ENHANCEMENT BANDWIDTH & GAIN OF HEXAGONAL PATCH ANTENNA AT 1.8 GHz

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Abstract- In this paper, we discussed two hexagonal patch antennas for L-band applications. After designing the antennas on 1.8GHz (L-band) frequency, we study and analyzed the results of both antennas using ie3d software. 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 same for both the antennas. But the different feeding points differs both the antennas from one another. The designed antenna with feeding point (x=26.05,y=6.32) showing the bandwidth 22.9% & the designed antenna with feeding point (x=25.9,y=6.2) showing the bandwidth 52%.

Keywords- Hexagonal Patch antenna, ie3d software, bandwidth, gain.

1. INTRODUCTION

Printed planar microstrip antennas [1] 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, ε_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:

$$\mathbf{w} = \frac{\mathbf{c}}{2f_o\sqrt{\frac{\varepsilon_r + 1}{2}}}$$

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

$$\varepsilon_{re} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left(1 + \frac{12\mathbf{h}}{\mathbf{W}}\right)^{-\frac{1}{2}}$$

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

$$Le = L + 2\Delta L$$

4: **Calculation of the length extension (ΔL):** The following equation gives the length extension as:

$$\Delta L = \frac{h}{\sqrt{\varepsilon_r}}$$

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

$$L = \frac{c}{2 f_r \sqrt{\varepsilon_{re}}} - 2\Delta L$$

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 the feed 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	Hexagonal Shape	Hexagonal Shape
Frequency of Operation (GHz)	1.8	1.8
Dielectric constant of substrate	4.2	4.2
Loss tangent	.0012	.0012
Height of the dielectric substrate	2mm	2mm
Feeding method (Probe feeding)	Point (x=26.05,y=6.32)	Point (x=25.9,y=6.2)
Width of the ground (W_g)	64mm	64mm
Length of the ground (L_g)	52mm	52mm
Width of the patch (W_p)	52mm	52mm
Length of the patch (L_p)	40mm	40mm

Proposed Antenna Design 1.

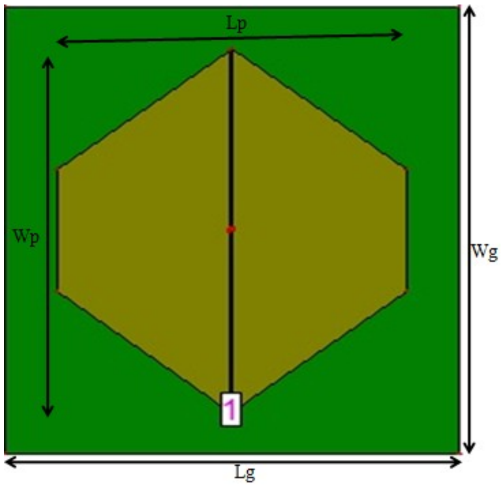

Figure no.1- Antenna feeding at(x=26.05,y=6.32)

Proposed Antenna Design 2.

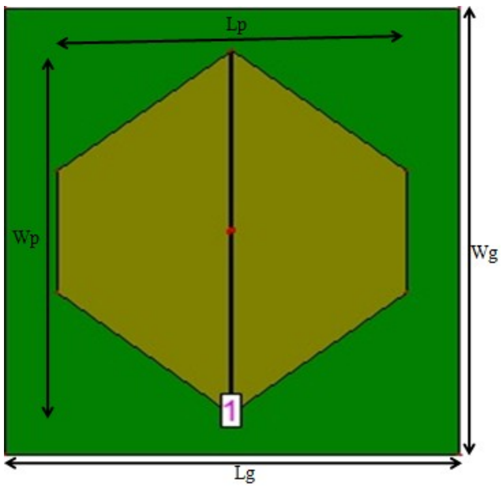

Figure no.2 - Antenna feeding at(x=25.9,y=6.2)

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-

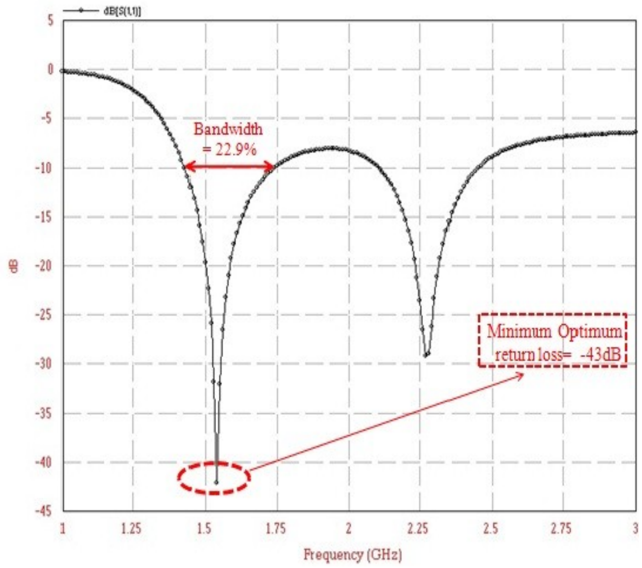

Figure no.3- Frequency Vs Return Loss

(B) Gain Vs Frequency –

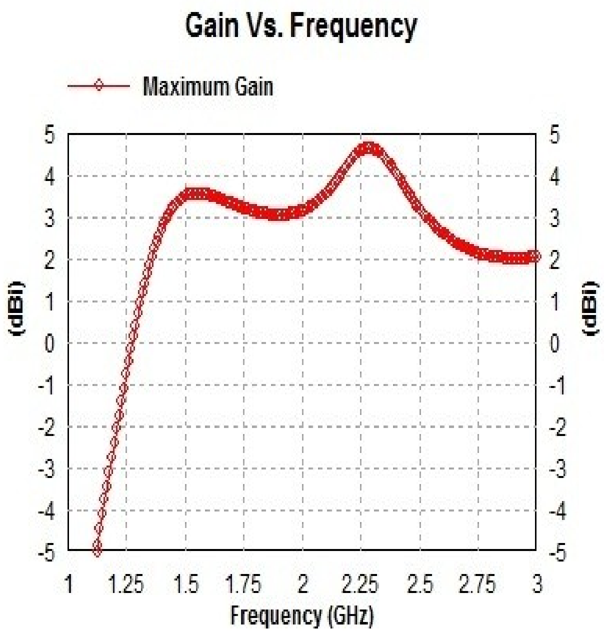

Figure no.4 - Gain Vs Frequency

(C) Radiation Pattern –

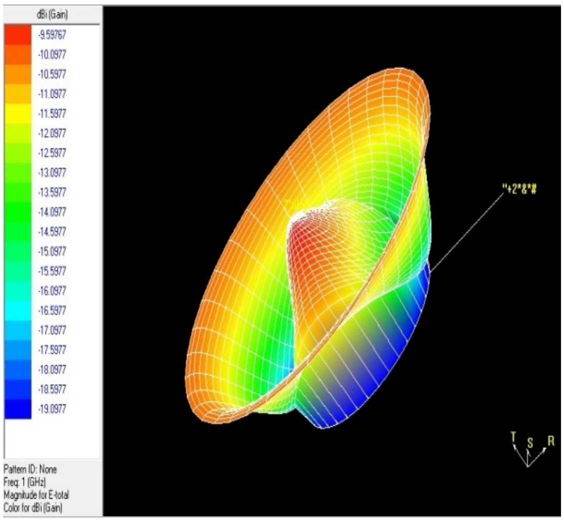

Figure no.5 - 3D View of radiation pattern

(D) Smith Chart –

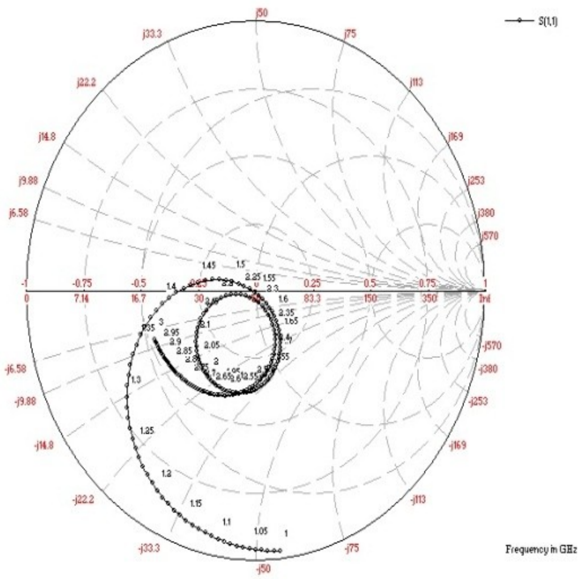

Figure no.6- Smith Chart

Simulation results for design 2

(A) Return Loss Vs Frequency

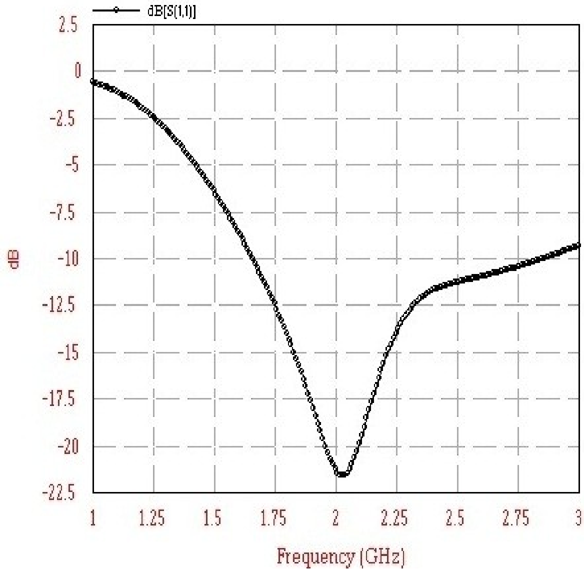

Figure no.7- Frequency Vs Return Loss

(B) Gain Vs Frequency –

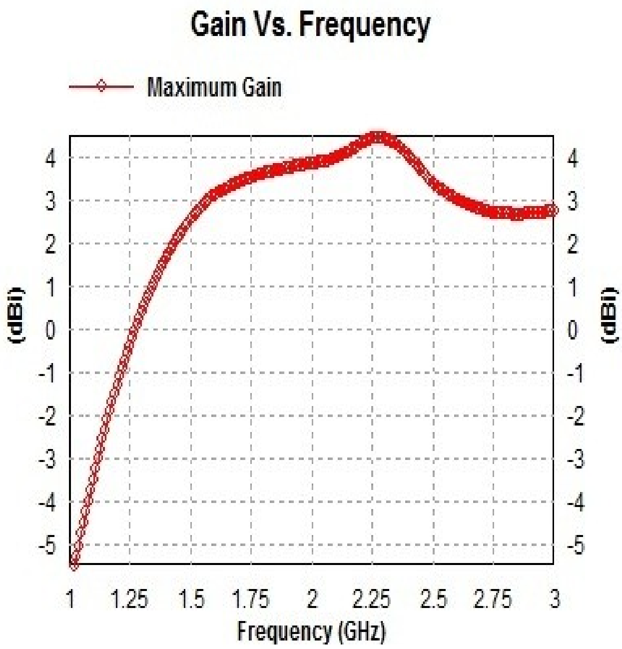

Figure no.8 - Gain Vs Frequency

(C) Radiation Pattern –

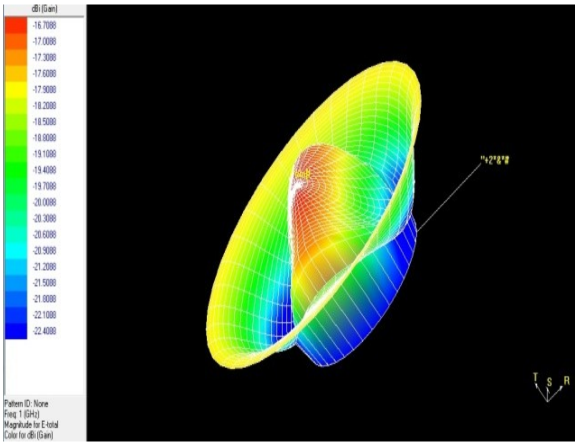

Figure no.9- radiation pattern

(D) Smith Chart –

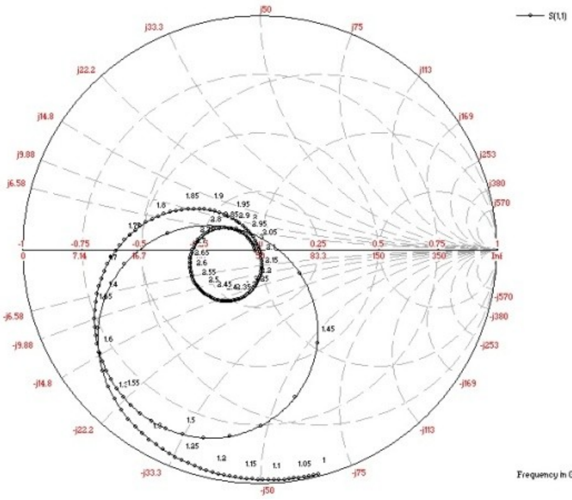

Figure no.10- Smith Chart

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 antennas on 1.8GHz (L-band) having patch length, Lp = 40mm & patch width, Wp = 52mm. 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 both the results at 1.8GHz (L-band) are shown below in the tabular form-

Antenna Designs	Bandwidth (%)	Gain
1	22.9	3.5
2	52	3.9

5. REFERENCES

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