. Antennas Propag.*, vol. 9, issue. 15, pp. 1673 –1682, Dec 2015.

[8] Ansoft High Frequency Structure Simulation (HFSS) ver.13, Ansoft Corp., 2010.

[9] D. M. Pozar and D. H. Schaubert, Microstrip Antennas, NewYork: IEEE Press, 1995.

[10] R. Garg, P. Bhartia, I. Bahl, and A. Ittipiboon, Microstrip Antenna Design Handbook, Artech House, Norwood, 2001.

[11] A. Sudhakar, M. Satyanarayana, M. Sunil Prakash and Sudhir Kumar Sharma "Single band frequency notched square monopole UWB antenna with extended stepped side inverted U slot," *International Journal of Microwave and Optical Technology*, vol. 10, no 5, pp 301-306, Sep 2015.