A Compact Design of multiband antenna for wireless application

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Abstract— A compact multiband antenna which can be applied to multisservice wireless application is proposed in this paper. The antenna is designed to cover both WiFi and wi-Max. A compact microstrip resonance cell (CMRC) low pass filter is to be designed to allow feeding the monopole antenna at WiFi frequency bands and also for isolating the monopole from the patch. It is built on Duroid 5880 substrate with a dielectric constant of 2.2 and thickness of 3.157mm. The design has to be fabricated by standard PCB and plated through hole technologies. This design will reduce the overall size of the antenna.

Keywords: WiFi, Wi-Max, microstrip antenna, Compact microstrip resonance cell (CMRC).

I. INTRODUCTION

In wireless communication, there is an increase in demand for a compact multiband microstrip antennas. Recently the mobile communication use hygen’s source to develop the wideband unidirectional antenna with stable frequency. In early implementation antennas suffered from narrow bandwidth, complicated feeding technique, more than one layer and more than one patch. Therefore, various approaches have been proposed in the literature[1]-[12] to reduce these limitations. In Recent techniques the Band notch can be introduced by cutting U slots on the patch antenna. This complicated feeding techniques are required for achieving multiband characteristics in microstrip patch antenna. For multiband, achieving a maximum possible frequency bands with suitable return loss and radiation pattern are desirable. Recently, multiband patch antennas are investigated because of coverage of many wireless communication.

Many mobile communication systems use several frequency bands such as Wi-Fi (Wireless Fidelity)/Wireless Local Area Networks (WLAN) bands (2.4-2.5 GHz and 5.1-5.8 GHz) Universal Mobile Telecommunication Systems (UMTS) and UMTS 3G expansion bands (1.9 – 2.2 GHz and 2.5 -2.7 GHz); GSM 900/1800/1900 bands (890-960 MHz and 1710-1990 MHz). In [11], multi band antenna with meander structure were used for GSM and LTE, which are wireless communication access technologies. For design of current WiFi band on monopole shows bandwidth from 2.4GHz to 10GHz which also cover WiMax (5.2/5.8GHz). WLAN antenna uses lower frequency 2.4 - 3.6 GHz, for the 802.11b/g standard and higher frequency of about 5.8 GHz for the 802.11a Standard. Monopoles are used for the reduction of size of the antenna. The smallest size achieved was with the use of a ROGER DUROID substrate with a relative permittivity εr=2.2. Similar in [9] designed for WLAN and WiMax in rectangular monopole with microstrip feedline. Studies in [1] presented multiband antenna for WiFi and WiGig which covers 2.4GHz, 5.2/5.8GHz and 60GHz.WLAN and WiMax are the two techniques had widely used because of its high speed data connectivity solution, cost effective, cost-effective, and enabling user mobility. Every component that connects to a WLAN is considered a station as access points (APs) and clients. Similar work had done[5] for multiband with triple frequency as 2.7GHz, 3.5GHz and 5.6GHz which had a simple structure and slots than other multiband antennas. Multiband antenna operates lower frequency of 1.4GHz and 3.2GHz of higher frequency, which was designed in single layer and single feed[2]. A multiband antenna with modified ground plane was designed [3] for frequency from 1.7GHz to 2.5GHz and 4.5GHz to 5.35GHz.IEEE 802.11b/g and WLAN IEEE 8021.1a. For lower frequency 2.4GHz and 5.8GHz, the multiband fractal antenna array was designed on FR4 substrate which is suitable for wireless power transmission[4].

The bandwidth get enhanced by adding parasitic elements, wide open-ends of the slots in planar slotted antenna for millimeter wave techniques [6]. By adding rectangular or L-shaped slots, the multiband operation can be achieved. This printed antennas with radiating characteristics have been useful for dual and multiple frequency bands. The dielectric substrate material’s consistency play a vital role in microstrip antenna’s design because loss tangent of substrate material, thickness, type and relative permittivity has effects on the shape attributes and performance of any patch antenna. Studies in several papers [1][3][5] had designed for lower frequency with simple structure. The operating frequencies were able to radiate in omni directional. By using two printed monopole slots[7] with different length at the edge of ground.
plan for multiband mobile phone antenna which covers wideband centered about 900MHz and 2100MHz. By inserting a circular slot in patch, the UWB antenna was designed on FR4 substrate for multiband wireless application which covers 5GHz, 6GHz, 7GHz and 9 GHz. In Miniaturized single feed, the quad bands were operated with 74% efficiency\[12\] which was designed in HFSS.

TABLE 1

Frequency bands for mobile communication:

<table>
<thead>
<tr>
<th>Wireless Application</th>
<th>Frequency Band</th>
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<tbody>
<tr>
<td>GSM 1900</td>
<td>1850-1990 (MHz)</td>
</tr>
<tr>
<td>UMTS</td>
<td>1885-2200 (MHz)</td>
</tr>
<tr>
<td>Wi-Fi/WLAN(IEEE 802.11b/g/n)</td>
<td>2.4-2.48 (GHz)</td>
</tr>
<tr>
<td>WiMAX( Worldwide Interoperability for Microwave Access)</td>
<td>5.3-5.8 (GHz)</td>
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II. ANTENNA STRUCTURE AND WORKING PRINCIPLE

Many conventional techniques such as the use of PIN diodes, switches and varactor diodes are used for multiband operation. Also, the use of active components increases complexity in the design and their use are difficult to handle because it needs extra biasing network. The overview of antenna is shown in fig.1

The antenna is printed on single layer of substrate ROGER DUROID with dielectric constant 2.2 and thickness of 3.157mm. The monopole are designed for the frequency of about 2.4GHz,5.3/5.8GHz. Part 1 is a patch antenna for shorted higher order mode. In contrast, part 1” is designed for below the frequency of 60GHz. The plated through technology was realized for Vias. There is no ground plane on back of the printed monopole. The slot prevents lower frequencies from shorting to the ground. The width (s_w) of substrate on opposite side of the ground plane G at higher-order mode. CMRC low pass filter is used at part 2. It connected a co-axial feed to monopole for lower frequency band which also acts as an open circuit. The port can be tuned for impedance matching. At part 3, the rectangular monopole antenna with 2 corners closed to the feeding port. The width of the CMRC is 1.4*0.8mm. The patch over the ground plan covers the higher order frequency. The slot in monopole has dimension is 0.5*0.64mm.

By introducing the slots, it had very narrow band characteristics. The dimension of ground plan is 14*33mm. The feed line and patch will be fabricate on this substrate. This multiband antenna was excited through a 50Ω feed line

The monopole stripes in resonant modes was adjusted to get a lower frequency band of 2.4GHz and 5.8GHz. This design for the multiband was done in advanced design system (ADS) version 2011.

Fig. 1. Antenna design and parameters involved.

S_x=35mm  S_l=43.5mm  G_l= 14mm  P_x=2mm
P_y=2.75mm  P_z=1.625mm  P_r=0.25mm  C_x=0.9mm
C_y=1.4mm  C_z=0.8mm  C_r=0.1mm  C_l=0.3mm
C_s=0.1mm  M_a=0.9mm  M_i=3.14mm  M_s=42mm
M_l=20mm
III. ANTENNA PERFORMANCE

The above mentioned dimensions required to achieve the multiband antenna. Fig 2 demonstrates the simulated performance of the slot structure. With the slot inserted to the design, the antenna can be analyzed separately into two different responses for Wi-Fi and Wi-Max.

The performance of the proposed antenna in terms of smith chart and reflection coefficient had simulated in ADS. To visualize the process of impedance matching, the smith chart had helped. Fig 3 shows the smith chart simulation for the proposed multiband antenna. The proposed antenna has a good impedance matching because the constant resistant points in chart came very close to the centre of the circle. The simulated result of the reflection coefficient is shown in fig 4. The reflection co-efficient of the antenna is affected when the ground plan get vary. The simulation for the proposed antenna’s reflection co-efficient and SWR are shown in table 1. These data shows the proposed antenna has a dual band characteristic. The radiation pattern of the proposed antenna for 2.4GHz and 5.8GHz are shown in fig 5 and 6. The radiation pattern obtained for 5.8GHz is bidirectional. At 2.4GHz, it experiences lower side lobe level.

The measured peak gain for the frequency 2.4GHz and 5.8GHz is 6.97dBi and 4.9dBi. This output were acceptable for mobile phone applications.

TABLE II. Simulated output for proposed antenna

<table>
<thead>
<tr>
<th>FREQUENCY</th>
<th>S11</th>
<th>SWR</th>
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<tbody>
<tr>
<td>2.35GHz</td>
<td>-22db</td>
<td>1.1</td>
</tr>
<tr>
<td>5.8GHz</td>
<td>-31db</td>
<td>1.01</td>
</tr>
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</table>

To validate the design, the antenna will be fabricate and may testing will be done by using network analyser.
IV CONCLUSION AND FUTURE WORK

In this paper, a compact multiband antenna is covering both wi-Fi and wi-Max frequency bands (2.4GHz and 5.8GHz) has been demonstrated. The antenna is designed in ADS software. At both frequency band, the designed antenna simulates with good response. This proposed antenna design will be used for fabrication and testing to measure the return loss, radiation pattern, VSWR by using network analyzer.

REFERENCES


