International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 6 June 2022, pp: 961-967 www.ijaem.net ISSN: 2395-5252

Design of Dual Band Flexible Antenna for Wlan/ Wimax Applications Using Hfss

L. Sarika[1], V.Grishmika[2], S. SaiAkhila priya[3], S. Lavanya[4] , P. Samyuktha[5]

[1]*Assistant Professor, Department of ECE, Gayatri Vidya Parishad College of Engineering for Women*
[2]*Student, Department of ECE, Gayatri Vidya Parishad College of Engineering for Women*
[3]*Student, Department of ECE, Gayatri Vidya Parishad College of Engineering for Women*
[4]*Student, Department of ECE, Gayatri Vidya Parishad College of Engineering for Women*
[5]*Student, Department of ECE, Gayatri Vidya Parishad College of Engineering for Women*

Submitted: 01-06-2022 Revised: 10-06-2022 Accepted: 15-06-2022

ABSTRACT: This research paper is about to design a novel and compact dual band planar antenna for 2.4/5.2/5.8 GHZ wireless local area network WLAN/ WIMAX applications is proposed and studied. Dual band planar antenna can have any shape. In this paper we will design the T dual band, H dual band, F dual band rectangular antenna. This design simulation is done by using High frequency structure simulator software.
The parametric study is performed in order to understand the characteristics of the proposed antenna. The characteristics include return loss, radiation pattern, gain. Finally, these parameters are compared with each other to find out the desirable design. The return loss obtained after simulation indicates the suitability of this antenna for the WLAN applications.

KEYWORDS: Microstrip patch antenna, T-shape, H-shape, F-shape, dual-band, WLAN/WIMAX, HFSS

I. INTRODUCTION

Modern wireless and mobile communication systems require antenna which should have light weight, low profile, low cost and easy to be integrated with RF devices. This demand can be fulfilled by using dual band antennas.

Dual band antennas have lots of practical uses, especially for mobile devices. These antennas operate on two bands of frequencies (similar to radio stations) and can either work on these different frequencies one at a time or simultaneously, depending on the capabilities of the individual antenna

The concept of Microstrip antenna was first proposed in 1953, twenty years before the practical antennas were produced. Since the first practical antennas were developed in early 1970's, interest in this kind of antennas was held in New Mexico [4]. Dual frequency operationof antenna is very necessary in recent wireless communication system for some applications such as GPS, WLAN etc.

Microstrip antenna has been established as a separate entity in the field of microwave antenna because of its numerous advantages such communication base stations, and as small size, light weight, low profile, low cost, and ease of integration with other microwave components. It is being used in large variety of applications such as radar, missiles, aircraft, satellite communications, and mobile handsets as well as in biomedical telemetry services.

II. ANTENNA DESIGN EQUATIONS

The mathematical formula is used to calculate the dimensions of ground plane and patch in the form of length and width.

A. Width formula of Rectangular MSP is taken by

$$W = \frac{\lambda_0}{f_0\sqrt{(\varepsilon_r+1)/2}}$$

B. Formula of effective dielectric constant is taken by

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

At h=1.6mm

C. Formula of length extension is taken by

$$\frac{\Delta L}{H} = 0.412\frac{(\varepsilon_{reff}+0.300)\left(\frac{W}{H}+0.262\right)}{(\varepsilon_{reff}-0.258)\left(\frac{W}{H}+0.813\right)}$$

D. Length formula of Rectangular MSP is taken by

$$L_{eff} = \frac{C}{2f_0\sqrt{\varepsilon_{eff}}}$$

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E. Formula of length and the width of the ground plane are taken by

Lg= L + 6h

Wg= W + 6h

III.ANTENNA DESIGN AND CONFIGURATION

Proposed T Dual-band antenna design:

Figure 1 shows the geometry of the proposed T shaped antenna capable for dual-band operational characteristics. In our present design structure, the antenna is etched on both sides of FR-4 substrate with relative dielectric constant 4.4, thickness 1.6 mm, and a total area Ls*Ws is 70*60 mm2 . Also, the substrate used is having the metal thickness of 0.07 mm. The radiating structure consists of a two inverted L-shaped patches located symmetrically along the center line and separated by a small gap "g". The dimensions of wide vertical and horizontal arms of L-shaped patches are denoted as L1 and W1. The symbol L2 represents the length of narrow arm of L-shaped patches and "d" represents the width of narrow strips.

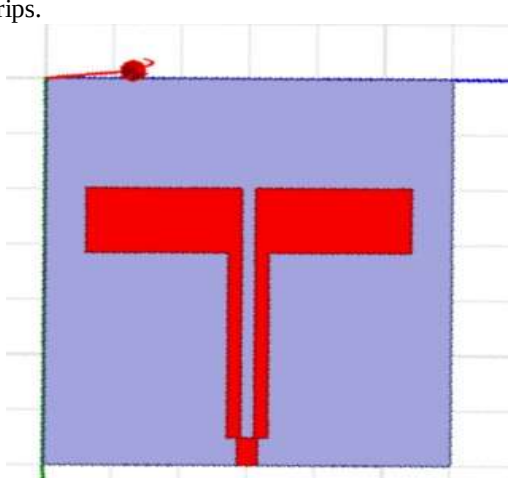

Fig.1.Design of T dual band antenna

Optimised Antenna dimensions are given in table1:

Antenna Dimension	Specification(mm)
W1	11.7
L1	23
D	2
L3	5
W2	3
L2	33.5
Ws	60
Ls	70
g	2

Table1: Dimensions of T

Proposed H Dual-band antenna design:

The design of proposed antenna is shown in fig 2. The proposed antenna is designed by substrate which has a dielectric constant 4.2 and the design frequency is 2.4GHz. Height of the dielectric substrate is 1.6mm.Antenna is fed through Microstrip feed line. Antenna dimensions are given in table2.

All the dimensions of proposed antenna are calculated by using the formulas A to E. Design frequency taken is 2.4GHz.

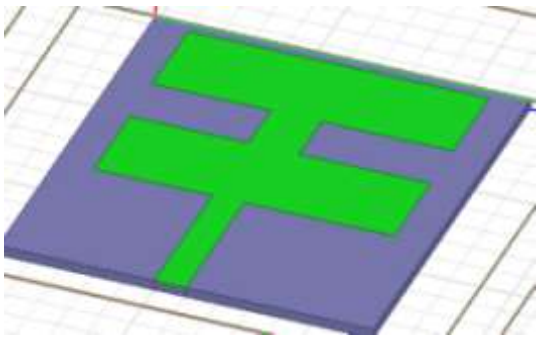

Fig.2.Design of H dual-band antenna

Optimised Antenna dimensions are given in table2:

Antenna Dimension	Specification(mm)
A	70
B	60
C	48
D	16
E	19
F	10
G	21
H	16

Table2: Dimensions of H

Proposed F dual-band antenna design:

An F-shaped monopole antenna with dual-band operation at 2.45 GHz (WLAN applications) and 5.45 GHz (WIMAX applications) is designed and simulated using Ansoft HFSS. The configuration of this proposed antenna is depicted in Fig. 1. It is printed on an FR-4 epoxy substrate with relative permittivity r = 4.4 and thickness h = 1.6 mm. The dual-band operation is obtained by tuning the lengths of the two resonant paths and relating them to the effective wavelengths at 2.45 GHz and 5.45GHz, respectively.

The design and dimensions of F dual-band antenna is shown in Fig.3 and table3

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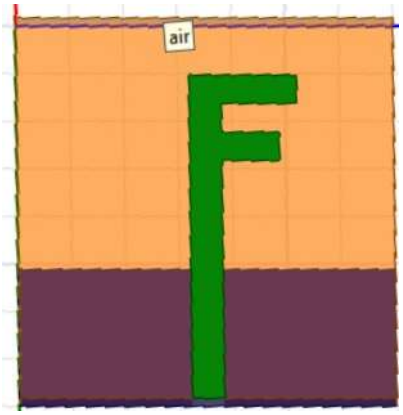

Fig.3. Design of F dual-band antenna

Optimised Antenna dimensions are given in table3:

Antenna Dimension	Specification(mm)
A	10
B	5.35
C	3
D	16.6
E	10.6
F	3
G	35
H	40

Table3. Dimensions of F

IV.SIMULATION RESULTS AND ANALYSIS

The proposed T dual-band rectangular microstrip antenna studied successfully and Since the proposed antenna has dual frequency band (3.2 GHz) and (5.2GHz) it is suitable for many applications.

The plot graph of return loss Vs frequency is taken at the two resonating frequencieswith the obtained return loss of -18.5 at 3.4 GHz ,-21.6 at 5.2GHzwhich is shown in Fig.4.1

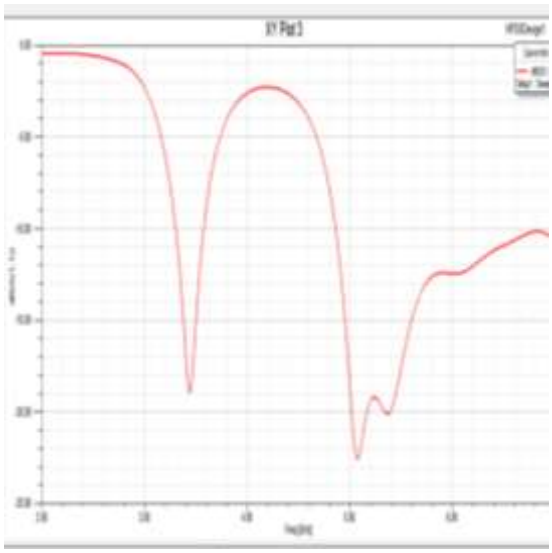

Fig.4.1 Return loss v/s frequency graphof proposed T dual-band antenna

In Fig.4.2the plot graph of VSWR Vs Frequency represents that the bandwidth of design antenna is useful or not. The obtain VSWR is 2.05 at 3.4GHz ,1.73 at 5.2 GHz.

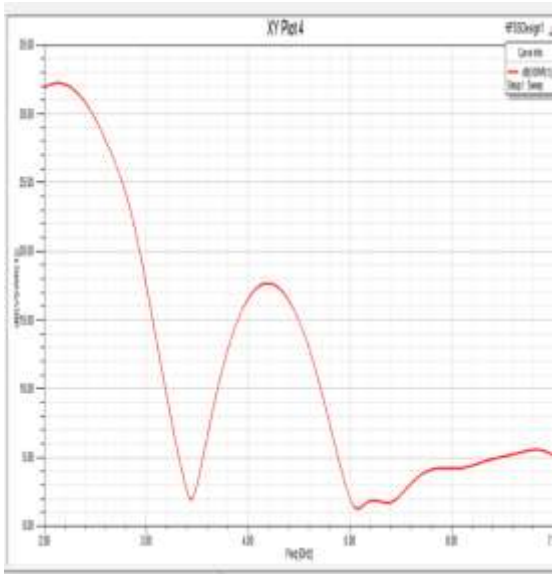

Fig.4.2 VSWR of proposed T dual-band antenna.

In Fig 4.3 the fractional bandwidth of proposed antenna is found to be 8.8% in first frequency band and 32.7% in second frequency band.

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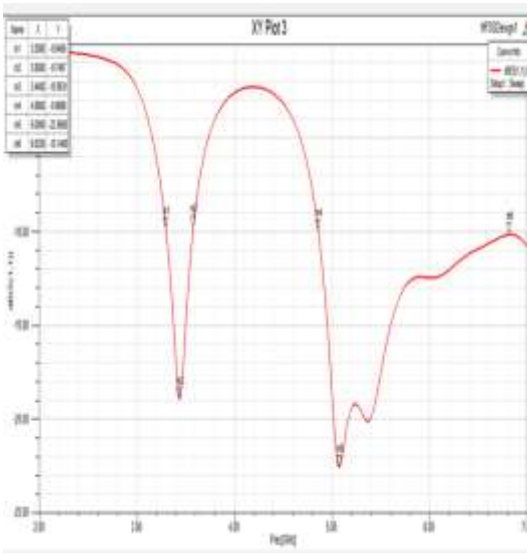

Fig.4.3 Bandwidth of proposed T dual-band antenna

In Fig.4.4 the plot graph of 3D Radiation pattern of proposed T dual-band antenna

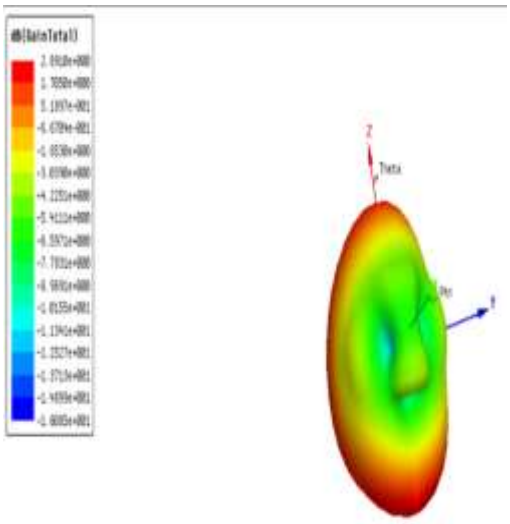

Fig.4.4 3D Radiation pattern of proposed T dual-band antenna

The simulation performance of proposed H dual-band micro strip patch antenna is analysed by using HFSS version 13.0 at select design frequencies of 3.2GHz and 5.45GHz. The performance specifications like gain, radiation pattern etc of proposed antenna is shown in the fig 4.5 to 4.8

The plot graph of return loss Vs frequency is taken at the two resonating frequencieswith the obtained return loss of -19.41 at 3.2GHz ,-19.28 at 5.45GHzwhich is shown in Fig.4.5

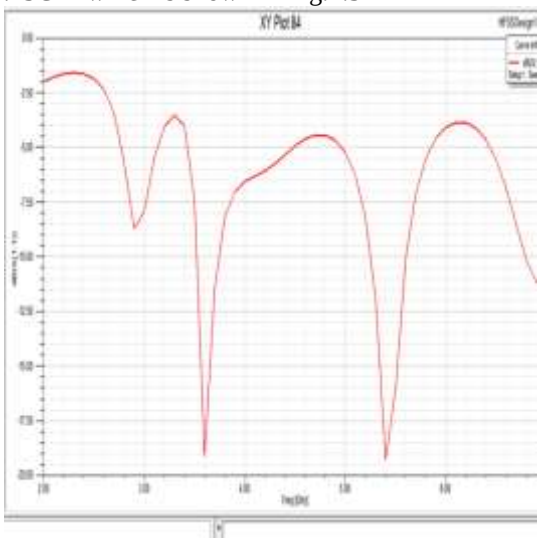

Fig.4.5 **Return loss v/s frequency graphof proposed H dual-band antenna**

In Fig.4.6the plot graph of VSWR Vs Frequency represents that the bandwidth of design antenna is useful or not. The obtain VSWR is 1.92 at 3.2GHz ,1.89 at 5.45 GHz.

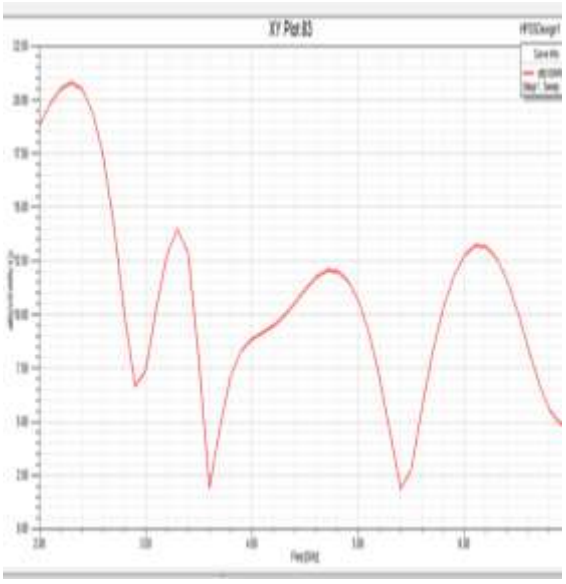

Fig.4.6VSWR of proposed H dual-band antenna.

In Fig 4.7 the fractional bandwidth of proposed antenna is found to be 5% in first frequency band and 6.66% in second frequency band.

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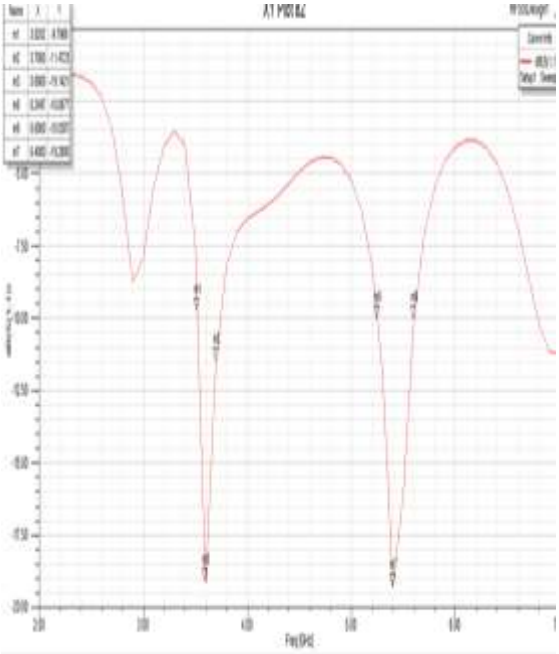

Fig.4.7 Bandwidth of proposed H dual-band antenna

In fig.4.8 the plotof 3D Radiation pattern of proposed H dual-bandantenna is shown.

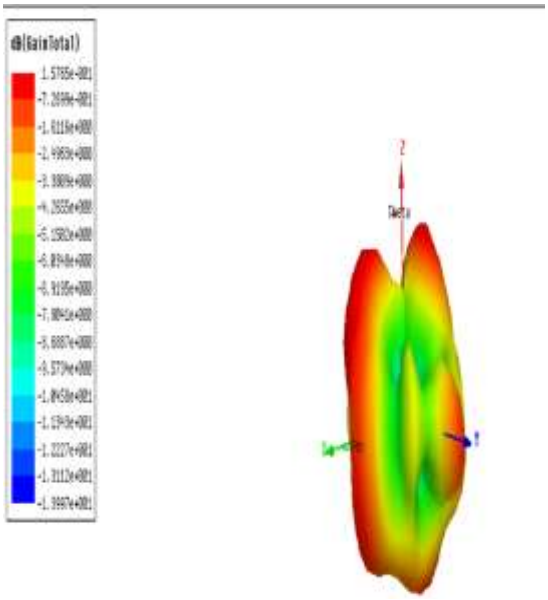

Fig.4.8 3D Radiation pattern of proposed H dual-band antenna

The Characteristics of antenna such as return loss, VSWR, radiation pattern etc of F dual band antenna is shown in the fig 4.9 to 4.12.The two resonating frequencies of F dual band antenna are 2.4GHz,5.4GHz.
The plot graph of return loss Vs frequency is taken at the two resonating frequencieswith the obtained return loss of -21.46 at 2.4 GHz ,-22.46 at 5.4GHzwhich is shown in Fig.4.9

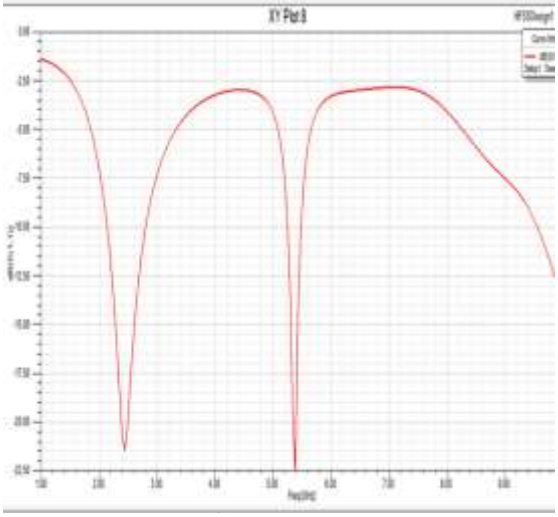

Fig.4.9 **Return loss v/s frequency graphof proposed F dual-band antenna**

The obtain VSWR of F Dual band antenna is 1.47 at 3.4GHz ,1.3 at 5.4GHzand the plot is indicated in fig4.10

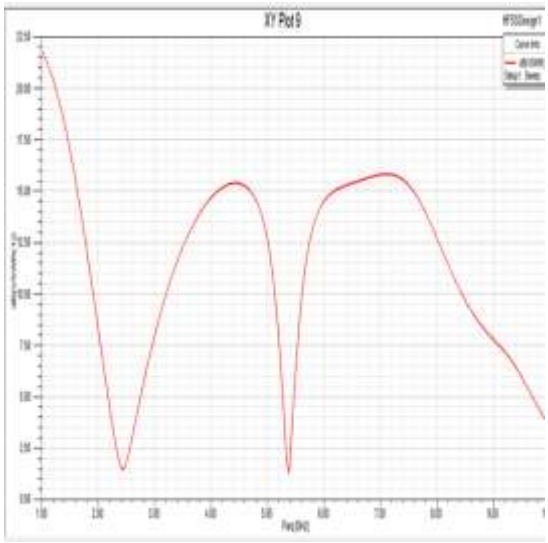

Fig.4.10VSWR of proposed F dual-band antenna.

In Fig 4.11 the fractional bandwidth of proposed antenna is found to be 27.45% in first frequency band and 4.08% in second frequency band.

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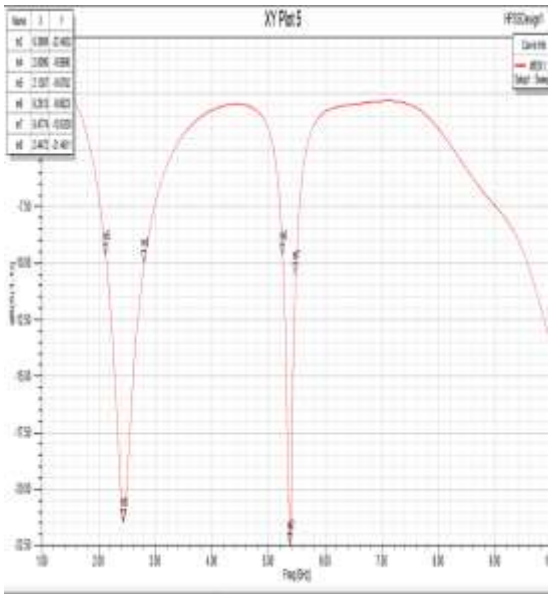

Fig.4.11 Bandwidth of proposed F dual-band antenna.

In fig.4.12 the plotof 3D Radiation pattern of proposed H dual-bandantenna is shown.

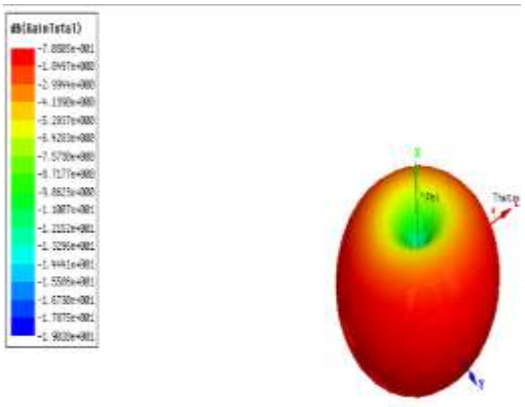

Fig.4.12 3D Radiation pattern proposedF dual-band antenna

V.COMPARISION:

Shape of the antenna	Return loss(dB)	VSWR	Bandwidth(%)
T dual-band at 3.4GHZ	-18.53	2.05	8.82
T dual-band at 5.2GHz	-21.62	1.73	37.2
H dual-band at 3.2Ghz	-19.41	1.92	5
H dual-band at 5.45Ghz	-19.28	1.89	6.66
F dual-band at 2.4Ghz	-21.46	1.47	27.45
F dual-band at 5.4GHz	-22.46	1.3	4.08

Table4: Simulated values of antenna parameters at each frequency

From the simulation results from table4, it is observed that the proposed F dual-band antenna has good return losses of -21.46 and -22.46 with the VSWR of 1.47 and 1.13 at 2.4GHz (WLAN applications) and 5.4GHZ (WIMAX applications).

VI. CONCLUSION:

In this paper three microstrip patch antennas are designed for dual band operation, which operates at WLAN and WIMAX applications. The T shaped dual band operates at two resonating frequencies, the first band operates at 3.4GHz with return loss -18.53 and second band operates at 5.2GHz with return loss -21.62. The achieved values of VSWR are 2.05 and 1.73 respectively. The H shaped dual band operates at 3.2GHz and 5.45GHz with return loss of -19.41 and -19.28 and the simulatedvalues of VSWR are 1.92 and 1.89 respectively. And the F shaped dual band antenna operates on two frequencies such as 2.4GHz and 5.4GHz. The first band operates with a return loss of -21.46 and VSWR is of 1.47 and the second band appears at 5.4GHz with the simulated return loss of -22.46 and the VSWR of 1.3. By comparing the above three dual band antennas we can conclude that F shaped dual band antenna has good return loss, VSWR, bandwidth and has less patch size compared to other dual band antennas. This proposed antenna has a promising performance such as dual band, low profile, simple feed network, easy fabrication and low cost. As F shaped dual band antenna covers two operating bands of 2.40GHz-2.48GHz and 5.4GHz-5.8GHz it is flexible to use in WLAN/WIMAX applications. Consequently, it also suitable for multi-frequency applications of wireless communication systems.

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