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Design of single feed microstrip antenna for long distance radio telecommunications with size reduction of 45.70%

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***Abstract*— We are designing a single layer single feed microstrip antenna with an increased frequency ratio. We change the different feed locations for getting the better results. First, we apply feed for (2, 2.5) location. But we are getting the resonant frequency at 8.97 GHz which is more than the conventional antenna structure. So, we change our feed location from (2, 2.5) to (1, -1) position and we achieve the resonant frequency at 5.35 GHz and we also achieve some multiple frequency. Here we use the PTFE substrate with dielectric constant of 4.4. We also achieve an increased frequency ratio of about 10% with absolute gain of 4 dBi (gain of isotropic antenna) and we are able to get -3 dB beam-width of about 170.32^{0}which is a broad beam for the application which is intended. We also achieve lower VSWR for this paper.**

***Keywords*— Isotropic Antenna, PTFE, Frequency Ratio, Resonant Frequency, Frequency ratio**

I. Introduction

For new era of communication, design of compact microstrip antenna creates a lot of interest among the young engineers especially for microwaves engineer [1]. For the portability of microwave devices, we need small, light weight and compact antenna and on this ground Compact Microstrip Antenna is the most suitable device. For microwave communication as well as also for the wireless communication, now a day's more than one operating frequency is required due to many reasons. The two operating frequencies are required mainly because most of the microwaves and wireless engineers use different communication bands and for uses of different bands different frequencies are used by the engineers. Therefore recently the engineers design antennas which has multiband characteristics. Another criteria needed to design the antenna is size reduction which is the new technique and in this method the size of the antenna is same for conventional as well as proposed antenna. For size reduction the most useful technique is to cut different structures in the proper position on the conventional microstrip antenna [2-5]. Reducing the size of the antenna means the resonant frequency of slotted antenna is drastically reduced compared to conventional antenna [6-8]. There are so many antennas are used to reduce the size of proposed antenna like DRA (Dielectric Resonator Antenna), Fractal Antenna etc [15-20]. But the above mentioned antennas are very difficult to design compared to microstrip patch antenna. Now the structure of Fractal antennas are just like a euclidean geometry structure and it is a combination of triangle, square and circles etc. So Fractal antennas are very much difficult to design and DRA requires high dielectric constant substrates (more than 20) which are not readily available. Now a day's the size of the compact microstrip antenna is very small and miniaturization is possible so these antennas are increasing the demand of their application in various communications especially microwave and mobile communication [9-10]. In this paper two bevels are cut at the left-top corner and the right-bottom corner to increase the return loss and gain bandwidth performance. It also gives the increased frequency ratio for the proposed compact microstrip printed Antenna. For size reduction of the antenna, we need dielectric constant with high values [11-14]. Our aim is to design the antenna with multiband operation and increased frequency ratio as well as increase the operating bandwidth. The simulation has been carried out by IE3D [21] software which uses the MOM method.

II. Antenna Design

The configuration of the conventional printed antenna is shown in Figure 1 with L=10 mm, W=10 mm, substrate (PTFE) thickness h= 1.6 mm, dielectric constant ε_r = 4.4. Coaxial probe-feed (radius=0.5mm) is located at W/2 and L/3.

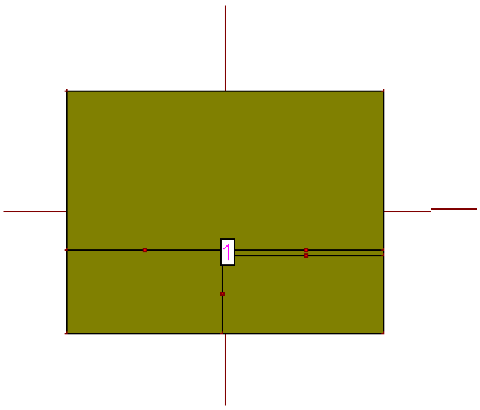

Figure1: Conventional Antenna Structure

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Figure 2 shows the configuration of proposed antenna designed with similar PTFE substrate. Four rectangular slot with small slits whose dimensions are shown in the figure 2. The location of the co-axial probe feed is also shown in the illustrated figure.

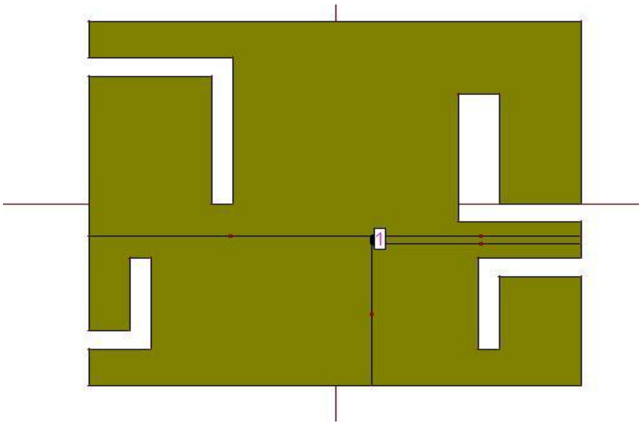

Figure 2: Proposed Antenna Structure

III. Results and Discussion

Simulated (Using IE3D) results of return loss in conventional and slotted antenna structures are shown in the below figure 3 and figure 4. A significant improvement of band-width as well as return loss is achieved in proposed antenna with respect to the conventional antenna structure.

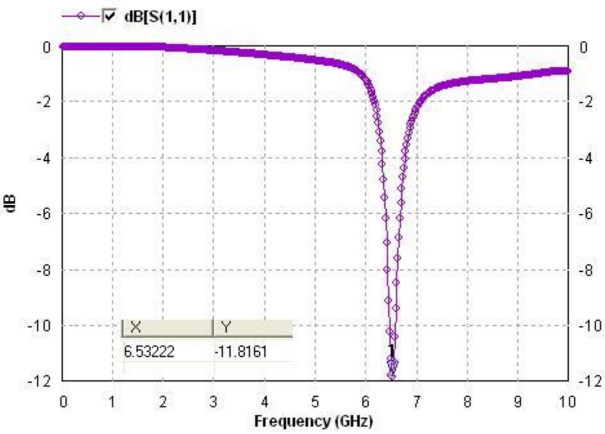

Figure 3: Return Loss vs. Frequency (Conventional Antenna)

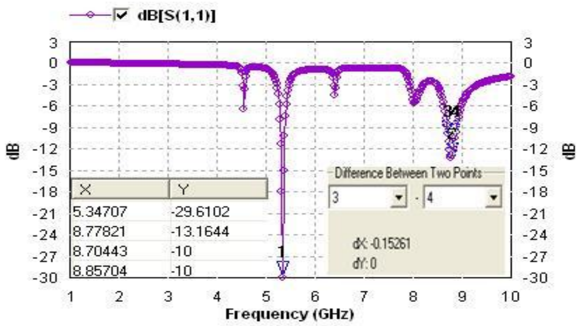

Figure 4: Return Loss vs. Frequency (Proposed Antenna)

The simulated E-Plane and H-Plane conventional and proposed antenna radiation patterns for all resonant frequencies are shown in figures 5-8.

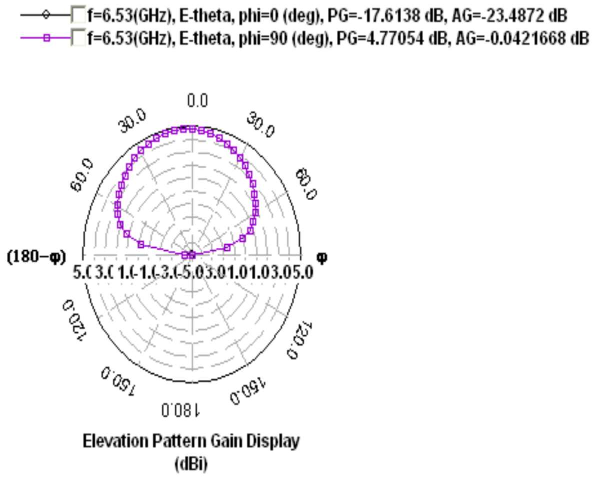

Figure 5: E-Plane Elevation Radiation Pattern Gain for Conventional Antenna at 6.53 GHz

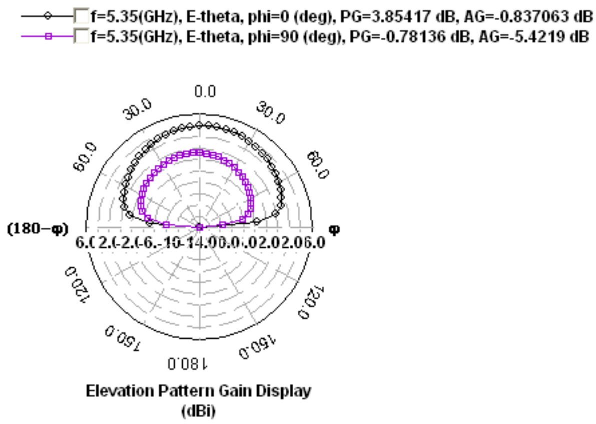

Figure 6: E-Plane Radiation Pattern for Proposed Antenna at 5.35 GHz

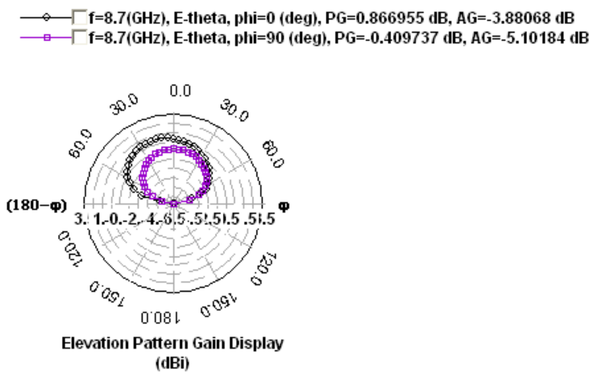

Figure 7: E-Plane Radiation Pattern for Proposed Antenna at 8.7 GHz

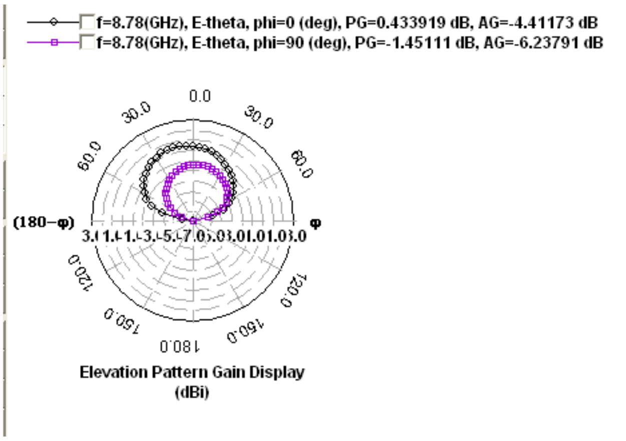

Figure 8: E-Plane Radiation Pattern for Proposed Antenna at 8.78 GHz

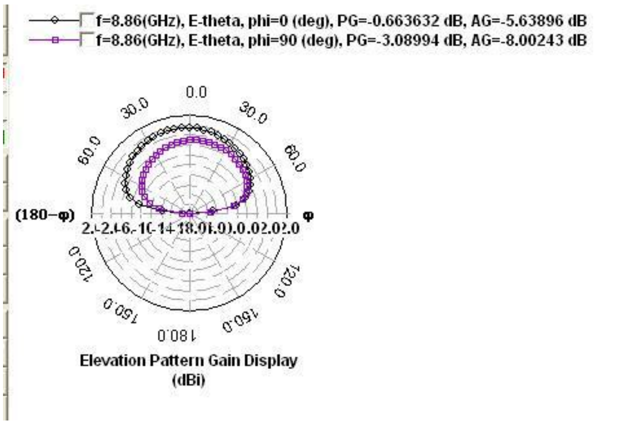

Figure 9: E-Plane Radiation Pattern for Proposed Antenna at 8.86 GHz

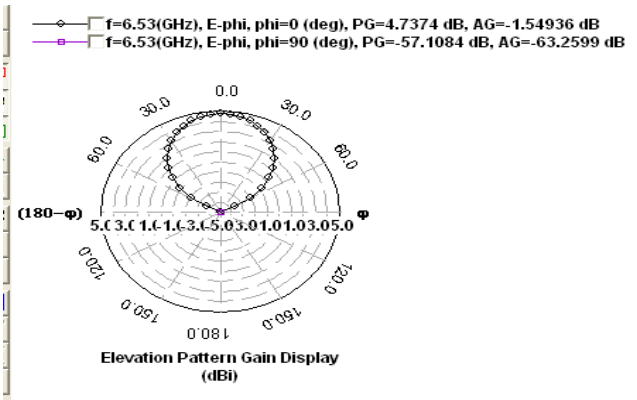

Figure 10: H-Plane Radiation Pattern for Conventional Antenna at 6.53 GHz

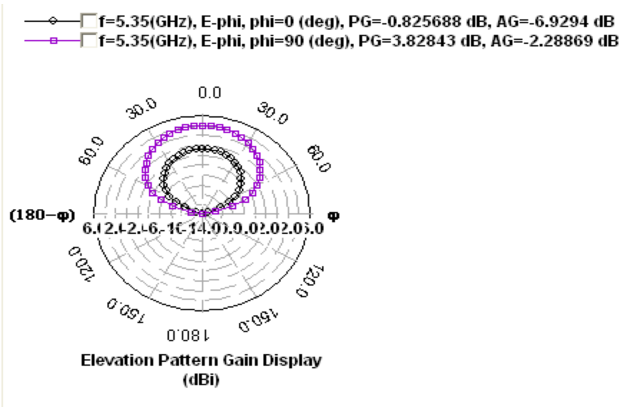

Figure 11: H-Plane Radiation Pattern for Proposed Antenna at 5.35 GHz

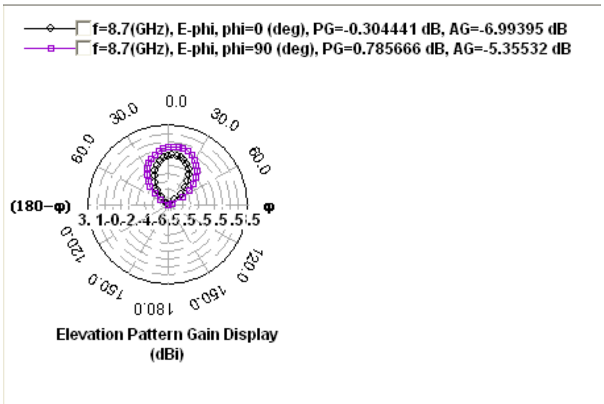

Figure 12: H-Plane Radiation Pattern for Proposed Antenna at 8.7 GHz

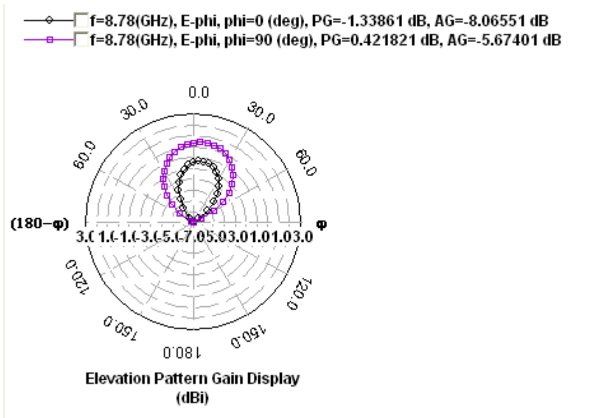

Figure 13: H-Plane Radiation Pattern for Proposed Antenna at 8.78 GHz

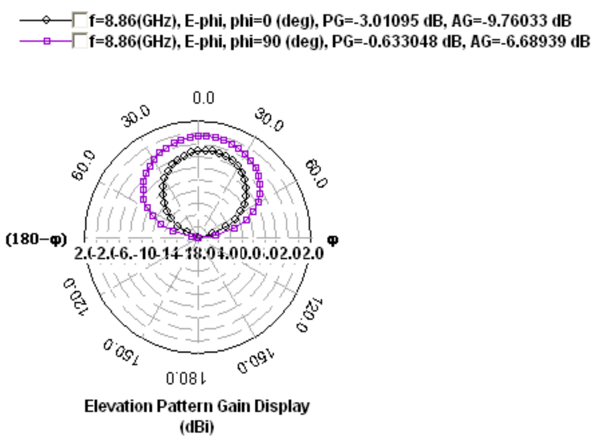

Figure 14: H-Plane Radiation Pattern for Proposed Antenna at 8.86 GHz

With the help of Table1 and Table2 all the simulated results are summarized under below:

TABLE I: Simulated results for Proposed Antenna with respect to Radiation Pattern

TABLE II: Simulated results for Proposed Antenna with respect to Return Loss

ANTENNA STRUCTURE	RESONANT FREQUENCY (GHz)	RETURN LOSS (dB)	10 DB BANDWIDTH (MHz)
Conventional Antenna	**f_1= 6.53**	**-11.82**	**173.45**
Proposed Antenna	**f_1= 5.35**	**-29.61**	**79.96**
	f_2= 8.78	**-13.16**	**152.61**

IV. CONCLUSION

Single layer, single feed compact rectangular slot micro strip printed antenna on which theoretical investigations have been carried out using Method of Moment based software IE3D. Introducing four rectangular slots at the edge of the patch on both sides, a significant improvement is achieved in return loss of about -29.61 dB as well as in VSWR value which was closer to the minimum value of VSWR. Another result is also observed that for the proposed antenna, the -3dB beam-width of the radiation pattern of about 168.54^0 is achieved which is sufficiently broad beam for the applications for which it is intended. The resonant frequency for proposed antenna presented in the paper for a particular location of feed point (1mm, -1mm) considering the centre as the origin) was quite large as is evident from table-II. If we change the location of the feed point, then the results give narrower 10dB bandwidth and less sharp resonances.

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ANTENNA STRUCTURE	RESONANT FREQUENCY (GHZ)	FREQUENCY RATIO	3 DB BEAMWIDTH (^{0})	ABSOLUTE GAIN (dBi)
Conventional Antenna	**f_1=6.53**		**170.24^0**	**4.71**
Proposed Antenna	**f_1= 5.35**		**168.54^0**	**5.07**
	f_2= 8.70	**f_2/ f_1= 1.33**	**159.02^0**	**3.14**
	f_3= 8.78	**f_3/ f_1= 3.71**	**151.57^0**	**2.57**
	f_4= 8.86	**f_4/ f_1= 6.56**	**130.94^0**	**1.29**

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