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Research Article

DEVELOPMENT AND OPTIMIZATION OF MULTI BAND PATCH ANTENNAS FOR IEEE802.15, IEEE802.15.3a, WIMAX, WLAN, ISM APPLICATIONS

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ABSTRACT

In this paper, Multi Band in Ultra wide band monopole patch antennas is proposed. These newly simulated structures are proposed for fabrication. The antennas are suitable for operating frequency of 3.5GHz and 7.5 GHz in Wi Max and ISM band it is shown that return loss of the antennas at 3.5 GHz and 7.5 GHz is better than -10 dB. The VSWR obtained is less than 1.5 the patch antenna is found to have the compact size and more bandwidth. The return loss value of first band is -39.68 dB and for second band are 18.0 dB. With radiation efficiency 94% and Antenna efficiency 80% calculated using HFSS-13 simulation software. The measured results are also calculated with Vector Network analyzer.

INTRODUCTION

FCC (Federal communications commission) allocated a block of radio spectrum from 3.1GHz to 10.6 GHz for UWB operations [1].UWB systems can support more than 500 Mbps data transmission within 10m [1]. Compact size, low-cost printed antennas with Wideband and Ultra wideband characteristic are desired in modern communications. The Ultra wide band antennas can be classified as directional and omni-directional antennas [2]. A directional antenna have the high gain and relatively large in size. It has narrow field of view. Whereas the omni-directional antenna have low gain and relatively small in size. It has wide field of view as they radiates in all the directions [3].

The UWB antennas have broad band. There are many challenges in UWB antenna design. One of the challenges is to achieve wide impedance bandwidth. UWB antennas are typically required to attain a bandwidth, which reaches greater than 100% of the center frequency to ensure a sufficient impedance match is attained throughout the band such that a power loss less than 10% due to reflections occurs at the antenna terminals [4]. Various planar shapes, such as square, circular, triangular, and elliptical shapes are analyzed and reported. Compared with monopole based planar antennas, the design of ultra wide band circular ring type antennas is difficult because of effect of the ground Plane [5].

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The bandwidth of the micro strip antenna can be enhanced by modifying the ground plane [6]. Many designers have tried various ways to improve the structure of the traditional circular antennas, and many valuable results have been obtained [7-10].

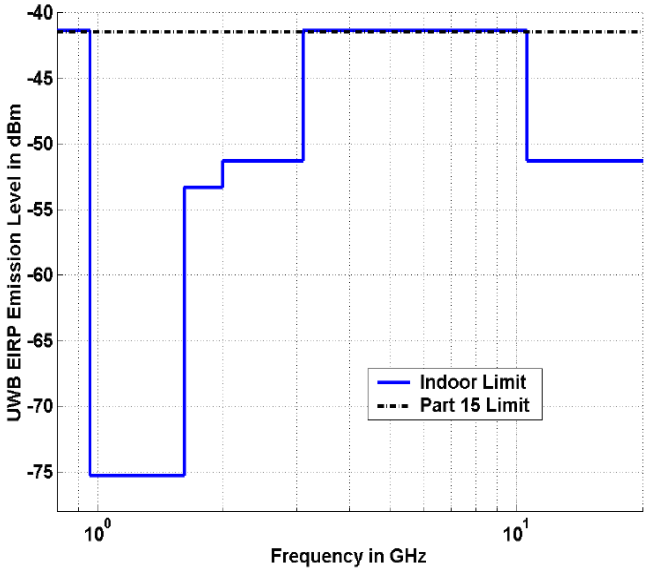

Fig 1 UWB Spectral Mask per FCC (Modified) Part 15 Rules [1]

Antenna Configuration and Design

For patch antenna the length and width of patch antenna are used as calculated from the equations. The first step is of dimension 2.5 x 1 mm^2 and second step is 4 mm on Y-axis and 1 mm on X- axis. The ground plane is of 30x18 mm^2. The slot

present at patch is 3x7.9 mm^2. The ground plane is modified to enhance the bandwidth of the antenna. The whole structure of patch antenna is shown in fig. 2 and the dimensions of proposed antenna are shown in Table 1

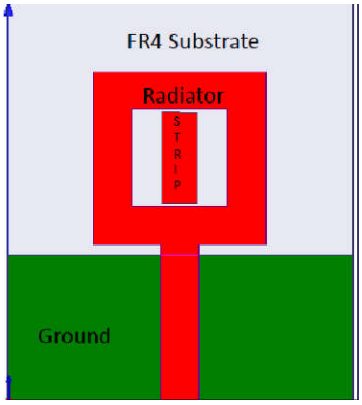

Fig 2 Geometry of rectangular patch whole sturcture

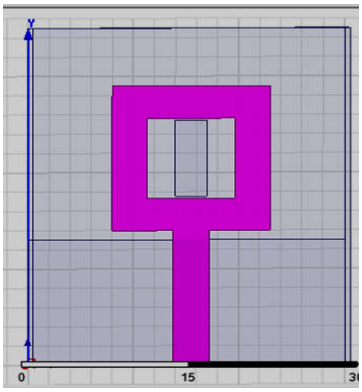

Fig 3 Geometry of rectangular patch Top View

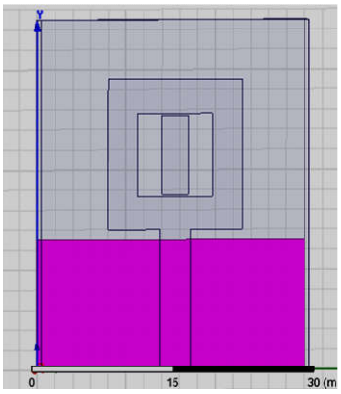

Fig 4 Geometry of rectangular patch Bottem View

Table 1 Antenna designing parameters in mm

W sub	L sub	Wg	Lg	Wf	Lf	Wp	Lp	Ws	Ls
30	35	30	18	3.4	14	15	15	3	7.9

Whole structure, Top view and bottom view of design geometry of patch antenna is indicated in fig. 2, fig. 3and Fig. 4. The proposed antenna designed on a FR4 substrate with dielectric constant $\varepsilon_r = 4.4$ and height of the substrate is h = 1.6 mm. The substrate has length L= 30 mm and width W = 35mm.The substrate is mounted on ground of 18 mm length and 30 mm width.

SIMULATION RESULTS

Fig. 5 and Fig.6. Shows that S_{11} of dual band patch antenna. This antenna is suitable for operating frequency of 3.5 GHz and 7.5 GHz in WLAN, WI MAX and ISM band of frequencies. It is shown that return loss of the antennas at 3.5 GHz and 7.5 GHz is better than -10 dB. The VSWR obtained is less than 1.5 the patch antenna is found to have the compact size and 48.48 % Maximum Fractional Bandwidth. The return loss value of first band is 42.0 db and for second band are 19.0db.

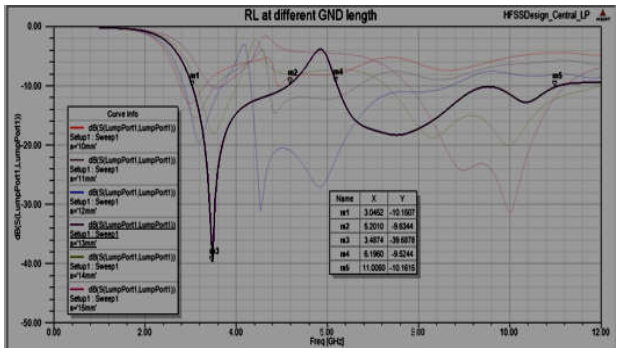

Fig 5 S_{11} of dual band patch antenna at different Lg

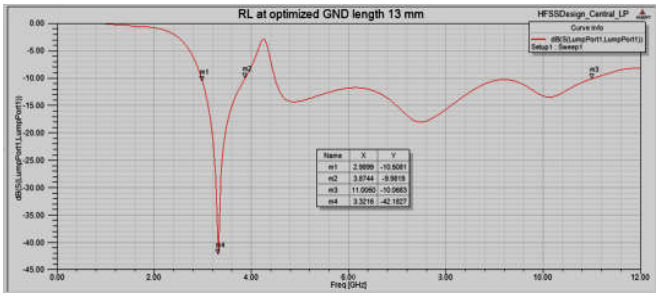

Fig 6 S_{11} of dual band patch antenna at optimized Lg =13mm

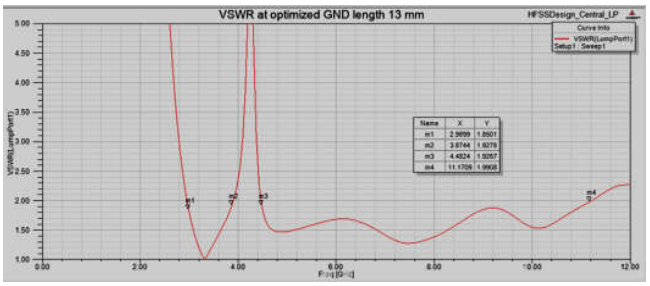

Fig 7 VSWR of dual band patch antenna

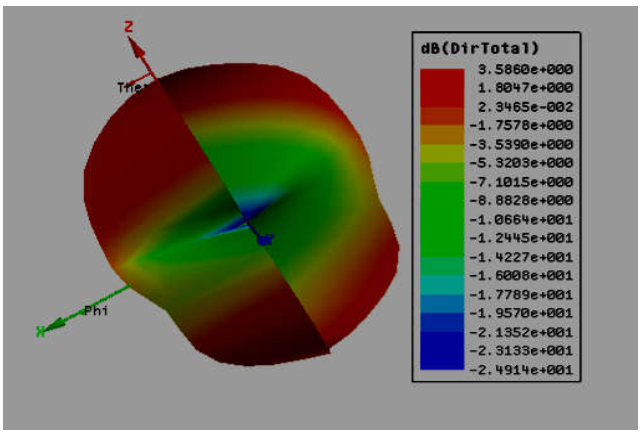

Fig 8 Directivity of patch antenna at 7 GHz

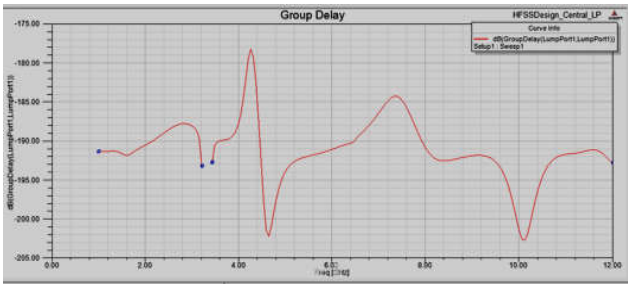

Fig 9 Group Delay at 7GHz

The various parameter of proposed geometry of patch are calculated like VSWR, Directivity, group delay, radiation efficiency, 3D Polar gain, E-field, radiation pattern, and Axial Ratio are to be calculated and shown in fig. 7 fig. 8 fig.9 fig.10 fig.11 fig. 12 fig. 13 fig. 14 respectively at the solution frequency of 7 GHz.

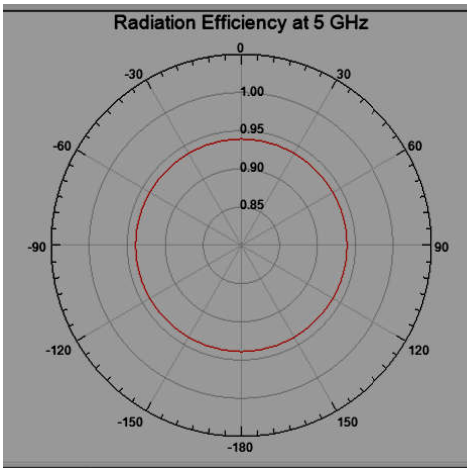

Fig 10 Radiation Efficiency at 7GHz

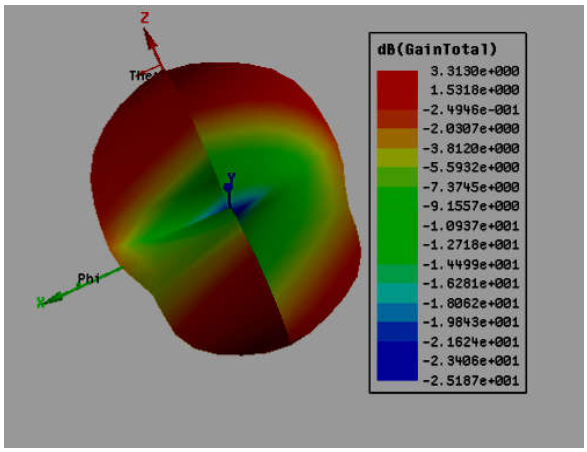

Fig 11 3D Polar Gain in db at 7GHz

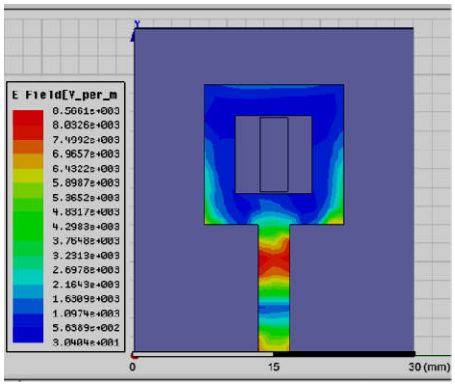

Fig 12 E Field at 7GHz

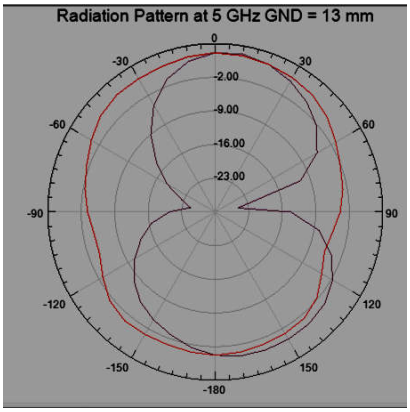

Fig 13 Radiation Patten at 7GHz

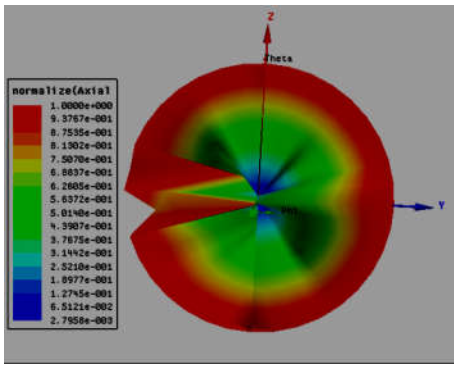

Fig 14 Axial Ratio at 7GHz

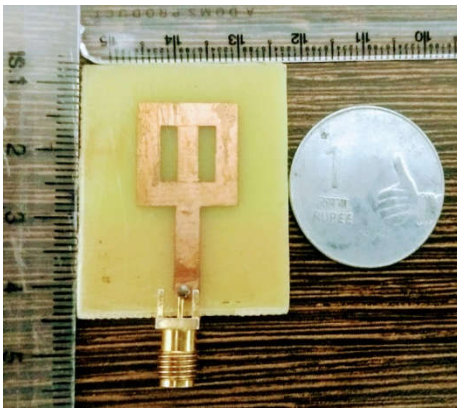

Fig 15 Fabricated Antenna on FR-4 Substrate

Fabrication

The antenna structure is fabricated on FR -4 substrate using Photolithography technique. The proposed design is tested on vector network analyzer. The top view and measurement set up of fabricated antenna is shown in Fig 15 and Fig. 16.

Fig 16 Measurement set up for Proposed Design

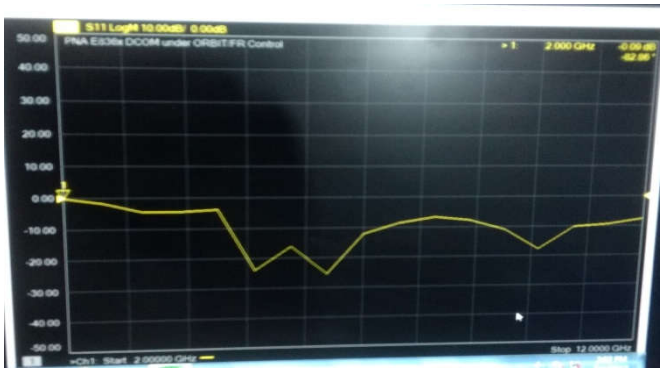

Fig. 17 Measured Result of S11 for Proposed Design

CONCLUSION

In this paper, the Dual band monopole patch antenna for WLAN, WIMAX, ISM applications is simulated using HFSS-13. The proposed antenna has advantages of small size, easy fabrication and simple construction. The simulated results of proposed antenna shows that return loss is less than -10 dB and VSWR is less than 1.5. The bandwidth is found of 4.3 GHz and 4.4GHz. It shows that the antennas can be good candidates for the operating frequency of 3.5 GHz and 7.5 GHz The return loss value of first band is 39.68 db and for second band are 18.0 db, radiation efficiency 93% and Antenna efficiency 80% calculated. Microstrip line feeding is used for transmission of EM wave.

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