Comparison of Different Types of Microstrip Patch Antennas

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ABSTRACT
In this paper, microstrip patch antennas with six different shapes i.e. rectangular, circular, square, elliptical, pentagonal and hexagonal are implemented using Ansoft HFSS version 13.0.0 software. Antennas are designed on Rogers RT/duroid 5880 material with dielectric constant 2.2 and thickness 3.2 mm. The different performance parameters such as return loss, gain and bandwidth of these antennas are compared. The operating frequency for all these antennas is taken 7.5 GHz. All the antennas are fed with the probe feed. It is found that pentagonal microstrip patch antenna has better results at this frequency than all other shapes.

Keywords
Microstrip; Patch; Antenna; gain; return; loss; bandwidth.

1. INTRODUCTION
Wireless technology provides less expensive alternative and a flexible way for communication. Antenna is one of the important elements of the wireless communications systems. According to the IEEE Standard Definitions, the antenna or aerial is defined as “a means of radiating or receiving radio waves" [1]. In other words, antennas act as an interface for electromagnetic energy, propagating between free space and guided medium.

Microstrip patch antennas are widely used in the microwave frequency region because of their simplicity and compatibility with printed-circuit technology, making them easy to manufacture either as stand-alone elements or as elements of arrays. The advantages of microstrip antennas make them suitable for various applications like, vehicle based satellite link antennas [2], global positioning systems (GPS) [3], radar for missiles and telemetry [2] and mobile handheld radios or communication devices [3]. In its simplest form a microstrip patch antenna consists of a patch of metal, generally rectangular or circular (though other shapes are sometimes used) on top of a grounded substrate [9] as shown in fig 1.

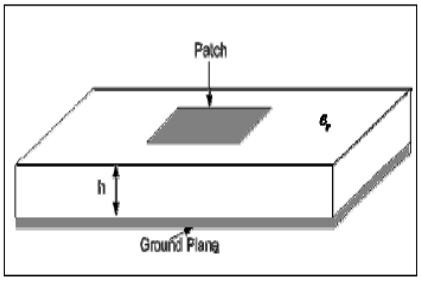


Fig 1: Microstrip patch antenna [1]

The commonly available shapes of patch antenna are rectangular, circular, dipole, triangular, square and elliptical with rectangular and circular shapes the most common. The various shapes are illustrated in fig 2.

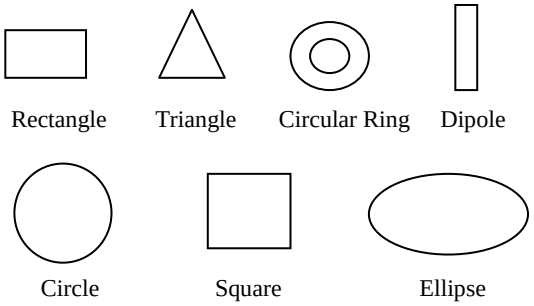


Fig 2: Common available shapes of microstrip patch antenna

Basically there are four feeding techniques available to us while designing of antenna. These are line feed [5], probe feed [1 and 8], aperture coupled feed [4] and proximity coupled feed [6]. The feed that is used here is probe feed (or coaxial feed). The antenna array is designed using standard equations and simulated by professional software called, High Frequency Structural Simulator (HFSS). It proves to be the tool for analyzing the working of any antenna [7]. Before designing of any antenna, its working and simulation is checked by this software such that any kind of change if required could be made.

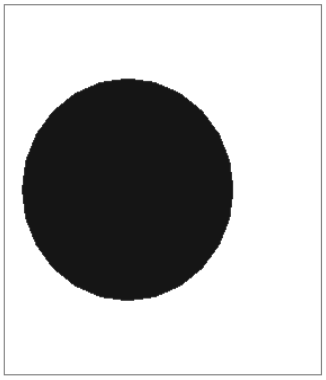
2. DESIGNING OF ANTENNAS
The designing of the microstrip antennas with circular, rectangular, elliptical, pentagonal, hexagonal and square patch is done with HFSS software [7]. The position and dimensions of the substrate is kept constant throughout. The dimensions of substrate are as follows.

Position: -50, -45, 0

XSize: 100 YSize: 90 ZSize: 3.2

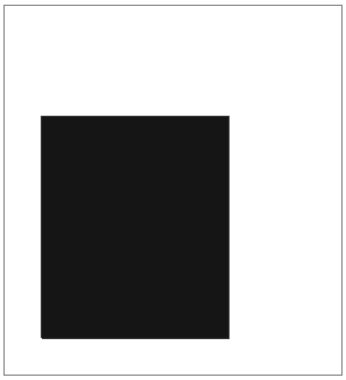
The radius of circular patch is taken 30 mm. For the rectangular patch the length is 60 mm and breadth is 50 mm. The elliptical patch has major axis with radius 20 mm and minor axis with 10 mm. Pentagonal, hexagonal and square patches are designed with 44.36 mm, 35 mm and 60 mm side respectively. All of these shapes are illustrated in fig 3.

After designing of various patches the simulation is carried out and the performance parameters such as return loss, gain and bandwidth are found. These results are then compared to find the best of these microstrip antennas.



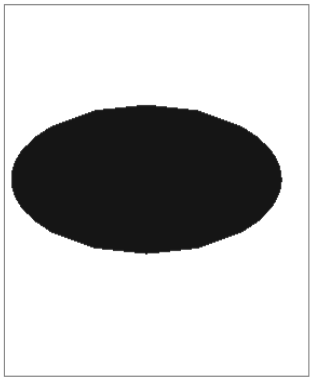
Center Position: 0, -10, 3.2
Radius: 30mm

(a)



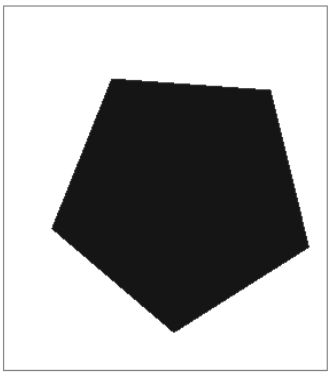
Length: 60 mm, Breadth: 50 mm
Position: -20, -30, 3.2

(b)



Center Position: -3, -3, 3.2
Major Radius: 20mm

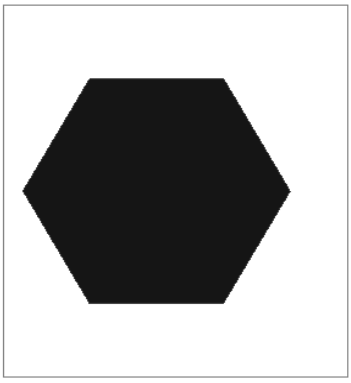
(c)



Center Position: 2, 5, 3.2

Start Position: -30, -15, 3.2
Side: 44.36mm

(d)

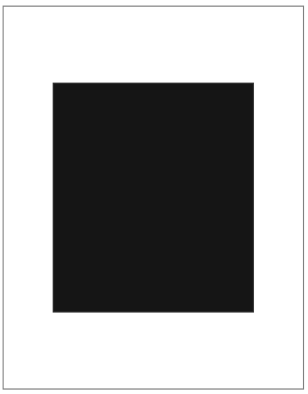


Center Position: 0, -5, 3.2

Start Position: 0, 30, 3.2

Side: 35mm

(e)



Center Position: -30, -30, 3.2

Size: 60 mm

(f)

Fig 3: Microstrip Antenna with (a) Circular patch (b) Rectangular patch (c) Elliptical patch (d) Pentagonal patch (e) Hexagonal patch (f) Square patch

Table 1: Comparison of various performance parameters of different patches of microstrip antenna

S. No.	Shape of Patch	Return loss vs. frequency	Gain (dB)	Lower cut off frequency (GHz)	Higher cut off frequency (GHz)	Bandwidth (GHz)
1.	Circle (Radius: 30)	-16.50	8.1756	6.80	7.43	0.63
2.	Rectangular (60, 50, 0)	-19	6.7619	7.33	8.47	1.14
3.	Ellipse (Major Axis:20, Ratio:2)	-25	7.2326	6.90	7.96	1.06
3.	Pentagon (Side: 44.36mm)	-23	9.0943	7.30	8.54	1.24
4.	Hexagon (Side: 35mm)	-22	7.4406	7.30	8.52	1.22
6.	Square (60, 60, 0)	-21	8.2799	6.53	7.45	0.92

From the table it is clear that at the operating frequency of 7.5 GHz the minimum return loss [1] is found in case of elliptical patch with -25dB. At the same time the gain [1] is found maximum in case of pentagonal microstrip patch antenna with a value 9.0943 dB.

The bandwidth [1] when observed is found maximum in pentagonal microstrip patch antenna with a value of 1.24 GHz. Also the return loss of pentagonal patch is comparable with elliptical patch. Hence the best results are obtained with pentagonal microstrip patch antenna.

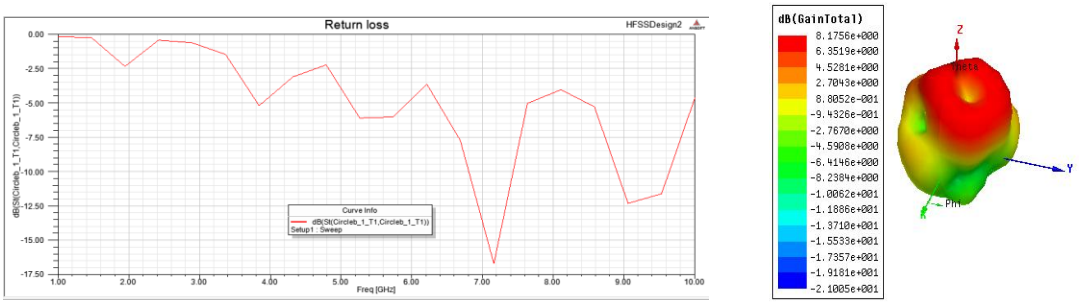


Fig 4: Return loss vs. frequency and 3D Radiation Pattern of circular microstrip patch antenna

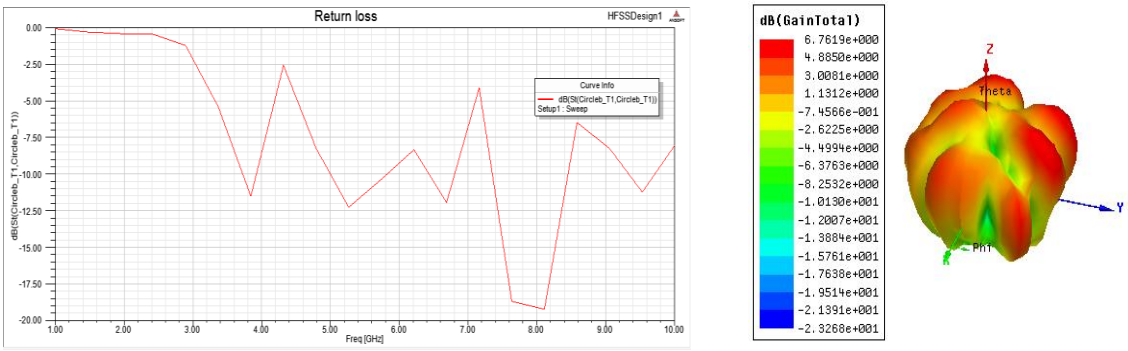


Fig 5: Return loss vs. frequency and 3D Radiation Pattern of rectangular microstrip patch antenna

The graphs for return loss vs. frequency and 3D Radiation pattern of the six different microstrip patch antennas are illustrated in fig 4,5,6,7,8 and 9.

The fig 4 illustrates return loss vs. frequency and 3D Radiation pattern of circular microstrip patch antenna.

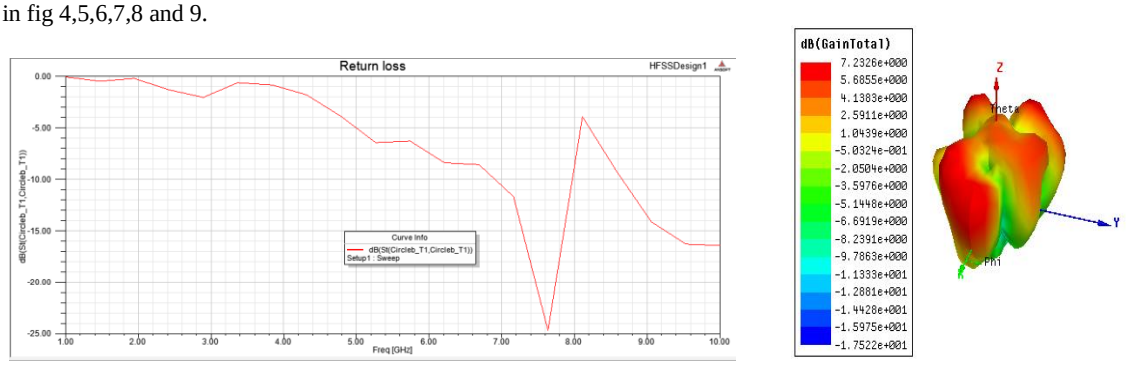


Fig 6: Return loss vs. frequency and 3D Radiation Pattern of elliptical microstrip patch antenna

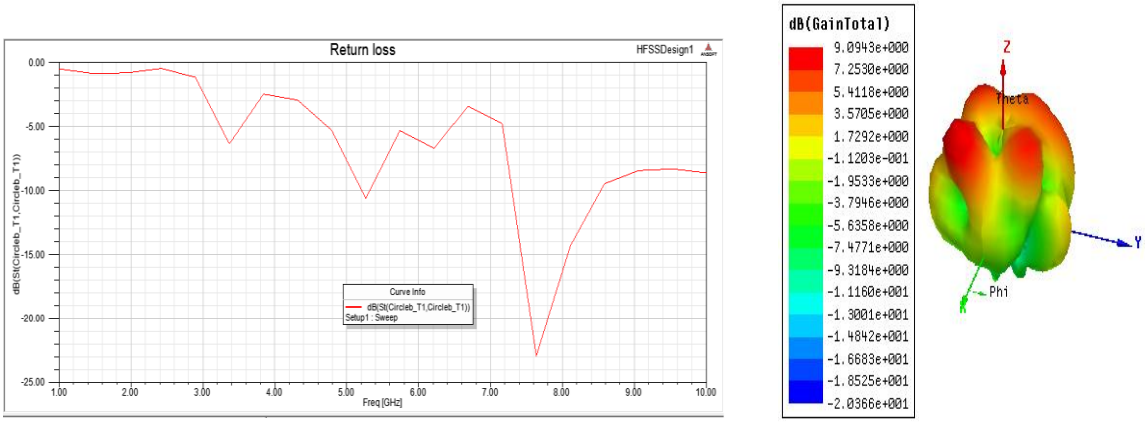


Fig 7: Return loss vs. frequency and 3D Radiation Pattern of pentagonal microstrip patch antenna

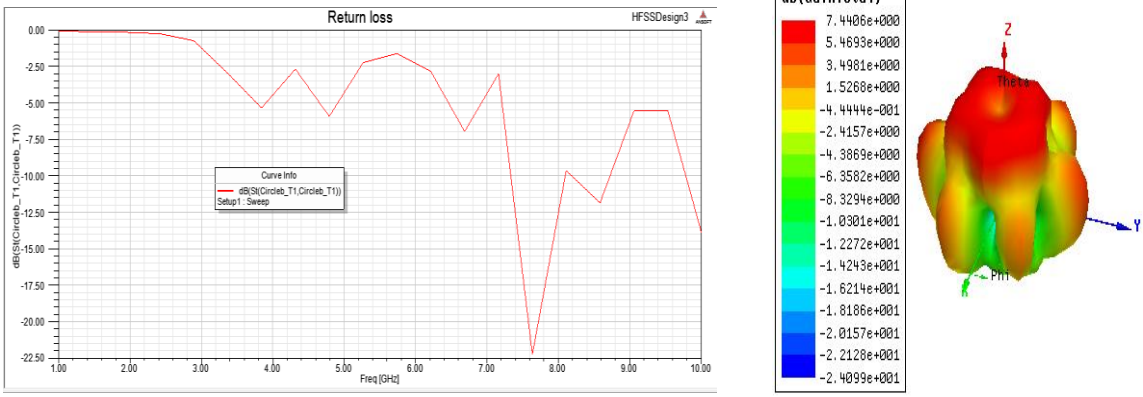
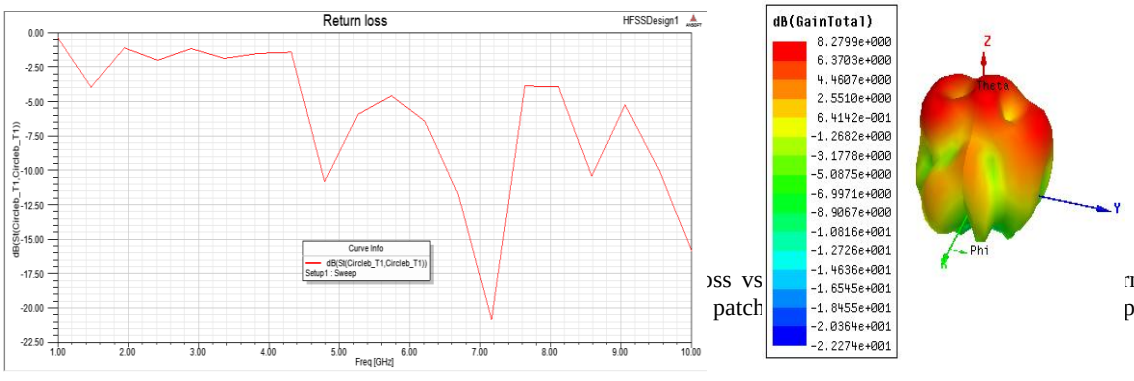


Fig 8: Return loss vs. frequency and 3D Radiation Pattern of hexagonal microstrip patch antenna



oss vs ns of patch patch,

Fig 9: Return loss vs. frequency and 3D Radiation Pattern of square microstrip patch antenna

hexagonal patch and square patch microstrip antennas are shown in fig 5,6,7,8 and 9 respectively.

4. CONCLUSION

From the simulation analysis of the rectangular, circular, square, elliptical, pentagonal and hexagonal microstrip patch antennas it is observed that at 7.5 GHz of operating frequency the pentagonal patch antenna gave the best results with a gain of 9.09943 dB and bandwidth of 1.24 GHz.

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