FUNNEL SHAPE CUTTING SLOT RECTANGULAR PATCH ANTENNA FOR ENHANCEMENT BANDWIDTH AT 2.5GHz

Rupal Shivhare¹ (M.E), Rachit Jain² (Assistant Professor)
rupalsshivhare@gmail.com, Rachit.itm@gmail.com
ITM College Gwalior M.P. (India), ITM College Gwalior M.P. (India)

Abstract- In this paper, we discussed Funnel patch antennas for WLAN applications. After designing the antennas on 2.5GHz (WLAN) frequency, we study and analyzed the results of antenna using ie3d software. We uses the dielectric substrate 4.4, loss tangent 0.002 and having the substrate height 1.6mm, and the feed point of the antennas is (x=31.7mm, y=4.8mm) showing the bandwidth 48.9% , the VSWR is less than 2 and the maximum return loss is -36db, antenna resonant at 1.925GHz.

Keywords- Funnel, cutting slot, Patch antenna, IE3D software, bandwidth.

1. INTRODUCTION

Printed microstrip antennas [1] are getting popular for modern communication system due to their features which includes compact size, low cost and ease to fabricate. An extensive work on simple microstrip geometries including rectangular, circular and triangular shaped structures have been reported [2]. Bandwidth and efficiency of a Microstrip antenna depends upon many factors for example patch size, shape, substrate thickness, dielectric constant of substrate, feed point and its location, etc. For good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable for higher bandwidth, better efficiency and better radiation [3-5]. Circular or rectangular microstrip patch has been modified for some applications to other shapes. Orthogonal shape microstrip antenna has smaller size compared to the square and circular microstrip antennas for a given frequency. The small size is an important requirement for portable communication equipments [6-9]. In this paper Funnel shape patch is used for WLAN and S-band. Coaxial probe feed is used to feed the antenna. Moreover thick substrate properties are used for improvement in characteristic of proposed antenna. IE3d software is used to carry out the results. IE3d software is a fully featured software package for electromagnetic simulation analysis and design for the high frequency range.

2. ANTENNA DESIGN AND LAYOUT

The length and width of rectangular patch antenna are calculated from below equations. Where c is the velocity of light εr is the dielectric constant of substrate.

1: Calculation of the Width (W): The width of the Microstrip patch antenna is given by equation as:

\[ W = \frac{c}{2\sqrt{\varepsilon_r}} \]

2: Calculation of Effective dielectric Constant (εreff): The following equation gives the effective dielectric constant as:

\[ \varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2} \left(1 + \frac{12h}{W}\right)^{-\frac{1}{2}} \]

3: Calculation of the Effective length (L_eff): The following equation gives the Effective length as:

\[ L_{eff} = \frac{c}{2\sqrt{\varepsilon_{reff}}} \]
4: **Calculation of the length extension**

\( \Delta L \): The following equation gives the length extension as:

\[
\Delta L = \frac{h}{\sqrt{\varepsilon_r}}
\]

5: **Calculation of actual length of patch**

\( L \): The actual length is obtained by the following equation:

\[
L = L_{\text{eff}} - 2\Delta L
\]

6: **Calculation of the ground plane dimensions**

\( L_g \) and \( W_g \): Ideally, the ground plane is assumed of infinite size in length and width but it is practically impossible to make a such infinite size ground plane, so to calculate the length and width of a ground plane followings equations are given as:

\[
L_g = L + 6h
\]

\[
W_g = W + 6h
\]

7: **Feed point location**

\( (X_f, Y_f) \): A coaxial probe type feed is to be used in this design. The center of the patch is taken as the origin and the feed point location is given by the coordinates \( (X_f, Y_f) \) from the origin. The feed point must be located at that point on the patch, where the input impedance is 50 ohms for the resonant frequency. Hence, a hit and trial and method is used to locate the feed point. For different locations of the feed point, the return loss (R.L) is compared and that feed point is selected where the R.L is most negative.

<table>
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<th>Table 1. Proposed antenna design parameters</th>
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<td><strong>Design of Microstrip patch antenna</strong></td>
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<tr>
<td>Type of Pattern</td>
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<td>Frequency of Operation (GHz)</td>
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<td>Dielectric constant of substrate</td>
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<td>Loss tangent</td>
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<td>Height of the dielectric substrate</td>
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<td>Feeding method (Coaxial feeding)</td>
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<td>(X=31.70 mm , Y=4.8 mm)</td>
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<td>Width of the ground ( (W_g) )</td>
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<td>Length of the ground ( (L_g) )</td>
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<td>Width of the patch ( (W_p) )</td>
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<td>Length of the patch ( (L_p) )</td>
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Proposed Antenna Design 1.

Fig. 1: Geometry of Proposed antenna on IE3D

Fig. 2: 3D view of Proposed antenna on IE3D

3. SIMULATION RESULTS AND DISCUSSION

After simulating the proposed antenna design 1 on IE3d simulator we get various results. All these various results are shown below. Firstly we shown & discuss all the results of proposed antenna and we discuss all the results of proposed antenna design

Simulation results for design

Return Loss Vs Frequency-

Fig. 3: Return loss Vs frequency of proposed geometry

Gain Vs Frequency –

Fig. 4: Gain Vs frequency of proposed geometry
Radiation Pattern – 2D and 3D

Fig. 5: 3D radiation pattern of proposed geometry

Fig. 6: 2D radiation pattern of proposed geometry

Smith Chart –

Fig. 7: Smith chart of proposed geometry on IE3D

Fig. 8: VSWR vs Frequency of proposed geometry on IE3D
4. CONCLUSION

Microstrip antennas have become a rapidly growing area of research. Their potential applications are limitless, because of their light weight, compact size, and ease of manufacturing. One limitation is their inherently narrow bandwidth, low gain.

In our paper, we have designed and analyzed the Funnel Shape slotted Microstrip Patch antenna on 2.5 GHz (WLAN) having patch length, Lp = 27 mm & patch width, Wp = 37 mm. The proposed antenna designs have been analyzed between 1GHz to 3GHz. The proposed antenna is designed on a GLASS EPOXY Substrate dielectric constant 4.4, loss tangent .002.

References


