COMPARISON BETWEEN PENTAGONAL AND E-SHAPED MICROSTRIP PATCH ANTENNAS FOR 5G APPLICATION

Abstract

Microstrip patch antennas are in huge demand because of their compact size and low cost. In this paper, we have done comparative study of pentagonal and E-shaped microstrip patch antennas. The resonancefrequency chosen for the comparison is 27 GHz for 5G applications.Return loss,Reflection coefficient, VSWR and far field radiation pattern etc. are chosen parameters for thecomparison. Roger RT 5880 is used as substrate for the designing of the antennas, its dielectric constant is 2.2 and has a height of 0.797 mm. The software used for designing and comparison of the antennas is Computer Simulation Technology Microwave Studio (CST MW Studio). We have studied the effect of change in geometric shape of antennas on their performance.

Keywords: Return loss, far field radiation pattern, VSWR, Reflection coefficient, CST MW Studio

Authors

Anand Kumar Gupta
Professor
Department of ECE
F.E.T
RAMA University
Kanpur, India.
akgietk@rediffmail.com

Prof. Rajendra Kumar
Professor
Department of ECE
F.E.T
RAMA University
Kanpur, India.
drrajendra.fet@ramauniversity.ac.in

Prof. Ashutosh Singh
Professor
Department of ECE
HBTU
Kanpur, India.
ashuhbti@gmail.com

I. INTRODUCTION

Microstrip patch antenna emerged as a huge achievement in the field of wireless communication systems. They serve so many advantages [1], like very lightweight, planner structure, and very costeffective. Butthe major disadvantages associated with them are smaller bandwidth, lower handling of power and excitation of the wave at surface [2]. This limitation of narrow bandwidth can be overcome by applying various methods like increasing substrate thickness, introducing parasitic elements or by having patch in slotted form [3].The structure of microstrip patch antenna comprises of ground, radiating patch, dielectric substrate and feedline. Theradiating patch can be of various shapeslikesquare, pentagonal, hexagonal, E-shape, rectangular, circular etc. [4]. When the feed line excites the patch, charge gets spread below and a large charge density appears at the edge of the patchbecause of the attractive force between the ground and the patch of microstrip patch antenna.Fig.1. The efficiency of antenna depends on the transfer of the power.Impendence matching between thepatchand the feedline is necessary to attain maximum transfer of power. Patch is excited by direct or indirect feeding methods using a feed line. Microstrip feedline, coaxial feedline, aperture coupling and proximity coupling etc. are some of the most popular feeding techniques thar are used today. [4,5]. We have used microstrip feedline method for feeding the antennas.

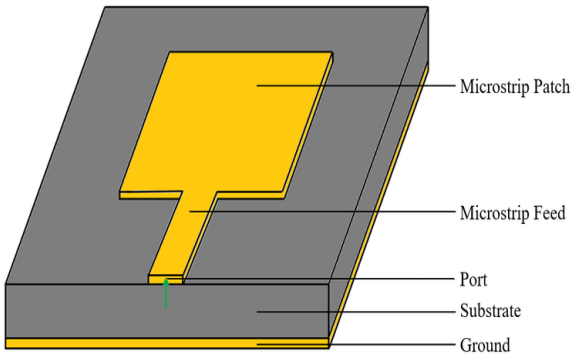


Figure 1: Basic Structure of Microstrip Patch Antenna

In our work, we have chosen Pentagonal and E-shaped microstrip patch antennas for the comparison on the basis of various antenna parameters like VSWR, Gain, Return loss, Reflection coefficient etc. at the frequency of 27 GHz.

II. DESIGNING OF ANTENNAS

We have designed E-shaped and Pentagonal shaped microstrip patch antenna using CST software. The substrate is made up of RT Duroid 5880; the ground is made up of pure copper which has thickness of 0.0175 mm for both the antennas.

1. **E-Shaped Microstrip Patch Antenna:** For the E shape patch antenna,to increase the bandwidth, we have to vary the slot dimensions andpositions. It was previously found that the resonance frequency mainly depends upon the slot length[6]. The E-shaped microstrip patch antenna designed using the software CST is shown below.

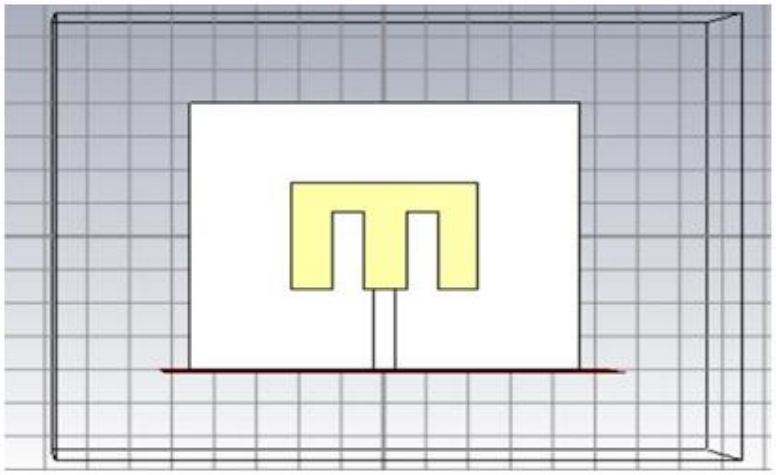


Figure 2: E-shaped Patch Antenna

Parameters	Description	Value(mm)
H	The substrate's height	0.797
L'	The substrate's length	7.973
W'	Width of the substrate and ground	9.174
T	Thickness of ground and patch	0.0175
l	The patch's length	2.8
w	The patch's width	3.7
Lf	Length of the feedline	3.986
Wf	Width of the feedline	0.5

2. **Pentagonal Shaped Patch Antenna:** We have designed pentagonal shaped microstrip patch antenna using CST software which is shown below along with its design parameters in the form of a table.

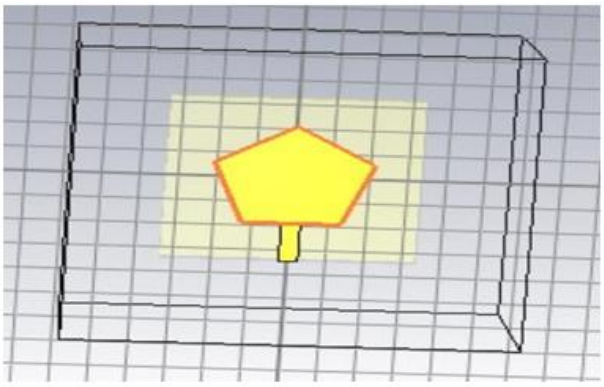
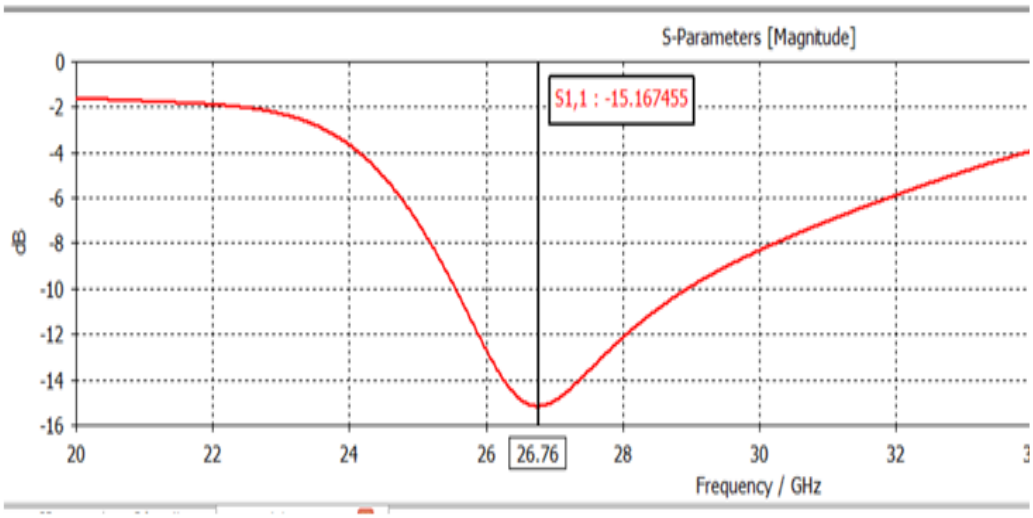


Figure 3: Pentagonal Patch Antenn

Parameters	Description	Value(mm)
H	The substrate's height	0.797
L'	The substrate's length and ground's length	6.682
W'	Width of the substrate and ground	6.678
T	Thickness of ground and patch	0.0175
l	The patch's length	5.539
w	The patch's width	4.184
Lf	Length of feedline	0.5
Wf	Width of feedline	3.339

III. COMPARISON OF ANTENNAS

1. **S11 or Return loss:** S-parameter stands for scattering parameter and is used to describe how energy is being propagated through an electric network. The input and output relationships between the ports of an antenna is demonstrated by S parameter. The reflection coefficient is a parameter thar represents amount of electromagnetic wave reflected.If all the power is reflected by the antenna, then S11=0 dB. Fig.3, shows the graph of S11 parameter of E- shaped and Pentagonal shaped microstrip patch antennas. The positive value of S11 parameter represents return loss.



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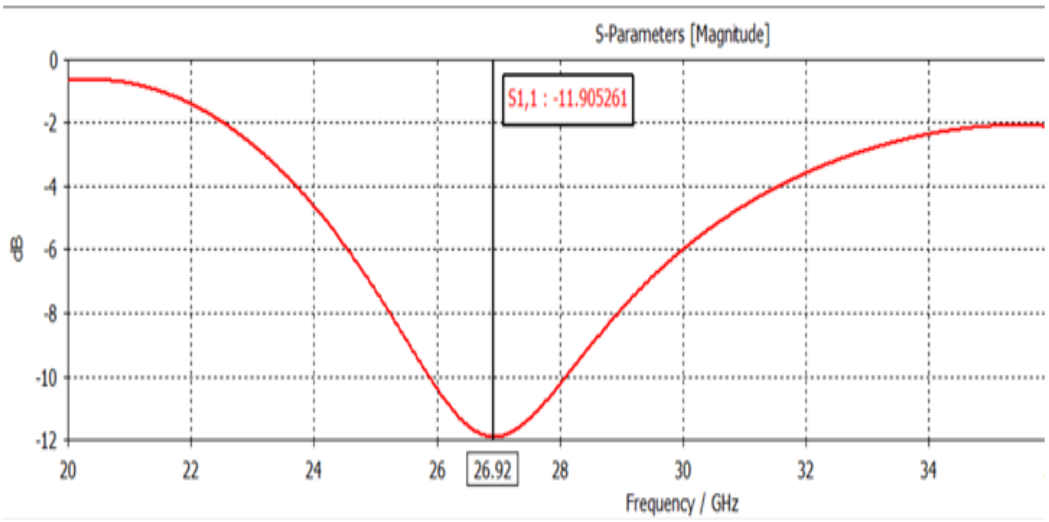
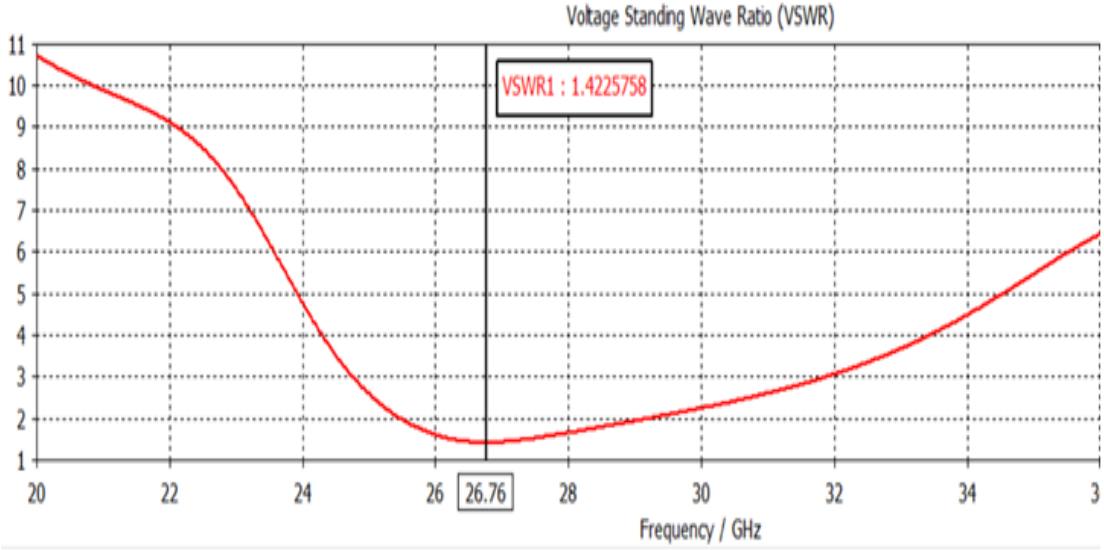


(b)

Figure 4: the S11 Result of Both Patch Antennas: (a) Microstrip Antenna with E-patch (b) Microstrip Patch Antenna with Pentagonal Shaped Patch

2. **VSWR Comparison:** VSWR stands for Voltage Standing Wave Ratio. It represents the power reflected from the antenna due to mismatchingof the impedance. Mathematically, it is the ratio of the maximum amplitudeof standing wave to the minimum amplitude of standing wave. If VSWR is closer to 1 then more power is delivered to the antenna and better impedance matching occurs. The figure 5 given below shows the graph of VSWR for both E-shaped and Pentagonal shaped microstrip patch antennas. It can be observed that VSWR of E-shaped patch antenna is smaller than that of pentagonal patch antenna.



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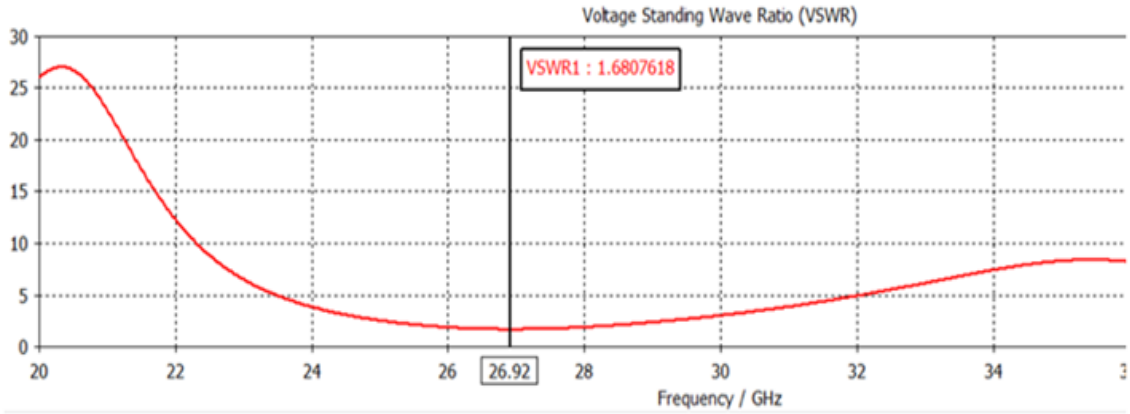
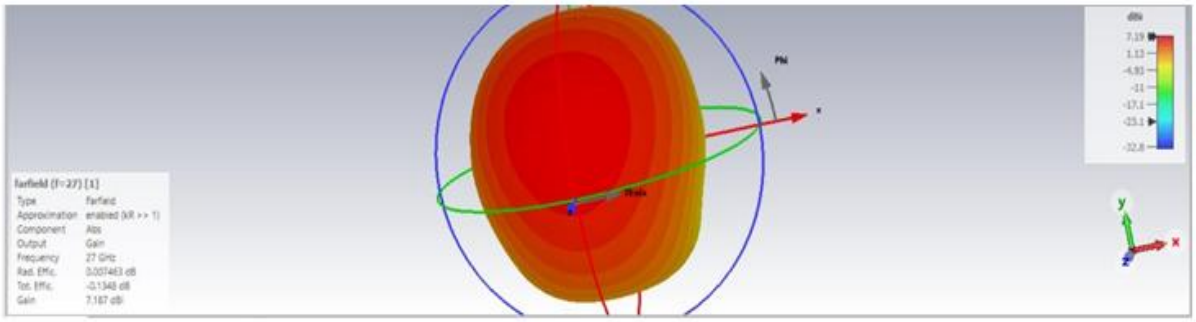


(b)

Figure 5: VSWR of both Patch Antennas: (a) E-Shaped Patch Antenna (b) Pentagonal Patch Antenna

3. **Far Field Radiation:** The 3D result of Far Field radiation pattern of both the E-shaped and pentagonal shaped microstrippatch antennas are shown in figure 6. It is found from our analysis that E- shaped microstrip patch antenna has higher gainin comparison to the pentagonal shaped microstrip patch antenna



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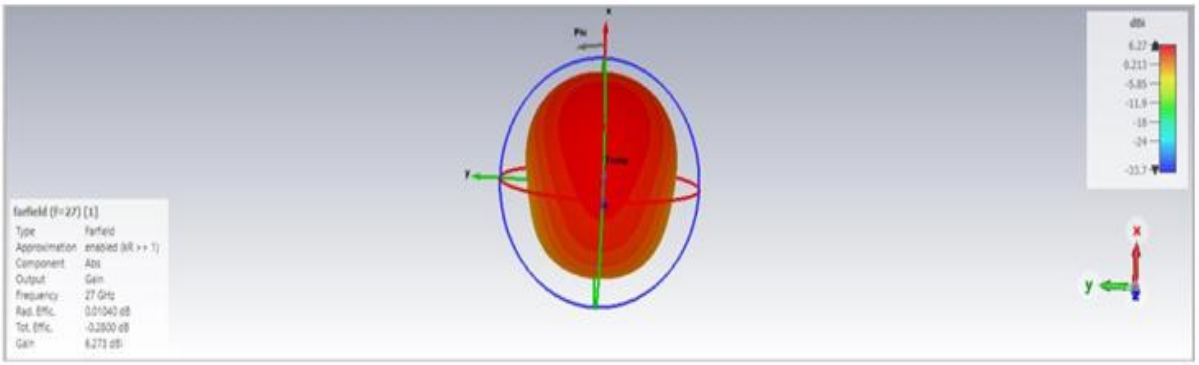

(b)

Figure 6: The Farfield Radiation Pattern of both the Antennas: (a) E-Shaped Microstrip Patch Antenna (b) Pentagonal Shaped Microstrip Patch Antenna

Table of Comparison

Patch shape	Reflection coefficient	Return loss	VSWR	Gain
E-shaped	0.177	15.17dB	1.43	7.19dB
Pentagonal	0.254	11.90dB	1.68	6.27 dB

IV. CONCLUSION

In this paper, after studyingand comparing different parameters of various types of patch antennas, we found that the parameters of the antenna depend highly upon the geometrical shape of antenna. We can conclude from our analysis that E-shaped patch antenna is better than pentagonal patch antenna as it has lower values of VSWR and Reflection coefficient, higher value of gain and return loss in comparison to the pentagonal shaped microstrip patch antenna at the frequency of 27 GHz which is suitable for 5G applications.

REFERENCES

[1] R. Garg, P.Bhartia, I.Bahl and A. Ittipiboon, "Microstrip Antenna Design Handbook", Artech House, 2001.
[2] R. Mishra, "An Overview of Microstrip Antenna", HCTL Open International Journal of Technology Innovations and Research (IJTIR), vol.21, pp.2-4, August 201
[3] G.C Nwalozie, C.C Okezie, S.U Ufoaroh, S.U Nnebe," design and performance optimisation of a microstrip patch antenna ", International Journal of Engineering and Innovative Technology (IJEIT) Vol 2, Issue 7, pp.380- 387, January 2013
[4] Ramesh Garg, PrakashBartia, InderBahl, ApisakIttipiboon" Microstrip Patch Antenna Design Handbook"2001, Pp 1-68,253-316, Artech House Inc.Norwood, MAIndrasen Singh, Dr. V.S. Tripathi," Micro strip Patch Antenna and its Applications: a Survey", International Journal Computer Technology Application, Vol. 2 Issue 5, pp. 1595-1599, October 2011
[5] Josko Kucan, MiroslavJoler," Impact of slot dimensions on the resonant frequencies of rectangular microstrip antennas", IEEE transaction, vol. 45 Issue.5, pp. 456-467, July 2013

