A Novel Compact Dual Frequency Microstrip Antenna

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Abstract

A dual frequency, compact single probe-feed rectangular microstrip patch antenna with reduced size has been proposed in this paper. The single layered antenna has been designed to resonate in dual frequency mode. The novel design is achieved by cutting rectangular slits at two sides of the patch. Compared with the conventional rectangular patch antenna, this antenna can achieve reduction in patch size up to 71\%. This antenna has been simulated in standard IE3D\textsuperscript{TM} (based on MoM) software and satisfactory return loss for each resonant frequency has been found and this antenna can be used for Wi-MAX and WLAN application.

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Keywords: Microstrip Patch Antenna, Size Reduction, slit, Dual Frequency;

1. Introduction

With development of communication with integration technology, size reduction and bandwidth enhancement of microstrip antennas is becoming an important design consideration for practical applications such as Wi-MAX, WLAN. However in modern communication systems reduction in antenna size and dual frequency operation for mobile transceiver applications are important considerations. In this paper a rectangular microstrip patch antenna with several rectangular slits has been proposed. For wireless application normally four frequency bands are used for various applications: 890 MHz to 960 MHz for GSM, 1920 MHz to 2170 MHz for UTMS, 3.1 GHz to 3.6 GHz for Wi-MAX, 4.9 GHz to 5.9 GHz for WLAN, Wi-MAX etc [1-4]. The printed antenna for dual frequency operation, cutting unequal slots has been proposed [5]. Size reduction using slit loaded ground plane has been proposed in [6]. Several works on size reduction of microstrip antenna has been reported in [7-10]. In the proposed antenna we are concentrated on size reduction of the microstrip antenna by introducing rectangular slits on the patch. The proposed antenna shows a remarkable size...
reduction as well as dual frequency operation. This antenna can be used for Wi-MAX and WLAN application.

2. Design Configurations of Proposed Antenna

The configuration of the compact-dual frequency antenna is shown in Fig-1. The rectangular patch of dimensions 16 mm x 12 mm is printed on a FR4 substrate of thickness 1.6 mm (h), relative permittivity 4.4 ($\varepsilon_r$), and dimensions of 50 mm x 40 mm. The patch antenna is coaxially probe-fed at (W5 x L3). The detailed dimensions of the proposed antenna have been mentioned in the Table 1. The width and length of the patch has been calculated using the following conventional equations.

$$ W = \frac{c}{2fr} \sqrt{2 \frac{1}{1 + \varepsilon_r}} $$

$$ L = \text{Leff} - 2\Delta L $$

Where, $\Delta L = 0.412 \frac{(\varepsilon eff + 0.3)(W + 0.264)}{(\varepsilon eff - 0.258)(W + 0.8)}$

$$ \varepsilon eff = \frac{2}{2\varepsilon eff} + \frac{(\varepsilon r + 1)}{2\sqrt{(1+12h/W)}} $$

$$ \text{Leff} = \frac{c}{2fr\sqrt{\varepsilon eff}} $$

Where $\varepsilon eff$ = Effective dielectric constant, $c$ = Velocity of light in free space, $\text{Leff}$ = Effective length of the patch, $\Delta L$ = Length extension of the patch.

Fig.1. Geometry of the proposed antenna
Table 1. Antenna Dimensions

<table>
<thead>
<tr>
<th>W_1</th>
<th>W_2</th>
<th>W_3</th>
<th>W_4</th>
<th>W_5</th>
<th>L_1</th>
<th>L_2</th>
<th>L_3</th>
</tr>
</thead>
<tbody>
<tr>
<td>8mm</td>
<td>6mm</td>
<td>5.5mm</td>
<td>2.5mm</td>
<td>5.8mm</td>
<td>5mm</td>
<td>2mm</td>
<td>4.8mm</td>
</tr>
</tbody>
</table>

3. Results and Discussion

The return losses of the proposed antennas were studied using IE3DTM (based on MoM). The feeding point and dimensions of the reference antenna is the same as that of the proposed antenna. In case of reference antenna slits are not presents. The comparative results are shown in the Fig. 2. The resonance frequency is shifted from 4.3 GHz to 3.1 GHz providing a size reduction of around 71%. With the slit loaded proposed antenna along with first frequency band at 3.1 GHz we obtain another useful frequency band at 5.5 GHz. These two frequency band has widely used in Wi-MAX (3.1 GHz to 3.6 GHz) and WLAN (4.9GHz to 5.9 GHz), respectively.

![Fig. 2. Return Loss vs. Frequency for Proposed Antenna](image)

4. Conclusions

A novel compact dual frequency antenna with slit loaded rectangular patch is proposed and investigated. By introducing slits on the patch, resonance frequency is shifted from 4.3GHz to 3.1GHz providing a size reduction around 71% and also provides a useful dual frequency band. Hence this compact microstrip antenna can be used for Wi-MAX and WLAN applications.
References