Bandwidth Improvement Using Slotted Circular Microstrip Patch Antenna

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***Abstract*— This paper introduces a new geometry of a circular microstrip patch antenna that improves the performance of a conventional microstrip patch antenna .This antenna is designed to operate at 4.13 GHz with enhanced bandwidth of 9.68%. For the desired result, three slots are inserted into the patch antenna. The proposed geometry provides improved return loss and impedance behaviour, when compared with the conventional microstrip patch antenna.**

***Keywords*—Circular Microstrip Patch Antenna, Antenna Feed, Antenna Radiation Pattern.**

I. INTRODUCTION

For communication purpose antenna is widely used. An antenna is a conductor that can transmitt, 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 or other common shape[4]. Length, width, input impedance, gain and radiation patterns are main parameters to characterize a microstrip antenna. For proper matched input impedence 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 impedence[5]-[7]. Various methods are used to analyse the microstrip patch antenna these are transmission line model, cavity model and full- wave model. In this paper full-wave method which is based on method of moment, is used to analyse 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 circular microstrip patch antenna is proposed. Narrow bandwidth and low gain is main limitations of a circular patch. These limitations can be overcome by some modification in the patch geometry. There are some examples to overcome these limitations like enhancement of bandwidth upto 4.13% of a skimmer shaped circular microstrip patch antenna [8] and in another example bandwidth is improved by 2.3 times of the conventional antenna bandwidth (1.4%) using slots in circular microstrip patch antenna [9].

In this paper, a novel geometry is proposed and simulated results are compared with conventional patch results. The proposed geometry is simulated using IE3D electromagnetic simulator [10]. It is found that to enhance the bandwidth, slots can be embedded on the patch. 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

Circular microstrip patch antenna is one of most popular used antenna, after rectangular microstrip patch antenna. Here conventional circular patch microstrip antenna is considered the reference antenna to compare the results of that simulated from three slots circular patch antenna.

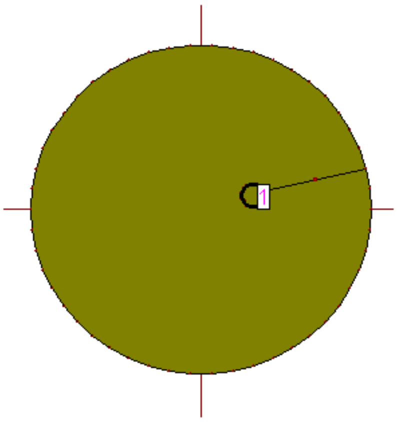

Fig.1. Circular microstrip patch antenna diameter= 14mm

The geometry of the conventional circular MPA is shown in Figure1.The patch has the diameter of 18 mm and FR4 is used as dielectric with dielectric constant, ε_r = 4.4 and the thickness of the substrate, h = 1.59 mm. A 50Ω coaxial probe is used to connect the microstrip patch at coordinates and it is made fixed for both the conventional and the three slot circular MPA.

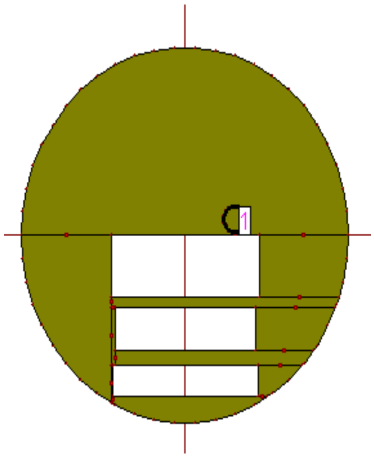

Fig.2.Proposed new geometry of circular microstrip patch antenna

The geometry is proposed to improve the radiation parameter of probe-fed patch antenna with three slots is shown in Fig. 2. Impedance bandwidth of about 9.68% can be obtained from the above geometry. Main advantage of this geometry is that it produces wider bandwidth than the conventional circular patch with simple topology and also improve the return loss.

III. SIMULATED RESULTS

There is a comparative study of the simulated results of conventional circular microstrip patch and proposed new geometry of the circular microstrip patch antenna.

1)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.

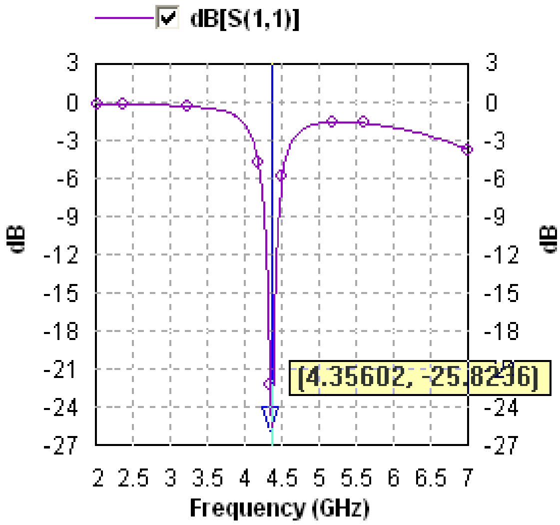

Fig.3. Simulated Return Loss for circular microstrip patch antenna.

Return Loss shown in Fig. 3 of the circular micro strip patch antenna is -25.82 dB at resonating frequency 4.35 GHz and from the Return Loss curve the bandwidth obtained is 3.67%.

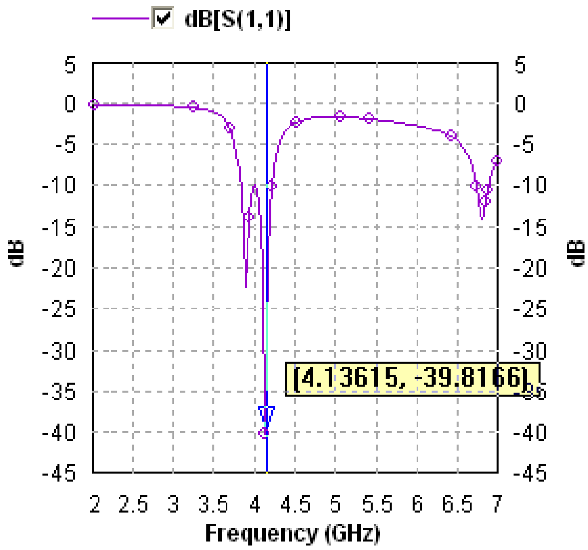

Fig.4. Simulated Return Loss for proposed new geometry

Fig.4 shows that the return loss of proposed microstrip antenna improves to -39.81dB from the conventional antenna of -25.82dB with the resonant frequency 4.13GHz. From the Return Loss curve the bandwidth obtained is 9.68%.Here resonant frequency also decreased and bandwidth is wider compared to the conventional geometry.

2) 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.

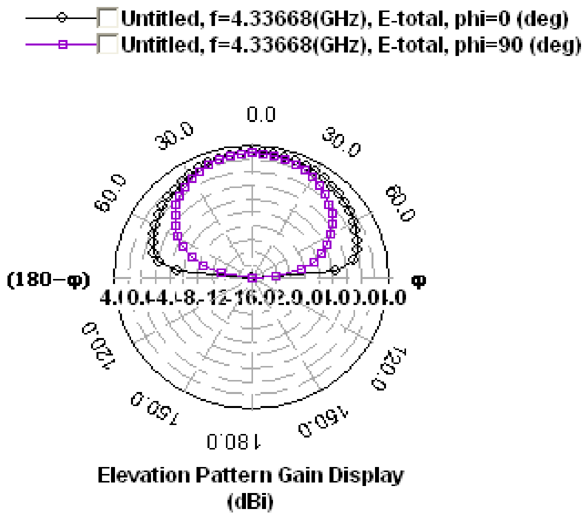

Fig.5. 2D Radiation Pattern for circular microstrip patch antenna.

The simulated E-plane and H-plane pattern, 2D pattern view the circular MPA is illustrated in Fig. 5. Radiation pattern is smooth and uniform over the band of frequencies.

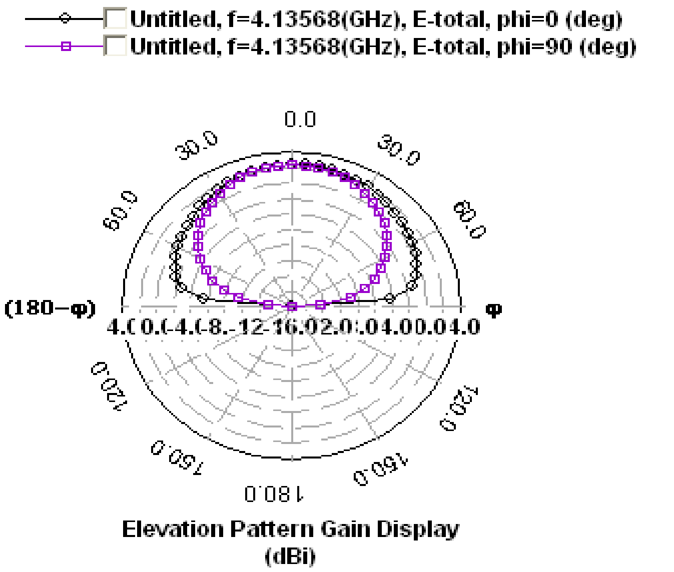

Fig.6. 2D Radiation Pattern for proposed new geometry

Radiation pattern of three slot circular microstrip patch antenna as shown in Fig 6 is also smooth and uniform over the frequency range.

3) Smith Chart: Smith Chart provides the information about polarization and the impedance match of the radiating patch. The smith chart for the conventional circular MPA is given in Fig.7.

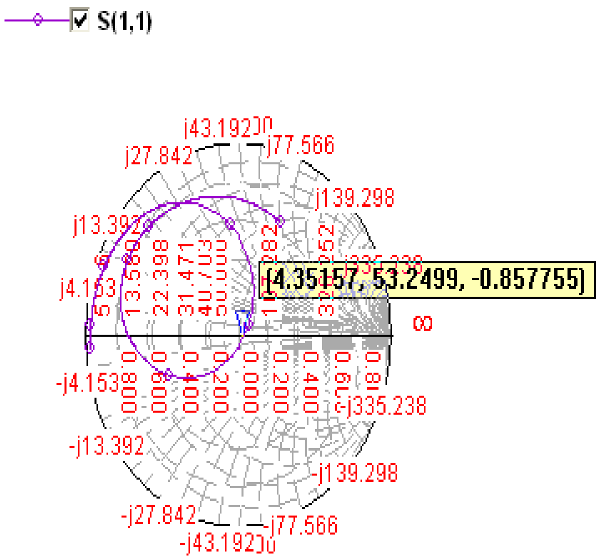

Fig.7. Smith Chart of circular microstrip patch antenna

Fig 7 shows the input impedance of 53.24Ω –j0.8577 at resonant frequency 4.35 GHz. This smith chart shows that the antenna is linearly polarized.

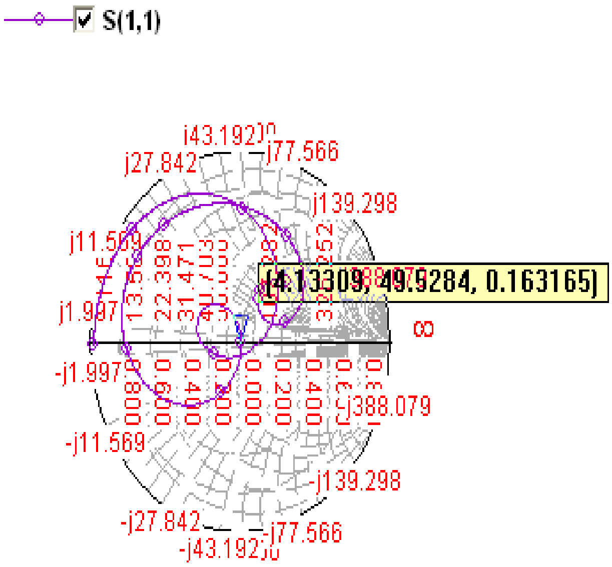

Fig.8. Smith Chart of proposed new geometry

Fig 8 shows that the 49.52Ω -j0.163 input impedance is obtained for the proposed antenna and the antenna is circularly polarized with some impurity.

The effects of embedding slots in circular microstrip patch antenna as shown in table I.

Sr. No.	Characteristics	First Slot	Second Slot	Third Slot
1.	Resonant Frequency (GHz)	4.33	4.25	4.13
2.	Return loss (dBi)	-23.76	-31.73	-39.81
3.	Bandwidth (%)	4.15%	4.94%	9.68%

Table I

IV. CONCLUSION

In this paper, the radiation performance of proposed new geometry of circular microstrip patch antenna is simulated by applying IE3D full-wave electromagnetic simulator and compared with conventional circular patch antenna. Simulated results indicate that the antenna exhibits bandwidth upto 9.68% by optimizing the length and width of the slots in antenna geometry. There is also improvement in return loss. The radiation pattern is also found to be stable over the entire bandwidth.

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