A compact single feed multiband planar antenna configuration suitable for GPS, DCS, 2.4/5.8GHz WLAN applications is presented. The antenna of dimensions 38mm x 3mm x 1.6mm offers good radiation and reflection characteristics in the above frequency bands. The antenna has a simple geometry and can be easily fed using a 50Ω coaxial probe.
Compact planar multiband antenna for GPS, DCS, 2.4/5.8 GHz WLAN applications

1. Introduction

The rapid progress in personal and computer communication technologies demand integration of more than one communication systems into a single compact module. To comply with the above requirement compact high performance multiband planar antennas with good radiation characteristics are needed. A planar single feed dual L antenna of dimensions 30.5mm x 21.5mm x 13mm operating in GPS and PCS bands is proposed in [1]. The dual band antenna for the ISM band (2.4/5.8GHz) using a backed microstrip line proposed in [2] has an overall dimension of 30 x 20 mm² on FR4 substrate and offers a maximum gain of 4dBi. Dual frequency antenna configuration proposed in [3] uses triple stacked microstrip patch antennas with a slot in the middle patch, to achieve triple band operation. In this section a compact single feed planar antenna with three wide 2:1 VSWR operating bands around 1.8GHz, 2.4GHz and 5.8GHz respectively, covering four useful frequency bands namely GPS (1575.4MHz), DCS (1800MHz), 2.4GHz (2400-2485MHz) and 5.8GHz (5725-5825MHz) WLAN is presented.

2. Antenna design

Geometry of the proposed antenna is shown in Fig. B.1. It is etched on FR4 substrate of relative permittivity, $\varepsilon_r = 4.7$ and thickness $h = 1.6mm$. The antenna has two arms of lengths $l_1 = 38mm$, $l_2 = 33mm$ and widths $w_1 = w_2 = 1mm$ placed symmetrically on either side of a middle element of length $l_3 = 17mm$ and width $w_3 = 1mm$. The feed point of the antenna is optimized to be at the middle of edge AB. Good impedance matching is achieved by embedding a reflector of dimensions $L = 40mm$ and $W = 25mm$ on the bottom side of the substrate at an offset $d = 0.5mm$ from the edge AB as shown in Fig.B.1.
Fig. B.1 Geometry of the proposed antenna (a) Top view   (b) Side view  
\[ L=40 \text{ mm}, \ l_1=38\text{mm}, \ l_2=33\text{mm}, \ l_3=17\text{mm}, \ W=25\text{ mm}, \]
\[ w_1= w_2=w_3=1\text{mm}, \ h=1.6 \text{ mm}, \ d=0.5\text{mm} \]

From the experimental and simulation results, it is understood that the lower resonance can be tuned by varying the length \( l_1 \) of arm 1. Resonance in the 2.4GHz band is influenced by the length \( l_1 + l_2 - 2 \ l_3 \). When length \( l_3 \) of the middle element is increased, the second resonance shifts upwards whereas: it gets lowered when the length \( l_2 \) is increased. Dimensions of the reflector affect both the resonance frequency and impedance matching in the 5.8GHz band. Another antenna with \( l_1=79.4\text{mm}, l_2=77.48\text{mm} \) and \( l_3=60.54\text{mm}, \) exhibits resonance at 940MHz,1.85GHz and 5.2GHz respectively suitable for GSM/DCS/5.2GHz WLAN applications.
3. Results & Discussion

The measured return loss characteristic of the proposed antenna is shown in Fig. B.2. Three resonant bands are observed at frequencies 1.75 GHz, 2.45GHz and 5.76GHz with 2:1 VSWR bandwidths of 23%, 5% and 4.5% respectively. The lower resonant band with 406MHz (1466-1872) bandwidth is wide enough to cover the GPS/DCS bands. The higher resonant bands with 124MHz (2372-2496) and 260MHz (5630-5890) bandwidths cover the 2.4GHz and 5.8GHz WLAN bands respectively.

![Fig. B.2. Return loss characteristics of the antenna](image)

The normalized E-plane and H-plane radiation patterns measured at the centre frequencies of the respective bands are shown in Fig.B.3. The patterns are observed to be nearly omni directional in the H-plane, with a cross polar level better than -15dB in the bore-sight direction. The antenna exhibits similar radiation characteristics in all the desired bands.

The measured antenna gain against frequency is presented in Fig.B.4. The antenna offers a peak gain of 7.38dBi in the GPS band. The maximum gain observed in the DCS, 2.4GHz WLAN, 5.8GHz WLAN bands are 3.73dBi, 4.22dBi and 4.65dBi respectively. The radiation performance of the antenna in all the above bands is summarized in Table.B1. It is observed
that all bands except the 5.8GHz band are linearly polarized along Y direction. The 5.8GHz band is orthogonal to the other bands.

Fig. B.3. Radiation Patterns at the centre frequency of the desired bands
3. a. GPS band  3. b. DCS band  3. c. 2.4GHz WLAN band  3. d. 5.8GHz WLAN band

Fig. B.4. Gain of the antenna in the desired bands
Table B-1

<table>
<thead>
<tr>
<th>Band (GHz) and application</th>
<th>Gain (dBi) max/ min</th>
<th>Polarisation</th>
<th>Cross-polar level (dB)</th>
<th>Radiation pattern</th>
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<tr>
<td></td>
<td></td>
<td>H-plane</td>
<td>E-plane</td>
<td></td>
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<tr>
<td>1.46–1.87 GPS</td>
<td>7.38/5.45</td>
<td>Linear along y direction</td>
<td>–23</td>
<td>Omnidirectional</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>HPBW = 90° at 1.75 GHz</td>
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<tr>
<td>DCS</td>
<td>3.73/2.1</td>
<td>Linear along y direction</td>
<td>–25</td>
<td>Omnidirectional</td>
</tr>
<tr>
<td>2.37–2.49 2.4 GHz WLAN</td>
<td>4.22/1.31</td>
<td>Linear along y direction</td>
<td>–19</td>
<td>Omnidirectional</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>HPBW = 126° at 5.76 GHz</td>
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<tr>
<td>5.63–5.89 5.8 GHz WLAN</td>
<td>4.65/3.12</td>
<td>Linear along x direction</td>
<td>–19</td>
<td>Omnidirectional</td>
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4. Conclusion

A novel compact multiband antenna suitable for GPS, DCS, 2.4/5.8GHz WLAN application is designed and analysed. Antenna shows moderate gain and nearly omnidirectional radiation characteristics in the entire band.

5. References

