DESIGN OF L-SLIT MICROSTRIP PATCH ANTENNA FOR WIMAX & HIPERLAN APPLICATIONS

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ABSTRACT

A single feed quad band compact rectangular microstrip antenna is presented in this paper. L slit is introduced on the edge of the patch to reduce the resonant frequency. For the proposed antenna four resonant frequencies are obtained at 2.5 GHz, 3.46 GHz, 4.76 and 5.68 GHz with bandwidth of 11.26 MHz, 26.29 MHz, 92.11 MHz , 50.62 MHz & return loss –29.09 dB , -15.23 dB, -23.73 dB & -19.93 dB respectively. An extensive analysis of the return loss, radiation pattern, gain and efficiency of the proposed antenna is presented. It is developed to operate in the WiMax & HIPERLAN applications. The size of the antenna has been reduced by 69% when compared to a conventional microstrip patch.

KEYWORDS: Conventional, Compact, Quad Band, Slit.

INTRODUCTION

A new standard known as WiMax (Worldwide Interoperability for Microwave access) has been established by the IEEE 802.16 working group. WiMax theoretically can have coverage of up to 50 km radius. WiMax antennas have aroused high interest in recent years [1-7]. Researchers are focusing on how to design antennas for WiMax technology. WiMax has three allocated frequency bands. The low band (2.5-2.69 GHz), the middle band (3.2-3.8 GHz) and the upper band (5.2-5.8 GHz). Due to its advantages such as low-cost, small size low weight and capability to integrate with Microwave integrated circuits, the microstrip patch antenna is a very good candidate for integrations in applications such as wireless communication systems, mobile phones and laptops. The work to be presented in this paper is a compact microstrip antenna design obtained by cutting L slit on the patch. The proposed dual band antenna (substrate with $\varepsilon_r=4.4$) simulated for the WiMax frequency ranges of 2.5-2.69GHz, 3.2-3.8 GHz & 5.2-5.8 GHz. It has a gain of 5.02 dBi at 3.46 GHz and 5.44 dBi at 4.76 GHz and presents a size reduction of about 69% when compared to a conventional square microstrip patch. The simulation has been carried out by IE3D software which uses the MOM method. Due to the Small size, low cost and low weight this antenna is a good candidate for the application of wireless communication systems, mobile phones and laptops.

ANTENNA CONFIGURATION

The configuration of the conventional printed antenna is shown in Figure 1 with W=20mm, L=16mm, substrate thickness h = 1.5875mm, dielectric constant $\varepsilon_r =4.4$. 
Figure 1: Antenna 1 Configuration

Figure 2 shows the configuration of antenna 2 designed with similar substrate. L slit is created whose dimensions and the location of coaxial probe-feed (radius=0.5 mm) are shown in the figure 2 as well.

The optimal parameter values of the L slit is listed in the Table.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>m</th>
<th>n</th>
<th>o</th>
<th>l1</th>
</tr>
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<tbody>
<tr>
<td>Values (mm)</td>
<td>5.2</td>
<td>3.3</td>
<td>7.3</td>
<td>8.5</td>
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</table>

RESULTS AND DISCUSSIONS

Simulated (using IE3D [9]) results of return loss of the Conventional & proposed antenna are shown in Figure 3& 4. A significant improvement of frequency reduction is achieved in with respect to a conventional rectangular microstrip antenna.
Due to the presence of L slit at the edge of the patch of antenna 2 multi frequency operation is obtained with large values of frequency ratio. For the antenna 1 return loss -36.73dB is obtained at 4.17 GHz with 86.12 MHz bandwidth. For antenna 2 return loss -29.09 dB is obtained at 2.5GHz, -15.23 dB at 3.46 GHz, -23.73dB at 4.76 GHz & -19.93dB 5.68 GHz. Corresponding 10 dB bandwidth is 11.26 MHz, 26.29 MHz, 92.11 MHz & 50.62 MHz respectively as shown in figure 4.

The simulated E–H plane radiation patterns for antenna 2 are shown in Figure 5-12.
Figure 9: E-Plane Radiation Pattern of the Antenna 2 for 4.76 GHz

Figure 10: H-Plane Radiation Pattern of the Antenna 2 for 4.76 GHz

Figure 11: E-Plane Radiation Pattern of the Antenna 2 for 5.68 GHz

Figure 12: H-Plane Radiation Pattern of the Antenna 2 for 5.68 GHz

Figure 13: Gain versus Frequency Plot for the Antenna 2.

Figure 14: Antenna Efficiency versus Frequency Plot for the Antenna 2.
Figure 13 shows the Gain versus frequency plot for the antenna 2. It is observed that gain is about 5.02 dBi at 3.46 GHz, 5.44 dBi at 4.76 & 3.78 dBi at 5.68 GHz.

Efficiency of the antenna 2 with the variation of frequency is shown in figure 14. It is found that maximum operation efficiency of the antenna 2 is about 75.23%.

The comparisons of the measured return loss with the simulated are shown in Fig.15 &16. All the measurements are carried out using Vector Network Analyzer (VNA) Agilent N5230A. The discrepancy between the measured and simulated results is due to the effect of improper soldering of SMA connector or fabrication tolerance.

**CONCLUSIONS**

A single feed single layer L slit microstrip antenna has been proposed in this paper. It is shown that the proposed antenna can operate in four frequency bands. L slit reduced the size of the antenna by 69% and increase the bandwidth up to 92.11 MHz with a return loss of -23.73 dB, absolute gain about 5.44 dBi. Efficiency of antenna has been achieved 75.23%. An optimization between size reduction and bandwidth enhancement is maintained in this work.

**REFERENCES**


9. Zeland Software Inc. IE3D: MoM-Based EM Simulator.