Investigation of Meandered Antenna for WLAN Application

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Abstract. In this paper patch antenna using coplanar waveguide structure is designed. The dimension of the antenna is 12x22mm. The substrate material used is FR4 with thickness of 1.6mm. The dual band frequency is obtained by creating slot in the patch. Four slot is created in the patch. The frequency obtained for proposed design is 2.5 and 5.00GHz. The gain obtained for proposed antenna is 2.8dBi. The return loss obtained for proposed design is -35dB at 5GHz and -34dB at 2.5GHz frequency. The meander antenna with two arm is designed using normal ground structure. Single band resonance is obtained for meander antenna with two arm at the frequency of 5.7GHz. The coplanar waveguide structure is chosen for dual band resonance and reduction in size. The designed antenna is used for WLAN application.

Keywords. Frequency, Return loss, Gain

1. Introduction

Microstrip antennas, consist of patch, groundplane and substrate. The patch is placed above the groundplane and substrate. The width and length of the groundplane and substrate is twice that of the patch. The compact dual band microstrip antenna using coplanar waveguide is designed\cite{1}. The excitation is obtained by matching the impedance that is by connecting 50ohm transmission line. Due to small size the microstrip antenna is used for biotelemetry applications\cite{2}. The patch is sepearted by substrate. The commonly used substrate material is FR4. The dielectric constant of the substrate material is 4.4. The thickness of the substrate material used for microstrip antenna is 1.6mm. The FF4 substrate is used due to ease of fabrication. Ultra wide band using notched antenna is designed\cite{3}. The antenna operation is based on the thicker substrates. Based on the dimension of the substrate material it provides good efficiency and wider bandwidth. The inverted F microstrip antenna is used for GPS application\cite{4}. The reflection coefficient should be greater than -20dB. The return loss obtained for ultra wideband antenna is -25dB\cite{5}. Due to compact size the antenna is used for WLAN application\cite{6}. Tripple band resonance can be obtained using microstrip antenna\cite{7}. The impedance matching can be obtained using coplanar waveguide structure\cite{8}. The MIMO antenna is used for 5G cellular and Wi-Fi applications\cite{9}. The printed array antenna is used for heart attack detection\cite{10}.

\begin{thebibliography}{99}

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\end{thebibliography}
2. Design Procedure

Design calculation for patch

Step 1: Width Calculation (W)

\[
W = \frac{2f_0 \sqrt{\frac{2}{\varepsilon_r + 1}}}{\varepsilon_r + 1}
\tag{1}
\]

W = 36.5mm \hspace{1cm} (2)

Operating frequency is 2.5GHz

Step 2: Determination of effective dielectric constant:

Dielectric constant

\[
\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2} \left[ 1 + \frac{h}{w} \right]^{1/2}
\tag{3}
\]

\[
\varepsilon_{eff} = 6.27
\tag{4}
\]

ii) Determination of \( \Delta L \)

\[
\Delta L = 0.412h \left( \frac{(\varepsilon_{eff} + 0.3)(h + 0.264)}{(\varepsilon_{eff} - 0.258)(h + 0.8)} \right)
\tag{5}
\]

\[\Delta L = 0.72\text{mm} \tag{6}\]

iii) Determination of length of the patch

\[
L = \frac{1}{2fr\sqrt{\varepsilon_{eff}\mu_0\varepsilon_0}} - 2\Delta L
\tag{7}
\]

\[L = 22.8\text{mm} \tag{8}\]

where,

\( f_0 \) is the operating frequency

\( W \) is the width of patch

\( L \) is the length of patch

\( h \) is the height of patch

\( \varepsilon_r \) is the dielectric constant

\( c \) is the speed of light: \( 3 \times 10^8 \)

3. Proposed Design 1

3.1 Meander Antenna With Two Arm

To reduce the size of the antenna the meander slot with two arm is designed using CST software. To further enhance the bandwidth of the resonance frequency the meander antenna with two arm is designed. The meander line antenna structure is chosen due to its compactness. The efficiency depends on the number of the turns. The frequency is shifted by varying the space of the arm. The length of the arm is reduced to \( 3/4 \). The operating frequency of the meander antenna is 5.56GHz. The returnloss obtained is -35dB which is greater than meander slot with six arm. The bandwidth of the antenna can be expanded using air substrate. The bandwidth of the meander antenna with two arm is 120MHz which is greater than bandwidth of the patch antenna.
4. Design Of Slot Antenna Using Coplanar Waveguide Structure

The patch antenna with slots is designed using coplanar waveguide structure. The first part is substrate the size of the substrate is . The substrate substance used is FR4. The thickness of the substrate is 1.6mm. The second plate is patch the size of the patch is 12x22mm. The patch is filled with PEC material. The thickness of the patch is 0.035mm. The 50ohm transmission line is connected to the patch excitation. The ground is reduced to half of the size of substrate and patch. The gap to the ground and the patch is 2mm. The material used for ground is PEC. The thickness of the ground is 0.035mm. The distance between the feed and the ground is 0.4mm. The return loss obtained is -17dB at 2.5GHz and -32dB at 4.47GHz frequency.

5. Proposed Design 2

In the second design the width and length of the substrate is varied to . The width of the second slot is 1mm. The width of the fourth slot is 1mm. While changing the dimension the operating frequency is tuned and obtained better results at the frequency 2.5GHz and 5GHz. When the dimension of substrate is changed return loss greater than -25dB is obtained. The distance around ground and the patch is 2mm. The fabrics used for ground is PEC. The thickness of the ground is 0.035mm. The distance between the feed and the ground is 0.4mm. The return loss obtained is -34dB at 2.5GHz and -34db at 5GHz frequency. The gain obtained is 2.8 dB.

Table 1. Dimensions of modified slot antenna

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patch(W)</td>
<td>12mm</td>
</tr>
<tr>
<td>Patch(L)</td>
<td>22mm</td>
</tr>
<tr>
<td>Ground (W)</td>
<td>11mm</td>
</tr>
<tr>
<td>Ground (L)</td>
<td>9mm</td>
</tr>
<tr>
<td>Feed (W)</td>
<td>1.65mm</td>
</tr>
<tr>
<td>Feed (L)</td>
<td>23mm</td>
</tr>
<tr>
<td>First slot (W)</td>
<td>0.5mm</td>
</tr>
<tr>
<td>First slot (L)</td>
<td>4mm</td>
</tr>
<tr>
<td>Second slot (W)</td>
<td>1mm</td>
</tr>
<tr>
<td>Second slot (L)</td>
<td>2mm</td>
</tr>
<tr>
<td>Third slot (W)</td>
<td>0.5mm</td>
</tr>
<tr>
<td>Third slot (L)</td>
<td>3mm</td>
</tr>
<tr>
<td>Fourth slot (W)</td>
<td>0.5mm</td>
</tr>
<tr>
<td>Fourth slot (L)</td>
<td>5mm</td>
</tr>
</tbody>
</table>
6. Results And Discussion

The slot antenna using coplanar waveguide structure is designed using CST software. The reflection coefficient obtained for proposed design 1 is -17dB at 2.5GHz and -32dB at 4.47GHz. Figure 5 shows the gain of slot antenna. The gain obtained is 1.785dB for the frequency of 2.5GHz. Figure 6 shows $S_{11}$ of modified slot antenna the reflection obtained for proposed design 2 is -34dB at 2.5GHz and -34dB at 5GHz frequency the gain obtained for proposed design 2 is 2.8dB.

Table 2 shows comparison parameter of designed antenna the various parameters such as bandwidth, gain, VSWR and reflection coefficient is analyzed. The bandwidth obtained for proposed design is wider than proposed design 1. From the table it is obvious that modified slot antenna provides better performance than meander with two antenna and slot antenna[10].
7. Conclusion

In this paper meander antenna and slot antenna using coplanar waveguide is designed using CST software. The results obtained for meander antenna with two arm is -30dB at the frequency of 5.7GHz. The results obtained for slot antenna is -17dB at the frequency of 2.5GHz. The design is modified and results obtained for this design is -34dB at the frequency of 2.5GHz and -34dB at the frequency of 5GHz. The results are compared and analyzed. The results obtained for modified slot antenna is better compared to other antenna. Thus the designed antenna is used for WLAN application.

References


Table 2. Comparison of different parameters of proposed design

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>MEANDER WITH TWO ARM</th>
<th>SLOT ANTENNA</th>
<th>MODIFIED SLOT ANTENNA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sy(dB)</td>
<td>-35</td>
<td>-17,-32</td>
<td>-34,-34</td>
</tr>
<tr>
<td>Bandwidth(MHz)</td>
<td>120</td>
<td>33,108</td>
<td>230,672</td>
</tr>
<tr>
<td>Centre frequency(GHz)</td>
<td>5.56</td>
<td>2.5,4.47</td>
<td>2.5,5</td>
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<tr>
<td>VSWR</td>
<td>1.02</td>
<td>1.125,1.06</td>
<td>1.06,1.06</td>
</tr>
<tr>
<td>Gain(dB)</td>
<td>5.27</td>
<td>1.785</td>
<td>2.82</td>
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