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Wireless implicated H-Shaped Slotted Circular Patch Antenna

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Abstract: In this dissertation, Micro strip antennas with their advantages and with the availability of tools to design were remains as a centre of research attraction. The main research aspect of the Micro strip Patch is to enhance its bands and bandwidth. To enhance the bands or bandwidth of the Micro strip Patch antenna several techniques were proposed. The slot on the patch, which increases the fringing fields, remains simple and effective technique. This paper provides an insight in the design of Micro strip antenna and presents a design of fifer band H shaped slot Circular Patch Antenna. The design utilizes the circular patch of radius 20mm and obtains multiband at the frequencies 2.44 GHz, 3.84GHz, 5.22 GHz, 6.35 GHz, 8.07 GHz. HFSS the Finite Element Method based analysis software is used to design the Patch Antenna and to simulate the results.

Keywords: Dual band, Multi Band. Circular Shape Antenna, Micro strip patch antenna,S-Parameters, smith chart, bandwidth, VSWR, resonant frequency,HFSS13.0.

I. INTRODUCTION

In recent years, with the increasing demand for information capacity of the communication, antenna's research is moving towards multi-polarization and multi-band. The difficulties and hot spots of designing dual polarized microstrip patch antennas are to expand the bandwidth, improve the isolation and reduce the cross-polarization. To improve the isolation, probe-fed is used in early years. It can make the isolation better than 20dB and the cross-polarization nearly 25dB. But it reduces the bandwidth, and then L-probe coupled feed is made to expand the width. However, the vertical structure is not conducive to the realization of the antenna array. Now most of the microstrip antennas especially in some lower frequency band are conducted in the form of aperture-coupled feed. It can help the isolation arrived 45dB. But for W-band, it is difficult to use multilayer structure. Another way to realize dual polarization easily is side-fed with microstrip. But it will impact the radiation performance of antenna. Many methods are tried to achieve wide bandwidth like increasing the thickness of the dielectric plate, reducing the dielectric constant, increasing tangent of the angle of reflection and so on. Cross polarization which is based on the radiation performance of patch, has not much been studied[8].

Micro strip patch antenna consists of a dielectric substrate, with a ground plane on the other side. If the antenna is excited at a resonant frequency, a strong field is set up inside the cavity, and a strong current on the surface of the patch. Advantages such as less weight, low costs and capability to integrate with microwave integrated circuits technology makes the Microstrip as research interest area. The micro strip patch antenna is very well suited for applications such as wireless communications system, cellular phones. Narrow bandwidth available from printed microstrip patches has been recognized as one of the most significant factor limiting the widespread applications of antenna. Through decades of research, it was identified that the performance and operation of a microstrip antenna is driven mainly by the geometry of the printed patch and the material characteristics of the substrate onto which the antenna is printed. Hence, it is realizable that with proper manipulations to the substrate can improve the performance of micro strip antenna. It is well known that the size of the antenna will impact its performance, specifically in terms of bandwidth and gain. In general, antennas can be split into two main types - resonant structures (e.g. microstrip patch antennas, dipoles, loops) and travelling wave structures (e.g. horns, helixes, spirals). Travelling wave antennas range in size from a wavelength up to many 10's of wavelengths in size, and in general have wider bandwidths. This increased bandwidth results from the antennas creating a smooth transition to couple energy from a guided wave to free space radiation as it propagates through the structure. Their larger size also allows for more directive antennas. Conversely, resonant antennas couple energy to free space via a structure proportionate to the operating wavelength, and only efficiently over limited frequency ranges. These antennas typically have dimensions on the order of /J2 and multiples thereof. Since their size is less than A, they also tend to have lower directivity, due to the smaller aperture size.[9]

Microstrip antenna technology began its rapid development in the late 1970s. By the early 1980s basic microstrip antenna elements and arrays were fairly well establish in term of design and modeling. Microstrip patch antennas radiate primarily because of the

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fringing fields between the patch edge and the ground plane. The u-slot microstrip patch antenna was introduced in 1995 by Huynh and Lee. One major drawback of microstrip patch antennas is their narrow bandwidth and low gain.[10]

The field of antennas is vigorous and dynamic, and over the last 60 years antenna technology has been making a lot of improvements and has become an integral part of the communication revolution. A number of advancements have occurred and are being used today. However as the demands for the system performance are increasing day by day there are a lot of issues and challenges which are facing us today. An antenna is the most critical element of the wireless communication system. A good antenna design can improve the system performance. A particular example is of a TV for which the overall broadcast reception can be improved by using a high performance antenna. The purpose that eyes and eyeglass serve for a human body is the same as antenna does for a communication system. In order to reduce the multipath fading and enhance data transmission the use of multiple input multiple output (MIMO) technology at transmitter and receiver terminals has attracted the attention of industries recently. For short distance communication MIMO is combined with ultra-wideband (UWB) technology [7].

II. ANALYSIS OF ANTENNA

The length of the patch is denoted by L and width of the patch is denoted by W. Because the dimensions of the patch are finite along the length and width, the fields at the edges of the patch undergo fringing. Since some of the waves travel in the substrate and some in air, an effective dielectric constant $\varepsilon reff$ is introduced to account for fringing and the wave propagation in the line.

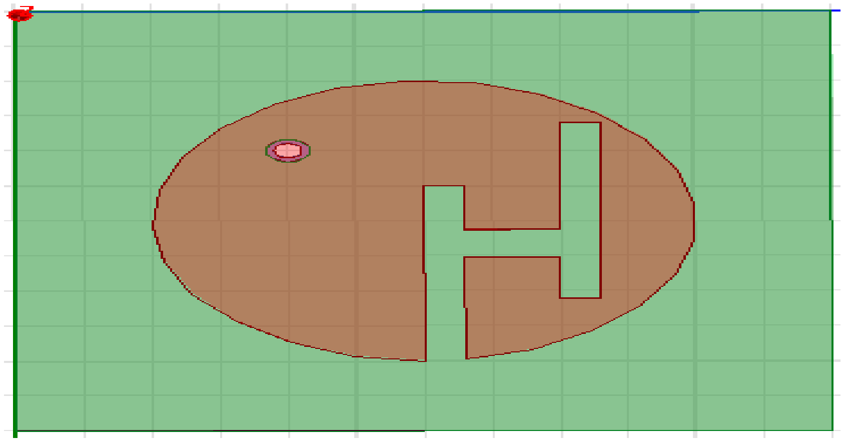

Figure 1 Basic Geometry of Circular Microstrip Patch Antenna

A. *Microstrip Line Feed*

It is the easiest of the feeding methods to fabricate as it is just a conducting strip connected to the patch and can be considered as an extension to the patch. The conducting strip is smaller as compared to the patch width and it has advantage that the feed can be etched on the same substrate to provide planer structure. The advantage of this technique is that there is no need for any additional matching element to match the impedance of the feed line to patch. However as the thickness of the dielectric substrate increases spurious radiation increases which limits the bandwidth.[25]

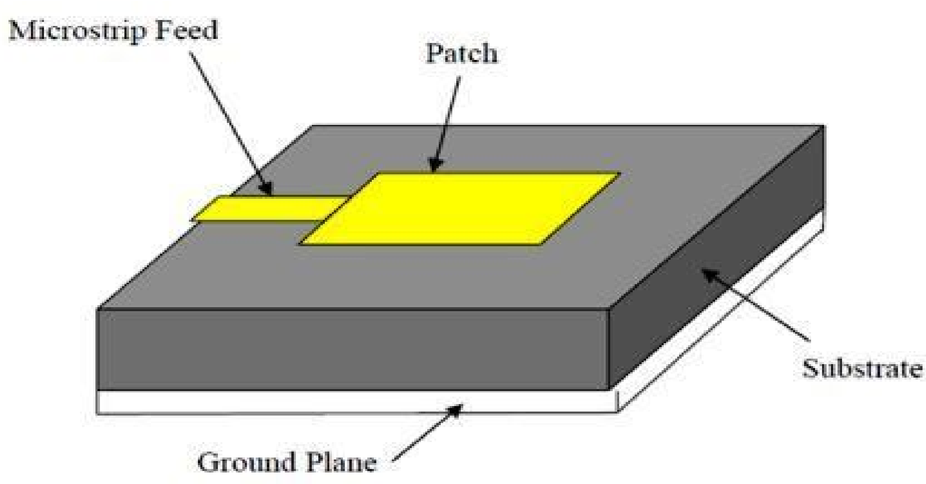

Figure 2 Microstrip line feed

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III. DESIGNINGOF ANTENNA

A. Design of H-Shape Antenna using square patch using MSL feed

In this design we introduce some rectangular slot in square patch to made H-Shape slot as according to reference paper and design a multi band antenna.

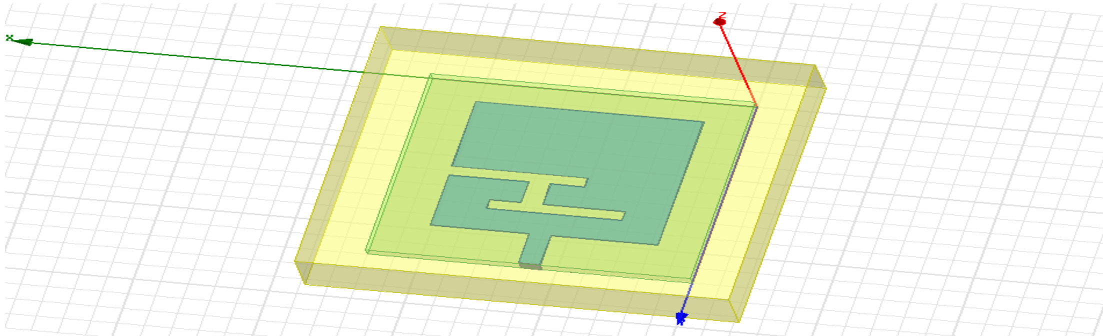

Figure 3 Square Patch antenna

B. Observation from -10dB return loss

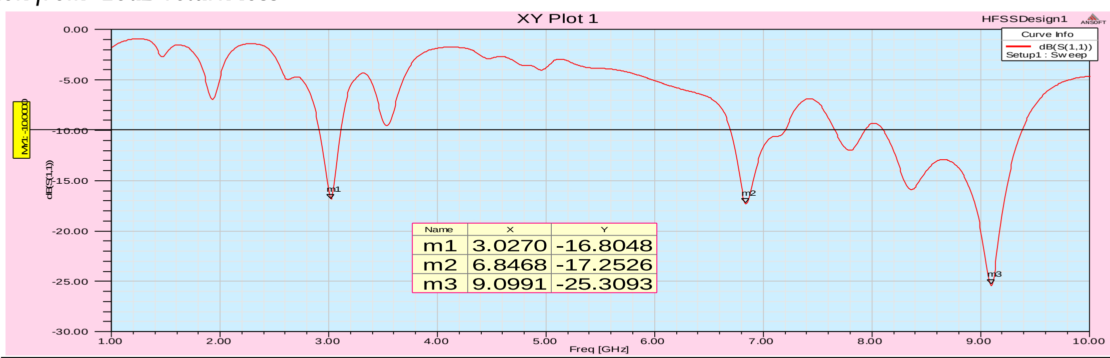

Figure 4 Return loss graph of square patch antenna

The Proposed antenna is resonating at Five frequencies means provide three band as described below:

1) Resonant frequency = 3.02 GHz at -16.80 dB(S-parameter)
2) Resonant frequency = 6.86 GHz at -17.25 dB(S-parameter)
3) Resonant frequency = 9.09 GHz at -25.30 dB(S-parameter)

C. Observation from VSWR

The proposed antenna give the value of VSWR less than 2 at each resonating frequency which is practically very good.

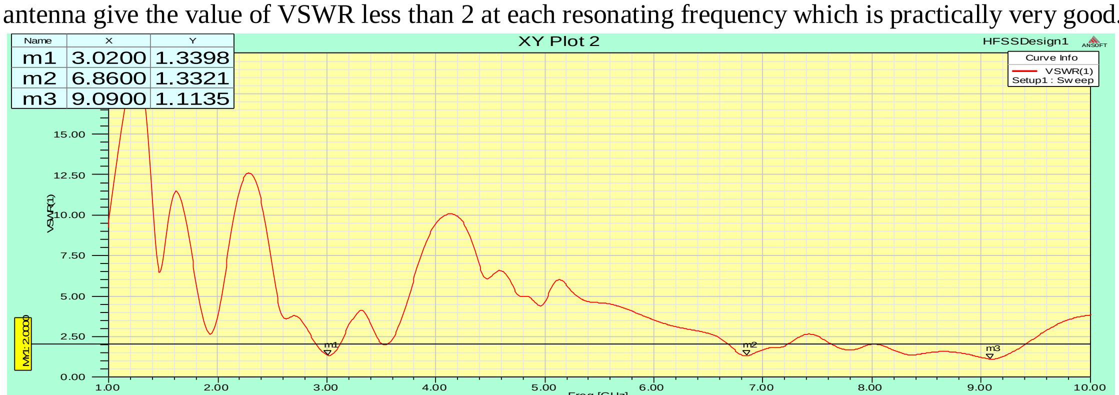

Figure 5 VSWR graph of square patch Antenna

1) VSWR at Resonant frequency 3.02 GHz is 1.33
2) VSWR at Resonant frequency 6.86 GHz is 1.33
3) VSWR at Resonant frequency 9.09 GHz is 1.11

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D. Smith Chart

The smith chart curve of Proposed Antenna is shown in Figure.

Impedance Matching at maximum VSWR frequency (9.09 GHz) = 0.9571 ×50= 47.85 ohm

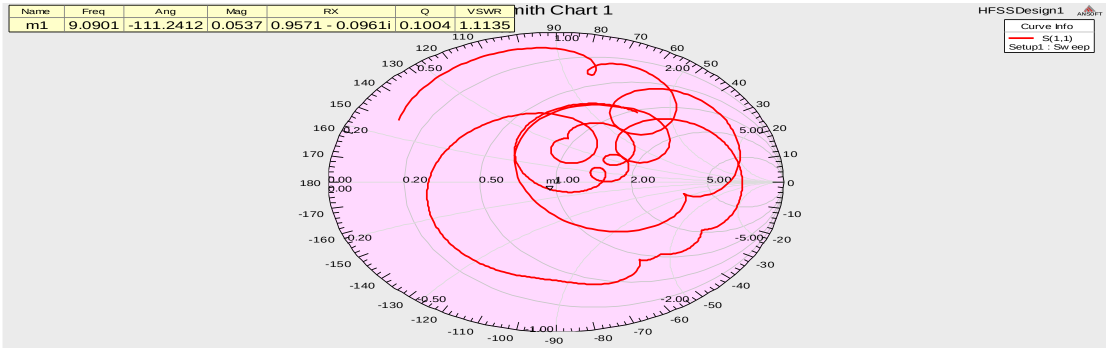

Figure 6 Smith chart curve of square patch antenna

1) Design of rectangular patch antenna (H-Shape in Patch):

In this design we introduce some rectangular slot in rectangular patch to made H-Shape slot as according to reference paper and design a multi band antenna.

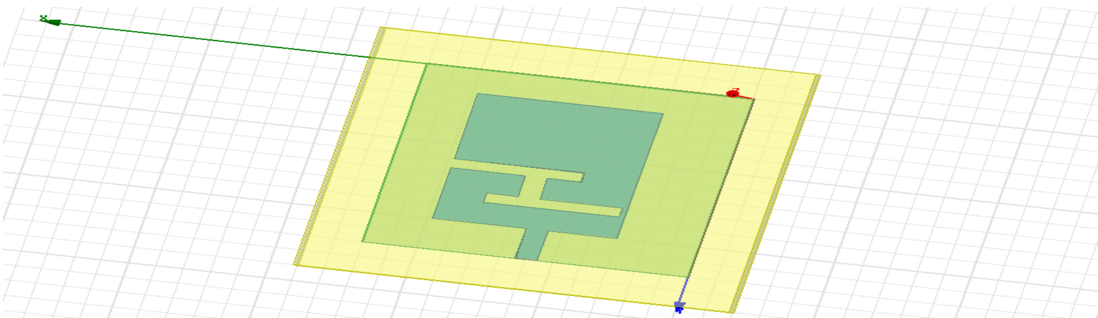

Figure 7 Rectangular Patch antenna

2) Observation from -10dB return loss

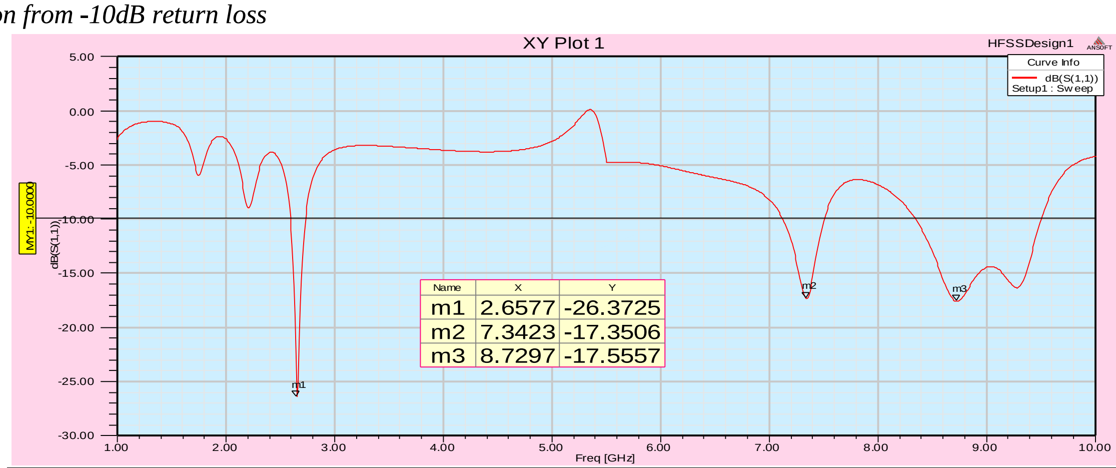

Figure 8 Return loss graph of rectangular patch antenna

The Proposed antenna is resonating at three frequencies means provide three band as described below:

a) Resonant frequency = 2.65 GHz at -26.37 dB (S-parameter)

b) Resonant frequency = 7.34 GHz at -17.35 dB (S-parameter)

c) Resonant frequency = 8.72 GHz at -17.55 dB (S-parameter)

E. Smith Chart

The smith chart curve of Proposed Antenna is shown in Figure.

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Impedance Matching at maximum VSWR frequency (2.65 GHz) = 0.9398 ×50= 46.99 ohm

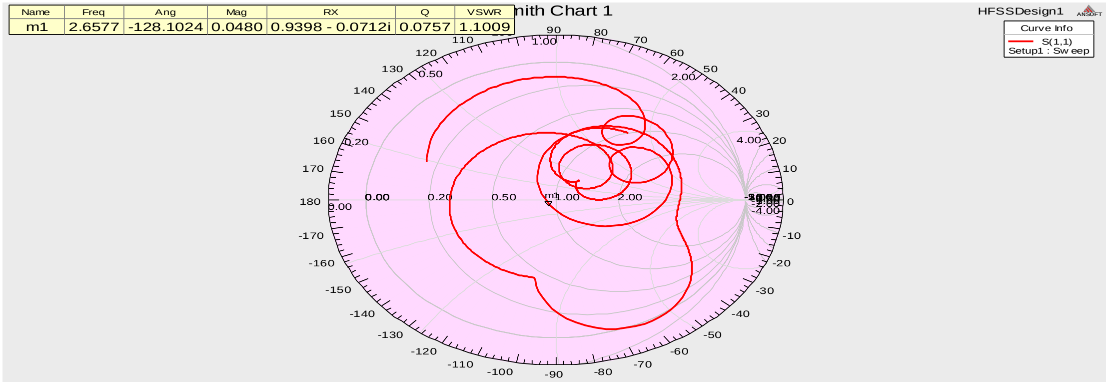

Figure 9 Smith chart curve of rectangular patch antenna

F. Design of a H-Shape Antenna using circular patch

In this design we introduce some rectangular slot in circular patch to made H-Shape slot as according to reference paper and design a multi band antenna.

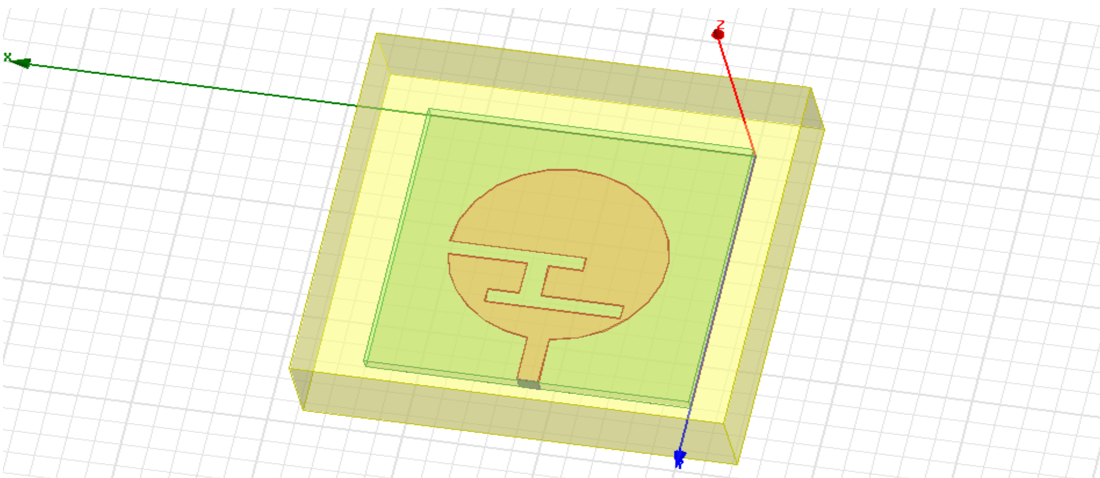

Figure 10 Circular Patch antenna

1) Observation from -10dB return loss

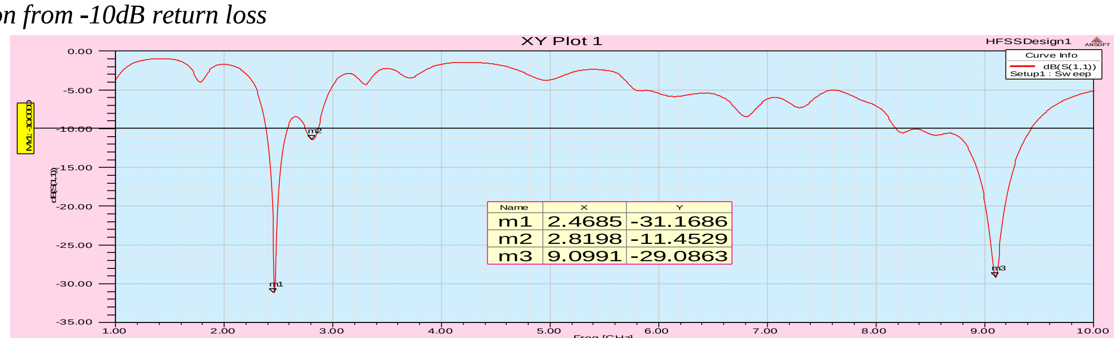

Figure 11 Return loss graph of circular patch antenna

The Proposed antenna is resonating at three frequencies means provide three band as described below:

a) Resonant frequency = 2.46 GHz at -31.16 dB(S-parameter)

b) Resonant frequency = 2.81 GHz at -11.45 dB(S-parameter)

c) Resonant frequency = 9.09 GHz at -29.08 dB(S-parameter)

2) Observation from VSWR

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The proposed antenna give the value of VSWR less than 2 at each resonating frequency which is practically very good.

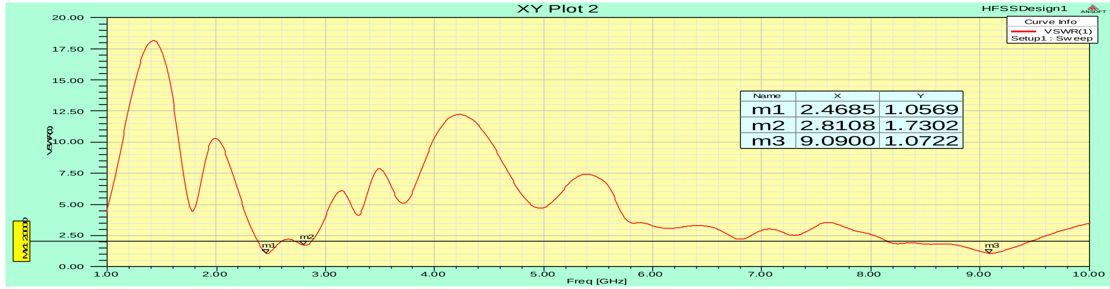

Figure 12 VSWR graph of circular patch Antenna

a) VSWR at Resonant frequency 2.46 GHz is 1.05
b) VSWR at Resonant frequency 2.81 GHz is 1.73
c) VSWR at Resonant frequency 9.09 GHz is 1.07

3) Smith Chart

The smith chart curve of Proposed Antenna is shown in Figure.

Impedance Matching at maximum VSWR frequency (2.46 GHz) = 1.0473 ×50= 52.36 ohm

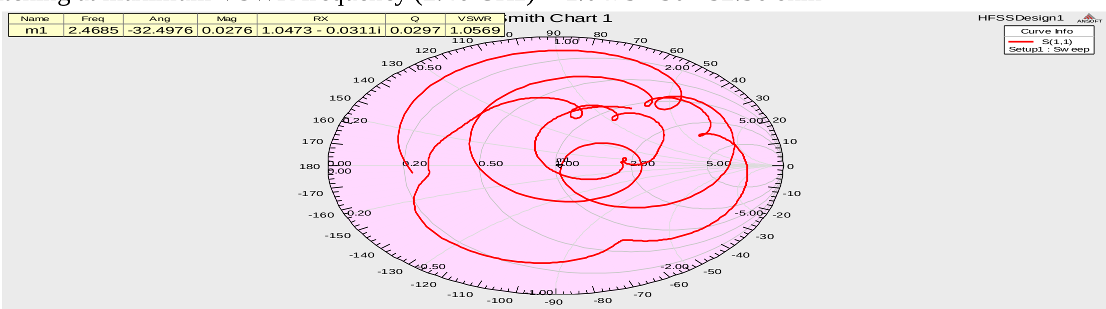

Figure 13 Smith chart curve of circular patch antenna

G. Design of Proposed H-Shape Circular Antenna using coaxial probe feed:

In this design we introduce some rectangular slot in patch to made H-Shape slot as according to reference paper and design a multi band antenna.

In this technique, microstrip patch antenna is designed using coaxial feed and three different dimension slot in patch detailed as shown below:

In this proposed design (H-Shape) the width of H slot is increased as compare to reference antenna and coaxial feed (in reference antenna).

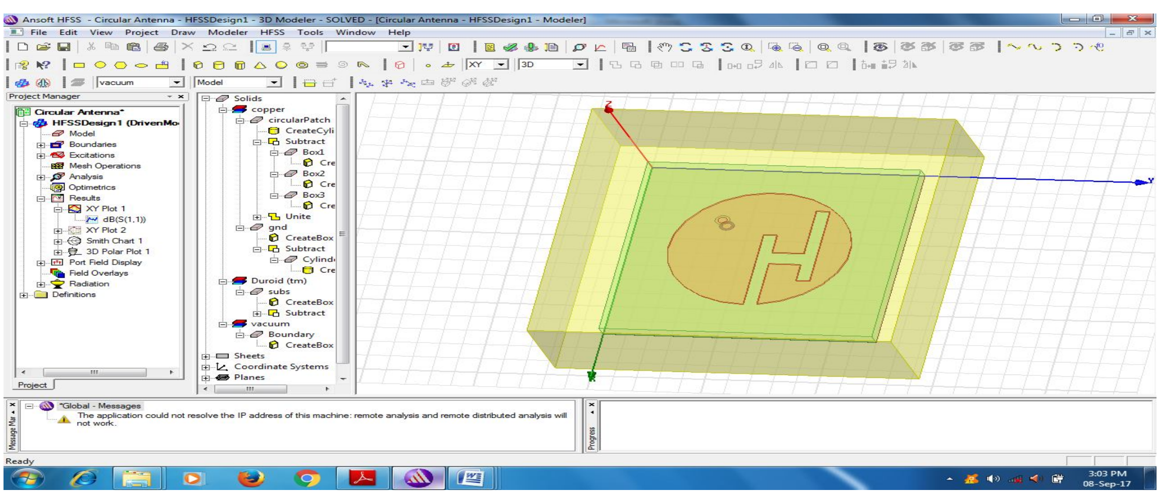

Figure 14Designing of proposed antenna

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1)) Observation from -10dB return loss

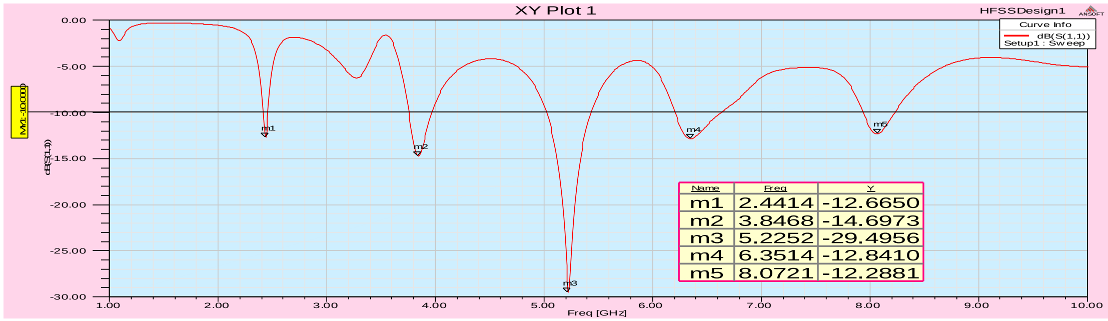

Figure 15 Return loss graph of Proposed antenna

a) The Proposed antenna is resonating at Five frequencies means provide five band as described below:

4) Resonant frequency = 2.44 GHz at -12.66 dB(S-parameter)

5) Resonant frequency = 3.84 GHz at -14.69 dB(S-parameter)

6) Resonant frequency = 5.22 GHz at -29.49 dB(S-parameter)

7) Resonant frequency = 6.35 GHz at -12.84 dB(S-parameter)

8) Resonant frequency = 8.07 GHz at -12.28 dB(S-parameter)

2) Observation from VSWR

The proposed antenna give the value of VSWR less than 2 at each resonating frequency which is practically very good.

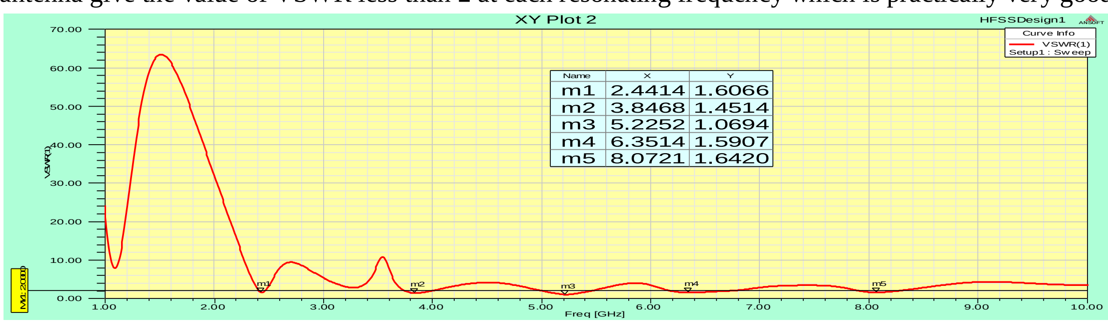

Figure 16 VSWR graph of Proposed Antenna

a) VSWR at Resonant frequency 2.44 GHz is 1.60

b) VSWR at Resonant frequency 3.84 GHz is 1.45

c) VSWR at Resonant frequency 5.22 GHz is 1.06

d) VSWR at Resonant frequency 6.35 GHz is 1.59

e) VSWR at Resonant frequency 8.07 GHz at 1.64

3) Radiation Pattern: Radiation Pattern of proposed antenna shows that the antenna is highly directed in particular direction.

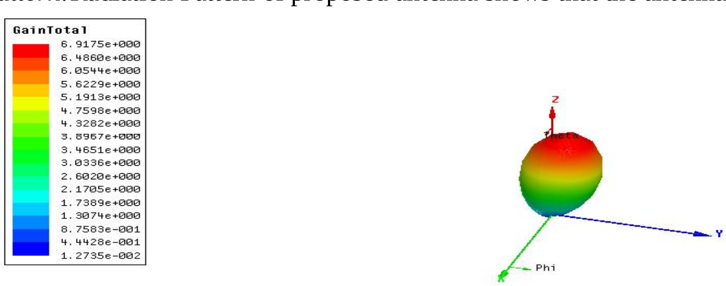

Figure 17 Radiation pattern curve of Proposed Antenna

4) Smith Chart: The smith chart curve of Proposed Antenna is shown in Figure.
Impedance Matching at maximum VSWR frequency (5.22 GHz) = 1.007 ×50= 50.035 ohm

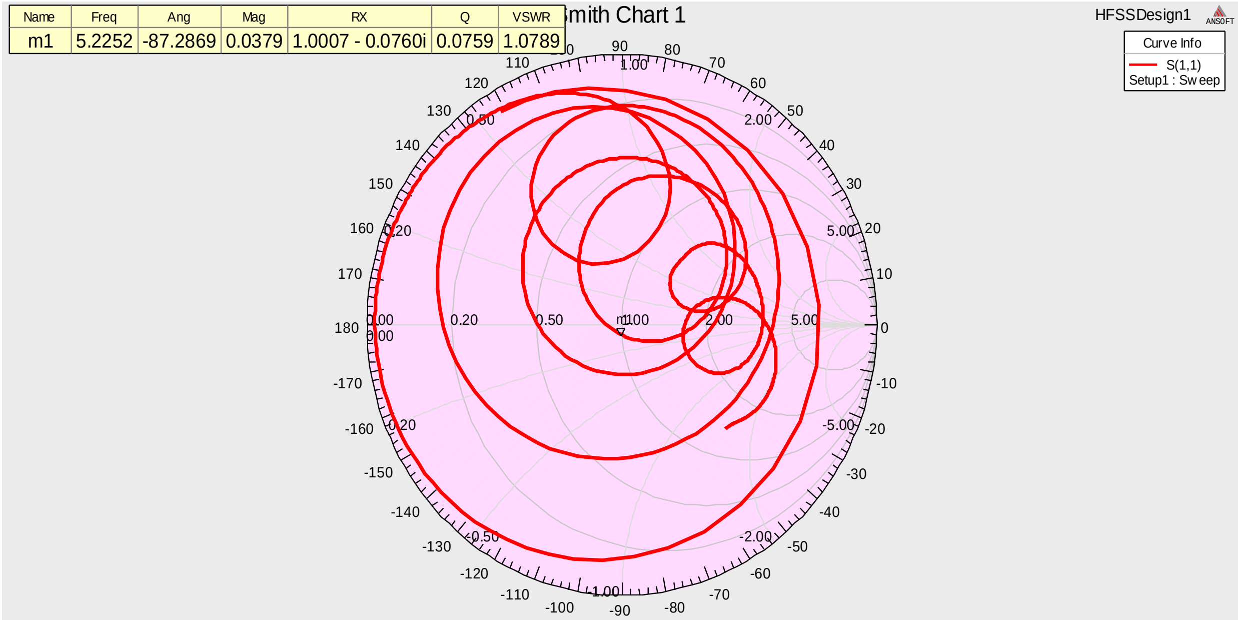

Figure 18 Smith chart curve of Proposed antenna

H. Conclusion between Reference Antenna and Proposed Multiband Antenna:

So the proposed antenna give the better result in terms of more multiband (5 bands as compare to reference antenna has 3 band), better S-Parameters, better VSWR and impedance matching.

Table 1 Difference Table between Reference and Proposed antenna

Antenna	Difference in Design	Resonant Frequency	Impedance Matching
Reference Triple band Antenna	Using H Shape slot in patch and coaxial feeding technique	2.4 GHz 4.5 GHz 6.5 GHz	Not Given
Proposed Triple Band Square Antenna	Using wider H Shape slot in patch and microstrip line feed is used.	3.02 GHz 6.86 GHz 9.09 GHz	47.85 ohm
Proposed Triple Band Rectangular Antenna	Using wider H Shape slot in patch and microstrip line feed is used.	2.65 GHz 7.34 GHz 8.72 GHz	46.99 ohm
Proposed Triple Band Circular Antenna	Using wider H Shape slot in patch and microstrip line feed is used.	2.46 GHz 2.81 GHz 9.09 GHz	52.36 ohm
Final Proposed Multi-Band H-Shape Circular Antenna	Using wider H Shape slot in patch, improved boundary conditions and coaxial feed with changes feed point is used.	2.44 GHz 3.84 GHz 5.22 GHz 6.35 GHz 8.07 GHz	50.035 ohm

IV. CONCLUSION

A Multi-band Circular patch antenna with H shaped slot is designed using HFSS. The design exhibits five frequencies at 2.44 GHz, 3.84GHz, 5.22 GHz, 6.35 GHz, 8.07 GHz. The return loss, gain and radiation patterns were measured with the help of HFSS tool and tabulated. The design shows that the slot based bandwidth enhancement technique is simple and effective in the lower GHz frequencies. The impedance matching is very high 50.035 ohm which is very near about characteristic impedance.

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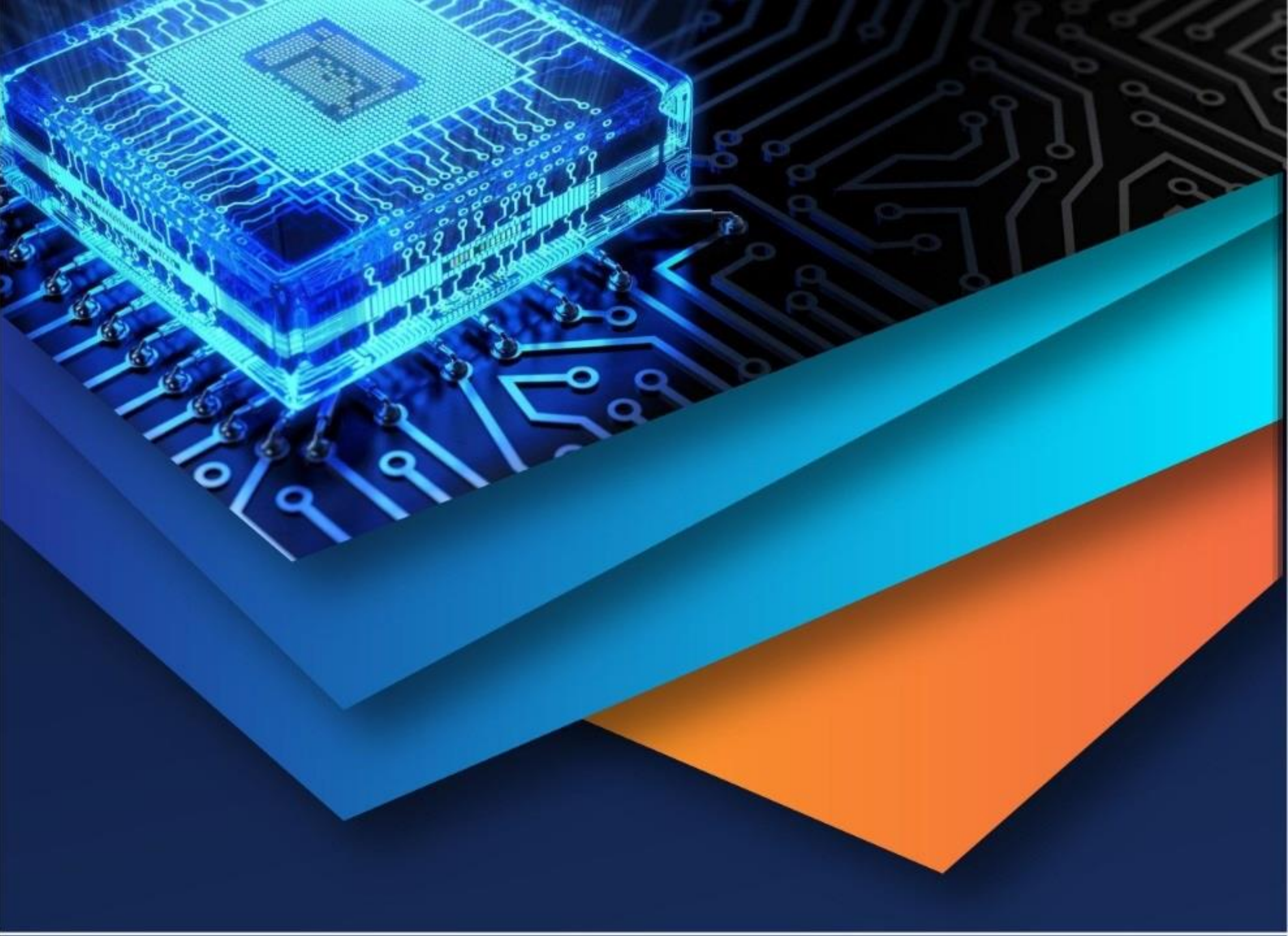

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