Improvement in Radiation Parameters of Rectangular Microstrip Patch Antenna

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Abstract— This paper introduces a new geometry of a rectangular microstrip patch antenna that improves the performance of a conventional microstrip patch antenna .This antenna is designed to operate at 5.38 GHz with enhanced bandwidth of 11.15%. For the desired result, a triangular notch is inserted into the patch antenna. The proposed geometry provides improvement in other radiation parameters like gain, efficiency and impedance behavior, when it is compared with conventional antenna.

Keywords— Rectangular Microstrip Patch Antenna, Antenna Feed, Antenna Radiation Pattern.

I INTRODUCTION

For communication purpose antenna is widely used. An antenna is a conductor that can transmit, send and receive signals such as microwave, radio or satellite signals. Many fields are there, where antenna is used like space technology, aircrafts, mobile communication, missiles tracking, remote sensing and satellite broadcasting [1].There are different types of antenna e.g. monopole, dipole , leaky-wave, aperture, reflector, microstrip antenna and many more . Type of antenna depends on the application. Due to development in communication systems, these systems require development of low cost, light weight, low profile antennas those are capable to give high performance over a wide band of frequencies[2][3]. To fulfill these requirements use of microstrip patch antenna is increasing day by day. Microstrip patch antennas are most widely used antenna in microwave frequency range. A microstrip patch antenna consists of conducting patch on a ground plane separated by dielectric substrate. Conducting patch is made of conducting material such as copper or gold. The shape of the patch could be square, rectangular, circular, elliptical, semicircular [4], hexagonal, triangular or other common shape [5] Length, width, input impedance, gain and radiation patterns are main parameters to characterize a microstrip antenna. For proper matched input impedance there are four types of feeding techniques like Microstrip line feed, Coaxial feed, Aperture coupled feed, Proximity coupled feed. Main advantage of coaxial feeding technique is that the location of feed can be changed at desired location on the patch to match with its input impedance [6]-[8]. In this paper coaxial feed technique is used. Various methods are used to analyze the microstrip patch antenna these are transmission line model, cavity model and full- wave model. In this paper full-wave method is used to analyze the proposed geometry because this model is accurate, versatile and can work on single element, stacked element, different shaped element and coupling, other two models are complex in nature. Here new geometry of rectangular microstrip patch antenna is proposed. Narrow bandwidth and low gain is main limitations of a microstrip patch antenna. These limitations can be overcome by some modification in the patch geometry. There are some examples that shows the work of researchers to overcome these limitations like bandwidth improved upto 3.5% using 'H' shaped patch [9] and in other example 4.01% & 11% bandwidth was obtained using pi shape slot loaded patch antenna[10]. In this paper there is improvement in bandwidth upto 11.15% which is better than the past proposed results.

In this paper, a novel geometry is proposed and simulated results are compared with conventional patch results. The geometry was simulated using IE3D electromagnetic simulator [11]. This software is a full-wave, method of moments based electromagnetic simulator solving the current distribution on 3D and multilayer structure of general shapes. The second section comprises of antenna geometry and in the third section of the paper simulated results are discussed followed by conclusion in the forth section.

II. ANTENNA GEOMETRY

Rectangular and circular microstrip patch antennas are most widely used antenna in wireless communication. This paper introduces a new geometry of compact size rectangular antenna. Here conventional rectangular microstrip patch antenna is considered as reference antenna. Results of reference antenna are compared with the results of that simulated new proposed patch antenna. The geometry of the conventional rectangular MPA is shown in Fig.1(a) using FR4 as dielectric with dielectric constant, $\varepsilon_r = 4.4$ and the thickness of the substrate, h = 1.59 mm, is simulated by applying IE3D full-wave electromagnetic simulator. The patch has length and width of

14mm and 20mm. A 50Ω coaxial probe is used to connect the microstrip patch at coordinates and it is made fixed for both the conventional and the proposed new geometry of rectangular MPA.

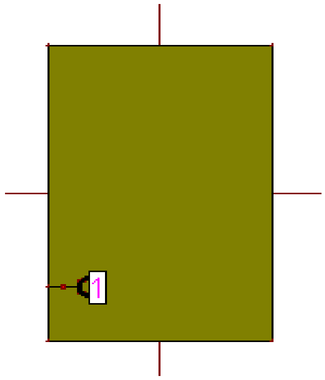

Fig.1(a). Rectangular microstrip patch antenna

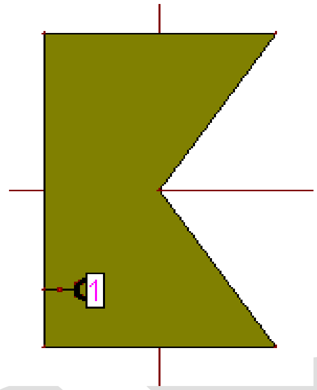

Fig.1(b).Proposed geometry of rectangular microstrip patch antenna

Fig 2 Manufactured rectangular microstrip patch antenna

The geometry is proposed to improve the radiation parameter of probe-fed patch antenna is shown in Fig.1(b).Fig 2 shows the manufactured rectangular patch antenna with coaxial feed. There is a cut of 90 angle from the centre. Impedance bandwidth of about 11.15% can be obtained from the above geometry.

III SIMULATED RESULTS

A) Results of conventional rectangular MPA

1) Radiation Pattern: A plot through which it is visualizes where the antenna transmits or receives power. The microstrip antenna radiates normal to its patch surface. So, the elevation pattern for φ= 0 and φ= 90 degrees are important for the measurement.

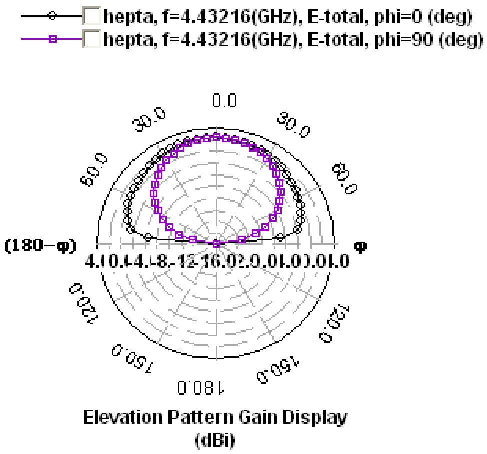

Fig.3. 2D Radiation Pattern for rectangular microstrip patch antenna

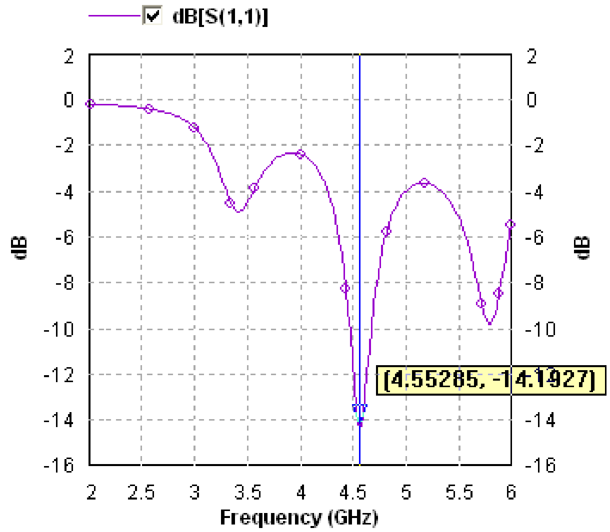

Fig.4. Simulated Return Loss for rectangular microstrip patch antenna

The simulated E-plane and H-plane pattern, 2D pattern of rectangular MPA is illustrated in Fig. 3. Radiation pattern is smooth and uniform over the band of frequencies.

2) Return Loss and Bandwidth: Return Loss is a measure of how much power is delivered from the source to a load and measured by S_{11} parameters. Bandwidth is the range of frequencies over which the antenna can operate effectively. Bandwidth can be calculated by going 10 dB down in return loss. Return Loss shown in Fig. 4 of the rectangular microstrip patch antenna is -14.19 dB at resonating frequency 4.55 GHz and from the Return Loss curve the bandwidth obtained is 4.56%.

3) Smith Chart: Smith Chart provides the information about polarization and the impedance match of the radiating patch. The smith chart for the conventional octagonal MPA is given in Fig.5. Fig 5 shows the input impedance of 73.60Ω –j1.86 at resonant frequency 4.55 GHz. This smith chart shows that the antenna is linearly polarized.

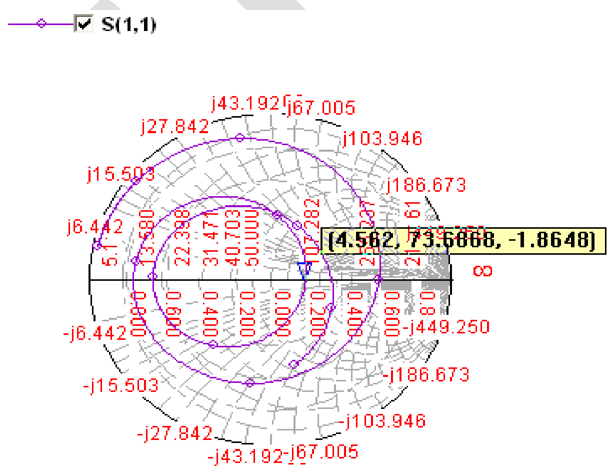

Fig.5. Smith Chart of rectangular microstrip patch antenna

Results of proposed new geometry of rectangular MPA.

1) Radiation Pattern: The 2D Radiation pattern is given in Fig. 6. Radiation pattern of proposed new geometry of rectangular microstrip patch antenna is also smooth and uniform over the frequency range.

2) Return Loss and Bandwidth: The Return Loss shown in Fig.7 of the proposed rectangular micro strip patch antenna is -26.04 dBi at resonating frequency 5.39 GHz and from the Return Loss curve the bandwidth obtained is 11.15%. Fig 7 shows that the return loss of proposed microstrip antenna improves to -26.04 dB from the conventional antenna of -14.19dBi and bandwidth is wider compared to the conventional geometry.

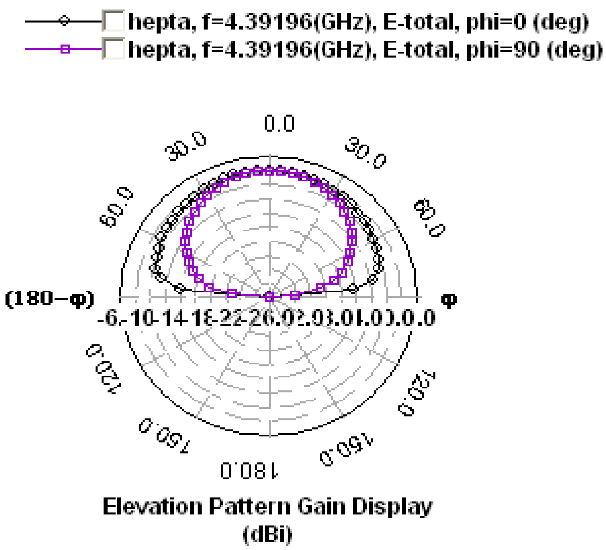

Fig.6. 2D Radiation Pattern for proposed geometry of rectangular microstrip patch antenna

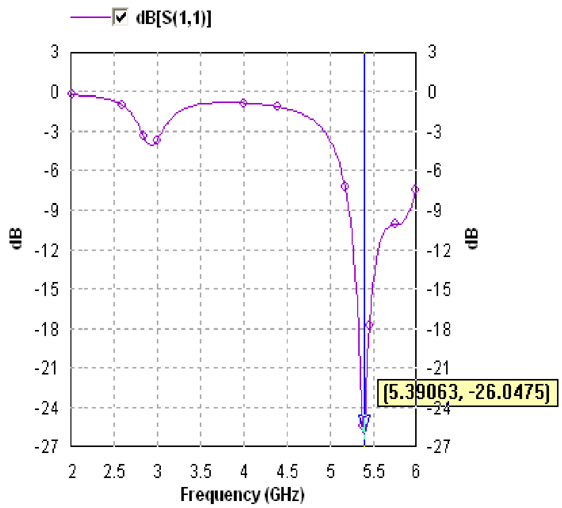

Fig.7. Simulated Return Loss for proposed geometry of rectangular microstrip patch antenna

3) Smith Chart: The Smith Chart for proposed geometry rectangular MPA is given in Fig.8. Fig 8 shows that the 53.11Ω –j3.995 input impedance is obtained for the proposed antenna and the antenna is circularly polarized with some impurity.

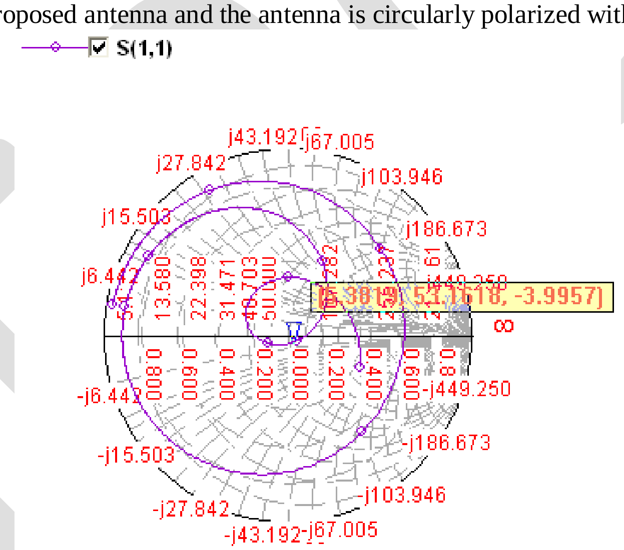

Fig.8. Smith Chart of proposed geometry of rectangular Microstrip patch antenna

Table I shows that the comparison of simulated result on conventional geometry and new proposed geometry.

Sr.No.	Characteristics	Conventional Rectangular Patch	Porposed Rectangular Patch
1.	Return Loss (dBi)	-14.19	-26.04
2.	Gain (dBi)	2.08	3.44
3.	Bandwidth (%)	4.56%	11.15%
4.	Antenna Efficiency (%)	35.24%	44.44%
5.	Radiation Efficiency (%)	43.33%	44.62%

I V. CONCLUSION

In this paper, the radiation performance of proposed new rectangular microstrip patch antenna is compared with conventional rectangular patch antenna. Simulated results indicate that the new proposed antenna exhibits bandwidth upto 11.15%. There is also improvement in radiation characteristics like gain and efficiency. The radiation pattern is also found to be stable over the entire bandwidth.

REFERENCES:

[1] Constantine A. Balanis,"Antenna Theory Analysis and Design," Third Edition, Wiley Publication.

[2] R.Garg, P.Bhartia,I.J.Bhal and A. Ittipiboon ,"Microstrip Antenna Design Book ," Artech House, New York 2001.

[3] D.M.Pozar,"Microstrip Antennas," Proc. IEEE , Vol 80 ,pp 79-91

[4] Kin-Lu-Wong ,"Compact and Broadband Microstrip Antenna" John Wiley & sons 2002.

[5] K.Kumar, Sukhdeep kr,"Investigation On Octagonal Microstrip Patch Antenna For Radar & Space–craft Application," International Journal Of Scientific &Engineering Research, vol 2, 2011.

[6] K.O.Odeyemi ,D.O.Akande &,E.O.Ogunti," Design Of S band Rectangular Microstrip Patch Antenna," European journal Of Scientific Research , Vol 55, 2011

[7] T.D.prasad,K.V.S.Kumar,K. Muinuddin Chisti ,"Comparisons Of Circular and Rectangular Microstrip Patch Antenna" ,International Journal Of Communication Engineering-IJCEA Vol 02, 2011

[8] Abolfazi Azari,"A New Super Wideband Fractal Microstrip Antenna" IEEE Transaction on Antenna &Propagation , vol 59, N0 5 , May 2011

[9] Sudhir Bhaskar & Sachin kr Gupta,"Bandwidth Improvement Of Microstrip Patch Antenna using H shaped Patch" International Journal Of Engineering Research and Applications ,Vol 2, Feb 2012

[10] Rajesh Kr. Tripathi & Rakesh Khanna,"Pi Shape Slot Loaded Patch Antenna For Wi-Max Application" Special Issue of International Journal of Computer Applications (0975 – 8887) on Electronics, Information and Communication Engineering - ICEICE No.6, Dec 2011

[11] Zealand IE3D software