Frequency Reconfigurable Triangular Microstrip Patch Antenna for Wireless Applications

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Abstract

Wireless communication has been developed widely and rapidly in the modern world especially during the last two decades. Multiband antennas are used to meet different applications in wireless communication like Wi-Fi, Bluetooth, Wi-MAX, WLAN and PCS. Hence the topic of reconfigurable antennas is gaining great attention. A new reconfigurable antenna with frequency has been proposed in this paper. The reconfigurability in frequency is obtained by connecting the switches in basic antenna. The basic antenna structure for frequency diversity consists of coaxial fed triangular shaped patch antenna of side 30mm printed on the Alumina_92pct substrate of thickness 3.2mm having dielectric constant 9.2 and antenna operates at a frequency of 2.4GHz which is used for 802.11b Wi-Fi applications. Reconfigurability allows the user to operate at different frequencies with single antenna. The proposed antenna is intended to use in wireless applications like WLAN/RFID. Ansoft HFSS simulation software is used to design and analyze the antenna.

Keywords: Microstrip Antenna, Reconfigurable antenna, RF switches, coaxial feeding, frequency diversity.

I. INTRODUCTION

The concept of microstrip radiators is first proposed by Deschamps in 1953. Microstrip antennas consist of a patch of metallization on a grounded substrate. These are low profile, light weight antennas most suitable for aerospace and mobile applications. Microstrip antennas have low power handling capability because of this these antennas can be used only in low power transmitting and receiving applications. Microstrip antennas are the extension of a microstrip circuit. This feature has given rise to microstrip integrated active antennas in which circuit. A Microstrip patch antenna (MPA) consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side is shown in Figure 1.1. The patch is generally made of a conducting material such as copper or gold and can take any available shape. Radiating patch and the feed lines is usually photo etched on the dielectric substrate.

![Figure 1: Structure of a Microstrip Patch Antenna](image)

The patch contains variety of shapes the commonly used shapes are square, elliptical, circular, rectangular and triangular or some other common shapes are shown in Figure 2. In rectangular patch, the length L of the patch is usually 0.3333λ< L < 0.5 λo, where λo is the free-space wavelength. Where t is the path thickness and it is selected very thin such that t << λo. Where h of the height of the dielectric substrate and it usually in between 0.003 < h < 0.05 λo. The dielectric constant of the substrate (εr) is typically present in between 2.2 ≤ εr ≤ 12.

![Figure 2: Common shapes of microstrip patch elements](image)

Microstrip patch antennas radiate primarily because of the fringing fields between the patch edge and the ground plane. For improving the antenna performance a thick dielectric substrate having a low dielectric constant is desirable since it gives a good efficiency, wide bandwidth and better radiation pattern but such configuration leads to a larger antenna size.

II. RECONFIGURABLE ANTENNAS

A reconfigurable antenna is an attractive feature in a modern wireless communication System because of its flexibility for use in multiple applications such as multiband and point-to-multipoint. Reconfigurable antenna systems were first introduced in 1998 by Brown. In the
reconfigurable antenna, the structure of the antenna can be changed by integrating appropriate switches, such as PIN diode switches, field-effect transistors (FET), piezoelectric transducers, or electromechanical system (MEMS) switches into the design. Reconfigurable antennas can be grouped into three categories: frequency, polarization and radiation pattern reconfigurable antennas. Several approaches have been proposed for implementing the reconfigurable antenna by controlling the on and off-states of the switches.

Radiation pattern reconfigurable antennas have the greatest potential to improve the overall performance of wireless communication systems. Such ability enables the antenna's radiation pattern to be changed to the desired direction whilst maintaining the operating frequency. One way to achieve reconfigurable antennas which were radiated at different beam patterns is by adjusting the apertures while maintaining their operating frequencies (or) by using switching technology.

Fig 3: Different mechanisms to achieve reconfigurable antennas

Frequency reconfigurable antennas (also called tunable antennas) can be achieved by modifying the effective electrical length of the antenna. The total effective electrical length of the antenna determines the operating frequency. A number of techniques can be used to change the effective length of resonant antennas, such as by using switches, having variable reactive loading, and changing the antenna structure.

Fig 4: Frequency diversity

III. DESIGN OF ANTENNA

The reconfigurable patch antenna can be designed using HFSS software. The proposed design consists of a single probe fed microstrip triangular, dielectric substrate with the thickness , 3.2mm and material used for the substrate is Alumina 92 pct which has relative permittivity, ε r=9.2, relative permeability, µ r=1,bulk conductivity =0,Dielectric Loss Tangent=0.008,Magnetic Loss Tangent=0,Magnetic Saturation =0,Lande G Factor=2.8λ=0,Mass Density=3720 and ground plane. Below figures shows reconfigurable antenna design in HFSS. Reconfigurability is achieved by using switches having radius of 0.5mm.

Fig 5: Antenna Design

Fig 6: Patch With Slots And Switches

IV. SIMULATED RESULTS

Fig 7: Return Loss Curve When All The Switches Are Open
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Table 1: Frequency Diversity Results

<table>
<thead>
<tr>
<th>Antenna parameter</th>
<th>Case 1 (all open)</th>
<th>Case 2 (s1 closed)</th>
<th>Case 3 (s1 and s2 closed)</th>
<th>Case 4 (all closed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>2.91</td>
<td>4.99</td>
<td>6.48</td>
<td>6.45</td>
</tr>
<tr>
<td>Return loss (Db)</td>
<td>-12.6</td>
<td>-18.3</td>
<td>-19.7</td>
<td>-27.3</td>
</tr>
<tr>
<td>Gain</td>
<td>8.8</td>
<td>8.9</td>
<td>8.8</td>
<td>8.8</td>
</tr>
<tr>
<td>Axial Ratio</td>
<td>2.2</td>
<td>5.8</td>
<td>1.5</td>
<td>1.8</td>
</tr>
<tr>
<td>VSWR</td>
<td>1.6</td>
<td>1.27</td>
<td>1.23</td>
<td>1.08</td>
</tr>
<tr>
<td>Application</td>
<td>S band</td>
<td>C band</td>
<td>WLAN/RFID</td>
<td>WLAN/RFID</td>
</tr>
</tbody>
</table>

V. CONCLUSION & FUTURE SCOPE

This paper gives a novel frequency reconfigurable coaxial fed triangular shaped patch antenna that operates at different frequency bands 2.9GHz, 4.99GHz, 6.48GHz, 6.45GHz and it is used for S band, C band, RFID/IEEE 802.11 WLAN applications. Frequency reconfiguration can be achieved by using a simple and compact triangular patch with coaxial feeding by controlling switches s1, s2 and s3. High gain can be obtained by increasing height of the substrate so both frequency reconfigurability and high gain can be achieved by using proposed antenna. Finally, what we conclude is only by using the single reconfigurable antenna we can achieve frequency diversity instead of using multiple antennas for high gain applications.

Future work of this thesis is, we can extend this concept by incorporating different switching configurations like...
MEMS, and also we can increase the number of switches in order to get more frequencies. We expect future smart reconfigurable antennas to be completely multifunctional and software controlled with machine learning capabilities that can detect changes in their RF environment and react accordingly. Applications such as cognitive radio will be implemented based on a new generation of communication protocols and antenna systems.

REFERENCES


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