A Novel Compact Rectangular Micro Strip Monopole Antenna with U and L Slot for C-Band Application

Bhavana Sharma  
M. Tech. Student  
Department of Electronics & Communication Engineering  
Haryana Engg. College, Jagadhari, Kurukshtrya University, Haryana, India

Miss Bhanisha Verma  
Assistant Professor  
Department of Electronics & Communication Engineering  
Haryana Engg. College, Jagadhari, Kurukshtrya University, Haryana, India

Abstract

In this paper we are presented a small novel monopole wide band microstrip-feed antenna in which the patch is intended with a L-probe and for dual-band and multi-band application by cutting U-slots on the patch. The first notch is given frequency range from 5.4-6.0GHz, and the second notch worked on the dual frequency range of 5.0-4.8GHz and 6.0-6.4GHz, 3rd notch has in the triple band frequency range of 4.8-5GHz, 5.9-6.1GHz and 6.4-6.6GHz with very standard impedance matching.

Keywords: HFSS Simulator, Micro Strip Antenna, U-Slot, L-Probe, High Gain

I. INTRODUCTION

Due to the rapid growth in wireless communication, the need of multiband frequency is raising. Thus, an antenna with multiband operations is required. Multiband antennas are developed for various wireless applications so that any equipment can employ several applications. Multiband antenna plays an important part in wireless systems.

Micro strip antennas became very popular in the 1970s primarily for space borne applications. Today they are used for government and commercial applications. An Antenna (aerial) is considered as a region of transition between a transmission line and space [8].These antennas consist of a metallic patch on a dielectric substrate base on metallic ground plane [6]. Recently, micro strip patch antenna has been used in many applications, which has some merits like low fabrications weight and cost, and operating in high frequency range [1]. At microwave frequencies Micro strip slot antenna becomes very small and light weight [2]. In spite of these advantages, it has main disadvantages of low efficiency, low Return loss, narrow bandwidth and large micro strip antenna aperture size [3].

In this paper, a monopole antenna with multiband operations is proposed. This antenna operates on three different resonant frequencies 4.8GHz, 5.0 GHz, 6.0GHz and 6.4 GHz with bandwidths of 4.8-5.0 GHz, 5.9-6.1 GHz, 6.4-6.6GHz and 6.0-6.4 GHz respectively. At 4.8 GHz frequency, the antenna is used for military applications like CMOD/CMOV and small satellite earth stations applications. WLAN band is also covered by the bandwidth provided by the antenna at 4.2GHz. At 6.1 GHz, the antenna is employed for Terrestrial Microwave applications.

II. ANTENNA DESIGN & METHODOLOGY

In this paper we are presented a patch with U-shape slot with intended a L-probe to generate multiband frequency. In this design FR4 substrate.

This antenna makes use of the finite ground plane made up of FR4 epoxy and a dielectric substrate having dielectric constant 4.4. Micro strip antennas, consist of a very thin (t<<λ0, where λ0 is the free-space wavelength) metallic strip (patch) placed a small fraction of a wavelength (h <<λ0, usually 0.003λ0 ≤ h ≤ 0.05λ0) above a ground plane. For a rectangular patch, the length L of the element is usually λ/3 < L < λ/2[6].

Fig.1. shows the top and the bottom view of the multi band antenna. The radiating patch is placed on a FR4 substrate material. The substrate has the dimensions of 40 x40 x 1.6 mm3 and dielectric constant of 4.4. For the perfect impedance matching or 50-Ω characteristics impedance, by using coaxial feeding.
A Novel Compact Rectangular Micro Strip Monopole Antenna with U and L Slot for C-Band Application (IJSTE/ Volume 3 / Issue 6 / 019)

The calculation of dimensions can be obtained by the following formulae:

\[ W = \sqrt{\frac{2}{(\varepsilon + 1)}} \]  \hspace{1cm} (1)

From the above formula the operating frequency can be calculated by knowing the width W and vice versa. For efficient results the effective of the dielectric constant \( \varepsilon \) considered, whose value is determined [5] by formula given below:

\[ \varepsilon_{eff} = \frac{\varepsilon + 1}{2} + \frac{\varepsilon - 1}{2} \]  \hspace{1cm} (2)

Substituting \( \varepsilon = 2.2 \), \( W = 40 \text{mm} \) and \( h = 0.024 \text{mm} \) then, \( \varepsilon_{eff} = 2.1414 \). The dimensions are shown in Table I. Simulation results, using HFSS software.

<table>
<thead>
<tr>
<th>Antenna</th>
<th>W</th>
<th>L</th>
<th>W'</th>
<th>L'</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>u'</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>40</td>
<td>40</td>
<td>18</td>
<td>22</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>B</td>
<td>40</td>
<td>40</td>
<td>18</td>
<td>22</td>
<td>10.8</td>
<td>7.5</td>
<td>10.8</td>
<td>10</td>
<td>0.8</td>
</tr>
<tr>
<td>C</td>
<td>40</td>
<td>40</td>
<td>18</td>
<td>22</td>
<td>10.8</td>
<td>7.5</td>
<td>10.8</td>
<td>10</td>
<td>3.5</td>
</tr>
</tbody>
</table>

### III. SIMULATION RESULTS

The Multiband Monopole Antenna is designed using HFSS tool. It’s user friendly software that has most accurate results. HFSS provides facility to study several antenna parameters like Return Loss, VSWR, Smith Chart and Radiation Pattern. These antenna parameters of proposed antenna are also studied in this paper. These are employed to measure the performance of an antenna. It works efficiently on three different frequencies.

The antenna should have a characteristic impedance of 50-Ω for perfect impedance matching. When the impedance at generator is not same as impedance at load, the impedance mismatching occurs. Due to this, the reflections are produced at the load side and travel from load to generator. This is measured by the return loss. It is found that antenna works efficiently at 4.8 GHz, 5.9 GHz and 6.1 GHz with the bandwidth of 4.8-5.1 GHz, 5.9-6.1 GHz and 6.1-6.4 GHz respectively. The Multiband antenna has the return loss of -20.58 dB at 4.8GHz, -15.54 dB at 5.9 GHz and -30.3 dB at 6.1 GHz.
The VSWR should be near to 1 or at least less than 2 for the efficient working of the antenna. The given plot represents the VSWR in the operating frequency range of the antenna. The above plot represents that the VSWR is less than 2.
The radiation pattern is presented with the body of the antenna so as to represent the major and minor lobe clearly. The values of the different antenna parameters obtained after the simulation has been shown below:

![Radiation Pattern](image)

(c)  

Fig. 3: VSWR of proposed multiband Antenna

![Radiation Pattern](image)

(a)  

(b)  

Fig. 4: Represents the directivity of the proposed multiband antenna
A. Antenna Gain

Antenna gain is calculated by directivity divided by efficiency of antenna. The variation in gain of antenna at different frequency should be less.

![Graph (a)](image1)

![Graph (b)](image2)

![Graph (c)](image3)

Fig. 5: Gain of the proposed multiband antenna

The impedance bandwidths and Gain are summarized in Table 2.

<table>
<thead>
<tr>
<th>Antenna</th>
<th>Simulated Frequency (GHz)</th>
<th>Antenna Gain (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>5.42-6.02</td>
<td>7.98</td>
</tr>
<tr>
<td>b</td>
<td>4.78-4.99</td>
<td>9.26</td>
</tr>
<tr>
<td></td>
<td>6.09-6.52</td>
<td></td>
</tr>
<tr>
<td>c</td>
<td>4.81-5.00</td>
<td>9.34</td>
</tr>
<tr>
<td></td>
<td>5.94-6.10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.40-6.60</td>
<td></td>
</tr>
</tbody>
</table>

IV. Conclusion

The U-slot patch antenna is mainly known for its wideband characteristics. In this letter, we show that, by combining with an L-probe feed, the use of U-slots can also yield dual- and multiband characteristics. At each frequency, VSWR < 2 shows a better impedance matching. The presented antenna can be used for WLAN, Satellite and Military Applications. The radiation parameters like Return loss, VSWR and Radiation Pattern at 4.8GHz, 5.9 GHz, and 6.1 GHz are all measured.
REFERENCES


