A NOVEL APPROACH TO IMPROVE THE GAIN AND BANDWIDTH OF MICROSTRIP PATCH ANTENNA

[1]RUSHIT D TRIVEDI, [2]DR.VEDVYAS DWIVEDI

[1] Research Scholar at J.J.T. University, Jhunjhunu, Rajsthan, India
[2] Director, C.U.Shah University,Wadhvan,Guharat,India

rushit_trivedi@yahoo.com, vedvyasdwivediphd@gmail.com

ABSTRACT : *This report presents the work on improvement of gain and bandwidth by means of Stacked 'Shi' shaped microstrip patch antenna with surface mount horn antenna. The proposed geometry is excited by co-axial cable. Using this technique bandwidth is achieved up to 3 GHz and gain is improved from conventional 4 dB to 15 dB. The fabrication and measurement of model is presented for validation purpose.*

KEY WORDS *:Bandwidth, gain, stacked microstrip patch antenna.*

1. Introduction

As the microstrip patch antenna having various advantages like small in size, compact in nature, ease of fabrication, easy to obtain desired polarization as well as various frequency operation. So many research papers published in the domain of microstrip patch antenna for improving the gain and bandwidth of microstrip patch antenna which are the disadvantages of it. This report presents the work on the improvement of the gain and bandwidth of patch antenna by means of stacking and surface mount horn antenna. Here basically stacked Shi shaped microstrip patch antenna is designed to improve the bandwidth of microstrip patch antenna. This 'Shi' shaped geometry provides the very wide bandwidth of operation. The gain of microstrip patch antenna is increased by adding surface mount conical horn antenna on to the stacked 'Shi' shaped microstrip patch antenna. Combining this structure improves the gain and also horn antenna structure doesn't disturb the overall bandwidth parameter.

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2. DESIGN OF PROPOSED MODEL

The stacked geometry structure is made up of two materials; lower structure is air (5mm) and upper structure selected as a duroid material (1mm). In Fig.1 shi shaped patch is only indicated. The stacked geometry is excited by coaxial cable. The maximum power transfer is achieved by adjusting the position of feed element. The dimensions of the shi shaped stacked patch is indicated in Fig.2.

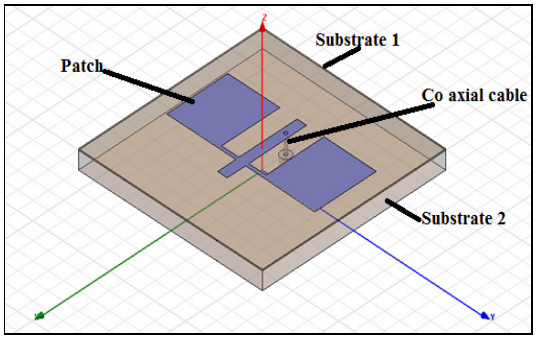

Figure 1 Stacked 'Shi' shaped microstrip patch antenna

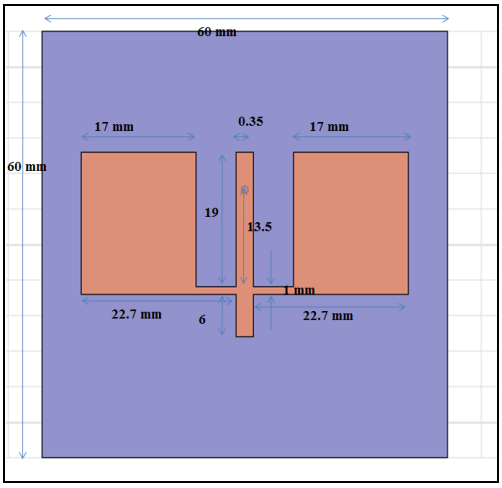

Figure 2 Dimensions of Stacked 'Shi' shaped microstrip patch antenna

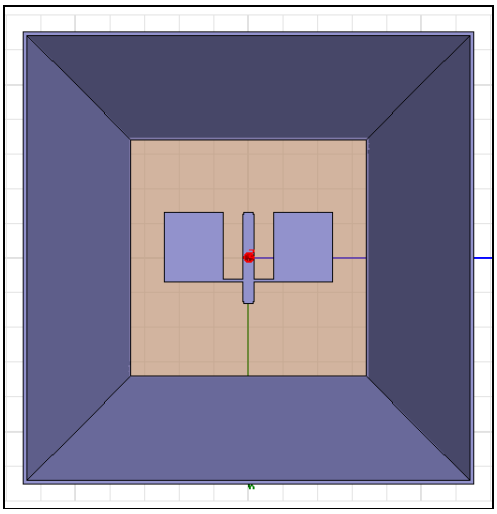

Figure 3 Stacked 'Shi' shaped patch antenna with surface mount pyramidal horn antenna

As shown in Fig.3 the surface mount horn is attached with the proposed shi shaped stacked geometry. Here pyramidal horn antenna is used as a surface mount horn antenna. Ground plane, Patch antenna and Pyramidal horn antenna is constructed by perfect conductor. In this model improvement of bandwidth is achieved by mainly two reasons, first by implementing stacked geometry and secondly by implementing Shi shaped geometry.

3 SIMULATED RESULTS

Simulated results are presented in this section. The below figure represents the tetrahedral meshes implemented in the stacked geometry. It gives the clear idea about the complexity of computation and also it shows the tradeoff between simulation time and the dimensions of geometry

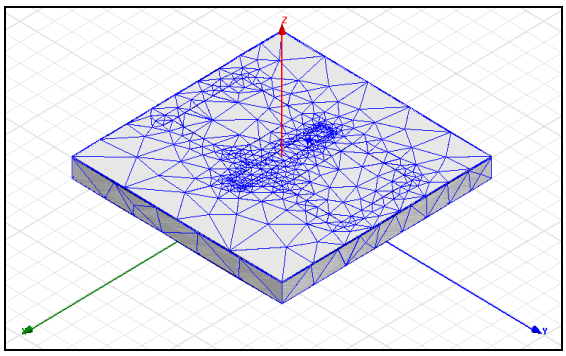

Figure 4 Meshing of the proposed geometry

The simulated return loss graph is presented in Fig.5. It indicates that the structure is strongly resonates on 4.5 GHz, but overall response of -10dB down is also encouraging. The bandwidth which is achieved from this model is 3 GHz which is really a very wideband achieved from this model from patch geometry. The same result is also obtained by smith chart (see Fig.6), which also represents the resonance behavior of proposed geometry. The gain plot (presented in Fig.7) shows that the proposed structure having very high gain up to 15 dB. The normal patch antenna geometry provides gain nearly 4 dB but using this structure, the gain is improved from 4 dB to 15 dB. The drastic amount of change is possible by adjusting the dimension of 'Shi' shape, antenna substrates and flaring of surface mount horn antenna. The directivity of proposed structure is shown in Fig.8.

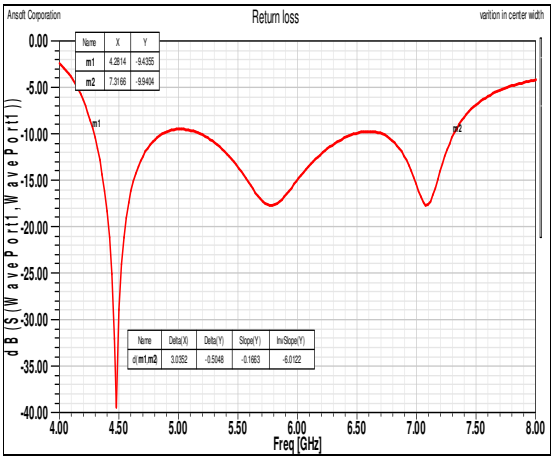

Figure 5 Return loss graph (Bandwidth= 3 GHz)

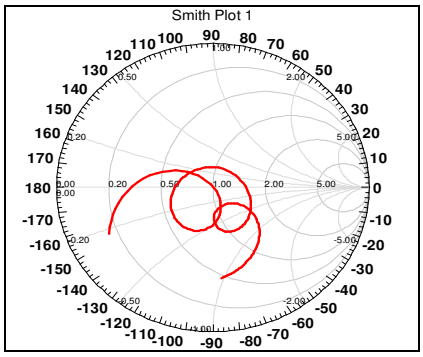

Figure 6 Smith Chart of proposed model

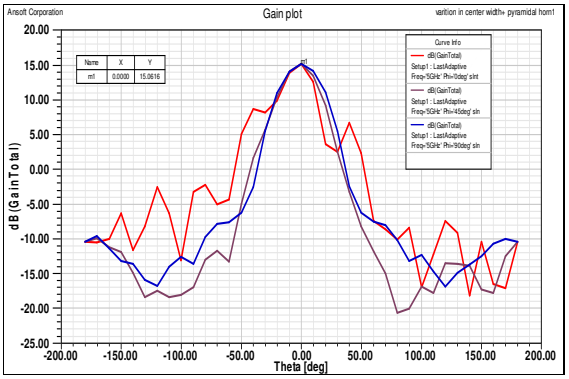

Figure 7 Gain plot (Bore sight gain 15 dB)

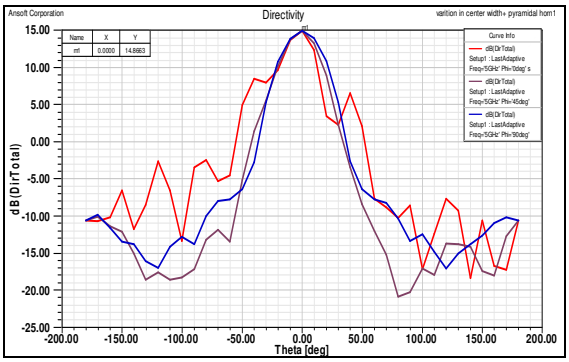

Figure 8 Directivity plot (Bore sight directivity 15 dB)

The two dimensional radiation pattern of E field plot is shown in Fig.9. It shows that very less amount of power is distributed on rear hemisphere. The magnetic field plot is also represented in Fig.10. Now observing the three dimensional radiation pattern in Fig.11, it clearly shows that all the energy is radiated in intended direction and very less amount of energy is spill out from edges of patch antenna.

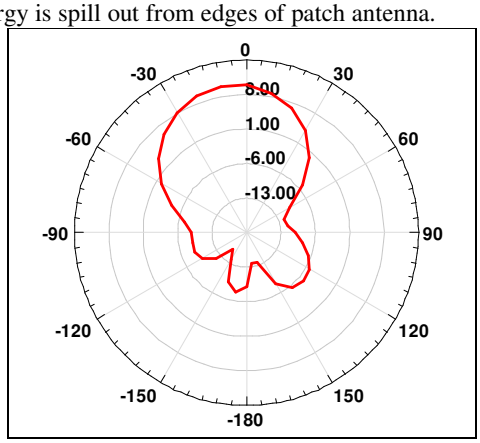

Figure 9 Two dimensional radiation pattern (E-field plot)

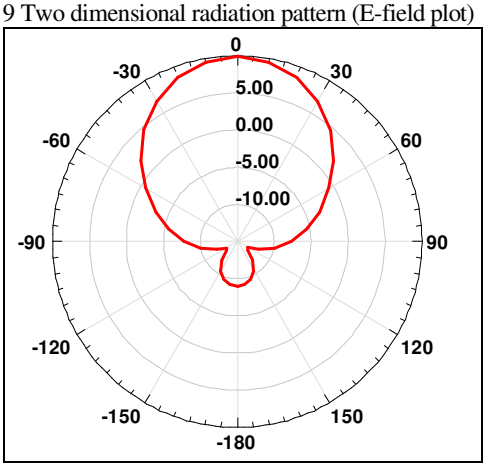

Figure 10 Two dimensional radiation pattern (H-field plot)

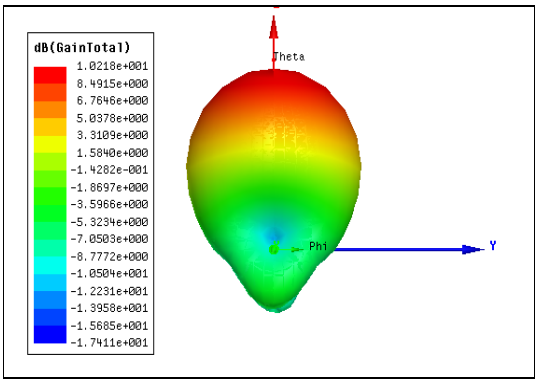

Figure 11 Three dimensional radiation pattern

To analyze the overall radiation characteristic the electric field is plotted in YZ plane, as shown in Fig.12. It represents the formation of loop and how it propagates through the horn antenna and finally how it is detached from the horn mouth. In three dimensional plot of gain and overall characteristic of proposed models figure, red color indicates the maximum radiation intensity.

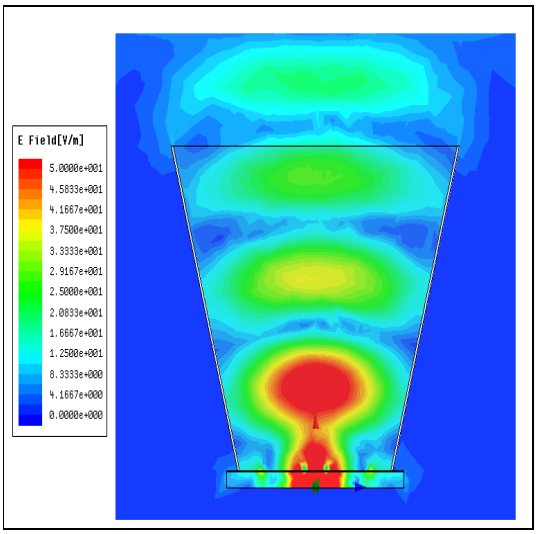

Figure 12 The overall radiation characteristic of Stacked Shi shaped microstrip patch antenna with Pyramidal horn antenna

4 FABRICATION AND MEASUREMENT

To validate the design fabrication and measurement is carried out. Fabrication technology requires good amount of accuracy to avoid the errors in measurement. Fabrication of 'Shi shaped' stacked antenna is presented in Fig.13.Overall geometry is presented in Fig.14. The measurement is carried out by vector network analyzer and it is shown in Fig.15. Comparing the measured result with simulated result shows that good amount of matching in terms of frequency response.

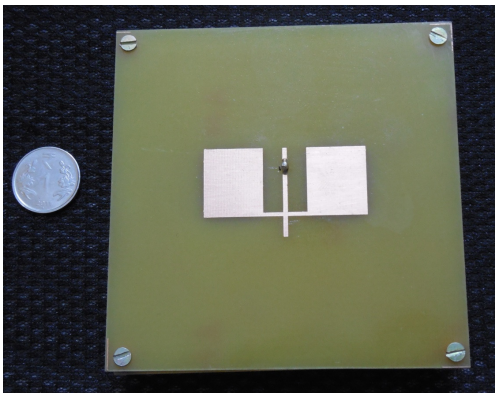

Figure 13 Fabricated 'Shi' shaped stacked microstrip patch antenna

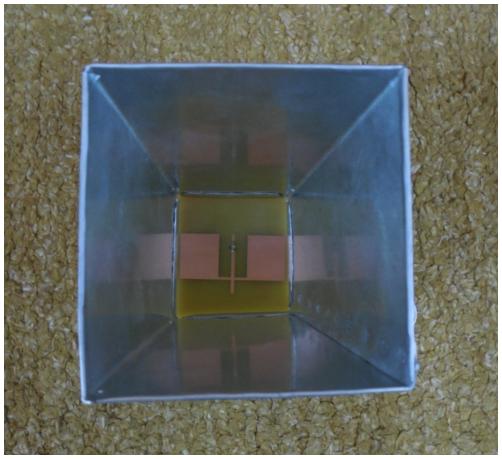

Figure 14 Fabricated 'Shi' shaped stacked microstrip patch antenna with Pyramidal Horn Antenna

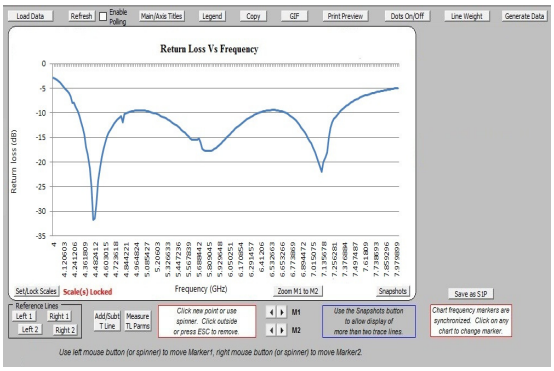

Figure 15 Measured Return loss graph on Vector Network Analyser

5 CONCLUSION

The proposed structure overcomes the basic disadvantage of patch antenna which is Narrow bandwidth and less gain. This structure gives enormous bandwidth (3 GHz) with high gain (15dB). The main disadvantage of this proposed model is its size as pyramidal horn antenna having larger dimensions. The fabrication of model is proposed for measurement purpose. It is also proved that simulated graph and measured graph is almost same. This proposed 'Shi' shaped stacked geometry with surface mount horn antenna can be implemented on air born vehicle, satellite communications and the communications where larger bandwidth is required.

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