A Novel Design and Analysis of Rectangular Microstrip Antennas for C to X Band Operations

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Abstract—A novel design of parasitic strip rectangular microstrip antenna (PSRMSA) is realized for single band operation. The single band operation is achieved by placing parasitic strip around the conducting patch to the conventional rectangular microstrip antenna (RMSA). The bandwidth of operating band is found to be 2.35 %. If a three vertical spur lines is placed along the bottom edge length side of PSRMSA, the single band operation is converted to multi band operations with an bandwidth of each operating bands are found to be 2.98%, 1.78 %, 0.55 %, 3.217% and 2.49 % respectively. These converting of bands do not change nature of broadside radiation characteristics of antennas.

Keywords: Rectangular Microstrip Antenna, Spur Lines, Bandwidth, Multi bands, Radiation

I. INTRODUCTION

Now a day's communication plays very important role in day today's life without communications nothing is possible. So to communicate it requires antennas, it is a heart of all communications, so without antennas no communication is possible. Now a day's antennas have got more demandable, all researchers are investigating or designing so many new antennas for various applications and making antennas as much as very compact. Among all antennas microstrip antennas are more in demands because of it so many attributes, it is simple in design, constructions and fabrications. Even though it has advantages like low handling power, high gain, easy to handle, less expensive etc [1]. Various techniques have been shown in the literature like slot loading, parasitic, spur lines, stubs, truncations, coupling of power etc [2] and these antennas can be fed by various feeding techniques like microstripline feeding, probe feeding, aperture coupled feeding, inset feed etc. [3] A study is taken up to design rectangular microstrip antennas by placing spur lines on the patch and parasitic strip around the patch of rectangular microstrip antennas.

II. ANTENNA DESIGN AND GEOMETRY

The schematics of the proposed antenna have been made using the design software called Auto-CAD. The simulation is performed on Ansoft HFSS software. The thickness is taken as h = 0.16 cm and relative permittivity of the substrate as $\varepsilon_r = 4.2$.

Figure 1 shows the geometry of conventional rectangular microstrip anenna (RMSA). This antenna is designed for the resonant frequency of 4 GHz [4]. The length and width of rectangular patch is L and W respectively. To feed the power to the patch the microstripline feeding is used herewith. To match the impedance between the patch and microstripline feed a quarterwave transformer is used and its length and width is L_t and W_t respectively. The length and width of microstripline feed are L_f and W_f respectively [4].

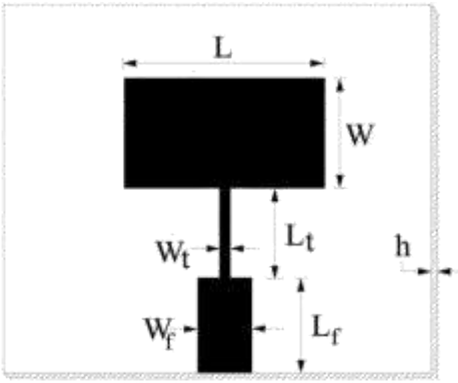

Fig. 1: Geometry of RMSA

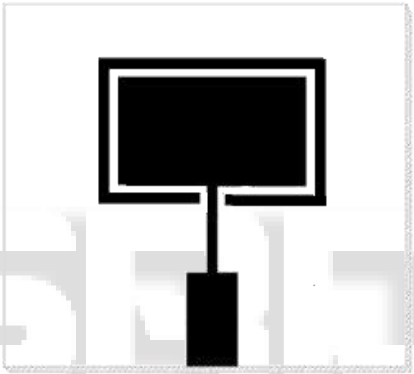
Fig. 2: Geometry of PSRMSA

Figure 2 shows the geometry of parasitic strip rectangular microstrip antenna (PSRMSA) in this antenna the parasitic strip is placed around the patch of RMSA. The length and width of strip are taken in terms of λ_o where λ_o is the free space wavelength in cm.

Further the study is extended by placing three vertical spur lines in the bottom edge along the length of PSRMSA and the antenna is named as parasitic strip three vertical spur line rectangular microstrip antenna (PSSRMSA) as it is shown in the figure 3.

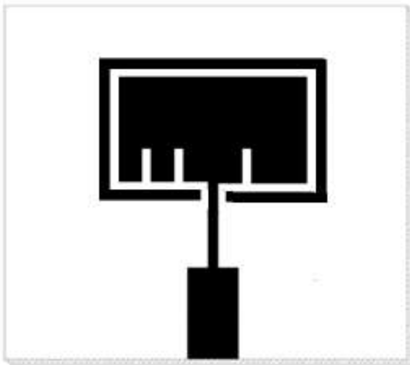
Fig. 3: Geometry of PSSRMSA

III. RESULTS AND DISCUSSION

The variations of Return loss vs Frequency results of simulation, made by means of software HFSS of the RMSA is as shown in figure 4. From this figure it is seen that the antenna is resonating with one band BW1 which is almost very nearly at 4 GHz which is the design frequency of the antenna. The percentage bandwidth is 1.70% which is determined by using the formula as given below, where, f_1 and f_2 are the lower and upper cut-off frequencies of the band respectively, when its return loss become -10dB and f_r is the centre frequency between f_1 and f_2 [5].

$$Bandwidth\ (\%) = \left[\frac{f_2 - f_1}{f_r}\right] \times 100$$

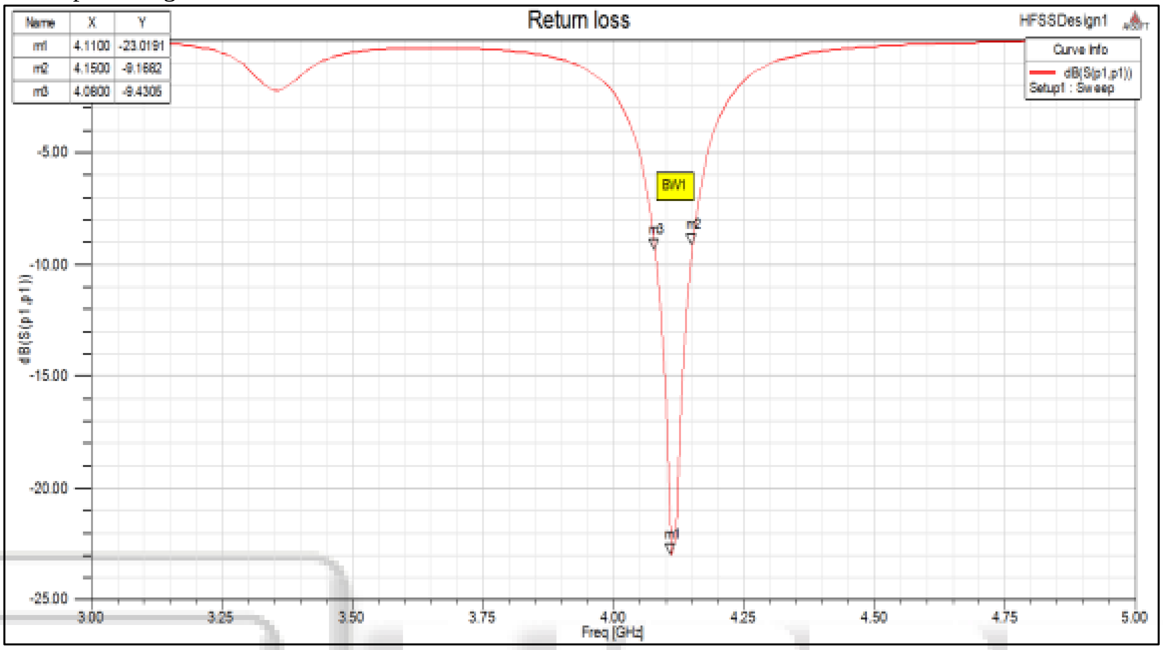

Fig. 4: The variation of return loss versus frequency of RMSA

The Fig. 5 shows the variation of Return loss vs Frequency of PSRMSA, from this figure it is seen that the antenna resonates for single band of frequency i.e BW2 with a percentage of bandwidth of 2.32 %. It is seen that when parasitic strip is placed the bandwidth is increased from 1.70 % to 2.32 % this is due to the combined effect of parasitic strip and the patch resonance [6].

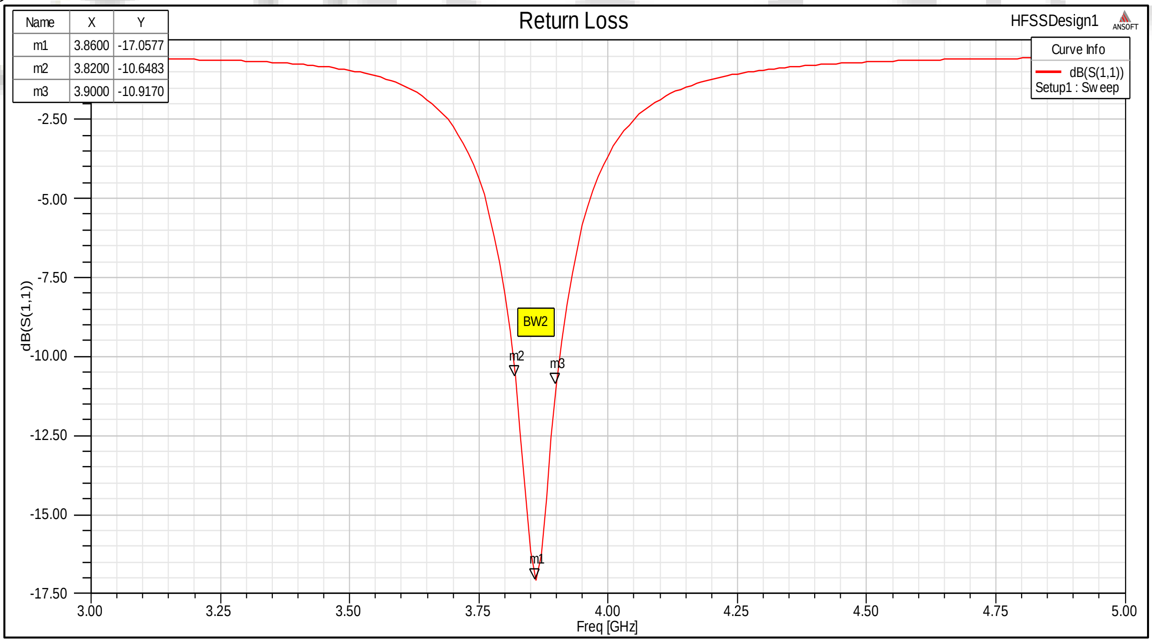

Fig. 5: The variation of return loss versus frequency of PSRMSA

The variation of return loss versus frequency of PSSRMSA is as shown in Fig. 6, when the three vertical spur lines are placed on the patch of PSRMSA, the antenna resonates for multi band of frequencies i.e. BW3, BW4, BW5, BW6 and BW7 with the percentage of bandwidths are found to be 2.98%, 1.78%, 0.55%, 3.21 % and 2.49%, respectively, It is also seen from this figure that, due to the spur lines effect the antenna convert single band operation to multi band operations.[7].

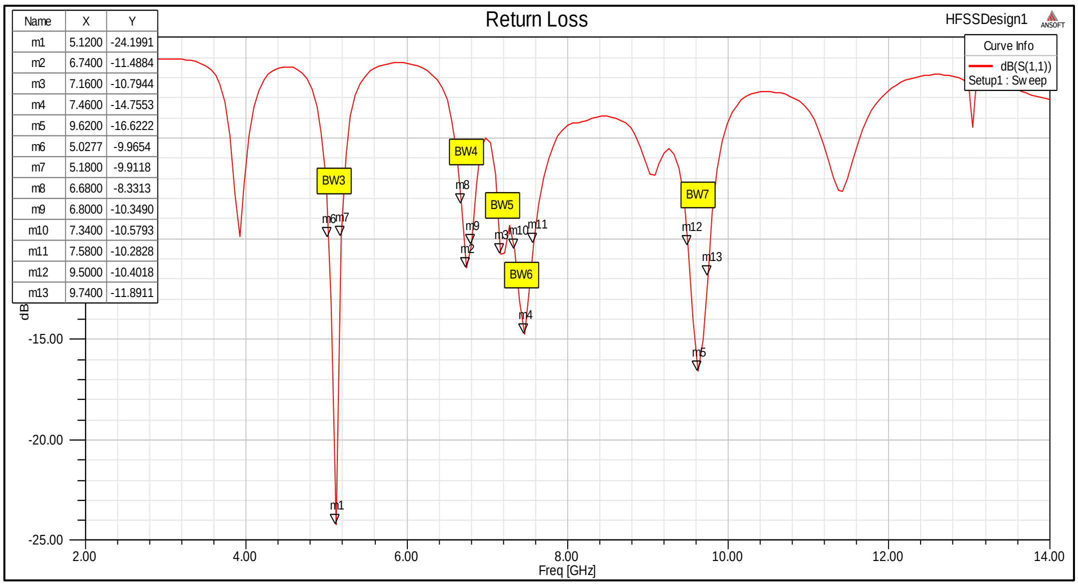

Fig. 6: The variation of return loss versus frequency of PSSRMSA

Fig. 7 and 8 shows the co-polar and cross-polar radiation pattern of PSRMSA and PSSRMSA from these figures it is seen that the patterns are broad sided and linearly polarized. The maximum gain of PSRMSA and PSSRMSA are found to be 4.25 dB and 4.87 dB.

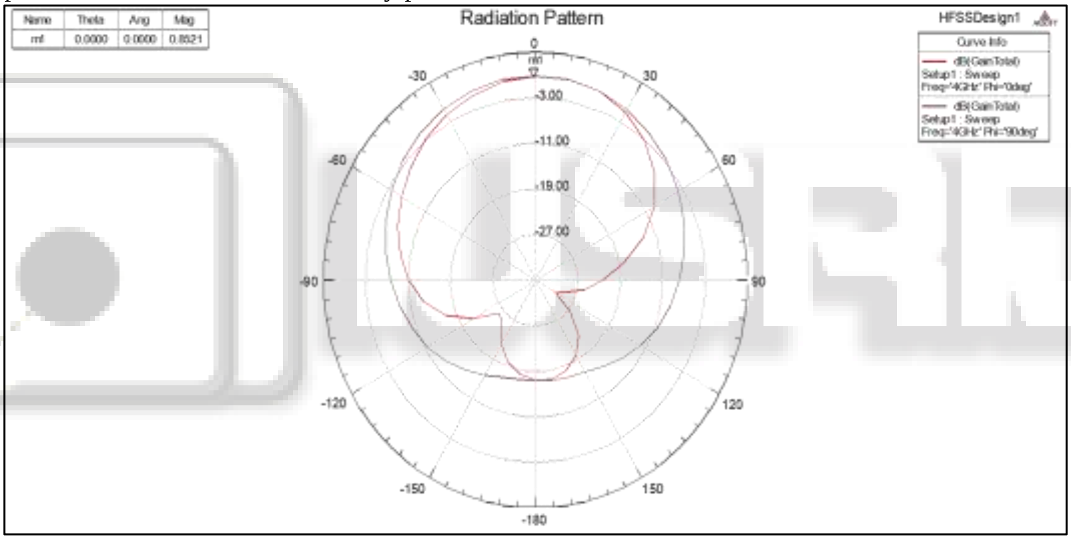

Fig. 7: Radiation Pattern of PSRMSA

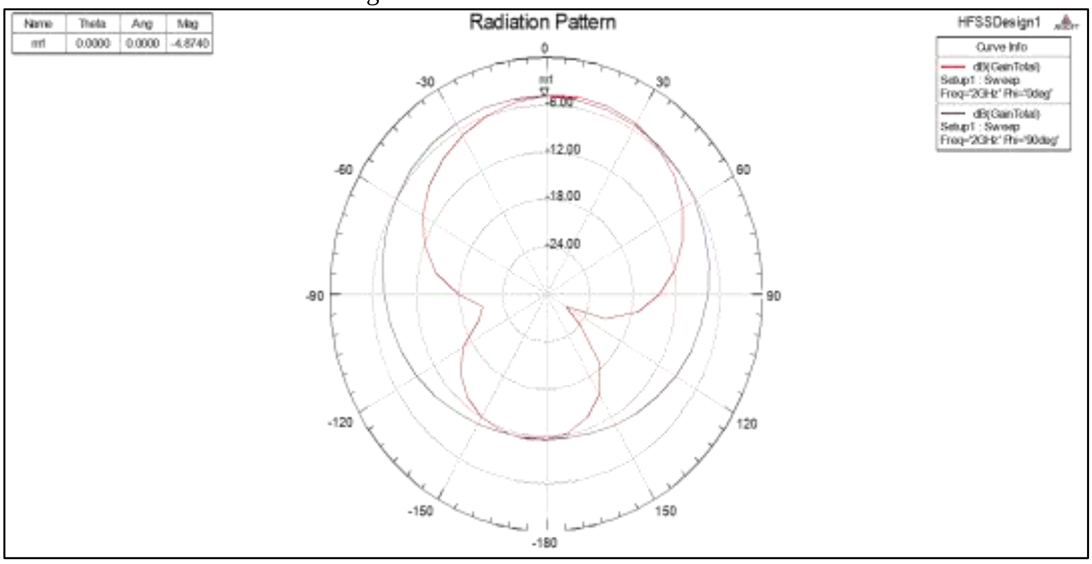

Fig. 8: Radiation Pattern of PSSRMSA

IV. CONCLUSION

It is concluded that, the novel design of RMSA is more effective in producing the single and multi-band operations. The single band is achieved by placing parasitic strip around the patch and maximum bandwidth received is 2.32 %. When the three vertical spur lines are placed, the antenna resonates with multi band operations which are covering C to X bands these antennas may find applications in fixed satellite services.

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