Performance Comparison between I slotted and U Slotted Shaped Microstrip Patch Antennas

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ABSTRACT

The electromagnetic simulation of the proposed antenna has been carried out using IE3D software. Through IE3D software Return loss, VSWR, antenna efficiency and radiation pattern can be evaluated for the design. In this thesis slotted dumbbell shaped microstrip patch antenna has designed and compare with the rectangular microstrip patch antenna. Cutting of a slot in antenna increases the current path which increases current intensity and as a result efficiency is increased and desired results are obtained. It has been used probe feed for obtaining gain, efficiency and bandwidth of the microstrip patch antenna. The gain enhancement has been achieved by suitable cutting slots in the rectangular patch using probe feeding technique. We have found the optimum feed point giving desired results. The electromagnetic simulation of the proposed antenna has been carried out using IE3D software. The analysis of performance will be based on changing the geometry of the patch and the obtained results are compared especially in gain, VSWR, antenna efficiency and radiation pattern.

Keywords: Slotted micro strip patch antenna, gain enhancement, antenna efficiency.

1. INTRODUCTION

The rapid growth in communication technology in last few decades has led to the development of different types of microstrip patch antennas with different attractive features like low profile, light weight, simple and inexpensive manufacturing procedure using printed circuit technology and compatibility with monolithic microwave integrated circuit (MMIC). These properties make it suitable for different applications like Missile Technology, Satellite and Mobile Communications, Global Positioning System, Remote Sensing, etc. In spite of their numerous advantages, microstrip antenna has low operational bandwidth, which puts constraints in using them in a number of applications like the case where operating frequency may be varied. Any wireless communication needs high gain and if the bandwidth of the antenna is also increased along with the gain it will be an additional advantage, though enhancing both gain as well as bandwidth at a same time is a challenging task. Our aim is to reduce the size of the antenna as well as increase the operate in gb and width. The proposed antenna (substrate with εr = 2.2) has again of 7.56 dB. The simulation has been carried out by IE3D [11] software.

2. ANTENNA DESIGN

The proposed antenna structures are designed by cutting a I shaped and U shaped slots of fixed dimensions. Cutting of these slots in antenna increases the current path which increases current intensity as a result efficiency is increased and desired parameters are obtained. Start off by calculating basic equation of typical rectangular patch and then convert its equivalent area to a Rectangular form. The Essential parameters of this Rectangular micro strip patch antenna are W=32mm, L=28 mm, Length of ground plane=40 mm, Width of ground plane=44 mm. The rectangular micro strip patch antenna designed on one side of glass/epoxy structure with εr = 2.2, height from the ground plane d=2 mm and loss tangent=0.0009. Design is being calculated.
**STEPS FOR CALCULATING THE DIMENSION OF PATCH [10]**

**Step 1: Calculation of the Width (W)**

The width of the Micro strip patch antenna is given as:

\[
W = \frac{c}{2f_o \sqrt{\varepsilon_{reff}}} = \frac{3.00 \times 10^8}{2 \times 3.5 \times 10^9 \sqrt{2.2 + 1}} = 0.03331 \text{ m} = 33.31 \text{ mm}
\]

Substituting \( c = 3.00 \times 10^8 \text{ m/s}, \varepsilon_r = 2.2 \) and \( f_o = 3.5 \text{ GHz} \), we get:

**W = 0.03331 m = 33.31 mm**

**Step 2: Calculation of Effective dielectric constant (\( \varepsilon_{reff} \))**

The effective dielectric constant is:

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

Substituting \( \varepsilon_r = 2.2 \), \( W = 33.31 \text{ mm} \) and \( h = 2 \text{ mm} \), we get:

**\( \varepsilon_{reff} = 2.3870 \)**

**Step 3: Calculation of the Effective length (\( L_{eff} \))**

The effective length is:

\[
L_{eff} = \frac{c}{2f_o \sqrt{\varepsilon_{reff}}} = \frac{3.00 \times 10^8}{2 \times 3.5 \times 10^9 \sqrt{2.3870}} = 0.02779 \text{ m} = 27.79 \text{ mm}
\]

Substituting \( \varepsilon_{reff} = 2.3870 \), \( c = 3.00 \times 10^8 \text{ m/s} \) and \( f_o = 3.5 \text{ GHz} \), we get:

**\( L_{eff} = 0.02779 \text{ m} = 27.79 \text{ mm} \)**

**Step 4: Calculation of the length extension (\( \Delta L \))**

The length extension is:

\[
\Delta L = 0.412h \left( \frac{W}{h} + 0.264 \right) + \left( \varepsilon_{reff} - 0.258 \right) \left( \frac{W}{h} + 0.8 \right)
\]

Substituting \( \varepsilon_{reff} = 2.3870 \), \( W = 33.31 \text{ mm} \) and \( h = 2 \text{ mm} \), we get:

**\( \Delta L = 1.00 \text{ mm} \)**

**Step 5: Calculation of actual length of patch (\( L \))**

The actual length is obtained by:

\[
L = L_{eff} - 2\Delta L = 27.79 - 2 \times 1.00 = 25.79 \text{ mm}
\]

**Step 6: Calculation of the ground plane dimensions (\( L_g \) and \( W_g \))**

The transmission line model is applicable to infinite ground planes only. However, for practical considerations, it is essential to have a finite ground plane. It has been shown by [9] that similar results for finite and infinite ground plane can be obtained if the size of the ground plane is greater than the patch dimensions by approximately six times the Substrate thickness all around the periphery.

Hence, for this design, the ground plane dimensions would be given as:

**\( L_g = 6h + L = 6(2) + 28 = 40 \text{ mm} \)**

**\( W_g = 6h + W = 6(2) + 32 = 44 \text{ mm} \)**
3. ANTENNA RESULT WITH U SLOTTED PATCH

The simulation of micro-strip patch antenna is done by using IE3D simulation software. The VSWR graph for a slotted plus shaped patch antenna is shown in figure (2). The VSWR indicates the mismatch between the antenna and the transmission line. For perfect matching the VSWR value should be close to unity. The VSWR for this slotted antenna is 1.04. The return loss graph is shown in figure (3) and it is -31.33 dB, the total field gain & frequency is shown in figure (4).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value(U Slotted Patch)</th>
<th>Value(I Slotted Patch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSWR</td>
<td>1.02</td>
<td>1.04</td>
</tr>
<tr>
<td>Directivity</td>
<td>7.5dBi</td>
<td>7.56dBi</td>
</tr>
<tr>
<td>Gain</td>
<td>6.52dBi</td>
<td>6.56dBi</td>
</tr>
<tr>
<td>Efficiency</td>
<td>86%</td>
<td>85%</td>
</tr>
<tr>
<td>Radiation Efficiency</td>
<td>90.2%</td>
<td>90%</td>
</tr>
<tr>
<td>R.L</td>
<td>-31.23dBi</td>
<td>-31.33dB</td>
</tr>
</tbody>
</table>

Fig. 1: Result Comparison.

Fig. 2: VSWR of the Proposed Antenna = 1.04 at 3.5GHz

Fig. 3: Return Loss of the Proposed Antenna = -31.33 dB at 3.5 GHz

Fig. 4: Total field gain & frequency of proposed antenna = 7.56 at 3.5 GHz
4. CONCLUSION

From the detailed experimental study it is concluded that a probe feed, slotted microstrip patch antennas can be designed efficiently to give the desired results. Gain and directivity of U slotted patch antenna is better than I slotted patch antenna but the return loss is approximately same for both patches. U slotted shape patch has higher radiation efficiency than I slotted patch as shown in the above table. Both the proposed antennas have a compact size of (28x32x2) and it can effectively cover wireless operations like Wi-Max.

5. REFERENCES


