IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 4, April 2016

L-slotted Microstrip Patch Antenna for WiMAX and WLAN Applications

Danish Hayat

Bhagwant University, Ajmer, India

Abstract: This paper is based on design and simulation of rectangular Microstrip Patch Antenna with double L slots which covers the frequency range of WiMAX and WLAN applications. The basics and fundamentals of Microstrip patch antenna is also covered in this paper. The various parameters of the antenna are the dimensions of the patch and ground planes and the separation between them and this antenna is fabricated using an h=1.6mm thick FR4 substrate (ε_r=4.4). The design and simulation of the antenna is carried out using CST microwave Studio suite. The design is a double L shaped Microstrip Patch Antenna that uses defected ground plane which covers the entire WiMAX and WLAN range. Return loss curve, E-field, H-field, Voltage standing wave ratio (VSWR) for designed antenna are shown. The proposed antenna has return loss of -20 dB at 3.5 GHz and -14db at 10.2 GHz This shows that the proposed antenna covers WLAN and WiMAX range. This design results in a reduction in size and weight and allows easy integration in hand-held devices.

Keywords: Flame Retardant 4(FR4), worldwide interoperability for microwave access (WiMAX) and wireless local area network (WLAN), Computer Simulation Technology (CST), Voltage standing wave ratio (VSWR).

I. INTRODUCTION

The electronics has covered a big part of our life and the wireless communication is playing a big role in making daily life very easy. An antenna is a device that radiates electrical energy in the form of microwaves that contains some use full information and at the other end converts them back into electrical energy from the waves. These days Microstrip antennas became very popular because of their compact structure and utility in wide range of applications. These antennas consist of a metallic patch on a grounded substrate. The metallic patch can take many different configurations. However, the rectangular and circular are the most popular designs because they are ease to analyse and fabricate and their attractive radiation characteristics, especially low cross polarization radiation [9]. Microstrip patch antenna offers low cost, light weight multi application designs. By using this technology wide beam narrowband antenna can be fabricated easily by the help of printed circuit technology where a metallic layer is lodged on a dielectric substrate as a radiating element and another continuous metallic layer on the other side of substrate as ground plane. The size of Microstrip antenna is closely related to the wavelength of operation and if the wavelength is λ then the size of antenna would be equal to $\lambda/2$. The Microstrip antennas are used above the microwave frequency range because below this frequency range the λ will increase and so the size of antenna. These antennas can be used for communication on the surface of the high performance aircraft, satellites, space craft, missiles, cars and even handheld mobile telephones.

There is a huge demand for the design of antennas which can operate over multiple bands due their vital role played in wireless communication systems. In order to satisfy the WLAN recommendations at 2.4/5.2/5.8 GHz operating bands and WiMAX standard at 2.5/3.5/5.5 GHz bands, microstrip patch antennas are preferred due to their extraordinary features. Microstrip patch antennas show some important features which are low profile, light weight, low cost, conformance to planar and non-planar surfaces, simplicity and inexpensive manufacturability using modern printed circuit technology, mechanical robustness when mounted on rigid surfaces, compatibility with Microwave Monolithic Integrated Circuit designs, etc. Also, on selecting a particular patch shape and mode microstrip patch antennas are very versatile in terms of resonant frequency, polarization, pattern and impedance [1].

Microstrip patch antenna has tremendous scope in WLAN and WiMAX applications due to their low profile platform de- sign. In [2], a unipolar printed couple-fed Planar inverted-F antenna (PIFA) with a band-notching slit for WLAN/WiMAX applications has been demonstrated. Though it is smaller in size and covers all the operating bands, the maximum gain that can be obtained is only 6 dB. In [3], a printed microstrip line-fed rhombus slot antenna with a pair of parasitic strips has been presented. Though the bandwidth of the antenna is enhanced in this design, it results in complex antenna configuration. Fur- there in [4], a compact planar Ultra-Wideband (UWB) antenna with dual band-notched characteristics has been reported. This configuration is capable of reducing the interferences between the systems at the expense of reduced gain.

II. ANTENNA DESIGN

The parameters of the proposed antenna are given in the figure table. The antenna design consists of a rectangular

IJARCCE
ISSN (Online) 2278-1021
ISSN (Print) 2319 5940
International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 4, April 2016

shaped Microstrip patch. The material used for antenna is FR-4 material with thickness h=1.6 mm and Microstrip feed line (50Ω) is used for feeding. . The simulation results show that the antenna fulfills the requirement of WLAN and WiMAX range.

The radiating element used in this proposed antenna is copper and we prefer rectangular shape patches compared to other types since rectangular patches are the first and probably the most utilized patch conductor geometries.

Initially single microstrip patch antenna is designed and the performance metrics such as radiation pattern, VSWR, return loss and gain are simulated The front and back view of the proposed antenna is shown in Fig.1 & Fig.2. This is a simulation based study. The design and simulation of the antenna is carried out using CST microwave Studio suite.

Microstrip slot antennas are capable of producing omni directional radiation pattern. The effects of ground location on micro strip antenna are important considerations in designing this type of antenna. The location of the ground from the feed point determines the impedance matching.

The Fringing effects should also be taken into consideration as this has an important consequence on the performance characteristics of micro strip patch antenna. Since the dimensions of the patch are finite along the length as well as the width, the fields at the edges of the patch undergo fringing.

The amount of fringing is a function of patch dimensions, the height of the substrate and the dielectric constant of the substrate. To reduce fringing effects, the ratio between the length of the patch L and the height H of the substrate should be less than one. Fringing effects must be taken into account because they influence the resonant frequency of the antenna.

Therefore, while designing a micro strip antenna, ground location and fringing effects must also be considered. Two finite ground planes with the same width GW = 10.5 mm and length GL = 16.2 mm are situated symmetrically on each side of the CPW feeding line. The pro- posed antenna is designed and fabricated on a FR4 epoxy substrate with relative dielectric constant er of 4.4 and loss tangent of 0.02. The length of the slot is 5.7 mm and the slot width is 7.5 mm. The gap between the ground plane and patch is 3 mm. By adjusting the feed point, perfect impedance match can be obtained. The length of the patch is 19.3 mm and the width of the feed line is 3 mm.

Using the parameters given in the table 1, we can depict the length L of the patch as 19.3mm and width of the patch as 19.27 mm and the height of the patch was kept to the 1.6mm and the extension of the patch can be seen up to the 0.1mm and the length of the feed line is 19.2mm and the width of the feed line is 3mm and width of substrate is 26mm and length of the substrate is 40mm.

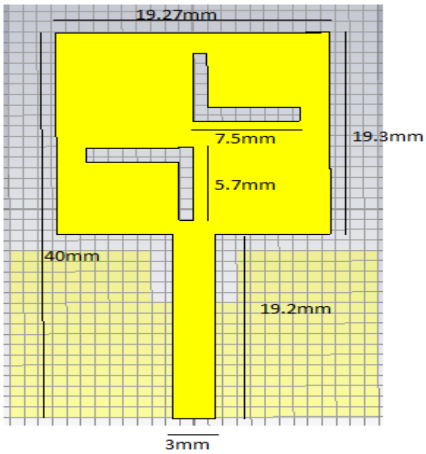

Figure 1: Front view of proposed antenna by CST Software

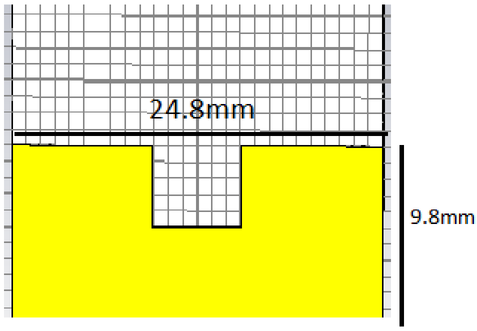

Figure 2: Back view of proposed antenna by CST Software

Effective dielectric constant can be given as

$$\varepsilon_{\text{eff}} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{H}{W}\right]^{-\frac{1}{2}}$$

The normalized extension of the patch is calculated by the formula given belove

$$\Delta L = 0.412 * H\frac{(\varepsilon_{\text{eff}} + 0.3) * (\frac{W}{H} + 0.264)}{(\varepsilon_{\text{eff}} - 0.258) * (\frac{W}{H} + 0.8)}$$

Length, width and effective length can be given by below formulas

$$L = L_{\text{eff}} - 2\Delta L$$

$$W = \frac{c}{2fo\sqrt{\frac{\varepsilon_r + 1}{2}}}$$

$$L_{\text{eff}} = \frac{c}{2fo\sqrt{\varepsilon_{\text{eff}}}}$$

The purpose of this paper is to present a new configuration of micro strip patch antenna array for WiMAX and WLAN applications. The antenna model consists of double L-slot microstrip patch antenna array with coplanar waveguide feed.

The radiating element used in this proposed antenna is copper and we prefer rectangular shape patches compared to other types since rectangular patches are the first and probably the most utilized patch conductor geometries. Initially single microstrip patch antenna is designed and the performance metrics such as radiation

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 4, April 2016

pattern, VSWR, return loss and gain are simulated. To increase the gain, a design of microstrip patch antenna array is also considered. The array consists of two single patches of antenna on the same substrate. The performance of a single patch antenna and a double patch antenna array is compared. It is one of the several commercially available tools used for antenna design, and the design of complex radio frequency electronic circuit elements including filters, transmission lines, and packaging.

1.1 Antenna Parameters

Parameters and their corresponding values are listed in the table .1. All the dimensions are in millimeter.

Table 1: Dimension of proposed antenna design

Parameter	Description	Value (mm)
L	Width of Patch	19.3
W	Length of Patch	19.27
h	Height of patch	1.6
Mt	Patch Extension	0.1
Lf	Length of feed line	19.2
Wf	Width of feed line	3
Ws	Width of substrate	26
Ls	Length of substrate	40

III. SIMULATION RESULTS

The S11 vs. frequency curve is shown below. The return loss curve shows that the antenna has bandwidth from 2.5 GHz to 4.3 GHz with a minimum S11 -20 dB at 3.5 GHz and -14db at 10.2 GHz This shows that the proposed antenna covers WLAN and WiMAX range.

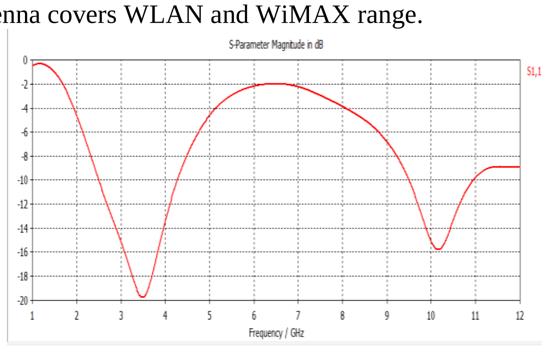

Figure 6: Return loss vs. frequency curve of proposed antenna.

The VSWR vs. frequency curve for the proposed antenna with Optimized parameters are shown below. The VSWR for the proposed antenna is 1.2280 that resemble with ideal value of VSWR.

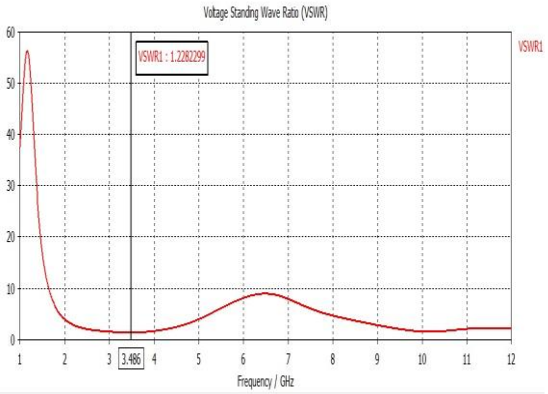

Figure 3: Voltage Standing Wave Ratio Curve

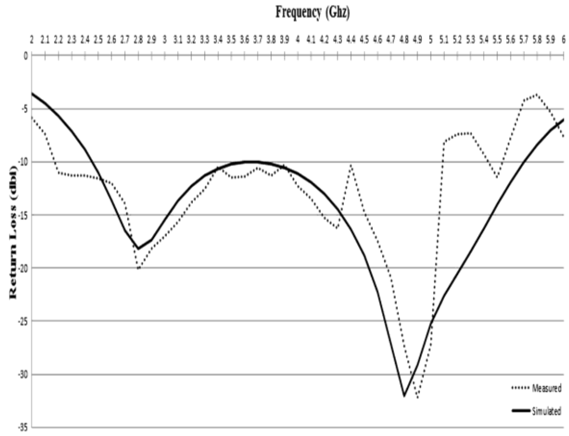

Figure 4: Simulated result loss of antenna

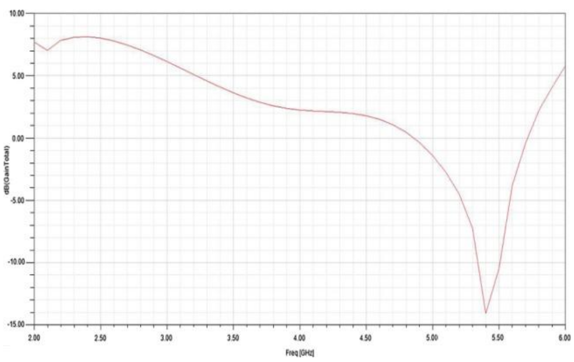

Figure 5 :Gain vs Frequency plot of antenna

Radiation pattern with principal E-plane and H-plane for the different frequencies are shown in figure.

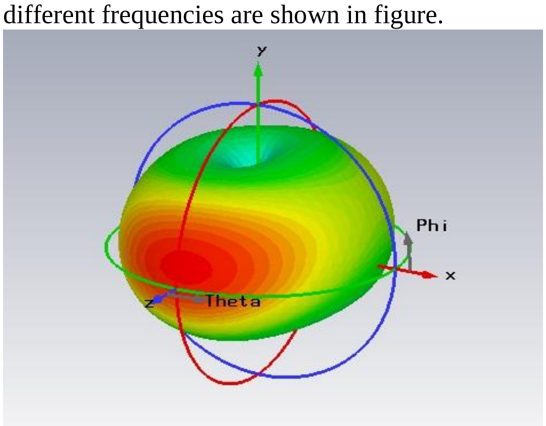

Figure 6: Realized 3D Design

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 4, April 2016

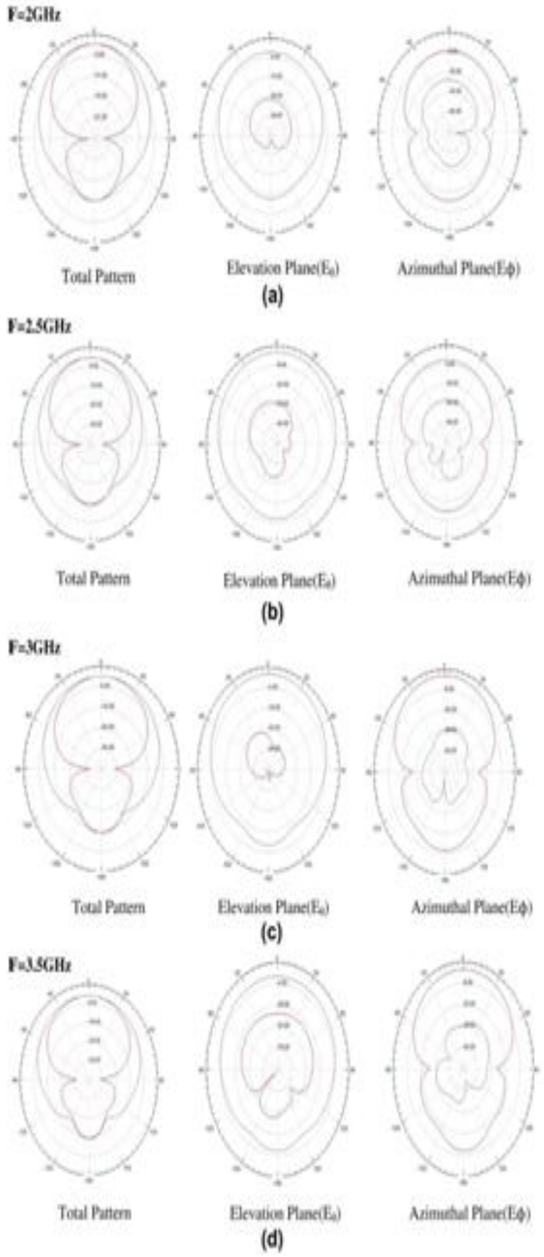

Figure 7:2D radiation pattern of antenna at 2Ghz,2.5Ghz,4Ghz and 3.5Ghz

The radiation pattern at various frequencies viz 2Ghz 2.5Ghz,4Ghz and 3.5Ghz can be seen in above diagram and it can be observed that the patterns are near to the desired results and the pattern complies with the various axis and dimensional results at different frequencies.

The total pattern as well as elevation plane and azimuthal plane is shown in the above digram.4Ghz ,4.5Ghz,5Ghz and 5.5Ghz radiation pattern is shown in thr next diagram.

At above given frequencies the results are also near to the desired results and complies with the standards of accepted parameters.

Hence it is observed that the antenna radiations are in the desired directions

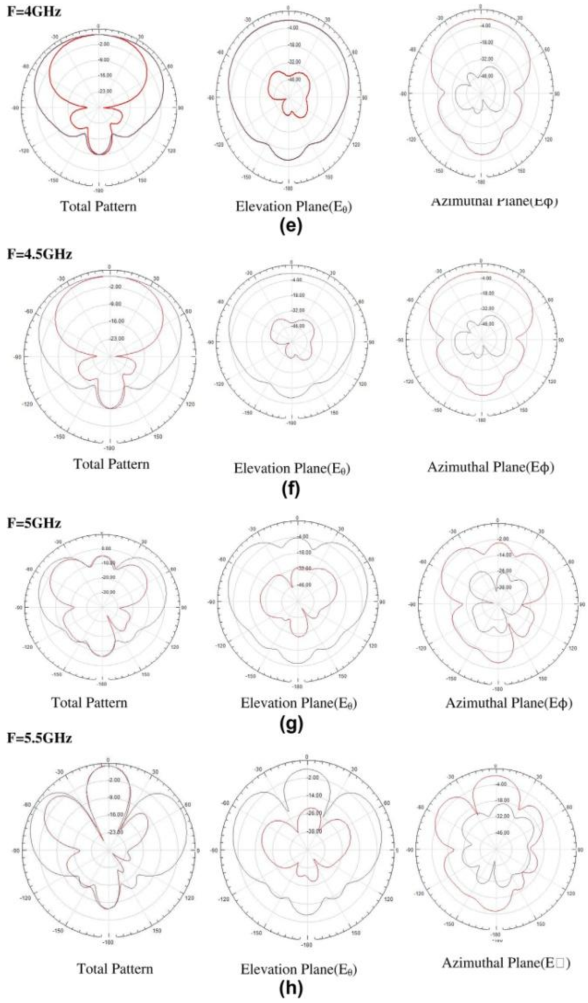

Figure 7:2D radiation pattern of antenna at 4Ghz,4.5Ghz,5Ghz and 5.5Ghz

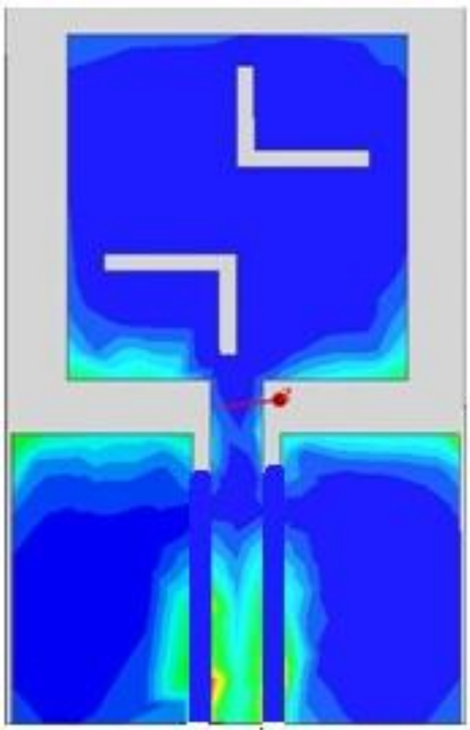

Figure 8:Current Diagram of antenna

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 4, April 2016

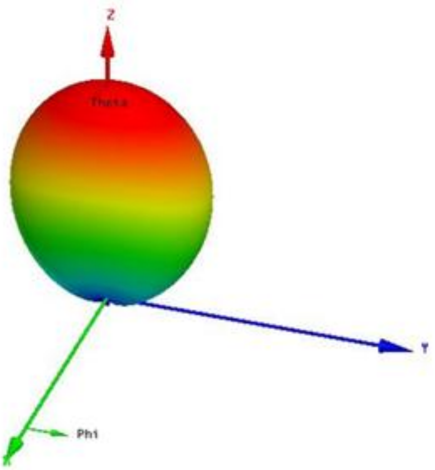

Figure 8:3D radiation Pattern of antenna

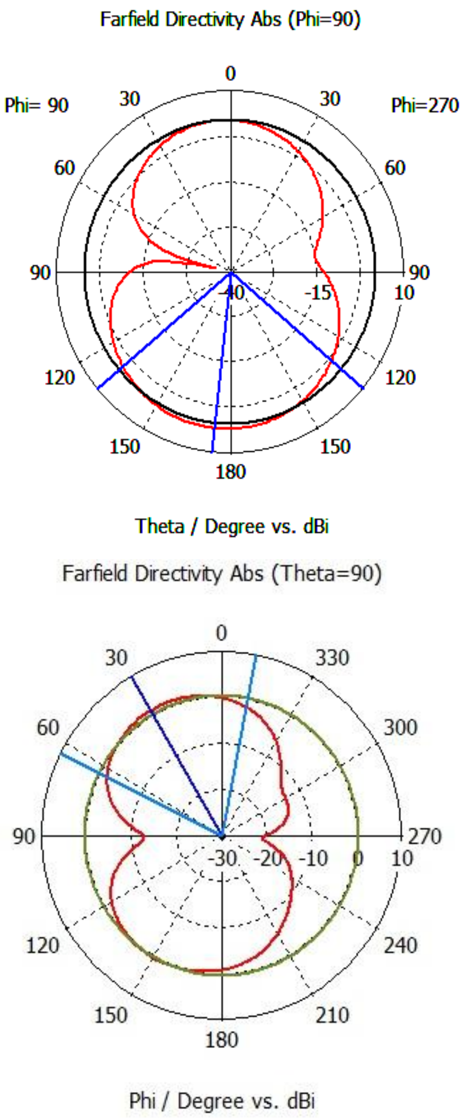

Figure 5: Radiation Pattern for frequency 5.5, 6 respectively.

We can observe that radiation patterns are omni directional at 5.5, 6 GHz have dumbly shape pattern The directivity for 5.5

IV. CONCLUSION

The design of a double L-slot microstrip patch antenna with rectangular feed technology for WLAN and WiMAX operating frequencies has been presented and discussed. I conclude that by employing two different slots, a good bandwidth and a perfect impedance match can be obtained. Further, the design resulted in smaller size antenna with good omnidirectional radiation characteristics for all operating frequencies. The measured and simulated results of return loss, VSWR are near to the desired results that show the antenna operates effectively in all the required WLAN and WiMAX communication bands.

ACKNOWLEDGMENT

I would like to adress a deep sense of gratitude towards **Mr. Prashant Singodiya** (Assistant Professor in Bhagwant University, Ajmer) for providing us with best facilities and his timely suggestions. My special thanks to M Tech colleagues **Tarun Dadheech** and **Chandraveer singh** for their help, cooperation and encouragement.

REFERENCES

[1]. W. Ren, "Compact dual band slot antenna for 2.4/5GHz WLAN applications", Progress In Electromagnetics Research B, vol. 8, 319–327, 2008

[2]. B.-K. Ang and B.K. Chung, "A wideband E-shaped microstrip patch antenna for 5-6 GHz wireless communications", Progress In Electromagnetics Research, vol. 75, pp 397–407, 2007.

[3]. Liua W-C, Wua C-M, Chu N-C. A compact low profile dual-band antenna for WLAN and WAVE applications. AEU Int J Electron C 2012;66: 467–71.

[4]. Su S-W. Compact four loop antenna system for concurrent, 2.4 and 5 GHz WLAN operation. Microw Opt Technol Lett 2014;56(1):208–15.

[5]. Balanis CA. Antenna theory, analysis and design. New York: John Wiley & Sons, Inc.; 1997.

[6]. Lee Cheng-Tse, Wong Kin-Lu. Uniplanar printed coupled-fed PIFA with a band-notching slit for WLAN/WiMAX operation in the laptop computer. IEEE Trans Antennas Propagat 2009;57(4).

[7]. P. Pigin, "Emerging mobile WiMax antenna technologies", IET Communication Engineer, October/ November 2006.

[8]. C.A. Balanis, "Antenna Theory Analysis and Design", 3rd edition, Wiley, New Jersey, 2005.

[9]. http://en.wiki.edia.org/wiki/WiMAX/Wlan.

[10]. "IEEE standard definitions of terms for antennas," IEEE Std 145-1983, 1983.

[11]. Y. P. Zhang and J. J. Wang, "Theory and analysis of differentially-driven microstrip antennas," IEEE Transactions on Antennas and Propagation, vol. 54, pp. 1092-1099, 2006.