Modeling and Simulation of Compact Dual Band Rectangular Micro Strip Patch Antenna for WLAN/WiMAX Applications

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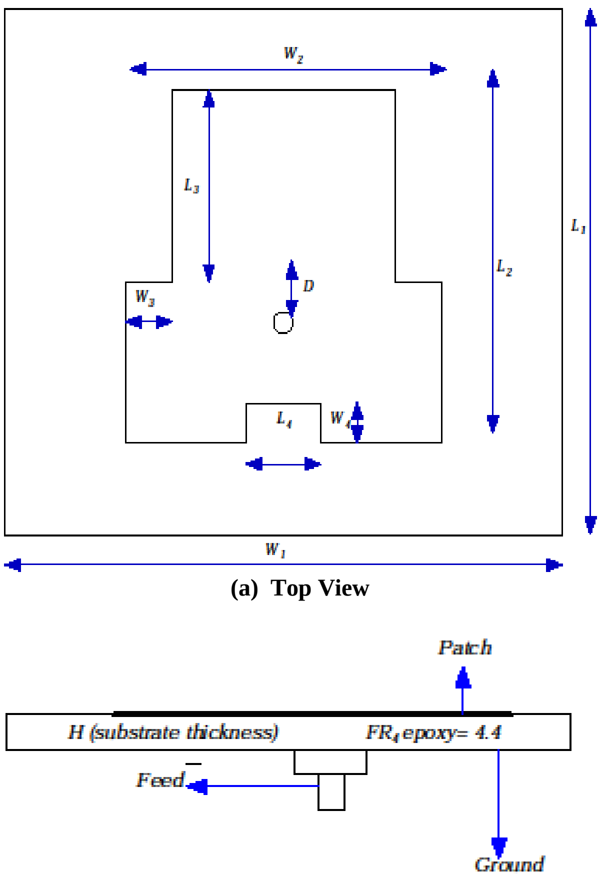
ABSTRACT
Miniaturized structure and high directive gain performance of a patch antenna are primary requirements for modern wireless communication systems. In this paper, a novel design of dual band micro strip patch antenna with rectangular notch has been proposed for WLAN and WiMAX applications. For dual bands (3.6 GHz and 5.1GHz), proposed patch antenna shows quite satisfactory radiation and gain performance. Proposed antenna was designed, simulated and analyzed by using a finite element method based on high frequency structural simulator HFSS. The result exhibit that the antenna operates over the frequency ranges 150 MHZ (3.52-3.67GHZ), 284 MHZ (4.92-5.20GHZ) and suitable for WiMAX 2.5/3.5/5.5 GHZ and WLAN (2.4/5.2/5.8) and applications.

Keywords
Micro strip patch antenna, HFSS, Dual band, Notch, Return loss.

1. INTRODUCTION
Now day's compact size dual band, antennas are used as effective alternative of large size of dipole antennas. Due to their compactness and dual frequency operation micro strip patch antennas have gain much interest in various wireless communication applications. Patch antennas are cost effective to fabricate, lighter in weight, and can be modeled with planar and non planar surfaces. Unfortunately, they have some drawback, including relatively low gain efficiency, narrow bandwidth, and sensitive to various profile parameter variation during fabrication [1-2]. Wireless local area network and the world wide interoperability for microwave Access (WiMAX) technology have extensively been used in commercial, medical, industrial applications. There are many reported antenna design for wireless system that shows dual band operations [3-5]. The dual frequency micro strip antennas found may be divided into two categories, namely, multi-resonator antennas and reactive loading antennas. In the first kind of structures, the dual frequency operation is achieved by means of multiple radiating elements, each supporting strong cur rents and radiation at its resonance. This category includes the multi-layer stacked-patch antennas using circular, annular, rectangular, and triangular patches [6-7]. A multi-resonator antenna structures usually involve multiple substrate layers, they are of high cost. The reactive loading micro strip patch antenna consists of a single radiating element in which the double resonant behavior is obtained by connecting coaxial and micro strip stubs at the radiating edge of rectangular patch [8-9]. In this proposed work a micro strip patch antenna with rectangular notch structure has been designed and investigated, which is able to radiate for two resonance frequency bands (3.52-3.67GHZ) and (4.92-5.20GHZ) make it suitable for WLAN and WiMAX applications.

2. ANTENNA DESIGN
The geometric configuration of the proposed conductive patch antenna loaded on FR4 epoxy substrate with permittivity of 4.4 and a loss tangent of 0.02 is shown in Figure 1. The dimensions of the substrate, coax probe feed location with respect to centre of the patch, patch structure and three rectangular notch made on the patch are shown in table1.



(b) Side View

Fig.1. Structure of the proposed patch antenna, (a) Top view (b) Side view.

3. RESULT AND DISCUSSION

Proposed antenna was designed, simulated and analyzed by using a finite element method based high frequency structural simulator HFSS. The impedance bandwidth (at -10 dB) of notch loaded dual band micro strip patch antenna are 150 MHz (3.52-3.67 GHz) and 284 MHz (4.92-5.20 GHZ) with centre frequency of 3.6 GHz and 5.1 GHz respectively. Gain of the proposed measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire proposed antenna are 1.48 dB for 3.6 GHz while 2.27 dB for 5.1 GHz. Simulated results in terms of return loss, VSWR, Radiation pattern, rE pattern (radial distance multiplied with electric field for far field radiation) and gain is shown figures 2,3,4,5 and 6 respectively.

For the designing of microstrip patch antenna basic equation are given as

Step 1: Calculation of the Width (W): The width of the Micro strip patch antenna is given by:

$$W = \frac{v_0}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}}$$

Step 2: Calculation of Effective dielectric constant (εreff): Equation gives the effective dielectric constant as:

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{w}\right]^{-\frac{1}{2}}$$

Step 3: Calculation of the Effective length (Leff): Equation gives the effective length as:

$$L_{eff} = \frac{c}{2f_{0\sqrt{\varepsilon_{reff}}}}$$

Step 4: Calculation of the length extension (ΔL):

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

Step 5: Calculation of actual length of patch (L): The actual length is obtained by re-writing Equation as:

$$L = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}\sqrt{\varepsilon_{reff}}} - 2\Delta L$$

Table 1. Dimension of Notch Loaded Patch Antenna

Parameters	**Materials and Dimensions(mm)**
Substrate material used	FR4 Epoxy
Relative permittivity of the substrate (εr)	4.4
Thickness of the dielectric substrate (H)	1.6 mm
Length of the substrate (L_1)	50 mm
Width of the substrate (W_1)	50 mm
Length of the patch (L_2)	38.2 mm
Width of the patch (W_2)	28 mm
Area of Rectangular $Notch_1$ and $Notch_2$ ($L_3 \times W_3$)	20×4 mm^2
Area of Rectangular $Notch_2$($L_4 \times W_4$)	10×4 mm^2
Feed Location(D) from centre	5 mm

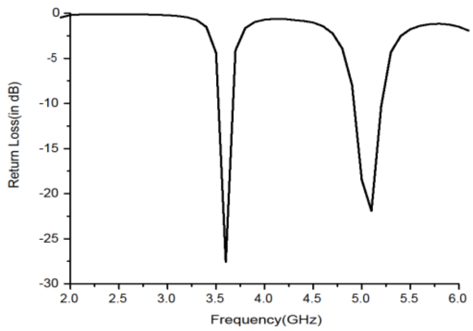


Fig.2. Return loss of patch antenna

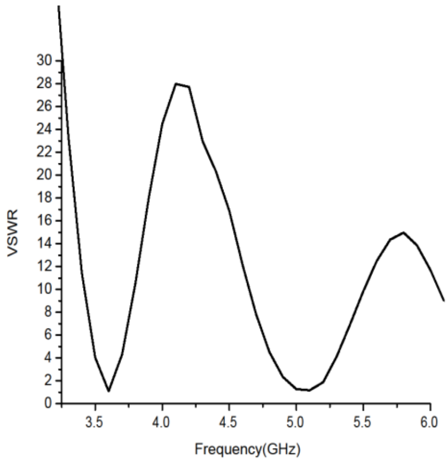
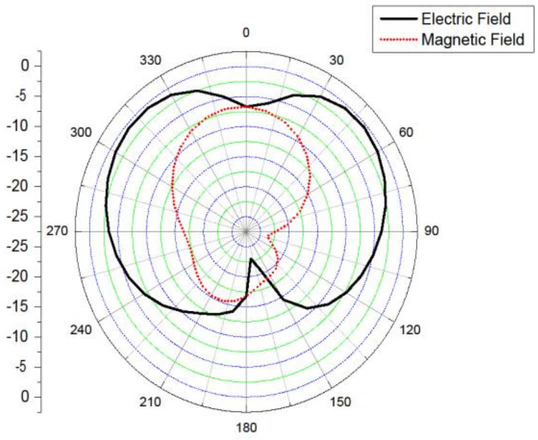
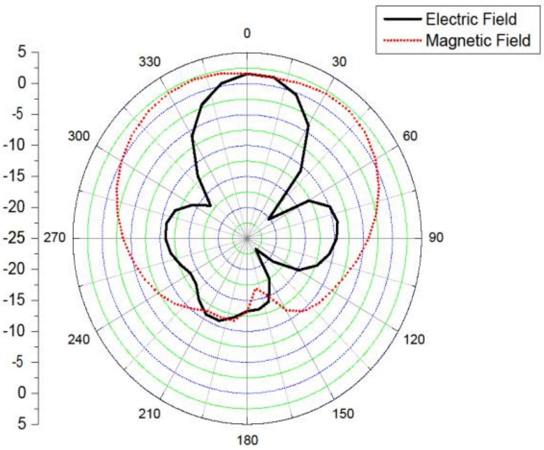


Fig 3. VSWR of patch antenna

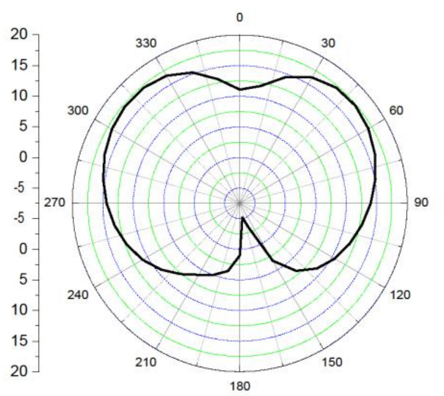


(a)

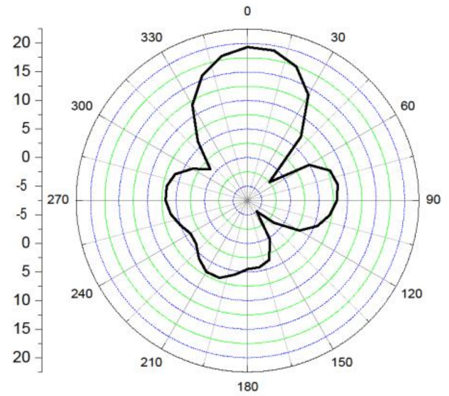


(b)

Fig.4. Radiation Pattern of patch antenna for (a) 3.6 GHz (b) 5.1 GHz

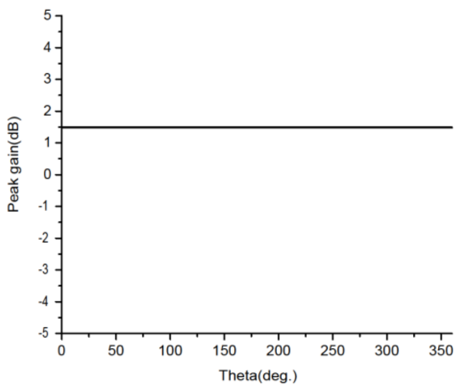


(a)

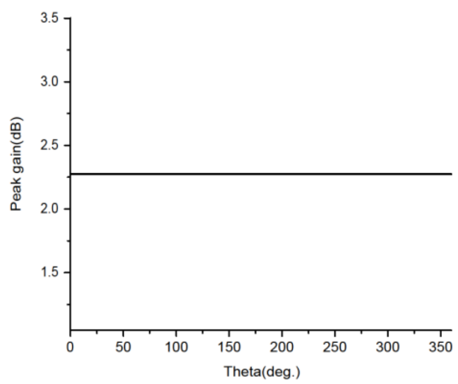


(b)

Fig.5. rE field for patch antenna at (a) 3.6 GHz (b) 5.1 GHz



(a)



(b)

Fig 6. Peak gain of the patch antenna at (a) 3.6 GHz (b) 5.1 GHz

4. CONCLUSION

A compact dual band micro strip patch antenna with three rectangular notches are designed and analyzed. Two rectangular notches at non radiating edges of the patch and one notch at radiating edge make the structure resonating for dual band in WLAN and WiMAX frequency range.

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