Research Paper Engineering

A Multiband Antenna Design For Wireless Applications

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ABSTRACT

The compact design of microstrip antenna is proposed for various wireless applications like GSM/GPS/UMTS/Bluetooth/ WLAN/WiFi/WiMAX applications. The proposed antenna is comprised of a multiple slotted antenna. In this work multiband operating microstrip antenna is designed which can operate in WiFi, WiMAX and C-band frequency range. The antenna operates at 3.48 GHz for WiMAX, 5 GHz for WiFi and 7.47 GHz for C-band which can be used for radar applications. The antenna system shows wide multi-operation band as well as good radiation patterns and small volume. This antenna can be printed on the FR4 substrate for real applications .A comparison with that of the existing antennas showed that wide impedance bandwidth of the proposed structure can be achieved without increasing the implementation complexity. CST software used to simulate the proposed antenna.

KEYWORDS Triple frequency, compact size, Multi band

INTRODUCTION

In today's advanced communication engineering, antennas are the most important components required to create a communication link. Each frequency range of the antenna has independent application. The Federal Communication Commission (FCC) has released the commercial operation of Ultra wide band (UWB) within the range 3.1-10.6GHz [5].The UWB frequency band is unlicensed which can be used for various application. Micro strip antenna are extensively used in present wireless application for their low profile, less weight, conformal design, low cost, easy to fabricate and integrate [7]. Patch, ground and substrate are the main components for micro strip antenna design [11]. Generally many design are available for UWB frequency range [1][3][10]. In order to avoid interference in the UWB range Wireless Local Area Network (WLAN) and Wireless Interoperability Microwave Access Network (WiMAX) are notched [7]-[9]. Since the operating frequency band of the UWB is notched the application of the antenna is reduced. The notch in the UWB range is achieved by etching L-shaped, U-shaped, arc shaped, C-shaped and π –shaped slots on the patch or in the ground plane of the antenna [6] [13].

In order to design patch antenna for multiband operation for common application Electromagnetic Band Gap (EBG) structures is proposed [4]. Another technique to obtain the multiband operation frequency is to use Meander lines in the patch. Meandering is obtained by inserting many narrow slits at the patch's non radiating edges. The excited patch's surface currents are meandered, leading to a greatly lengthened current path for a fixed patch linear dimension [12]. This behavior results in a lowered fundamental resonant frequency thus it can be used for lower frequency operation. Microstrip antenna is also designed in coplanar waveguide but in that design radiation is increased due to the absences of ground plane [3].

In this work planar multiband operating antenna is designed which can operate in WiFi, WiMAX and C-band frequency range. The antenna operates at 5 GHz for WiFi, 3.48 GHz for WiMAX and 7.47 GHz for C-band which can be used for radar application.

ANTENNA STRUCTURE AND DESIGN PROCESS

The CST software is used for this design. Fig.1 shows the geometrical design of the multiband antenna. The rectangular micro strip fed antenna has a low cost FR 4 substrate material with the dielectric constant $\epsilon r = 4.4$. The antenna dimension is 18 mm x 25 mm and thickness of 1mm. It is fed with 50Ω impedance. When the dielectric constant of the antenna increase the size of the patch decreases resulting in lower bandwidth and it is difficult to fabricate the antenna. By etching a rectangular shape in the ground plane and rectangular patch in the surface of the antenna the reflection loss is obtained less than -10 dB. This provides high broad band impedance. To achieve triple band operating antenna a C-shaped slot is etched at the patch provides WiFi application having a resonant frequency of 5 GHz, T-shaped patch in the ground plane provides WiMAX application having a resonant frequency of 3.48 GHz, I-shaped patch in the ground plane operates in C-band having a resonant frequency of 7.47 GHz. The parameters that are considered for this design are the length, dielectric constant, resonant frequency fr, Return loss, thickness, input impedance, bandwidth, directivity, Gain, VSWR, Radiation efficiency. Input impedance can be optimized if the patch is center fed. The permittivity of the substrate is essential because the lower the value better are the results but if the permittivity are lowered then fringing effect occurs. High thickness provides wider bandwidth and low thickness provides narrow bandwidth. But if the thickness is increased beyond a certain height then more radiation occurs. When the width of the feed line is increased then the antenna does not operate in the requisite band.

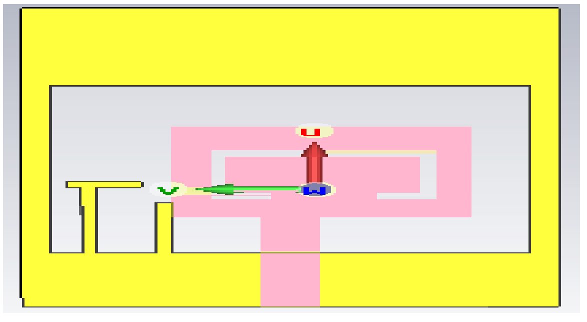

Figure 1: Design structure of the antenna for WiFi, WiMAX and Radar application

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IMPLEMENTATION

The design is implemented using equation derived from electromagnetic theory. The equations are as follows.

1) Calculation of the width W of antenna

$$W = \frac{c}{2f_r\sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

Where, *fr* = resonant frequency,

r = Dielectric constant of the substrate

2) Calculation of Effective dielectric constant (ε_{reff})

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\sqrt{1 + 12\frac{h}{W}}$$

3) Calculation of Effective Length ***(Leff)***

$$L = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}}$$

4) Calculation of Length Extension (LD)

$$\Delta L = 0.412h\frac{(\varepsilon_{reff} + 0.3)}{(\varepsilon_{reff} - 0.258)}\frac{\left(\frac{W}{h} + 0.264\right)}{\left(\frac{W}{h} + 0.8\right)}$$

5) Calculation of Actual Length (L)

$$L_{eff} = L + 2\Delta L$$

SIMULATED RESULTS

The return loss is simulated using CST. It show that the antenna operates at in the resonant frequency of 3.48 GHz having a return loss of -29.38dB which operates in WiMAX, - 19.96dB for Wi-Fi and -36.94dB for Radar application. There is a sharp resonant at the mentioned frequency.

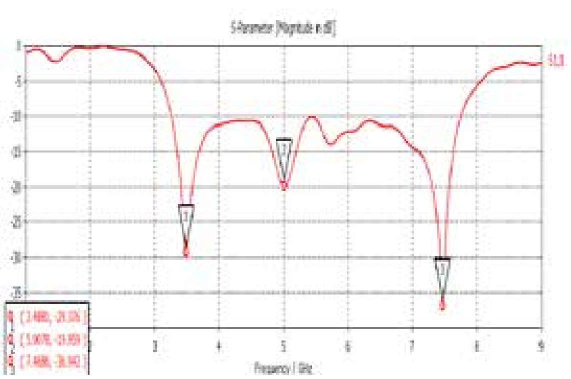

Figure 2: Return loss

It show that the antenna operates at in the resonant frequency of 3.48 GHz having a VSWR of 1.07 which operates in WiMAX, 1.22 for Wi-Fi and 1.02 for Radar application. There is mentioned by the array.

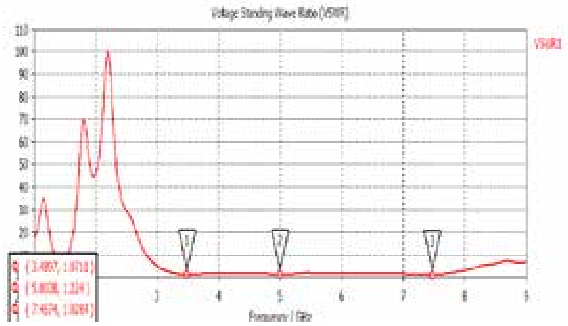

Figure 3: VSWR

It show that the antenna operates at in the resonant frequency of 3.48 GHz having a gain is 4.5dB in figure 4 and directivity is 2.8dBi in figure 5.

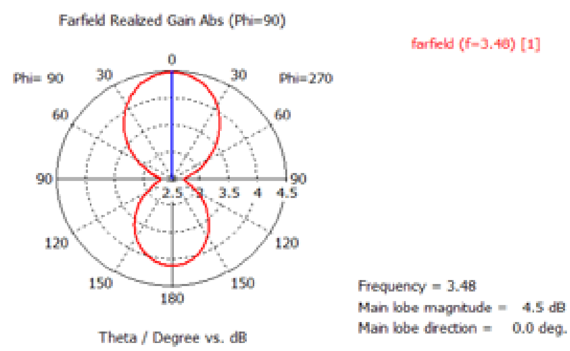

Figure 4: Gain for 3.48 GHz frequency

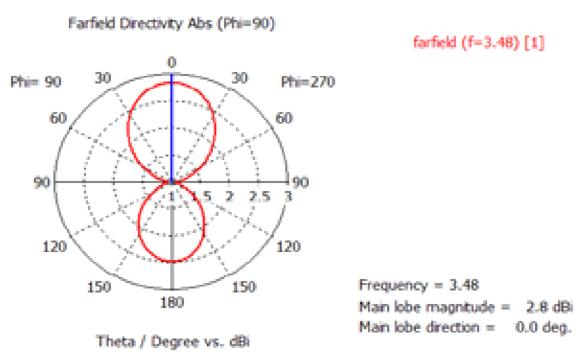

Figure 5: Directivity for 3.48 GHz frequency

It show that the antenna operates at in the resonant frequency of 5 GHz having a gain is 3.8dB in figure 6 and directivity is 3.0dBi in figure 7.

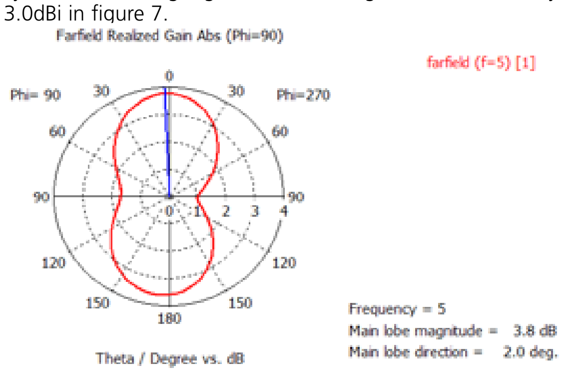

Figure 6: Gain for 5 GHz frequency

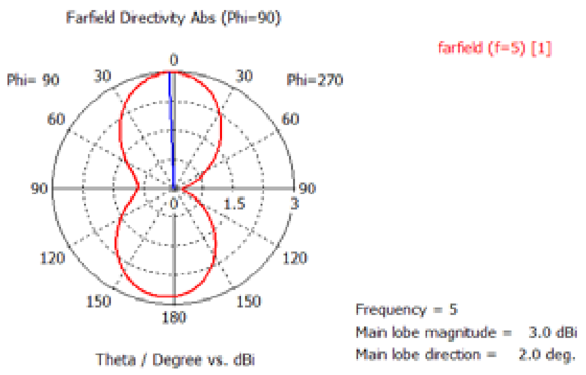

Figure 7: Directivity for 5 GHz frequency

It show that the antenna operates at in the resonant frequency of 7.47 GHz having a gain is 3.4dB in figure 8 and directivity is 2.9dBi in figure 9.

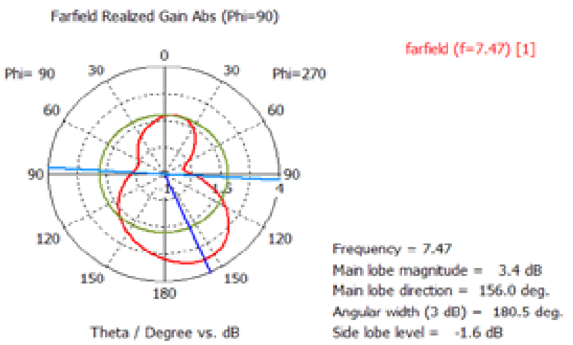

Figure 8: Gain for 7.47 GHz frequency

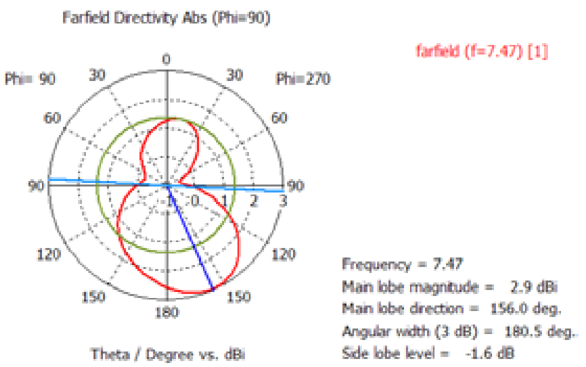

Figure 9: Directivity for 7.47 GHz frequency

TABLE – 1

Frequency (GHz)	Results			
	Return Loss	VSWR	Gain (dB)	Directivity(dBi)
3.48	-29.376	1.0711	4.5	2.8
5	-19.959	1.224	3.8	3.0
7.47	-36.942	1.028	3.4	2.9

CONCULSION

In this paper, a novel design of multi-frequency wideband microstrip patch antenna is proposed. The simulation is carried out using CST software. The proposed antenna operates at three bands, first frequency band from 3.282GHz to 3.672GHz with resonance frequency 3.48 GHz and covers the second resonance frequency 5 GHz and covers the third frequency band from 4 GHz to 8 GHz with resonance frequency 7.47 GHz at -10 dB return loss. Good Results have been found at three frequencies 3.48 GHz, 5 GHz and 7.47 GHz which can be applicable to WiMAX, Wi-Fi and radar communication system. VSWR is obtained less than 2 for the three bands and Gain is always greater than 3dBi.

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