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Department of Electronics & Communication Engineering

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Annexure I

1. Project Title: Design of Micro Strip Patch Antenna with Aperture Feeding & h-Shape Slot For UG Tech

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1. Abstract & Objective

1.1 Abstract

Microstrip patch antenna becomes very popular day-by-day because of its ease of analysis and fabrication, low cost, light weight, easy to feed and their attractive radiation characteristics. To overcome the drawbacks of patch antenna, various feeding techniques have proposed.

We propose a new simple design based on line feed technique and the dielectric constant used is Teflon. In this project we are inserting a C-Shape slot on rectangular patch to enhance the bandwidth and gain. After simulation,the obtained results are bandwidth 4% and gain as 4.8 db.

1.2 Motivation

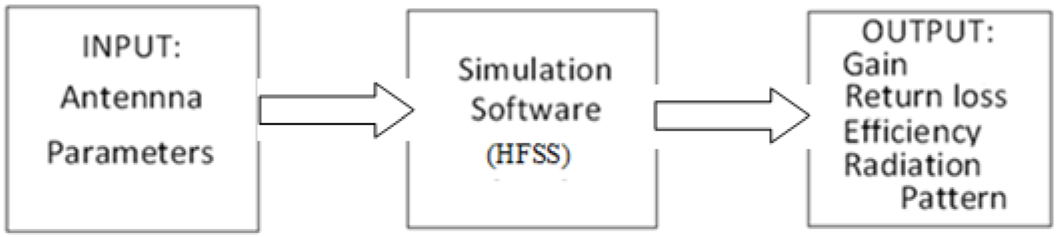
Wireless communications have progressed very rapidly in recent years, and many mobile units are becoming smaller and smaller. It started with hand gestures, then sounds produced by vocal chords and gradually me moved to wired communication and now wireless communication. In wireless communication we mainly exploit the Electromagnetic Spectrum. To meet the miniaturization requirement, the antennas employed in mobile terminals must have their dimensions reduced accordingly. Planar antennas, such as micro strip and printed antennas have the attractive features of low profile, small size, and conformability to mounting hosts. For this reason, compact, broadband and wideband design technique for planar antennas have been attracted much attention from antenna researchers. To increase the speed of access and number of users with less crosstalk and interference data rates and bandwidth have to be increased for a particular operating frequency. By using different feeding techniques available and by inserting different slots on patch improves return loss, gain and radiation pattern

Objective

The main objective of the project is to design and simulate micro strip patch antenna using High frequency structural simulator (HFSS) and to increase the antenna parameters such as Gain, Bandwidth, Return loss and Efficiency. To meet these requirements the patch antenna is designed at an operating frequency of 4.5GHz. By inserting slot on rectangular patch improves the antenna gain, return loss and antenna efficiency.

2. Block Diagram & Technical Specifications

2.1 Block Diagram and Working:



2.1.2. Description:

The summarizations of basic operation for microstrip patch antenna's parameters are discussed as follows.The antenna substrate dielectric constant is given as εr. The εr is primarily affects the bandwidth and radiation efficiency of the antenna. The lower the permittivity will give a wider impedance bandwidth and reduce the surface wave excitation.

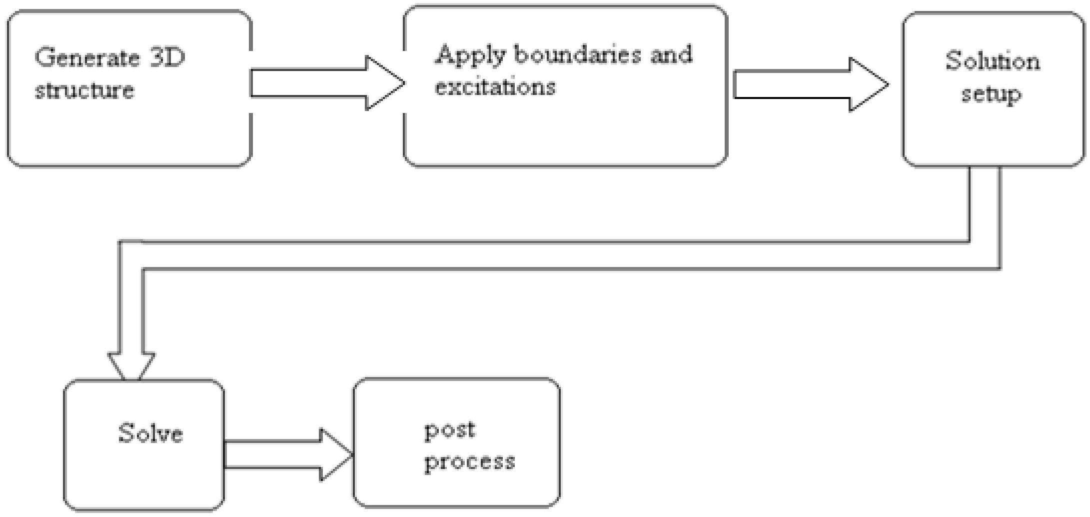
The antenna substrate thickness is given as h. The substrate thickness affects bandwidth and coupling level. A thicker substrate results in wider bandwidth, but less coupling for a given aperture size. L is the microstrip patches length. The length of the patch radiator determines the resonant frequency of the antenna. The microstrip patches width is given as w. The width, w of the patch affects the resonant resistance of the antenna, with a wider patch giving a lower resistance.This project is implemented using HFSS software.

1. Create model/geometry
2. Assign boundaries
3. Assign excitations
4. Set up the solution
5. Solve
6. Post-process the results

2.1 Technical specifications:

HFSS is a high performance full wave electromagnetic (EM) field simulator for arbitrary 3D volumetric passive device modelling that takes advantage of the familiar Microsoft Windows graphical user interface. It integrates simulation, visualization, solid modelling, and automation in an easy to learn environment where solutions to your 3D EM problems are quickly and accurate obtained. Ansoft HFSS employs the Finite Element Method (FEM), adaptive meshing, and brilliant graphics to give you unparalleled performance and insight to all of your 3D EM problems. Ansoft HFSS can be used to calculate parameters such as S-Parameters, Resonant Frequency, and Fields. Typical uses include

- Package Modelling – BGA, QFP, Flip-Chip
- PCB Board Modelling – Power/ Ground planes, Mesh Grid Grounds, Backplanes
- Silicon/GaAs-Spiral Inductors, Transformers
- EMC/EMI – Mobile Communications – Patches, Dipoles, Horns, Conformal Cell Phone Antennas, Quadrafilar Helix, Specific Absorption Rate (SAR), Infinite Arrays, Radar Section (RCS), Frequency Selective Surface (FSS)
- Connectors – Coax, SFP/XFP, Backplane, Transitions
- Waveguide – Filters, Resonators, Transitions, Couplers
- Filters – Cavity Filters, Microstrip, Dielectric
- HFSS is an interactive simulation system whose basic mesh element is a tetrahedron. This allows you to solve any arbitrary 3D geometry, especially those with complex curves and shapes, in a fraction of the time it would take using other techniques.
- The name HFSS stands for High Frequency Structure Simulator. An soft pioneered the use of the Finite Element Method (FEM) for EM simulation by developing / implementing technologies such as tangential vector finite elements, adaptive meshing, and Adaptive Lancozos - pade Sweep (ALPS). Today, HFSS continues to lead the industry with innovations such as Modes to Nodes and Full wave Spice.
- An soft HFSS has evolved over a period of years with input from many users and industries. In industry, Ansoft HFSS is the tool of choice for High productivity research, development, and virtual prototyping.



2. Results

2.1 RESULTS:

The below outputs represents the plots of **C-shape** slot on patch antenna with line feed.

5.1.1 S-parameters (S11) Vs Frequency plot:

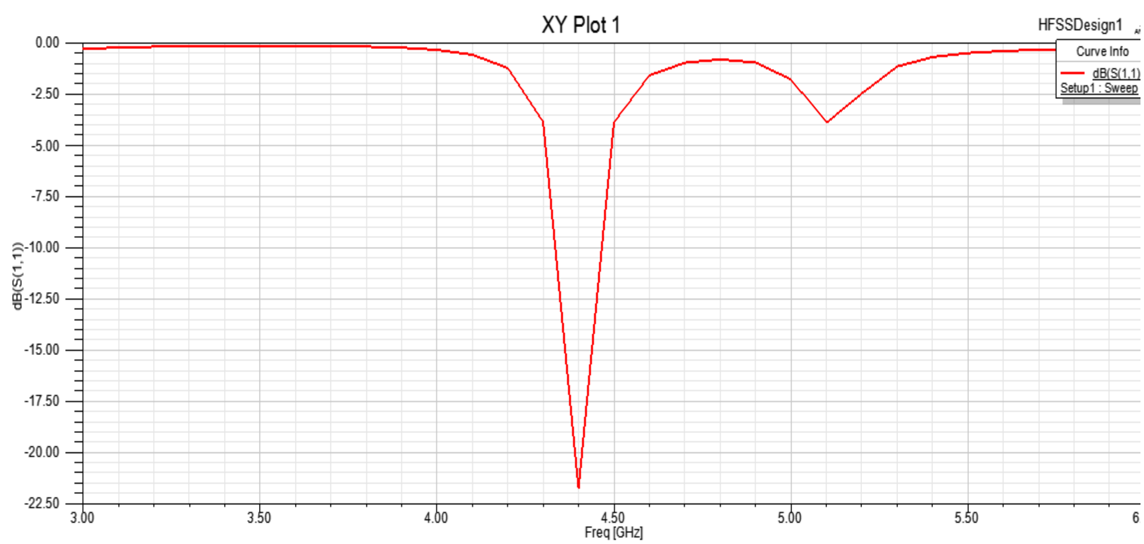


Figure 2.1 : S-parameters (S11) Vs Frequency plot

Here the Patch antenna is simulated at operating frequency of 4.5GHz. The S11 value at

-10db is return loss.

Return loss = -21.50

2.1.2 Bandwidth:

The difference between upper and lower-cut off frequencies at S11 value -10db from the above graph is taken as bandwidth.

Bandwidth(%) = (4.49 GHz – 4.31 GHz) / 4.5GHz

Impedance Bandwidth **= 4 %**

2.1.3 Directivity:

The directivity obtained for the designed micro strip line feed patch antenna is obtained as

D (θ, ϕ) = 5.2 db (as W< lambda)

The plot of directivity at different angles of θ is as follows.

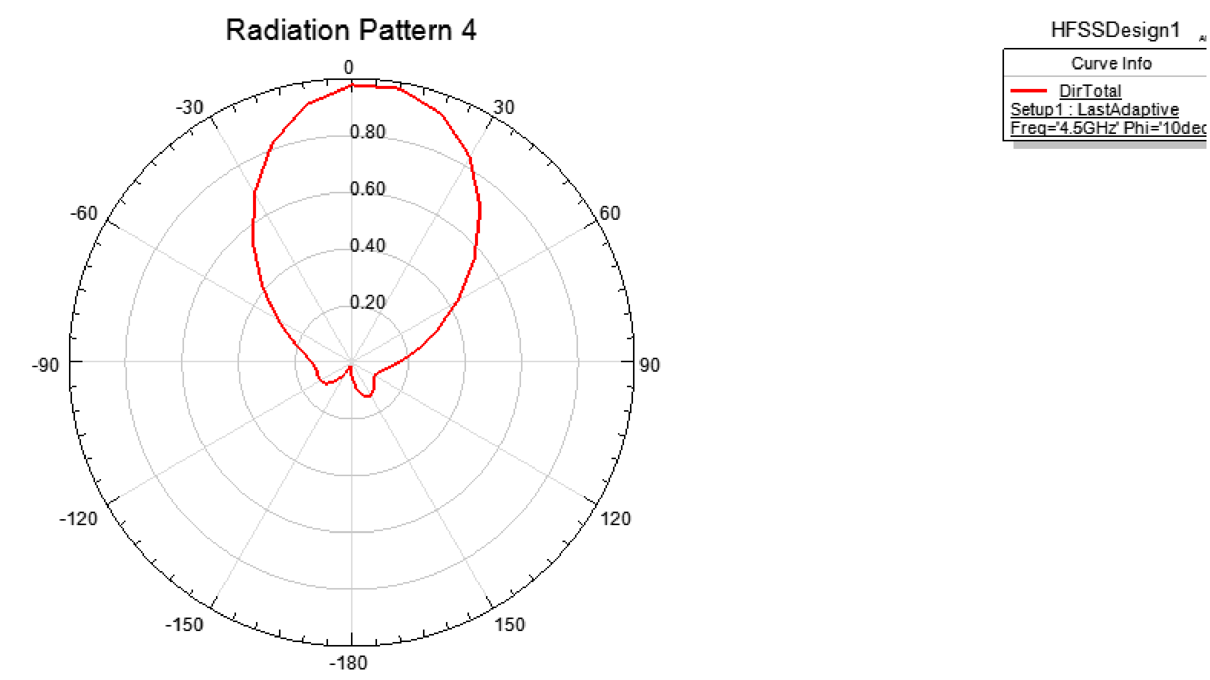


Figure 2.2: Polar plot for directivity

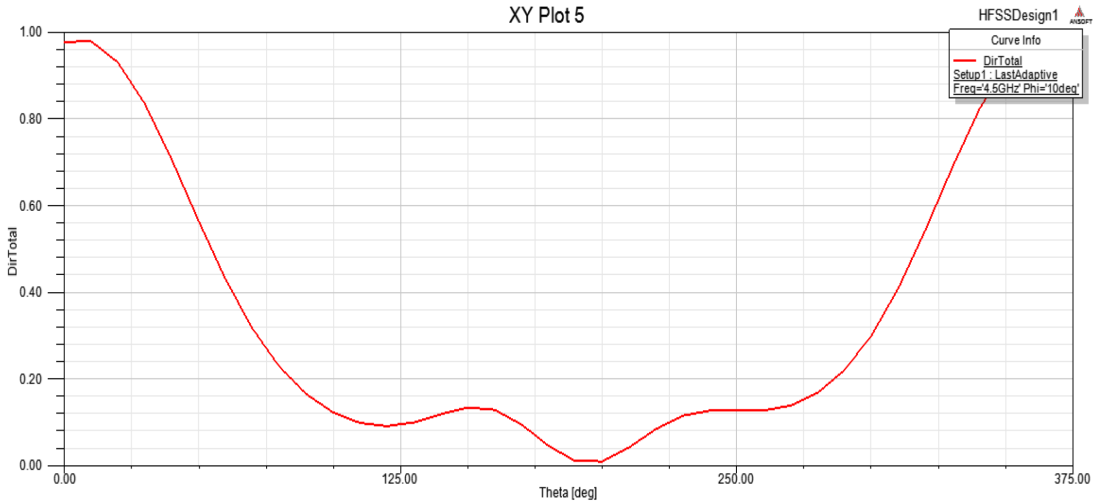


Figure 2.3: Rectangular plot for directivity

2.1.4 Radiation Efficiency:

Radiation efficiency obtained for this design is 0.92465 from the below table.

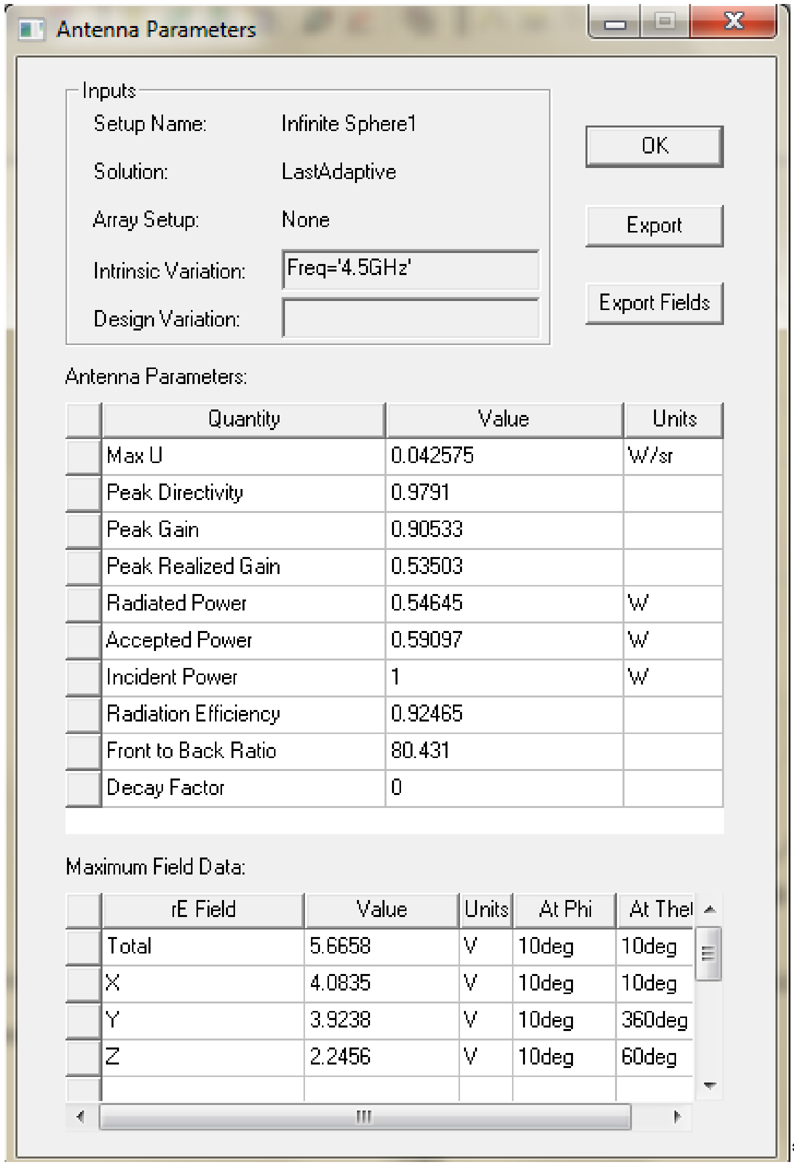


Figure 2.4: Antenna Parameters

2.1.5 Gain:

Antenna Gain in a particular direction is equal to the Directivity in that direction multiplied by the Antenna Efficiency.

$$G(\theta, \phi) = E*D(\theta, \phi)$$

$$G(\theta, \phi) = 0.92465*5.2$$

$$\mathbf{G(\theta, \phi) = 4.8\ db}$$

The plot of gain at different angles of θ is as shown below.

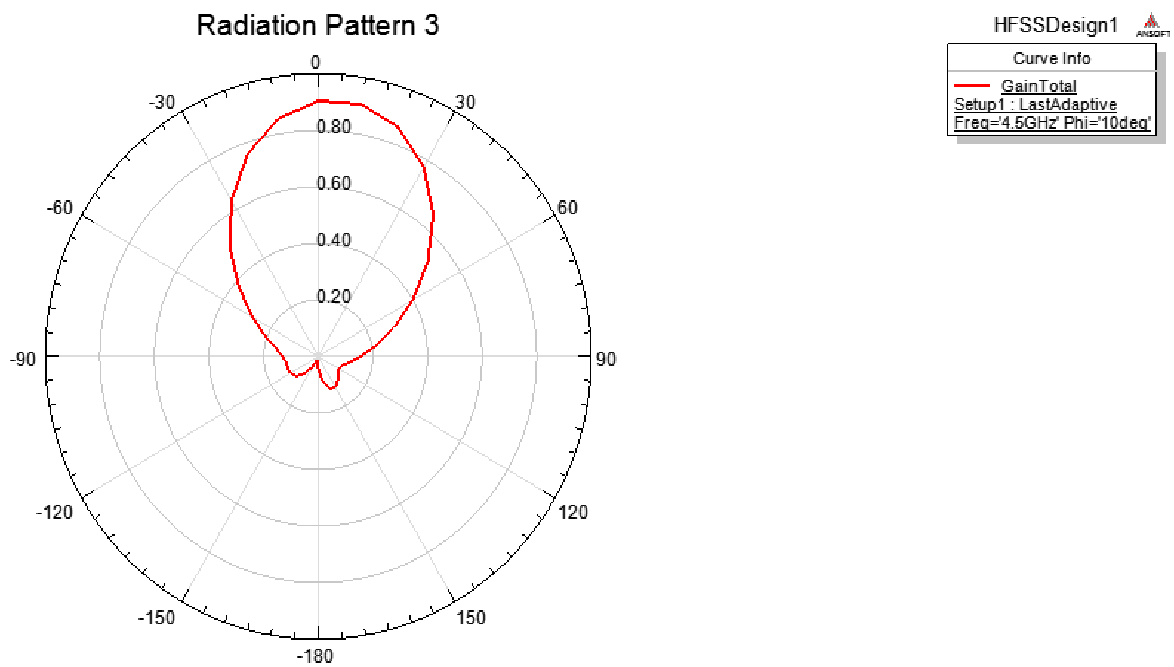


Figure 2.5: Polar plot for gain

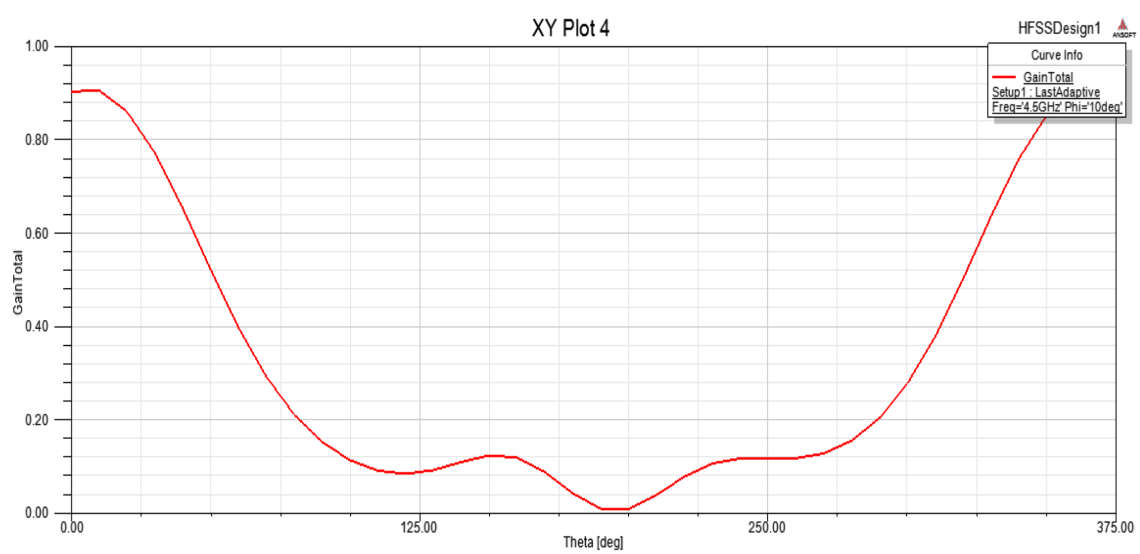


Figure 2.6: Rectangular plot for gain

2.1.6 VSWR Vs Frequency Plot:

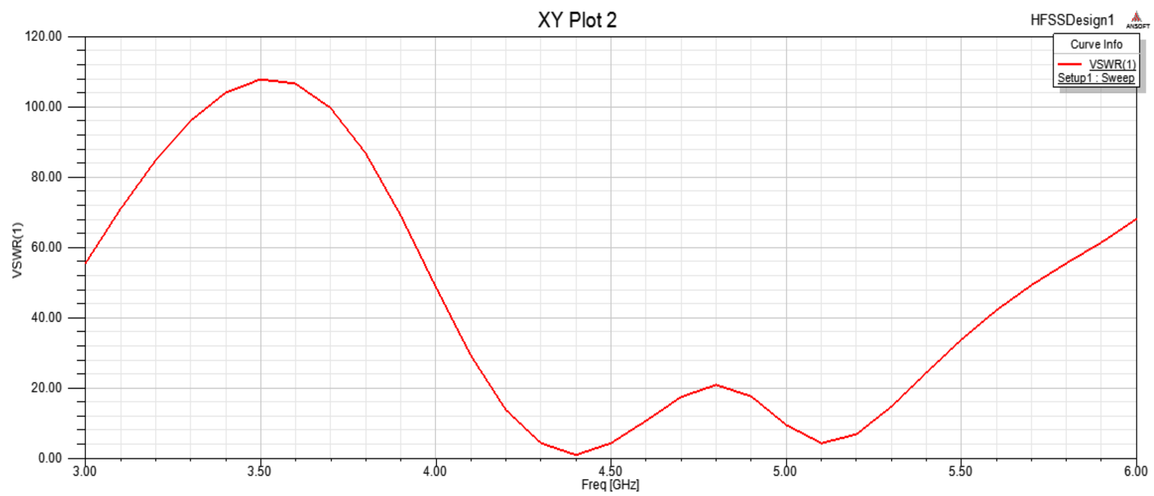


Figure 5.7: VSWR Vs Frequency Plot

VSWR obtained from the above graph is 1.

VSWR = 1

2.1.7 Radiation Pattern:

The 2-D far field pattern obtained for 4.5GHz is as shown below.

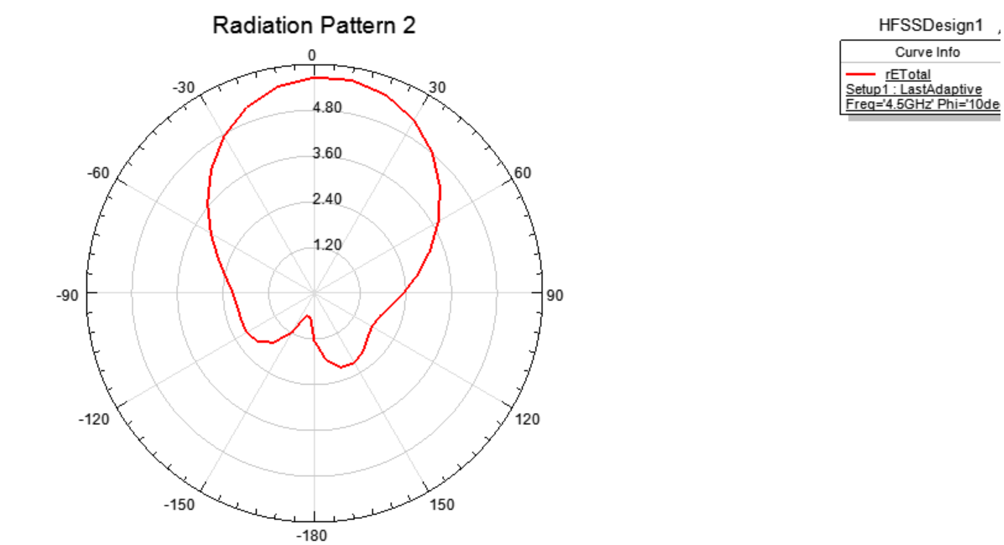


Figure 2.8: Polar plot for radiation pattern

3-D far field pattern is shown below.

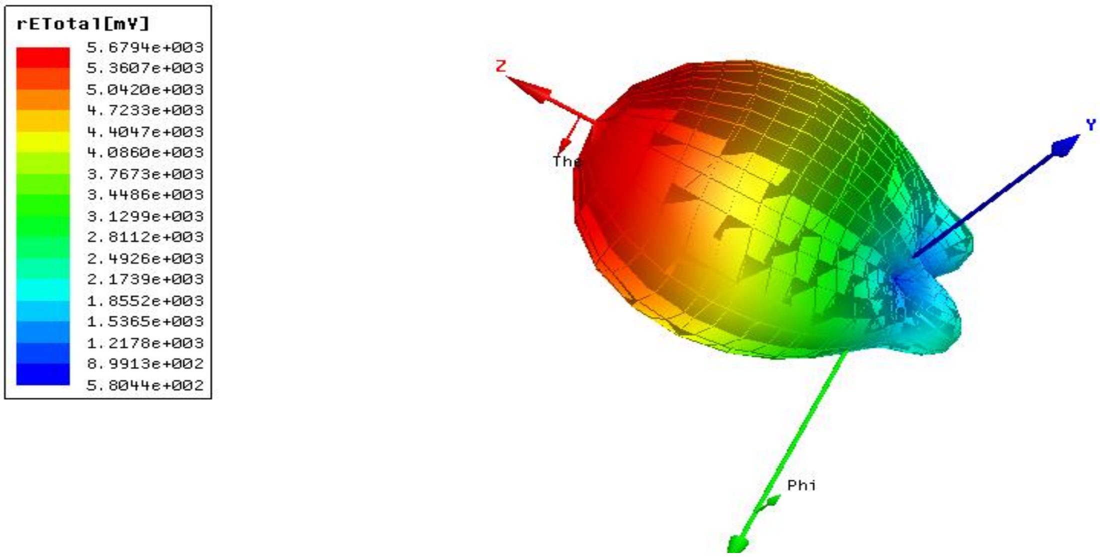


Figure 2.9: 3-D Radiation pattern

Table 2.1: Comparison of Output Parameters at Different Frequencies for H-slot

FREQUENY (GHz)	RETURN LOSS (db)	BANDWIDTH (MHz)	DIRECTIVITY (db)	GAIN (db)	VSWR
4.5	-22.7	70	5.2	4.7	1
2.6	-19	60	5.2	4.6	1
2.1	-18	50	5.2	4.7	0.8

The table 5.2 shows comparision of antenna output parameters at frequency 4.5 GHz with C-Shape and H-Shape slots on patch.

Table : Comparison of Output parameters at 4.5 GHz for C and H-shape slots

PARAMETER	H-Shape slot	C-Shape slot
Return loss (db)	-21.5	-22.7
Band width (%)	4.5	1.5
Gain (db)	4.8	4.7
Directivity (db)	5.2	5.2
VSWR	1	1

From the table 2.2 simulation results the patch designed with C-Shape slot produces more bandwidth and gain.

3. Conclusion

3.0. Conclusion

In this project we designed patch antenna operating at 4.5 GHz and compared the results for C and H-Shape slots. We can say that there are many aspects that affect the performance of the antenna such as dimensions, selection of the substrate, feed technique and also the Operating frequency can take their position in effecting the performance. After simulation ,the obtained results are bandwidth 4% and gain as 4.8 db.Therefore, from table5.2 we conclude that the design with H-Shape slot provides more bandwidth and gain compared to C-Shape slot results