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DESIGN AND OPTIMIZATION OF A BROADBAND MICROSTRIP PATCH ANTENNA

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ABSTRACT- The purpose of this project is to design a broadband microstrip patch antenna which can be used in wireless communication systems. A description of the microstrip line in microstrip antenna is given. Then, the modeling and design of a 50-ohm microstrip line are derived. All simulations are carried out using HFSS software. Fr4 substrate is used with copper patch and copper ground. An impedance matched broadband antenna is designed in order to broaden the bandwidth of the microstrip patch antenna. A comparison is made between antennas with separate slot dimensions and the best result is taken out.

KEYWORDS-microstrip patch antenna, broadband, wireless, U shaped structure, slots

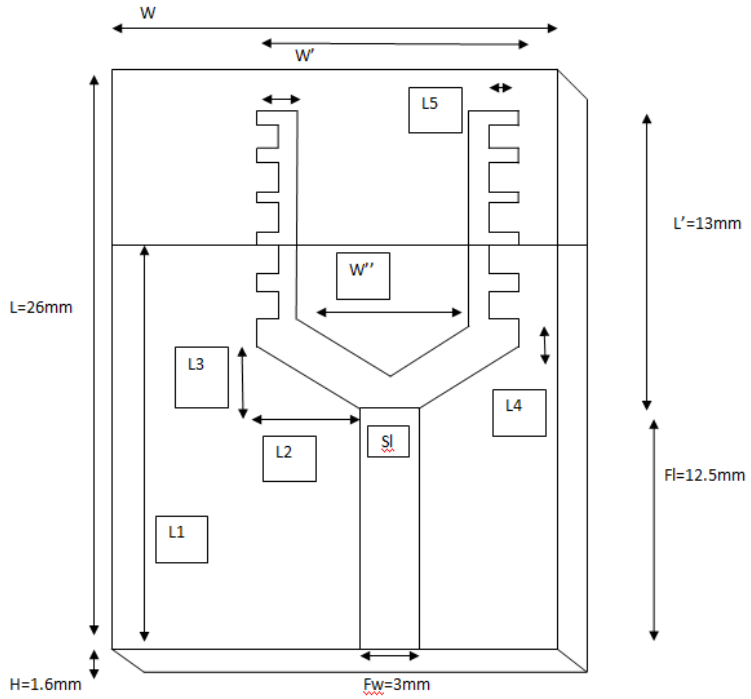
1. INTRODUCTION

Microstrip Patch Antennas have always been a source of attraction for the researchers due to their highly desirable attributes such as low profile structure, light weight, conformal shape, cost-effectiveness, high efficiency, ease of installation, small volume, and compatibility with microwave integrated circuits (MIC) and monolithic microwave integrated circuits (MMIC) [1,2]. These qualities have resulted in wide applications of microstrip patch antennas in radar, satellite and mobile communications. However micro strip patch antennas suffer from a major limitation of very low impedance bandwidth, typically about 5% bandwidth with respect to central frequency. Extensive research has been carried out in the past two to three decades in an attempt to increase the bandwidth of patch antennas. These bandwidth enhancement techniques include use of Frequency Selective Surface [3,4], use of low dielectric substrate, use of multiple resonators, use of thicker substrate [5], employing stacked configuration [6] and use of slot antenna geometry [7,8]. Singh et al. [9] proposed a T-slot rectangular patch antenna with an impedance bandwidth of 25.23%. Aneesh et al. [10] demonstrated that an S shaped Microstrip patch antenna can achieve a bandwidth of 21.62%. Mulgi et al.
Here we will design a comb shaped slots on the U shaped arms of microstrip patch antenna to obtain the broadband characteristics.

2. ANTENNA DESIGN

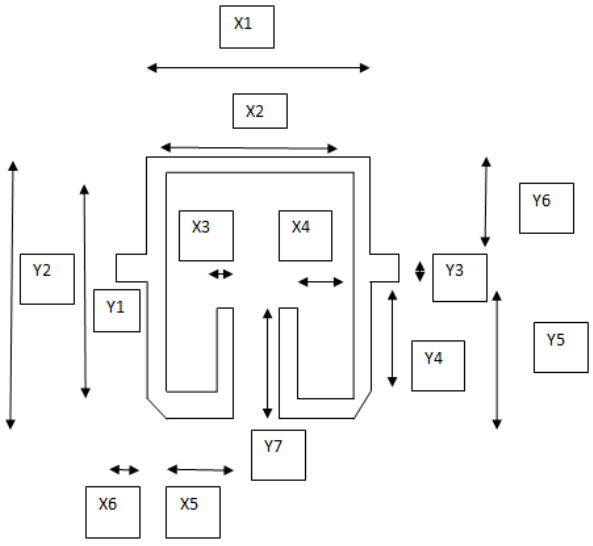
Here the proposed antenna is designed on a fr4 substrate of dimensions 23mm*26mm and of height 1.6mm.A rectangle patch of copper is taken of dimensions 15mm*13mm and of thickness 0.035 mm. A feed of dimensions 3mm*12.5mm is given to the feed. The feed is also of copper of thickness 0.035 mm. A copper ground is provided at the bottom of substrate of thickness 0.035mm but is not fully covered but up to 19.5mm. Two triangles are cut at the edges to form the U shaped structure and on the inner side another rectangle of dimensions 11mm*9mm and another triangle is cut to form the U shaped design. Then 5 squares each of 1.5mm*1.5mm is cut on both sides of the U shaped arm to form the comb like structure.
For better gain response we cut a square like slot in the feed just below the junction of feed and patch in the same dimension of antenna.

A. ANTENNA DESIGN 1



L1=19.5mm L2=7mm L3=2mm L4=2mm L5=1.5mm W''=11mm W'=15mm W=23mm
Sl represents the position of slot made.
We take three separate dimensions of the slot of the proposed antenna to get various outputs and compare the various results for broadband characteristics

FIGURE 1- THE DIMENSIONS OF THE PROPOSED ANTENNA DESIGN 1



X1=2mm X2=1.8mm X3=0.1mm X4=0.75mm X5=0.85mm X6=0.25mm Y1=1.8mm Y2=2mm Y3=0.1mm Y4=0.85mm Y5=0.95mm Y6=0.95mm Y7=0.5mm
The slot is placed at 0.2 mm below the junction of patch and feedline. The width of slot is 0.1mm in the design 1.

FIGURE 2 DIMENSIONS OF THE SLOT CUT IN THE ANTENNA DESIGN 1

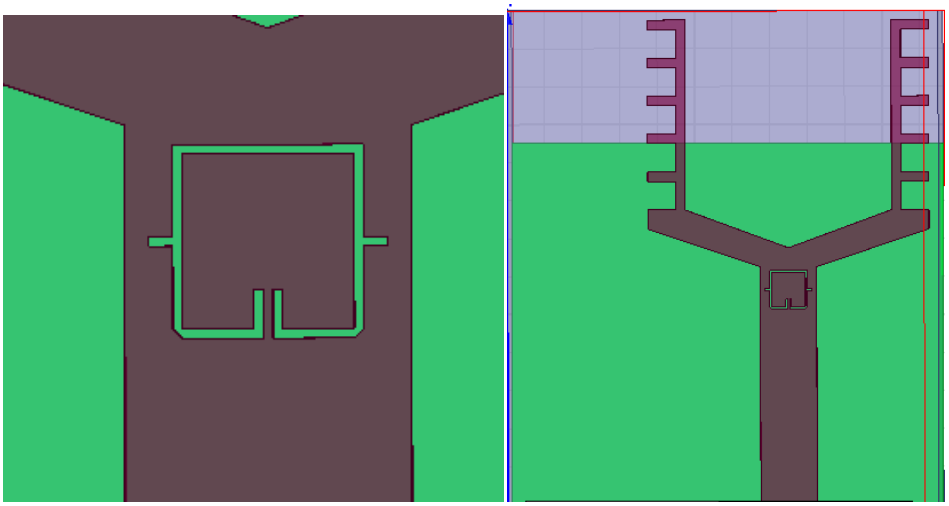


FIGURE 3-THE DESIGNED ANTENNA IN HFSS SOFTWARE

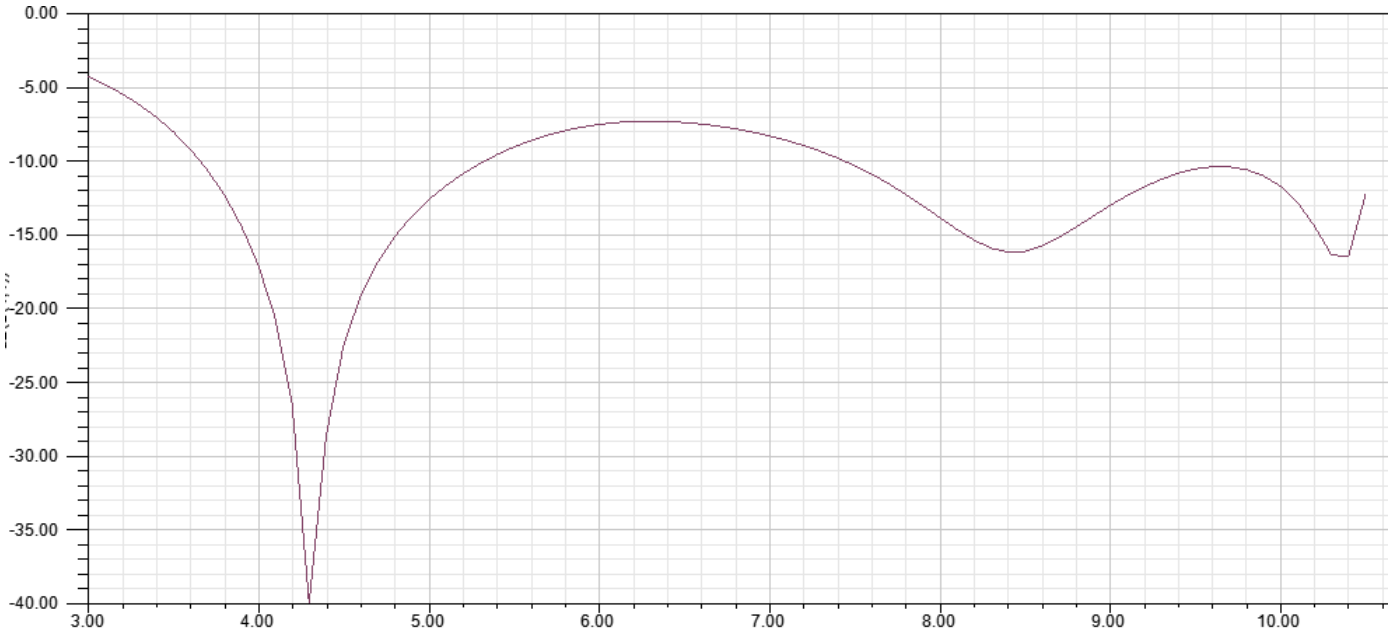


FIGURE 4-THE RETURN LOSS CHARACTERISTICS (S11 PARAMETERS) OF THE ANTENNA WITH THE DESIGN 1

The -10 dB is cut at 3.6 GHz falling till -40 dB and then till 5.2 GHz it remains till -10 dB so it can be used in different broadband applications. Again from 7.4 GHz till 10.6 GHz it remains below -10 dB with a wider bandwidth but lesser gain in comparison to previous frequency point.

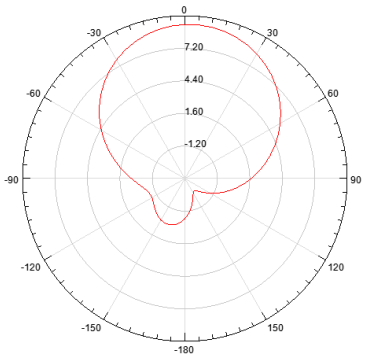


FIGURE 5-- RADIATION PATTERN AT ϕ=0 AND AT FREQUENCY=6 GHz

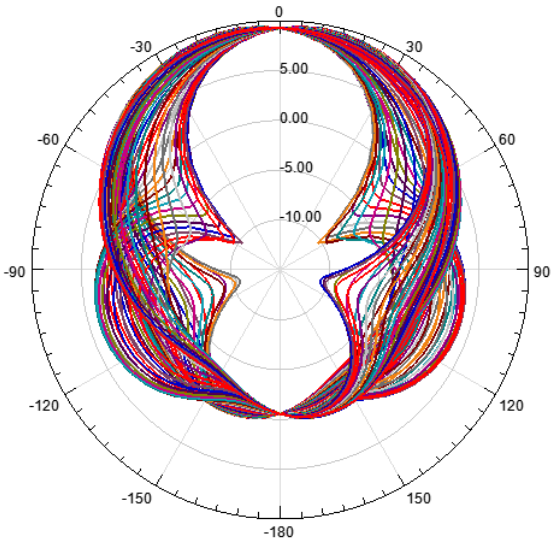
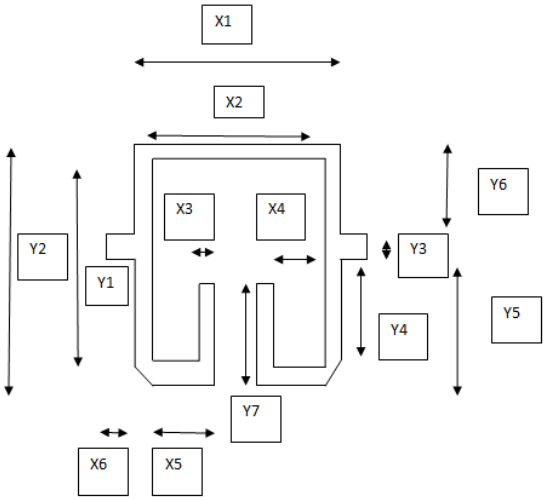


FIGURE 6-RADIATION PATTERN AT ALL ϕ AND FREQUENCY 6GHz

B. ANTENNA DESIGN2

Here the dimension of the slot is varied keeping all other parameters of antenna as described in figure 1.



X1=2mm X2=1.6mm X3=0.2mm X4=0.4mm X5=0.7mm X6=0.25mm Y1=1.6mm Y2=2mm Y3=0.2mm Y4=0.8mm Y5=0.9mm Y6=0.95mm Y7=1mm

The slot is placed at 0.2 mm below the junction of patch and feed line. The width of slot is 0.2mm in the design 1.

After bringing these parametric changes like increasing the thickness of gap width and height of two inner arms we get the following structures and results.

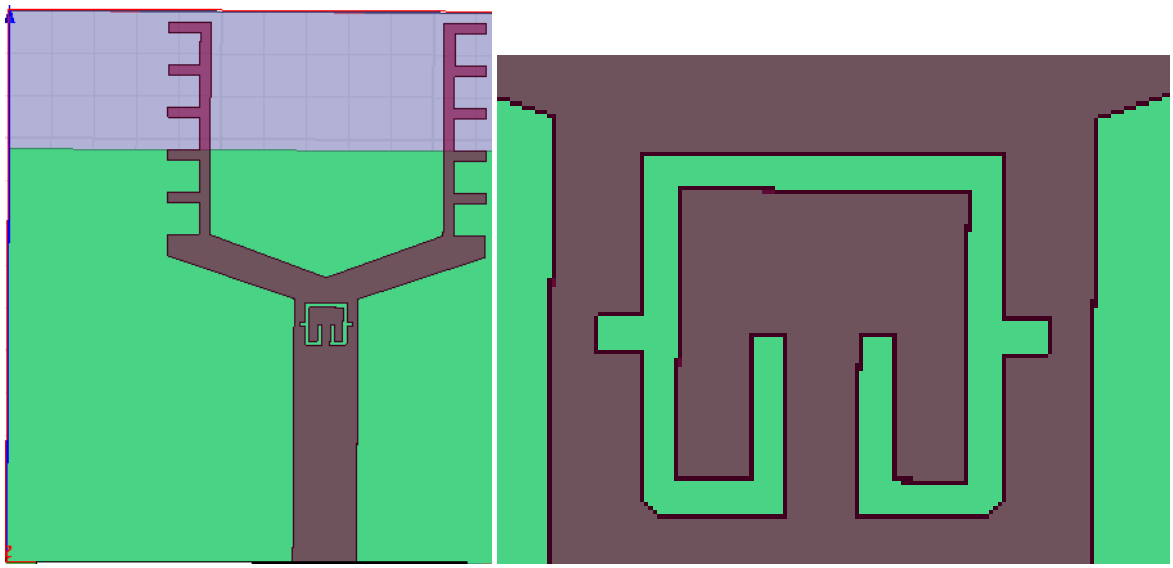


FIGURE 8-THE DESIGNED ANTENNA IN HFSS SOFTWARE

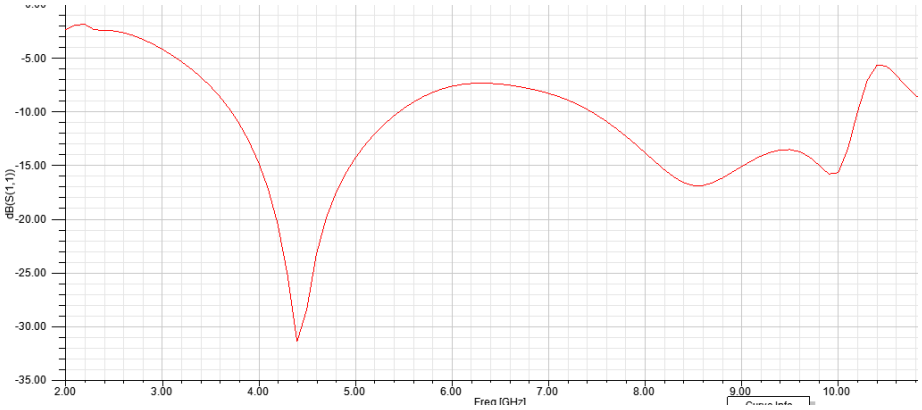


FIGURE 8-THE RETURN LOSS CHARACTERISTICS (S11 PARAMETERS) OF THE ANTENNA WITH THE DESIGN 2

The -10 dB is cut at 3.7 GHz falling till -31 dB and then till 5.4 GHz it remains till -10 dB so it can be used in different broadband applications. Again from 7.4 GHz till 10.2 GHz it remains below -10 dB with a wider bandwidth but lesser gain in comparison to previous frequency point.
It has a better response around 4.2 GHz in comparison to design 1 as bandwidth is higher but not sharper one.

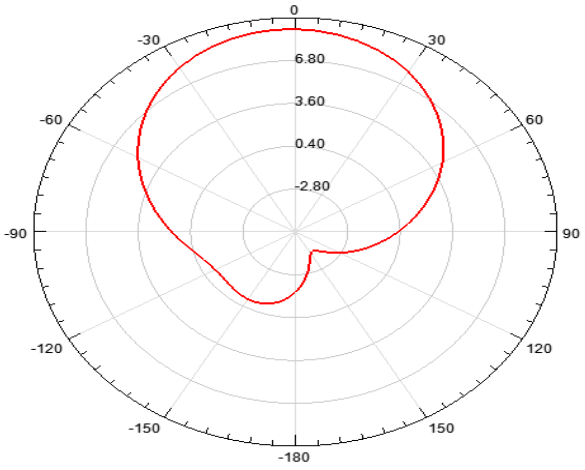


FIGURE 9-- RADIATION PATTERN AT ϕ=0 AND AT FREQUENCY=6 GHz

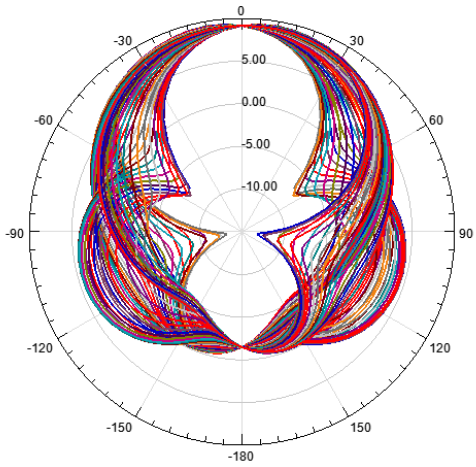
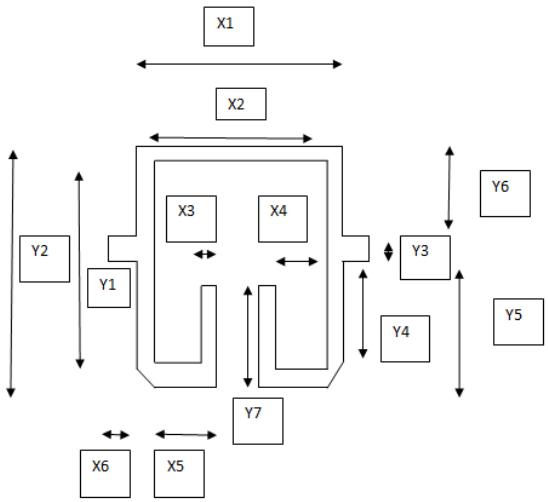


FIGURE 10 -- RADIATION PATTERN AT ALL ϕ AND AT FREQUENCY=6 GHz

C. ANTENNA DESIGN3

Here the dimension of the slot is varied keeping all other parameters of antenna as described in figure 1.



X1=2mm X2=1.8mm X3=0.1mm X4=0.4mm X5=0.5mm X6=0.25mm Y1=1.8mm Y2=2mm Y3=0.1mm Y4=0.85mm Y5=0.95mm Y6=0.95mm Y7=1mm
The slot is placed at 0.2 mm below the junction of patch and feedline. The width of slot is 0.1mm in the design3.

.After bringing these parametric changes like increasing the thickness of gap width and height of two inner arms we get the following structures and results.

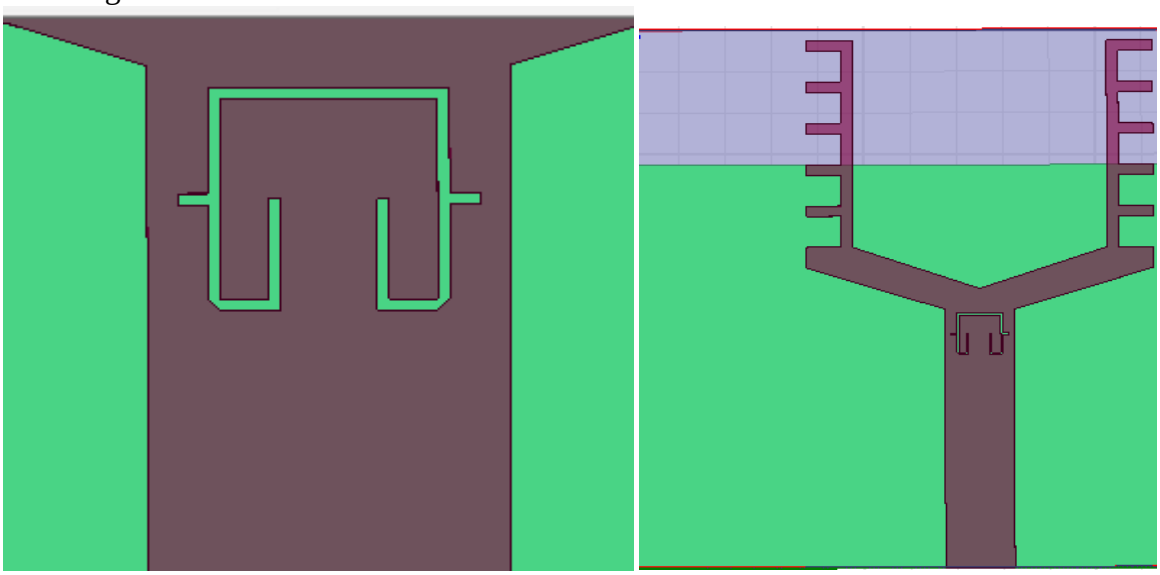


FIGURE 11-THE DESIGNED ANTENNA IN HFSS SOFTWARE

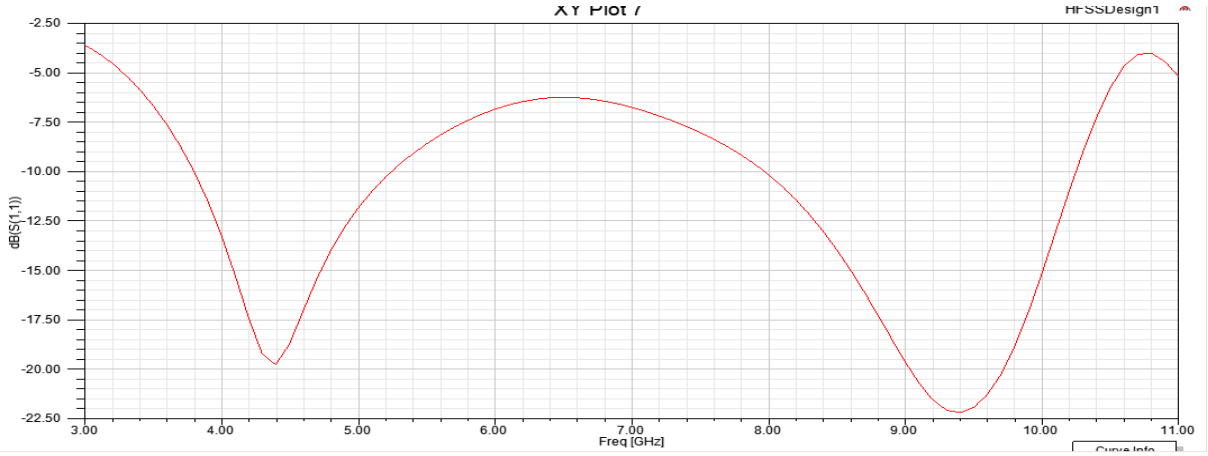


FIGURE 12-THE RETURN LOSS CHARACTERISTICS (S11 PARAMETERS) OF THE ANTENNA WITH THE DESIGN 2

The -10 dB is cut at 3.8 GHz falling till -20 dB and then till 5.2 GHz it remains till -10 dB so it can be used in different broadband applications. Again from 8 GHz till 10.2 GHz it remains below -10 dB with a wider bandwidth but more gain in comparison to previous frequency point.
It has a better response around 4.2 GHz in comparison to design 2 as bandwidth is higher but not sharper one.

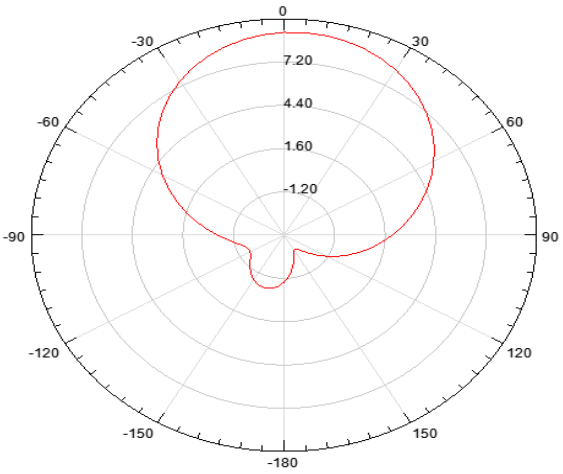


FIGURE 13-- RADIATION PATTERN AT ϕ=0 AND AT FREQUENCY=6 GHz

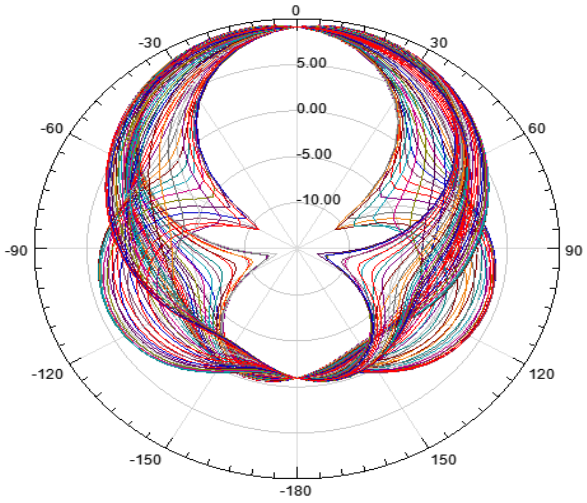


FIGURE 14-- RADIATION PATTERN AT ALL ϕ AND AT FREQUENCY=6 GHz

2. RESULT AND DISCUSSION

In this paper, a new method of improving the bandwidth of the microstrip antenna is proposed. The bandwidth broadening method is based on using a square like slots placed close to the junction of patch and feedline. Changing the dimensions of the slot we get different response but mostly from around 3.6 GHz to 5.2 GHz and from 7.6 GHz to around 10 GHz we get better response allowing for usage of various broadband applications. Because of its simple structure, it will be widely used in communication system.

3. CONCLUSION

The aim of this project was to design a broadband microstrip patch antenna for use in wireless communication systems. Before designing such an antenna, it was necessary to become familiar with microstrip lines because microstrip patch antennae are derived from them. The simulation and theoretical results of microstrip line have been illustrated. Comparison was made between these sets of results. However, impedance matching is a general technique and many other design forms could be devised, which possibly could yield better results. . This antenna has simple structure and compact size of 23 x 26 mm 2, which is easy to be implanted in miniature devices.

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