Design And Analysis Of Dual Frequency Band E-Shaped Microstrip Patch Antenna

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Abstract

This paper presents the designing and analysis of a E-shaped microstrip patch antenna. Our main aim is to design an antenna structure which can operate in more than one frequency bands which increases the utilization of the antenna in multiple applications. To achieve this aim a E-shaped microstrip patch antenna is designed and simulated over IE3D simulation software ver.15.2. This MoM based simulation software provides the results in terms of S_{11} parameter, VSWR, Gain, Directivity etc. which are quite useful to analyze the antenna performance. The designed antenna is simulated and the simulation result shows that the designed antenna can work in two different frequency bands with bandwidths 33.138% and 3.85867% respectively, the designed antenna also provides a gain of 3.60284dBi, directivity of 3.97701dbi, and antenna and radiation efficiency 88.4522% and 88.9497% respectively.

Keywords: E-shaped, ground plane, microstrip antenna, patch antenna, dual frequency band

1. Introduction

The drastic and dynamic development in the field of wireless communication leads towards miniaturization of the device size without compromising with its features. Antenna is one of the basic need for any wireless communication system. As the communication device size is reduced, the antenna structure used in it should also be reduced without affecting its quality of operation. Many conventional antennas like Yagi Uda, Parabolic Reflector, Helical, Horn etc have wider bandwidth and gain but large size of these antennas restrict their use in various applications, so these antennas cannot be used in the devices which are smaller in size and are used as an moving object. To meet this requirement of wireless communication microstrip antennas are widely used which satisfies the requirements of the wireless communication system. Though these antennas are simple, cost effective yet they have narrow bandwidth and gain. For increasing gain and bandwidth various methods are used -using different patch structure like H shape[2], W shape[3], cutting notches[4] and slots[5,10] etc. In this paper we have designed a E shaped microstrip patch antenna by cutting notches in rectangular patch antenna.

2. Research Methodology

E shaped microstrip patch antenna is designed by cutting two notches in rectangular patch antenna and this design is simulated using IE3D software ver.15.2. Co-axial probe feeding is used for feeding purpose. The designed antenna structure is simulated over IE3D and the results obtained by simulation is analysed.

3. Antenna Design

Design of E shaped Microstrip patch antenna is shown in *figure1*.This designed antenna structure has its ground plane 50X70mm^2 and has a patch size of 30X50 mm^2. The material considered for the antenna structure is of FR4 type.

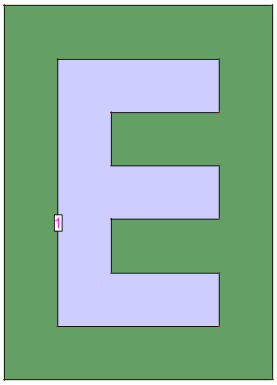

Fig. 1 E-shaped microstrip patch antenna

4. Result and Discussion

The designed E shaped Microstrip patch antenna is simulated over IE3D simulation software. The results obtained by this antenna structure is shown in this section and the analysis based on these is done further.

The first important parameter which is helpful to calculate the bandwidth of the antenna structure is its S_{11} parameter or return loss curve. The return loss curve of the designed antenna is shown in *fig. 2*.

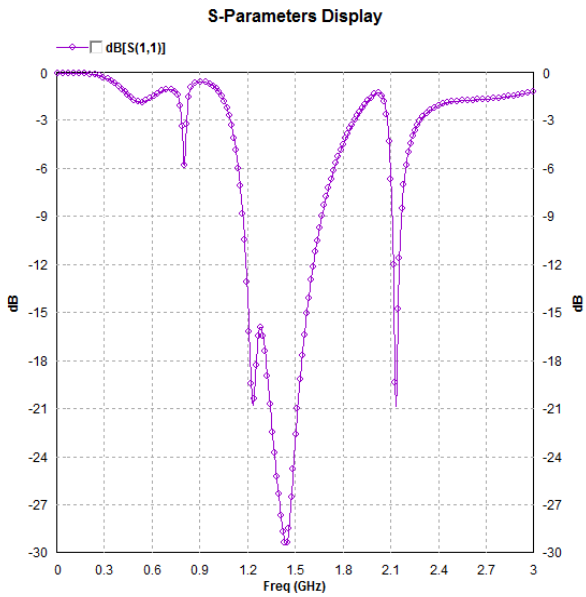

Fig.2 Return loss Vs Frequency curve

Analysing this curve we come to know that the designed antenna structure can work in two different frequency bands.

Calculation of the bandwidth

<u>For frequency band 1</u>

$f_{l1} = 1.18015GHz$, $f_{h1} = 1.6489GHz$,
$f_{r1} = 1.414525GHz$

$$Bandwidth_1 = \frac{1.6489 - 1.18015}{1.414525} \times 100 = \mathbf{33.138\%}$$

<u>For frequency band 2</u>

$f_{l2} = 2.112GHz$,$f_{h2} = 2.195GHz$,
$f_{r2} = 2.151GHz$

$$Bandwidth_2 = \frac{2.195 - 2.112}{2.151} \times 100 = \mathbf{3.85867\%}$$

On calculation of the bandwidth the designed antenna structure provides bandwidth of 33.138% and 3.85867%.

Next important curve which determines whether the required bandwidth is acceptable or not is the VSWR curve. The VSWR curve of the designed antenna is shown in figure 3.

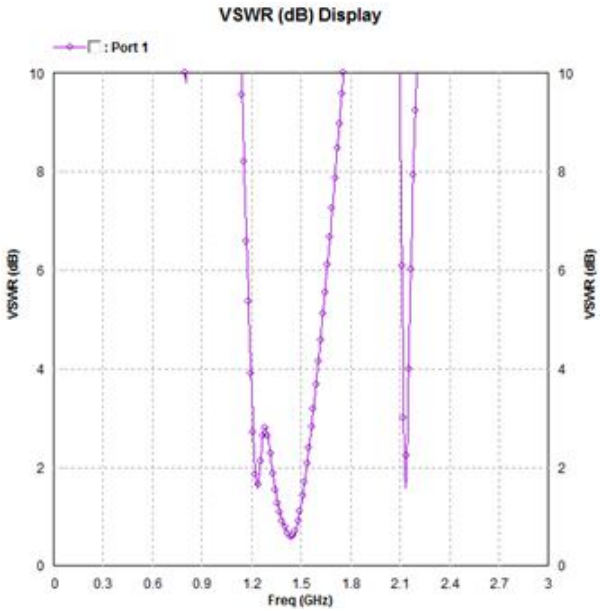

Fig.3 VSWR vs Frequency Curve

From the curve it is clear that VSWR satisfies the frequency range for which bandwidth is calculated. VSWR should be below 2 in this frequency range.

Another important parameter which defines the antenna directional capabilities is the antenna gain. The antenna gain curve of the designed antenna structure is shown in *figure 4*.

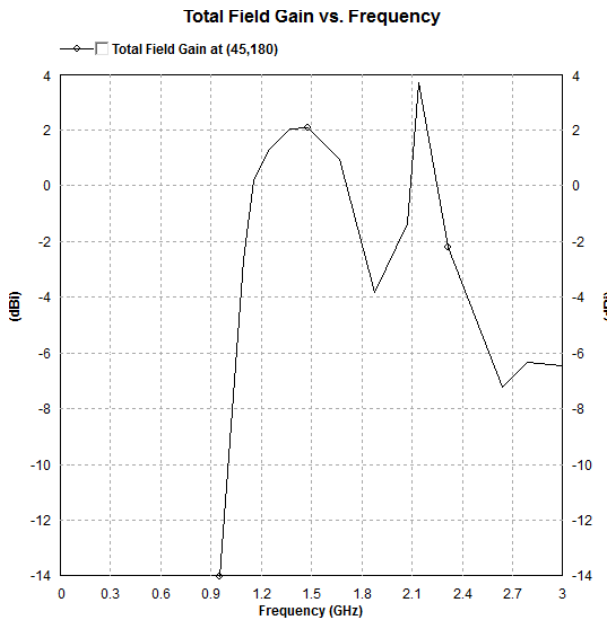

Fig.4 Gain Vs Frequency curve

Analysing the gain curve shown in *fig. 4* we can observe that the designed antenna provides a gain of 3.60284 dBi which is useful for many applications.

Another important parameter related to antenna gain and defines the directional capabilities of the antenna structure is the directivity. The directivity curve of the designed antenna structure is shown in *figure5*.

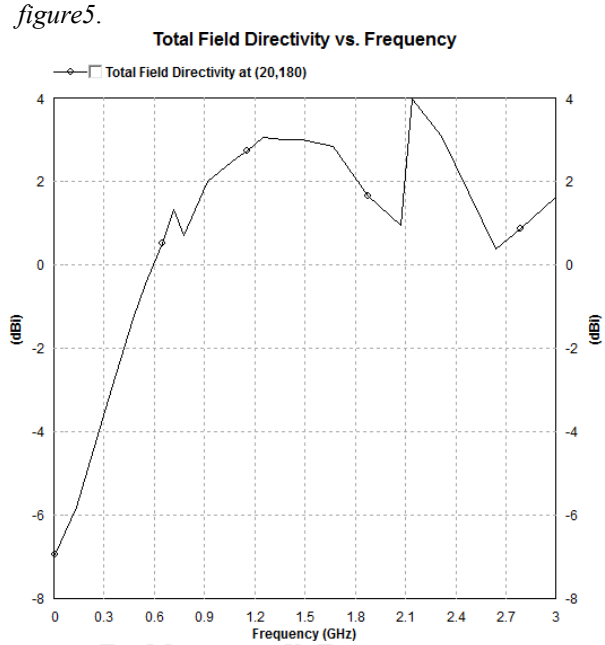

Fig.5 Directivity Vs Frequency curve

From the figure it is clear that the designed antenna structure has a directivity of 3.97701 dBi.

Another parameter which defines the capability of the antenna is its efficiency. The antenna and radiation efficiency of the designed antenna is shown in *fig. 6* and *fig. 7* respectively.

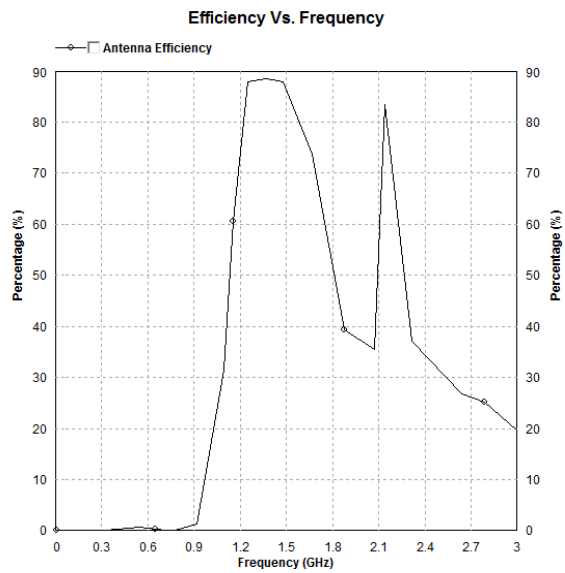

Fig.6 Antenna efficiency Vs frequency curve

Analysing the curve shown in *fig. 6* we can observe that the designed antenna has an antenna efficiency of about 88.4522% at 1.37528 GH_Z.

The radiation efficiency curve is shown in *fig. 7*.

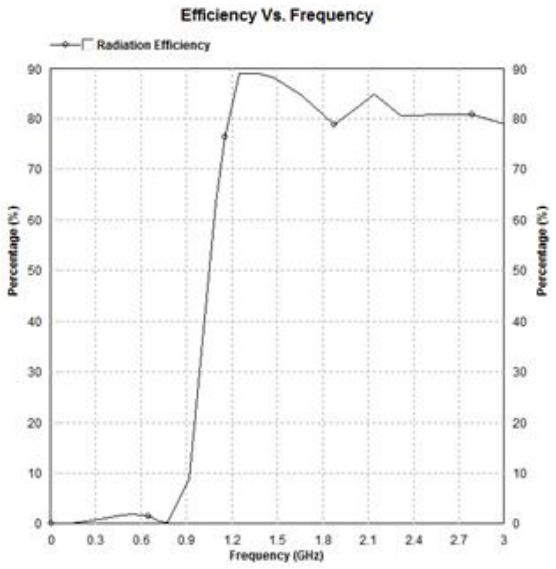

Fig.7 Radiation efficiency Vs Frequency curve

From the figure it is clear that the designed antenna provides a radiation efficiency of 88.9497% at 1.25393 GH_Z.

5. Conclusion

The designed antenna is simulated using IE3D software ver.15.2. The substrate is taken 1.6 mm thick, dielectric constant of 4.2, loss tangent of 0.0013.The obtained bandwidth is of 33.138%, gain of 3.60284 dBi, directivity of 3.97701 dBi, antenna efficiency of 88.4522% and radiation efficiency of 88.9497%.

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