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# Study and Analysis of Hexa Shape Patch Antenna on L-Band and S-Band

**Sumit Srivastava[1], Avinish Kumar Tripathi[2], H.P. Sinha[3]**
Department of Electronics & Communication, NITM, Gwalior( M.P.) India
[1]sumit_narayan2006@gmail.com, [2]av.tripathi@rediffmail.com, [3]sinhahps@yahoo.co.uk

***Abstract- In this paper, we designed a hexa shape patch antenna for L-band & S-band application. After designing the antenna on 1.8GHz (L-band) and 2.5GHz (S-band) frequency, we study and analysed the results for both bands using ie3d software. For both the bands, we uses the same dielectric substrate 4.2, loss tangent .0012 and having the same substrate height 2mm. The patch and ground plane dimension's are different for both the bands. The designed antenna on 1.8GHz (L-band) frequency showing the bandwidth 22.9% having return loss -43 dB while the designed antenna on 2.5GHz (S-band) frequency showing the bandwidth 31.9% having return loss -57 dB. All the other respective results i.e, VSWR, gain, directivity, efficiency and 3D-radiation pattern for both the bands are shown by the help of ie3d software.***

***Keywords-*** Patch antenna, ie3d software, bandwidth, gain, directivity and vswr.

## 1. INTRODUCTION

Printed planar microstrip antennas are getting popular for modern communication system due to their features which includes compact size, low cost and ease of fabrication. An extensive work on simple microstrip geometries including rectangular, circular and triangular shaped structures have been reported [2]. Bandwidth and efficiency of a Microstrip antenna depends upon many factors for eg. patch size, shape, substrate thickness, dielectric constant of substrate, feed point type and its location, etc. For good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable for higher bandwidth, better efficiency and better radiation [3-5]. Circular or rectangular microstrip patch has been modified for some applications to other shapes. Hexa shape microstrip antenna has smaller size compared to the square and circular microstrip antennas for a given frequency. The small size is an important requirement for portable communication equipments [6-9]. In this paper hexa shape patch is used for L-band and S-band. Coaxial probe feed is used to feed the antenna. Moreover thick substrate properties are used for improvement of proposed antenna. IE3d software is used to carry out the results. IE3d software is a fully featured software package for electromagnetic analysis and design in the high frequency range.

## 2. ANTENNA DESIGN AND LAYOUT

The length and width of rectangular patch antenna are calculated from below equations. Where c is the velocity of light, $\varepsilon_r$ is the dielectric constant of substrate.

1: **Calculation of the Width ($W$ ):** The width of the Microstrip patch antenna is given by equation as:

$$W = \frac{c}{2f\sqrt{(\varepsilon_r + 1)/2}}$$

2: **Calculation of Effective dielectric constant ($\varepsilon_{reff}$ ):** The following equation gives the effective dielectric constant as:

$$\varepsilon_{reff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2}\left[1 + 10\frac{h}{W}\right]^{-\frac{1}{2}}$$

3: **Calculation of the Effective length ($L_{eff}$ ):** The following equation gives the effective length as:

$$L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{reff}}}$$

4: **Calculation of the length extension ($\Delta L$ ):** The following equation gives the length extension as:

$$\frac{\Delta l}{h} = 0.412\frac{(\varepsilon_{reff} + 0.300)\left(\frac{W}{h} + 0.262\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.813\right)}$$

5: **Calculation of actual length of patch (L ):** The actual length is obtained by the following equation-

$$L = L_{eff} - 2\Delta L$$

6: **Calculation of the ground plane dimensions ( $L_g$ and $W_g$ ):**

Ideally the ground plane is assumed of infinite size in length and width but it is practically impossible to make a such infinite size ground plane, so to calculate the length and width of a ground plane followings equations are given as:

$$L_g = L + 6h,\ W_g = W + 6h$$

7: **Determination of feed point location ($X_f$ , $Y_f$):**

A coaxial probe type feed is to be used in this design.The center of the patch is taken as the origin and thefeed point location is given by the co-ordinates ($X_f$ , $Y_f$) from the origin. The feed point must be located at that point on the patch, where the input impedance is 50 ohms for the resonant frequency. Hence, a trial and error method is used to locate the feed point. For different locations of the feed point, the return loss (R.L) is compared and that feed point is selected where the R.L is most negative.

**Table 1. Proposed antenna design Parameters**

| Design of Micro strip patch antenna | Design 1. | Design 2. |
|---|---|---|
| Name of Pattern | Hexa Shape | Hexa Shape |
| Frequency of Operation (GHz) | 1.8 | 2.5 |
| Dielectric constant of substrate | 4.2 | 4.2 |
| Loss tangent | .0012 | .0012 |
| Height of the dielectric substrate (mm) | 2 | 2 |
| Feeding method (Probe feeding) | Point (x=26.05,y=6.32 ) | Point (x=20.6,y=42.4 ) |
| Width of the ground ($W_g$) | 64mm | 49mm |
| Length of the ground ($L_g$) | 52mm | 41mm |
| Width of the patch ($W_p$) | 52mm | 37mm |
| Length of the patch ($L_p$) | 40mm | 29mm |

**Proposed Antenna Design 1.**

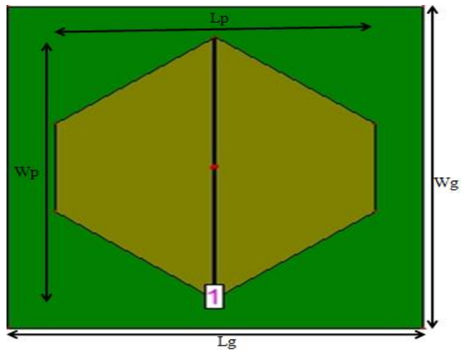


**Figure no.1-** 1.8GHz Hexa Shape antenna

**Proposed Antenna Design 2.**

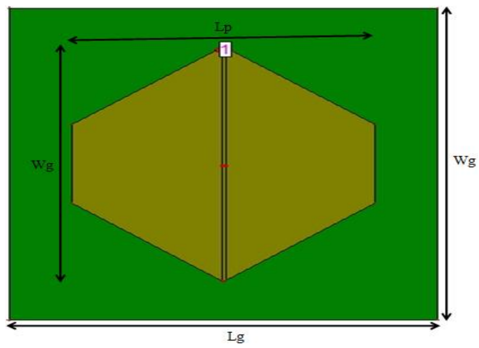


**Figure no.2 -** 2.5GHz Hexa Shape antenna

## 3. SIMULATION RESULTS AND DISCUSSION

After simulating the proposed antenna design 1 and design 2 on IE3d simulator we get various results. All these various results are shown below. Firstly we shown & discuss all the results of proposed antenna design 1 and then we shown & discuss all the results of proposed antenna design 2.

**Simulation results for design 1**

(A) Return Loss Vs Frequency-

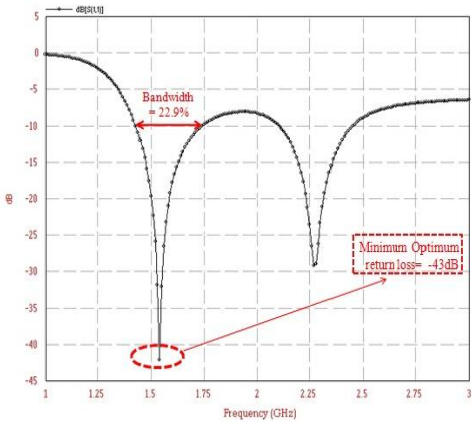


**Figure no.3**- Frequency Vs Return Loss(1.8GHz Hexa Shape)

(B) Frequency Vs VSWR -

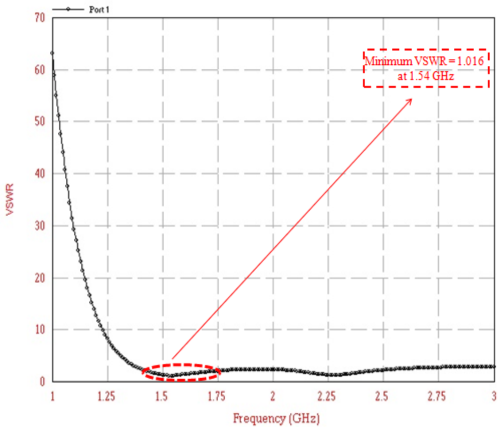


**Figure no.4**- Frequency Vs VSWR (1.8GHz Hexa Shape)

(C) Gain Vs Frequency –

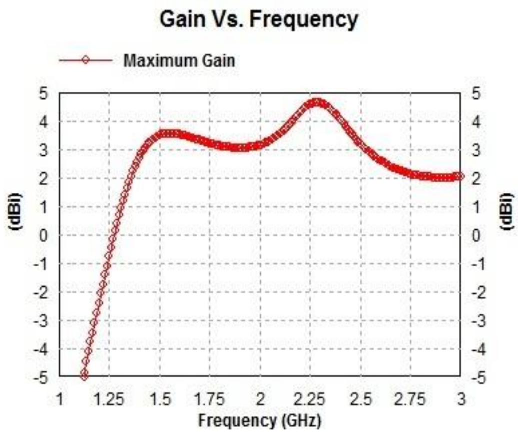


**Figure no.5** - Gain Vs Frequency (1.8GHz Hexa Shape)

(D) Directivity Vs Frequency –

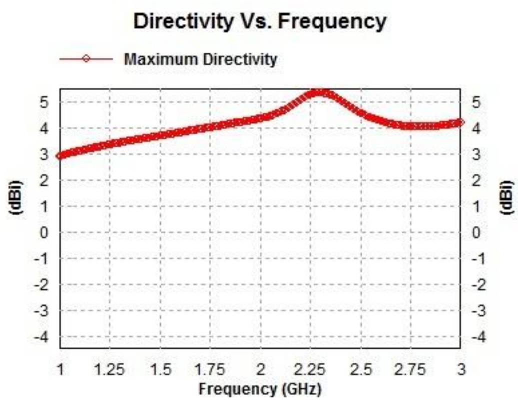


**Figure no.6** - Directivity Vs Frequency (1.8GHz Hexa Shape)

(E) Efficiency Vs Frequency –

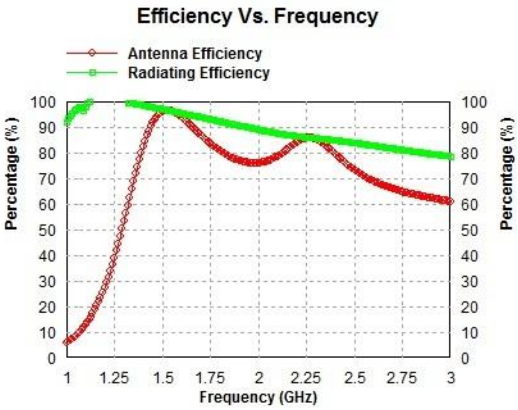


**Figure no.7** - Efficiency Vs Frequency (1.8GHz Hexa Shape)

(F) Radiation Pattern -

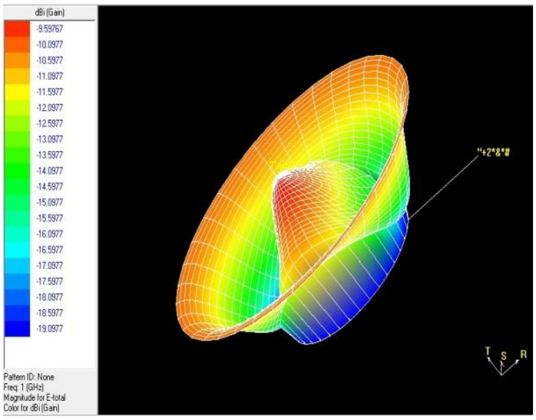

**Figure no.8** - 3D View of radiation pattern (1.8GHz Hexa Shape)

(G) Structure View –

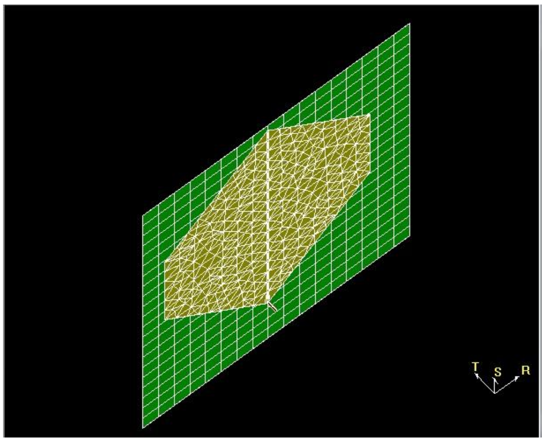

**Figure no.9** - Structure View (1.8GHz Hexa Shape)

(H) Smith Chart –

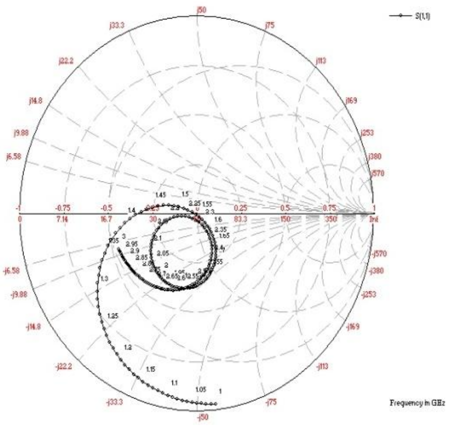


**Figure no.10**- Smith Chart (1.8GHz Hexa Shape)

**<u>Simulation results for design 2</u>**

(A) Return Loss Vs Frequency

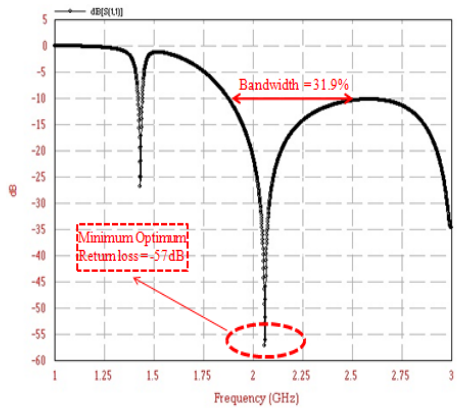


**Figure no.11**- Frequency Vs Return Loss (2.5GHz Hexa Shape)

(B) Frequency Vs VSWR -

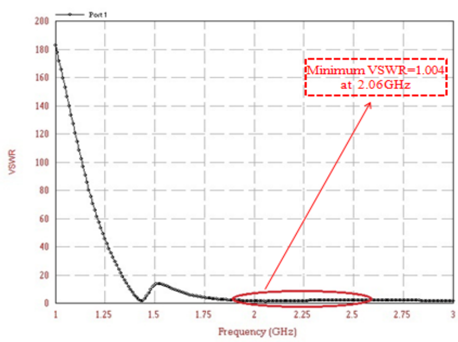


**Figure no.12**- Frequency Vs VSWR (2.5GHz Hexa Shape)

(C) Gain Vs Frequency –

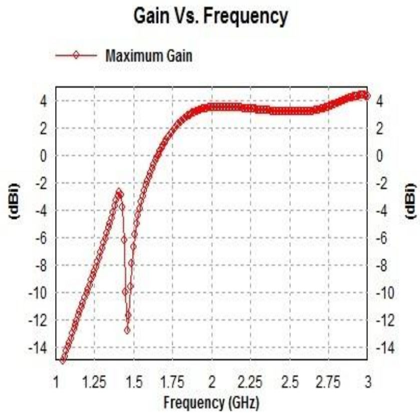


**Figure no.13 -** Gain Vs Frequency (2.5GHz Hexa Shape)

(D) Directivity Vs Frequency –

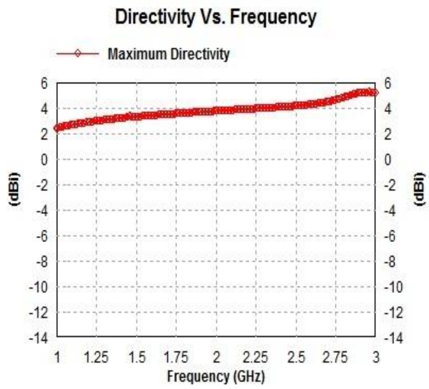


**Figure no.14 -** Directivity Vs Frequency (2.5GHz Hexa Shape)

(E) Efficiency Vs Frequency –

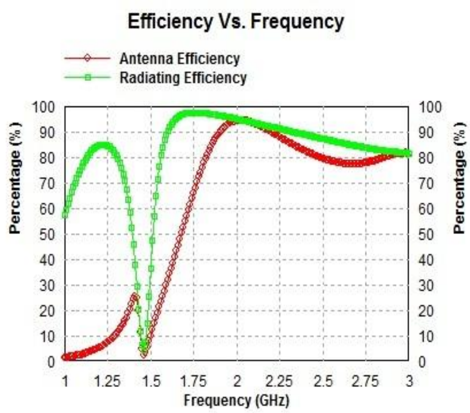


**Figure no.15 -** Efficiency Vs Frequency (2.5GHz Hexa Shape)

(F) Radiation Pattern -

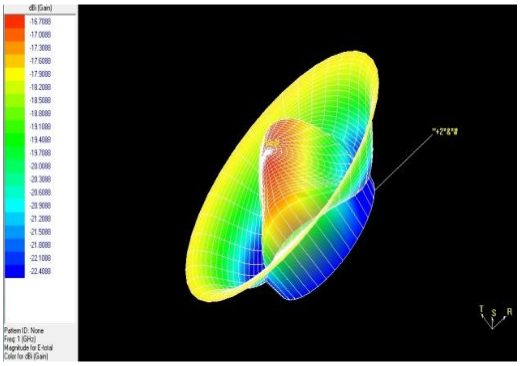

**Figure no.16 -** 3D View of radiation pattern (2.5GHz Hexa Shape)

(G) Structure View –

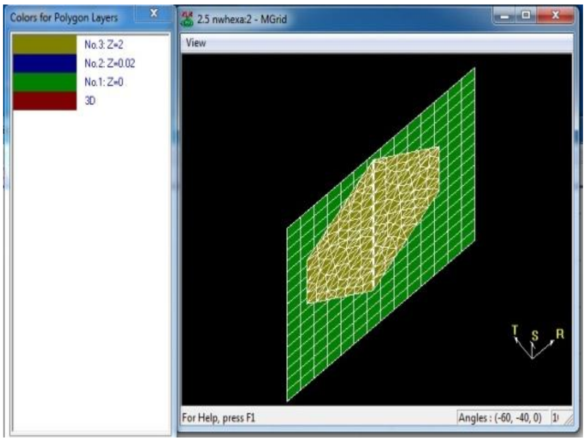


**Figure no.17 -** Structure View (2.5GHz Hexa Shape)

(H) Smith Chart –

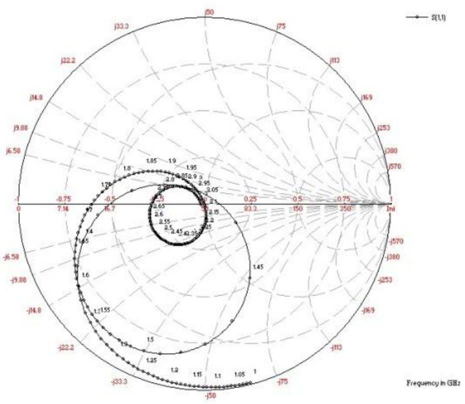

**Figure no.18-** Smith Chart (2.5GHz Hexa Shape)

## 4. CONCLUSION

Microstrip antennas have become a rapidly growing area of research. Their potential applications are limitless, because of their light weight, compact size, and ease of manufacturing. One limitation is their inherently narrow bandwidth.

In our paper, we have design and analyzed the Hexa Shape Microstrip Patch antenna on 1.8GHz (L-band) having patch length, Lp = 40mm & patch width, Wp = 52mm and 2.5 GHz (S-band) having patch length, Lp = 29mm & patch width, Wp = 37mm. The proposed antenna designs have been analyzed between 1GHz to 3GHz. The proposed antenna is designed on a GLASS EPOXY Substrate dielectric constant 4.2, loss tangent .0012. The comparison of the analysis carried out on 1.8GHz and 2.5GHz are given below in table 4.1

| PARAMETER | DESIGN 1 | DESIGN 2 |
|---|---|---|
| BAND | L(1.8GHz) | S(2.5GHz) |
| RETURN LOSS | -43 dB | -57 dB |
| BANDWIDTH | 22.9% | 31.9% |
| MAX. DIRECTIVITY | 3.98 dBi | 4.11 dBi |
| MAX. GAIN | 3.54 dBi | 3.48 dBi |
| VSWR | 1.016 | 1.004 |
| MAX. ANTENNA EFFICIENCY | 96.34% | 94.29% |
| MAX. RADIATING EFFICIENCY | 98.51% | 96.68% |

Table 4.1

Hence, on the basis of all above data, we can say that our proposed antenna design is showing a better result for S-band in compare of L-band.

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