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Design of Dual Band MIMO Antenna for Wlan/Wimax Application

[I]K.Kavitha, [II]Shanmuga Priya Rajan
[I]Associate Professor, [II]PG Scholar
[I,II]Mepco Schlenk Engineering College, Sivakasi, Tamil Nadu, India

Abstract
Recently, there is a demand to increase the data rate of existing wireless communication systems. The application of diversity techniques, most commonly assuming two antennas in a mobile terminal, can enhance the data rate and reliability without sacrificing additional spectrum or transmitted power in rich scattering environments. MULTIPLE-INPUTMULTIPLE-OUTPUT (MIMO) technology has attracted attention in modern wireless communication systems Multiple-input-multiple-output (MIMO) systems transmit the same power using multiple antennas at the transmitter and receiver thereby increasing the channel capacity without the need of additional bandwidth or power. In this paper a novel microstrip feed bowtie antenna for WLAN/ WiMAX operating at the frequency range of 2.3719-2.5839 and 4.8658-5.4368 is designed. The proposed antenna consists of bowtie patches loaded with slots above and below the substrate, The microstrip feed is designed in such a way that the two strips are narrower at the bottom and wider at the middle and again becomes narrower . Simulated impedance bandwidth of the frequency 2.3719-2.5839 and 4.8658-5.4368 is 8.4% and 22% respectively. The proposed antenna is designed in the ANSYS High Frequency Electromagnetics Suite(HFSS)

Keywords
MIMO, Bowtie, WLAN, WiMAX, Impedance Bandwidth

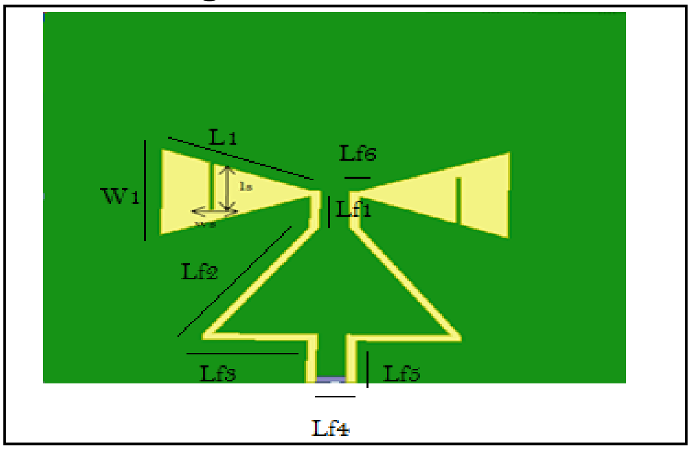
I. Introduction

In modern wireless communication system Multiple input Multiple output (MIMO) technology plays a significant role due to its ability to increase the spectral efficiency and reliability. Compact size ,light weight ,minimum cost, and ease of fabrication is the main constraint that would be considered while designing an antenna. Wireless LANs have become popular due to the ease of installation. Wireless Local Area Network otherwise called as wireless computer network consists of two or more devices using wireless distribution within limited area. This enables the users the ability to move around within a particular coverage area and yet to be connected to the network. In june 2001 the name WiMAX was created by the WiMAX forum to promote conformity and interoperability of the standard. Intially WiMAX was designed to provide data rates of 30 to 40 megabits per second. The original version of the standard on which WiMAX is based (IEEE 802.16) specified a physical layer operating in the 10 to 66 GHz range. 802.16a, updated in 2004 added specifications for the 2 to 11 GHz range In 2011 ,the WiMAX was updated providing upto 1 giabits for fixed stations. The bandwidth of WiMAX can be used for applications like portable mobile broadband connectivity ,Digital Subscriber Line (DSL),telecommunication services, IPTV services ,smart grids and metering .It can also provide internet access at homes .It is now commercially available to provide last mile broadband internet access in remote locations . A novel high gain dual band antenna covering IEEE 802.11a/b/g bands is presented in [1].In [2] triangular microstrip patch etched with two pair of slots is designed for WiMAX ,INSAT and WLAN applications .In [3] a wideband modified printed bowtie antenna is designed on the top and bottom of the substrate. In [4] a microstrip fed bowtie antenna is designed for GPS and WLAN. The designed .The designed antenna consists of two pairs of printed bowtie patched different dimensions that generate dual band characteristics. In [5] a single band circularly polarized antenna with dual feed is designed for RFID applications .In [6],[7] and [8] dual band antennas with single feed technique is designed have been proposed. A square slot antenna with symmetrical L strips is presented for WLAN and WiMAX application in [9]. By etching slots in the square cavity a single band broadside radiation is achieved and by placing the conductor strips at the center of the square slots four sides dual band broad side radiation is achieved in [10]. In [11] a broadband circularly polarized crossed dipole antenna is presented .The antenna covers BeiDou Navigation Satellite System, GPS, and GLNOSS bands. The antenna has a simple feeding structure, which uses an unequal power network. The designed antenna simply realizes 90° phase shift and four equal power divisions. In [12] a radiator with "C"-shaped strip and an "L"-shaped strip was designed for high band and low band respectively. It measured 3-dB axial-ratio (AR) bandwidths in the broadside. Bi-directional radiation patterns and stable gain was attained. A circularly polarized complementary antenna loaded with adjusting stubs was presented in [13].To achieve dual-band circular polarization, rectangular and L-shaped adjusting stubs are added.

In this paper a dual Band MIMO antenna is proposed for WLAN and WiMAX application. slots are cut along the edges of the bowtie antenna for satisfying the dual band nature.

In section two the design of the dualband MIMO antenna is discussed. In section three the simulation results of dualband MIMO antenna is presented.

II. Antenna Design



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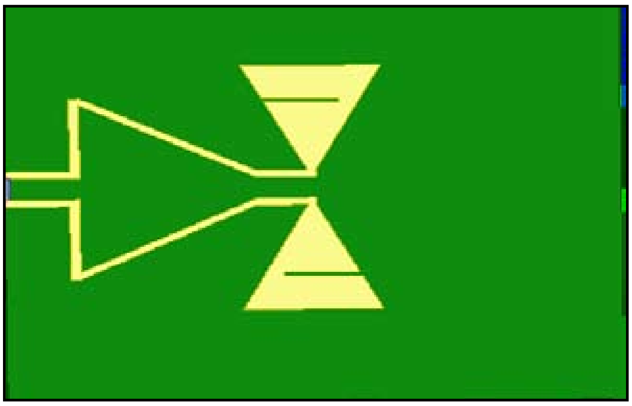


(b)

Fig 1:Structure of the single band MIMO antenna (a)Top view (b) Bottom view

The designed antenna is an MIMO antenna which consists of two antennas , antenna 1 is present on the top of the substrate and antenna 2 is present on the bottom of the substrate. Bowtie microstrip antennas have become attractive candidates in the present day communication due to their size that is smaller than the size of the conventional rectangular patch although they have similar characteristics and operations at the same frequency. A bowtie antenna is otherwise called as butterfly antenna or a biconical antenna. The bowtie antenna is a simplified two-dimensional structure using two triangular shapes separated by a small gap that resembles the shape of a bowtie. The bowtie antenna concentrates the energy and provides a good localization of electric field inside the feed gap, providing a strong near-field enhancement. The substrate used here is FR-4 substrate whose dielectric constant is 4.4 and the thickness of the substrate is 1.6mm.The overall dimension of the substrate is 63x63x1.6.A single band MIMO antenna without any slot on the patch is shown in the fig1.The bowtie antenna has an arm length of L1 and arm width of W1.The optimized parameter of the antenna in accordance to the configuration in Fig1 are asfollows:L_1=17mm,W_1=14mm,L_{f1}=6mm,L_{f2}=21mm;L_{f3}=11mm;L_{f4}=5mm,L_{f5} =7mm,L_{f6} =1mmFig 1a and Fig 1b shows the dual band MIMO antenna etched with slots in the radiating bowtie patches. One Slot is etched on the top in one arm of the bowtie antenna and another slot is etched in the bottom on the other arm of the bowtie antenna. After various trials the length and width of the slot is optimized to be 10 mm and 0.5 mm respectively. By etching slots in the edge of the bowtie dual resonance takes place ,i.e antenna resonates at two frequencies 2.5 GHz and 5.15 GHz. Similarly slots are etched on the radiating patches of the substrate found below the substrate.

III. Results And Discusion

1. Reflection Coefficient

S_{11} represents how much power is reflected from the antenna and hence is known as reflection coefficient .S_{11}= -10 dB implies that if 3 dB of the power is delivered to the antenna then -7dB is the reflected power. For an antenna to operate efficiently the return loss should be less than – 10dB. .

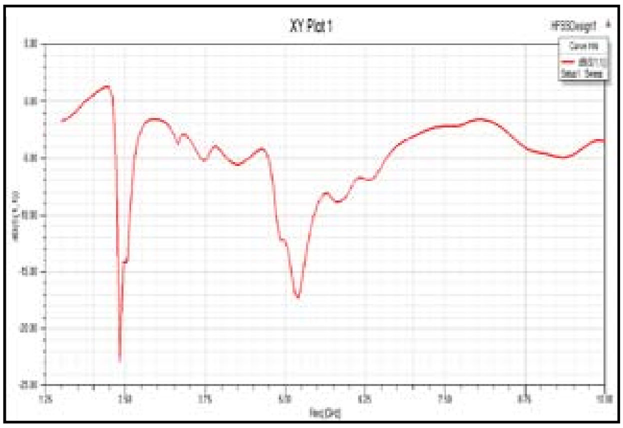
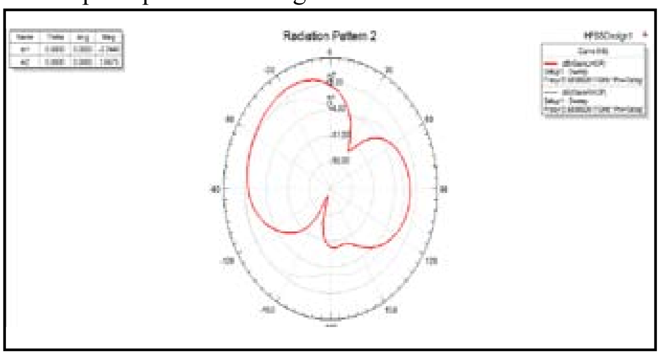


Fig. 5 : shows the reflection coefficient for the dual band MIMO antenna

Reflection coefficient S_{11} of the proposed dual band bowtie antenna is shown in Fig 5. Simulated impedance bandwidth of the frequency band for 2.3719-2.5839 and 4.8658-5.4362 are 8.4% and 22.8% respectively.

2. Radiation Pattern

The radiation pattern is a graphical depictions of the relative field strength transmitted from or received by the antenna and shows side lobes or backlobes .As antenna radiates in space often several curves are necessary to describe the antenna .The proposed antenna is circularly polarized. If the electric field vector propagates in the clockwise direction it is called as the right hand circular polarization, If the electric field vector propagates in the anti clockwise direction it is called left hand circular polarization The right hand circular polarization and left hand circular polarization at 2.5 GHz is shown in Fig 6a and 6b.Similarly Fig 6c and 6d shown the right hand polarization and left hand polarization at 5.15 at phi equal to zero degree.



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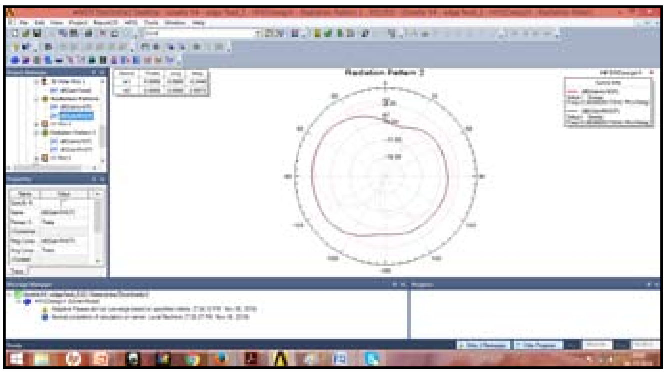

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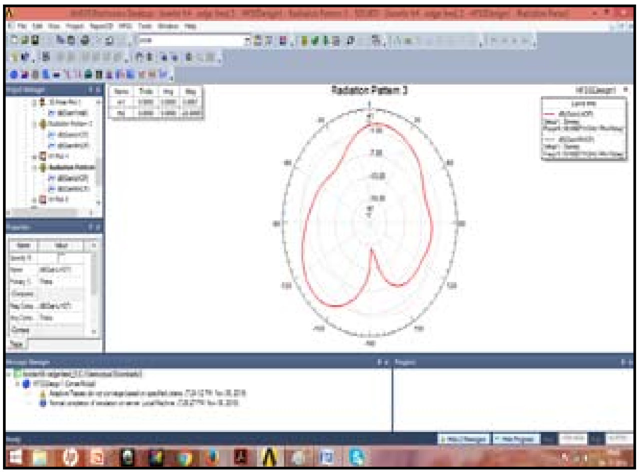

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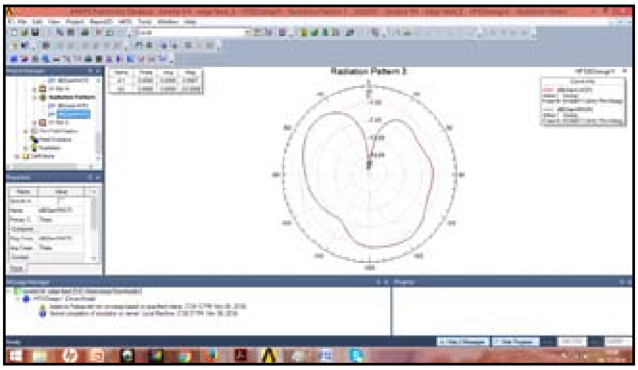

(d)

Fig 6: (a) and (b) shows the LHCP and RHCP of 2.5 GHz respectively.(c) and (d) shows the LHCP and RHCP of 5.15 GHz respectively .

Table 1 : Performance Comparison With Other Conventional Antennas

References	Bandwidth (GHz)	Peak Gain
[1]	2.4 GHz-2.52/ 5.1-5.85	4,10
[6]	2.4 /5.2 (4.8-5.57)	N.A
[7]	2.34-2.77 / 5.13-5.46	1.6/3.1
[13]	2.5 /5.8	1.3/2.8
This paper	2.3 -2.5 4.8 -5.4	1.8/13.07

Table 2 : Performance Comparison Of The Proposed Antenna With Other Mimo Antennas

References	Bandwidth (GHz)	Peak gain	ECC
[14]	2.4 - 2.5	1.57	NA
[15]	2.27 - 2.35	0.98	N.A
[16]	2.4 - 2.5 /5.15 -5.35	2.5/0.3	<0.29
[17]	2.4 -2.5 /5.45 -5.66	1.8/3	<0.1,0.07
[18]	2.18 /(5.03 -5.35)	N.A	<0.8
This paper	2.3-2.5 /4.8-5.4	1.8/13.07	<0.1,<0.001

The above table shows the comparison of the proposed antenna with other conventional and MIMO antenna .When compared with the other conventional antenna the gain of the proposed antenna is better .ECC is one of the important parameter which is to be analyzed in MIMO antennas. An ECC value of 1 represents the antenna are interconnected and a value of 0 represents they are highly isolated .A value of ECC less than 0.5 is said to have better performance .Here the obtained values of ECC are 0.1 for 2.3 -2.5 GHz band and 0.0001 for 4.8 GHz-5.4 GHz .Though the antenna operates similarly to other existing work in 2.3-2.5 GHz band the proposed antenna definitely outperformance other conventional and MIMO antenna at 4.8 to5.4 GHz

IV. Conclusion

A compact dual band MIMO antenna fed by microstrip line has been presented .The slots are etched on each arm of the bowie antenna present above and below the substrate to excite the antenna with extra frequency there by satisfying the dual band nature .The structure of the antenna is simple and easy to fabricate since microstrip feed is used. Since the FR-4 substrate is used as the dielectric material the proposed antenna is cost effective .Since the antenna is circularly polarized it is more resistant to signal degradation due to atmospheric conditions and has higher link reliability. Combining the features of MIMO antenna with circular polarization makes the antenna more attractive for wireless applications like WLAN and WiMAX .To design an antenna to resonate at multiple frequency might be the future work of this paper.

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Authors Profile

Mrs K.Kavitha is working as Associate Professor in Department of Electronics and Communication Engineering at Mepco Sschelnk Engineering College , Tamil Nadu, India.She has published about 11 Internationa journals on a wide variety of topics.She is a member of ISTE, MIIETE.She has done project for MSME and currently she is doing project for ISRO.

Ms Shanmuga Priya Rajan received her Bachelor of Engineering in Kalasalingam Institue of Technology and currently pursuing M.E Communication Systems in Mepco Schlenk Engineeering College,Tamil Nadu,. Her areas of interest are wireless communications, Electronics circuits and design and Antenna designing.