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Analysis and Design of S-shaped Microstrip Patch Antenna

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Abstract: *This paper gives a compact analysis and design of S-shaped Microstrip patch antenna which is best suited for Wi-max application. The analysis and design is simulated over IE3D software Ver. 15.2. We have taken a definite ground plane of 50x70 mm and patch size of 30x50 mm.The substrate thickness is taken as 1.6 mm and dielectric constant of 4.2 and loss tangent of 0.0013.*
The simulated result shows that the bandwidth is obtained in triple band- 7.79% at 0.262921 GHz band, 13.45% at 1.53034 GHz band and 28.0056% at 2.2382 GHz band. The obtained gain is 3.96 dBi at 2.33945 GHz. The obtained gain and bandwidth is best suited for Wi-max application.
Keywords: *S shape, Ground plane, Patch Antenna, Triple Band.*

I. Introduction

In communication systems antenna plays a vital role. Today is the era of microwave engineering where device size is very small. As we know that there are many conventional antennas which have high gain and bandwidth but they have big size and complex 3D geometry. So they are less efficient for microwave applications. To overcome this problem concept of Microstrip antenna is included. This antenna is small in size, cost effective and having 2D geometry. In spite of all these advantages this antenna has some disadvantages also like narrow bandwidth and gain, poor polarization etc. For enhancing the bandwidth and gain many methods are used like using different patch shape[1],[2],[7],[8], varying patch size, changing substrate thickness, using different dielectric substrate[4], using array configuration and stack configuration[3],[5] etc.

This paper gives analysis of S-shaped Microstrip antenna over IE3D software. The simulated result shows various curves from which we can calculate bandwidth, gain, directivity, antenna efficiency and radiation efficiency.

II. Research Methodology

The S-shaped Microstrip patch antenna is designed by cutting two slots in opposite direction and then this designed is simulated over IE3D software to obtain respective parameters. We have taken co-axial probe feed to fed this antenna because this feeding technique is much simple and have least radiation losses in comparison to other feeding technique like Microstrip line feed, Aperture coupled feed and Proximity coupled feed. In probe feeding we have chosen hit and trial method to calculate various parameters and the point where desirable result is obtained is taken as final point.

III. Antenna Design

The design of S-shaped patch antenna including dimensions is given below –

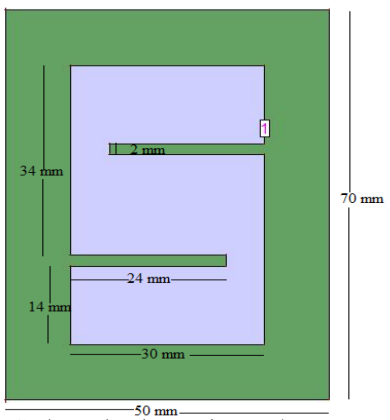

Fig.1: S-shaped Microstrip patch antenna

The dimensions of antenna are indicated in figure and in the table also.

Parameters	***Size in mm***
Ground plane	50x70
Patch size	30x50

Table.1: Dimensions of antenna structure

IV. Results and discussion

The simulated results shows various parameters. First of all return loss curve is considered to obtain the bandwidth, then we considered the VSWR curve to determine whether the obtained bandwidth is useful or not. VSWR should below 2 in desired frequency range. Then gain, directivity and efficiency curve is considered. Bandwidth and gain are the most desirable parameter in Microstrip patch antenna. Enhancing both bandwidth and gain is a challenging task. First curve that we consider is the Return loss curve to determine the bandwidth.

Return loss curve is given below –

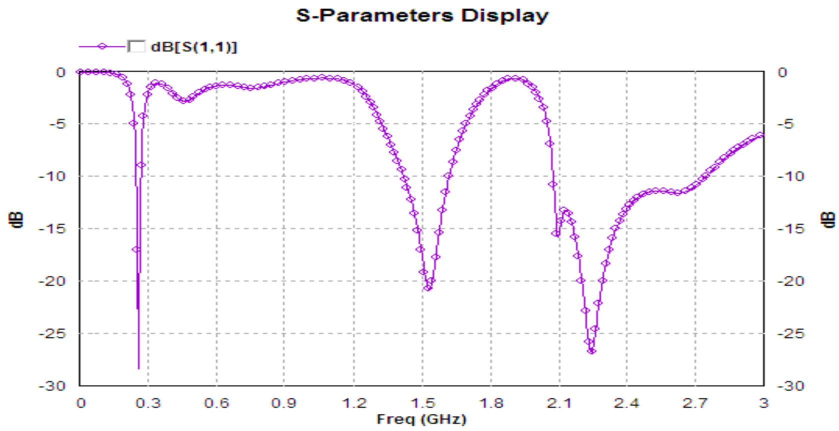

Fig.2: Return loss Vs frequency curve

Calculation of bandwidth

From the figure it is the clear that curve crosses the -10 dB line three times.

f_{l1} = 0.252273 f_{h1} = 0.272727 f_{c1} = 0.2625

% fractional Bandwidth$_1$ = $\frac{0.272727 - 0.252273}{0.2625}$ x100 = **7.79%**

f_{l2} = 1.41818 f_{h2} = 1.62273 f_{c2} = 1.520455

% fractional Bandwidth$_2$ = $\frac{1.62273 - 1.41818}{1.520455}$ x100 = **13.45%**

f_{l3} = 2.07273 f_{h3} = 2.74773 f_{c3} = 2.41023

% fractional Bandwidth$_3$ = $\frac{2.74773 - 2.07273}{2.41023}$ x100 =**28.0056%**

Next important curve is VSWR. This curve should below 2 in desired frequency range for optimum result.

The VSWR curve is given as –

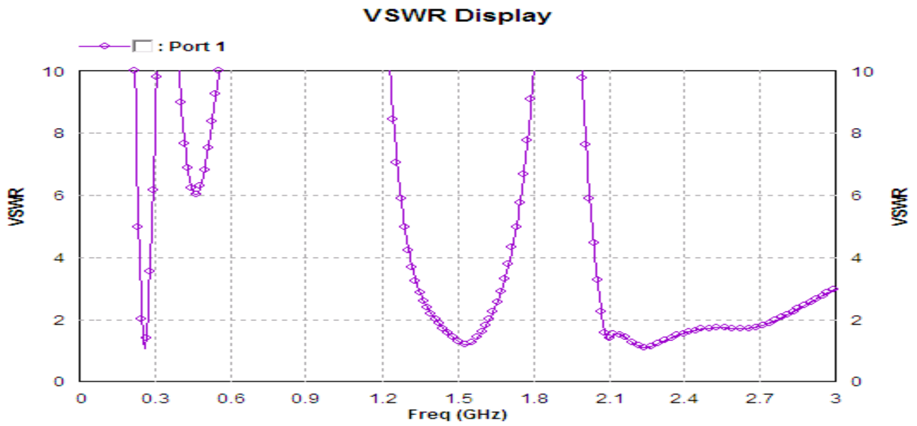

Fig.3: VSWR Vs Frequency curve

The VSWR is below 2 in desired range so obtained bandwidth is useful.

Next important parameter is gain which is given as –

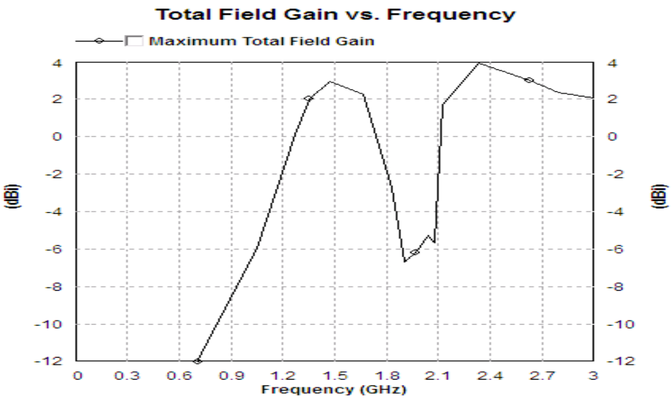

Fig.4: Gain Vs Frequency curve

The obtained gain is 3.96dBi at 2.33945GHz which is quite good.
Following figure gives information about directivity of this configuration –

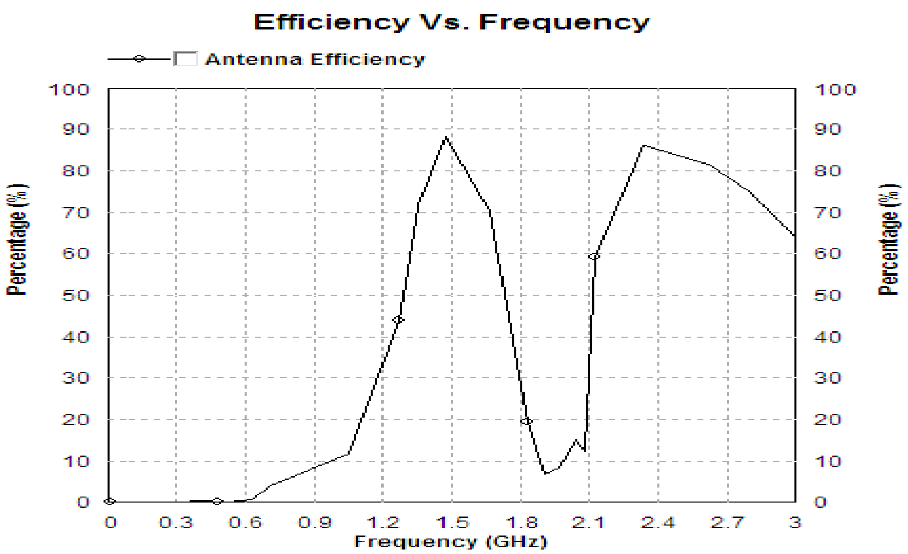

Fig.5: Directivity Vs Frequency curve

It is shown that the directivity is 4.97077 dBi at 1.90826 GHz.

Next important curve is antenna efficiency which is given as –

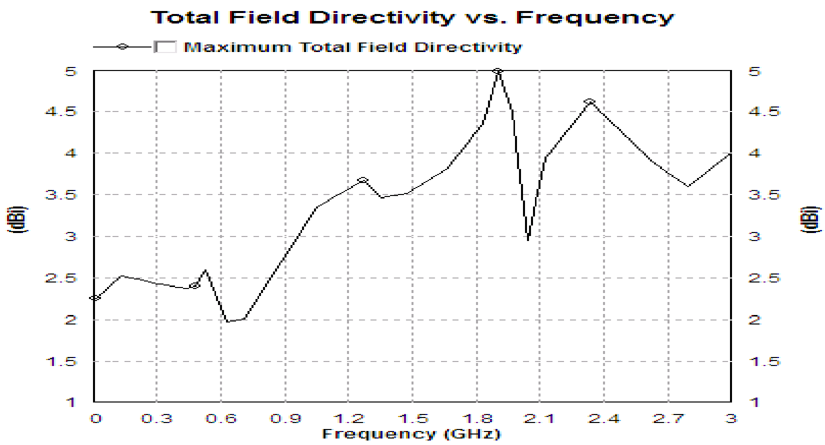

Fig.6: Antenna efficiency Vs Frequency curve

The antenna efficiency is 87.88% at 1.47706 GHz.
The radiation efficiency curve is given as –

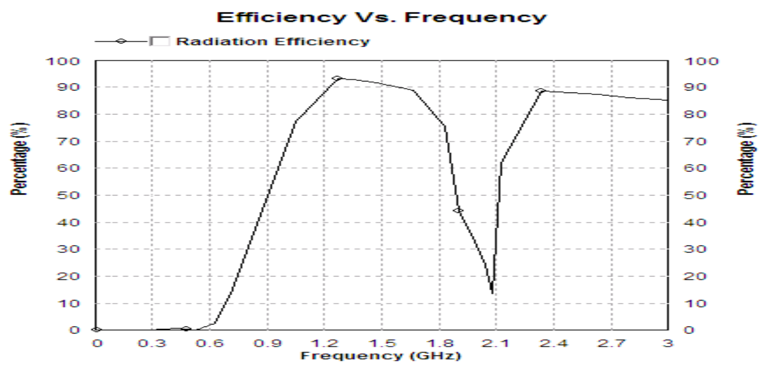

Fig.7: Radiation efficiency Vs Frequency curve

V. Conclusion

Finally S-shaped Microstrip patch antenna is analyzed using IE3D software Ver. 15.2. The Obtained percentage fractional bandwidths are – 7.79% at 0.262921 GHz band, 13.45% at 1.53034 GHz band, 28.0056% at 2.2382 GHz band. We have also obtained a gain of 3.96 dBi at 2.33945 GHz, a directivity of 4.97077 dBi at 1.90826 GHz, antenna efficiency of 87.88% at 1.47706 GHz, radiation efficiency of 93.06% at 1.27523 GHz.
Further improvement of enhancing the gain and bandwidth of Microstrip patch antenna using different technique is still in progress.

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