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Comprehensive Study and Design of Hexagonal and Pentagonal Microstrip Patch Antenna

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ABSTRACT: In this paper, Microstrip patch antenna with shape pentagonal and hexagonal are implemented using CAD-FEKO software antenna designed on FR4 material with dielectric constant 4.4 and thickness 1.6mm. The different performance parameters such as return loss, VSWR of these antennas are compared. The operating frequency for pentagon is 2.26GHz and for hexagon is 2.5GHz. All these antenna fed with line fed. It is found that pentagonal Microstrip patch antenna has better result.

KEYWORDS: Microstrip; Patch; Antenna; FR4 Material; VNA tester.

I. INTRODUCTION

Antennas are among the most common antennas types in use today. Antennas had first intense development in 1970s, as communication systems become common at frequencies where its size and performance were is useful. At the same time, its flat profile and reduced weight, compared to parabolic reflectors and other antenna options. Wireless technology provides less expensive alternative and a flexible way for communication. Antenna is one of the important elements of the wireless communications systems.

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. The advantages of microstrip antennas make them suitable for various applications like, vehicle based satellite, link antennas, global positioning systems (GPS), radar for missiles and telemetry and mobile handheld radios or communication devices.

II. FEEDING TECHNIQUES

There are many different techniques of feeding and four most popular techniques are coaxial probe feed, microstrip line, aperture coupling and proximity coupling.

Coaxial probe feeding is feeding method in which the inner conductor of the coaxial is attached to the radiation patch of the antenna. While outer conductor is connected to the ground plane. Advantages of coaxial feeding is easy of fabrication, easy to match low spurious radiation.

Microstrip line feed is one of the easier methods to fabricate as it is a just conducting strip connecting to the patch and therefore can be consider as extension of patch. It is simple to model and easy to match by controlling the inset position. However the disadvantage of this method is that as substrate thickness increases, surface wave and spurious feed radiation increases which limit the bandwidth.

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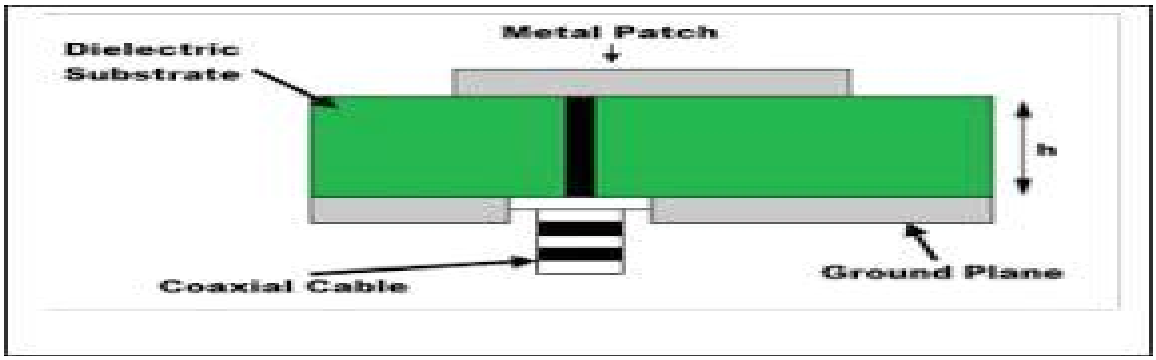

Figure1: coaxial feed

III. RELATED WORK

In this paper we designed antenna for of Wi-Max application. These antennas are operating in the range of 2.1GHz to 2.8GHz. The return loss for pentagonal antenna at 2.26GHz frequency and hexagonal antenna at 2.54GHz frequency are below -10dB, which shows that there is good matching at these points. The microstrip patch can be feed by different feed technique, but we have used coaxial feed technique. Also worked on important parameters like return loss and VSWR.

` In this paper we are calculated the corners of pentagon and hexagon by using mathematical geometery. First we decide the side, for pentagon antenna we made angle 108 degree and for hexagon antenna angle 120 degree. From this geometry we are calculated 5 corners for pentagon and 6 corners for hexagon. By putting these corners value on CAD-FEKO software, we designed the pentagon and hexagon microstrip patch antenna. The simulation result return loss and VSWR are shown.

IV. ANTENNA DESIGN

Design constraint of antenna:
The designing of the microstrip antennas with pentagonal and hexagonal patch is done with CAD-FEKO software.In this CAD-FEKO software first we select the model unit in millimetre. Then go for construction select polygon. For hexagon find 6 corner values and 5 for pentagon. After that select cuboid choose base corner, width, depth, height. For both the antennas we are selected square cuboid. Then go for union. Select line values, again go for union between line and union1. Select media, here we are selecting dielectric medium i.e. 4.4 for FR4. First select wire, create port at end then go for selecting region. Here we are selected dielectric for substrate and perfect electric conductor for patch and ground. Select frequency and give voltage source. After done with design go for meshing whose value is 0.25. This all procedure done in CAD-FECKO. Then we go for Postfecko, Select Cartesian, and give source voltage. After that select the parameter which we want.Then We get simulation result. For getting simulation result we have to give range of frequency here we are giving ISM band which is from 2.1GHz -2.8GHz.

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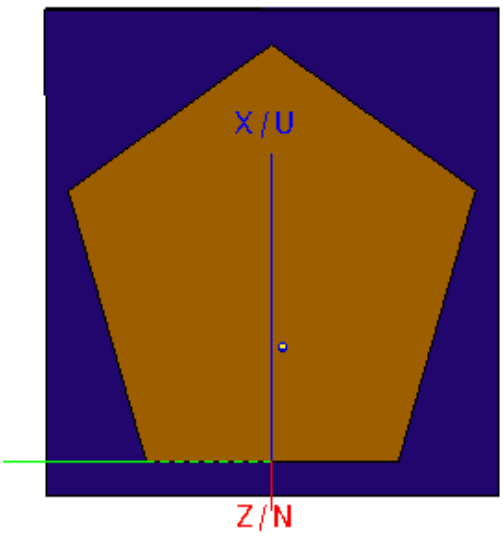

Figure2. Pentagon antenna

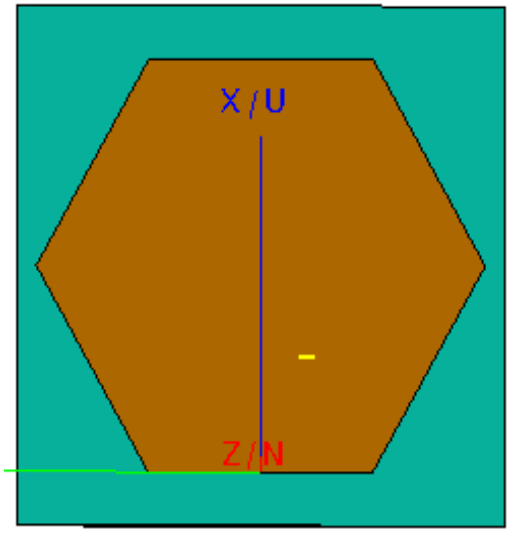

Figure3. Hexagon antenna

From above figure we can see that for pentagon there are 5 corners and for hexagon there are 6 corners.

Table1. Dimensions of antenna

Parameter	Pentagon	Hexagon
1.Substrate Side	39mm	29mm
2.Substrate Corner	(0,19.5,0) (39, 31.5,0) (60,0,0) (39, -31.5,0) (0,-19.5,0)	(0,14.5,0) (25,29,0) (50,14.5,0) (50,-14.5,0) (25,-29,0) (0,-14.5,0)
3.Substrate Cuboid	W=70mm, D=70mm	W=63mm, D=63mm
4.Substrate Height	H=1.6mm	H=1.6mm
5.Dielectric constant	Ɛr=4.4	Ɛr=4.4

Procedure for finding corner values for hexagon antenna.
1. First draw the 29mm length by scale.
2 .Take 120degree angle on that length.
3. Design the hexagon shape.
4. Consider midpoint of 29mm length as Y and remaining is X, and Z axis is zero.
5. From this geometry we can find all the corners of hexagon.

Same procedure do for pentagon shape. We get required shape.

V. SIMULATION RESULTS

The operating frequency for pentagon antenna is 2.26GHz and for hexagon 2.54GHz. The simulated return loss of pentagon is -23.28dB[4] and Hexagon is -22.51dB[5] are shown in figure. Both the return losses are below

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-10dB. The simulated VSWR of pentagon antenna is 1.19dB[6] and hexagon antenna is 1.30dB[7] are shown in figure . Both the VSWR values are in the range 1dB-2dB.

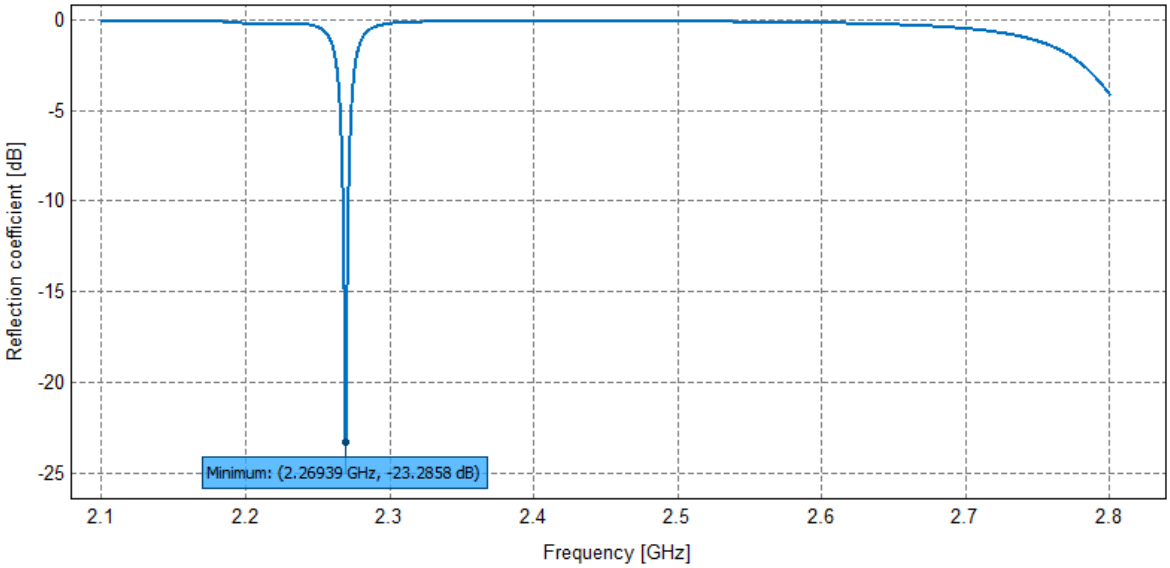

Figure4. Return loss of pentagon patch antenna

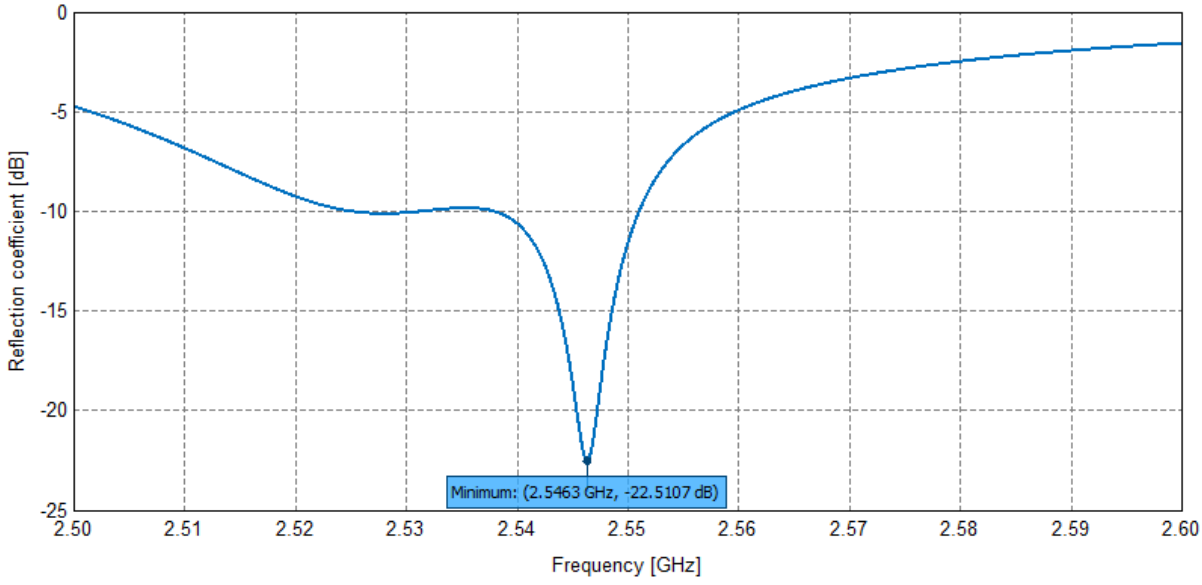

Figure5: Return loss of hexagon patch antenna

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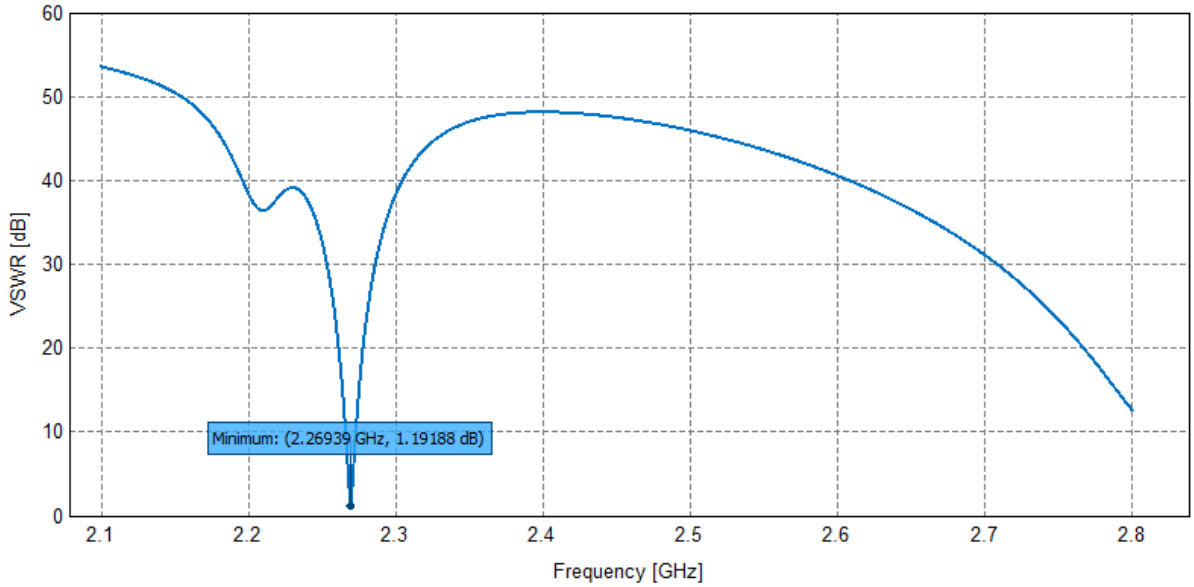

Figure6: VSWR of pentagon patch antenna

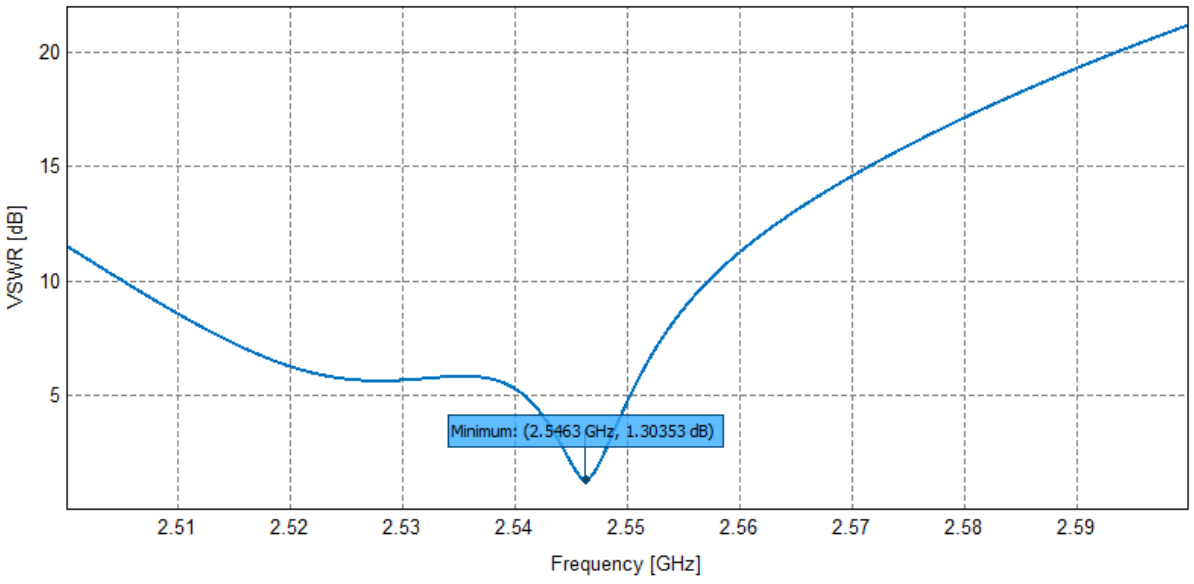

Figure7: VSWR of hexagon patch antenna

Table2: Comparison of performance parameters

Parameter	Pentagon	Hexagon
Return loss	-23.28dB	-22.51dB
VSWR	1.19dB	1.30B

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VI. CONCLUSION

From the simulation analysis of the pentagonal and hexagonal microstrip patch antennas it is observed that at operating frequency range 2.1GHz-2.8GHz pentagonal patch antenna gave the best results with return loss -23.28dB and VSWR 1.19dB.

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