International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 01 | Jan -2017 www.irjet.net p-ISSN: 2395-0072

Single Band MIMO Antenna For WLAN/Wi-MAX Application

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Abstract - *A very compact Bowtie multiple input multiple output (MIMO) antenna for WLAN application is presented in this paper .The proposed antenna consists of two bowtie antenna present above and below the substrate. The designed antenna has been optimized by ANSYS HFSS for 2.3719 – 2.5839 GHz. The microstrip feed is designed in a triangular shape in order to provide port isolation. The simulated results of the designed antenna have been illustrated in this paper. The bandwidth obtained is 8.4 %.*

Key Words: **MIMO, HFSS ,bandwidth ,microstrip feed, Bowtie.**

1.INTRODUCTION

In conventional wireless communication ,a single antenna is used at the source and destination. In some cases this gives rise to problem with multipath effects .When an electromagnetic wave travels from source to destination ,it is obstructed by hill, buildings and utility wires etc. The wave fronts are scattered and thus they take many paths to reach the destination. Fading cutout and intermittent reception many paths to reach. These effects can cause a reduction in data speed and increase in the number of errors. Thus the use of two or more antennas along with the transmission of multiple signal at the source and destination eliminate the trouble caused by and even take advantage of this effect. MIMO technology has aroused interest because of its possible applications in digital television (DTV).wireless local area networks (WLANS), Metropolitan Area Network(MANs) and mobile communication.

Wi- Fi or Wireless Fidelity has a range of about 100m and supports faster data transfer rate at the speed of 10-54 MBPS .There are three different standards under Wi-Fi,802.11a,802.11b,802.11g.The Institute of electrical and electronic engineers set 802.11 as the wireless standard set .Wi-Fi is used to create Wireless local area network. The IEEE 802.11 g is expected to grow rapidly. These two standards are relatively expensive and can be found providing wireless connectivity in railway stations, airports. restaurants and other public places.

Wi-MAX is the world wide Interoperability for Microwave access. The IEEE standard for Wimax is 802.16 and falls under the category of wireless metropolitan area network. This enables the smaller wireless lans to be interconnected by Wi-MAX creating a large wireless MAN. Wi-MAX operates in 2-11 GHz .Wi-MAX is also suited to provide the backbone services for and large corporations providing wireless networking and internet access.

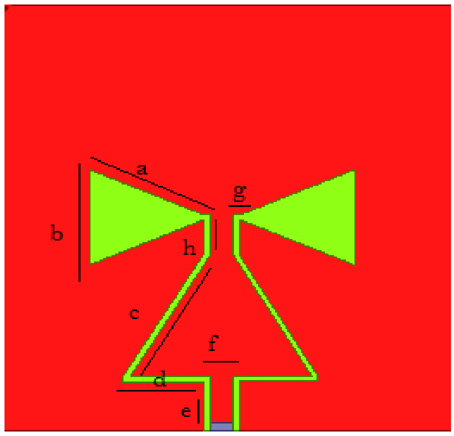
In [1] a microstrip patch antenna for WLAN is designed which is operating at the frequency range of 5 GHz to 5.5 GHz .The return loss obtained for 5.2 GHZ is -55.68 dB. In [2] a three element single band printed inverted F antenna system operating in the 28 GHz band for the millimeter wave (mm Wave) fifth generation (5G) wireless communication is presented .The return loss obtained is less than -20 dB. In [3] a rectangular microstrip patch antenna for 2.4 GHz communication using defected ground structure is designed the return loss obtained is less than -20 dB .In [4] single band array antenna with rectangular patch using polymide substrate is designed .The resonance occurs at %.25 GHz with return loss less than -14 dB .The VSWR value for the designed antenna for 5.25 GHz is 1.5.In [5] single band microstrip patch antenna having narrow operating bandwidth around GSM 900 band has been designed simulated. In [6] a single band a single band microstrip patch antenna for Wi-MAX is designed. The designed antenna operates at 3.41 GHz -3.64 GHz band with corresponding bandwidth 223 MHz. The gain of the designed antenna is 3.8 dBi and directivity of 4.51 dB. A single band rectangular patch antenna for WLAN application at 5.21 GHz is designed .The antenna has a frequency bandwidth of 196 MHz (5130 MHz-5300 MHz).The return loss value obtained is -47 dB. In [8] microstrip fed single band circularly polarized dielectric resonator antenna is designed. The fractional bandwidth is 67%.

2 ANTENNA DESIGN

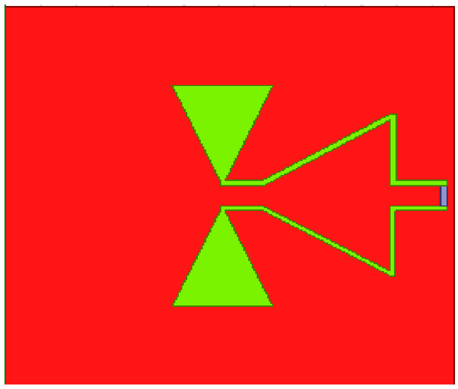
The geometry of the proposed Single band MIMO antenna is shown in Fig 1.It is printed on the FR-4 substrate with compact size of 63x63 mm and relative dielectric constant of 4.4. **FR-4** (or **FR4**) is a grade designation assigned to glass-reinforced epoxy laminate sheets, tubes, rods and printed circuit boards (PCB). FR-4 is a composite material composed of woven fiberglass cloth with an epoxy resin binder that is flame resistant. The material is known to retain its high mechanical values and electrical insulating qualities in both dry and humid conditions. These attributes, along with good fabrication characteristics, lend utility to this grade for a wide variety of electrical and mechanical applications. FR-4 is the primary insulating backbone upon which the vast majority of rigid printed circuit boards (PCBs) are produced. A thin layer of copper foil is laminated to one or both sides of an FR-4 glass epoxy panel. The top layer consists of bowtie antenna which is fed by a microstrip. Bowtie antenna is otherwise called as butterfly antenna or biconical antenna .Bowtie antennas have better directivity compared to other antennas such as horn and it is easier to fabricate in single microstrip boards..The bottom layer consists of a bowtie antenna which is placed orthogonally to the first antenna. The resonant frequency of the antenna f_r is 2.5 GHz. The design parameters optimized for the antenna are shown in the table :

Table- 1 : Shows the design specifications of the proposed antenna

Parameter	Value (mm)
Length of the substrate	63
Width of the substrate	63
Length of the bowtie arm (a)	17
Width of the bowtie arm (b)	14
Length of feed (h)	6
Length of feed (c)	21
Length of feed (d)	11
Length of feed (e)	7
Length of feed (f)	5
Length of feed (g)	1
Thickness of the substrate	1.6



(a)



(b)

Fig -1: Shows the structure of the designed MIMO antenna a) Top View b)Bottom View.

The specifications of the antenna designed on the backside of the substrate is same as the first antenna designed on the top of the substrate expect with the difference in the position of the antenna, which is placed orthogonal to the first antenna

3. RESULT AND DISCUSSION

3.1 Reflection Coefficient

Fig 2 shows the reflection coefficient of the single band MIMO antenna. According to maximum power transfer theorem ,the maximum amount of power will be transferred when there is perfect match between devices. Transfer between the feedline antenna takes place when the input impedance of antenna must identically match with characteristic impedance of feed line .If any mismatch in impedance results in return of energy back to the source called return loss. An antenna is said to be efficient if the return loss is below -10 dB. In the figure given below the return loss is below -10 dB for 2.4889 GHz to 2.611 GHz .The bandwidth obtained is 12%.

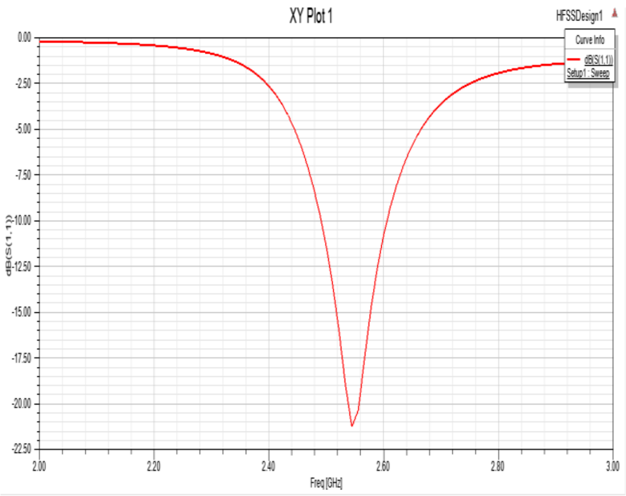


Fig-2: Shows the return loss of the proposed MIMO antenna.

3.2 VSWR

The VSWR measurement describes the voltage standing wave pattern that is present in the transmission line due to the phase addition and subtraction of the incident and reflected wave. It is also defined as the ratio of maximum radio frequency voltage to the minimum radio frequency voltage along line .For the obtained frequency the VSWR value is 1.1.The VSWR value should be less than 2.When the VSWR value exceed 2,the transmission line has significant loss in it.

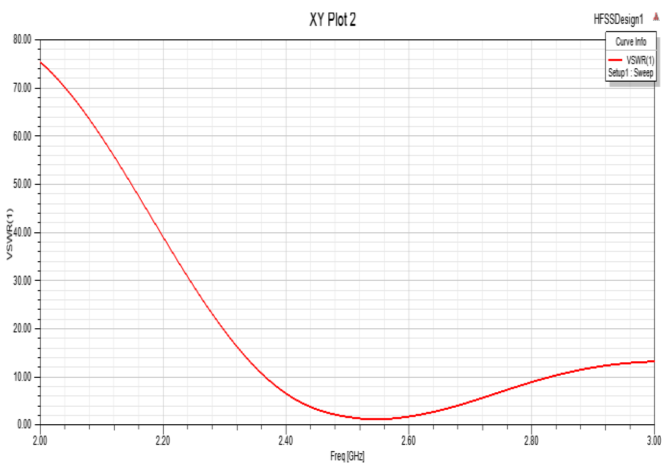
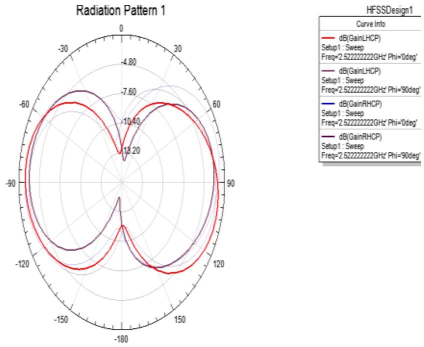


Fig-3: Shows the voltage standing wave ratio of the proposed antenna .

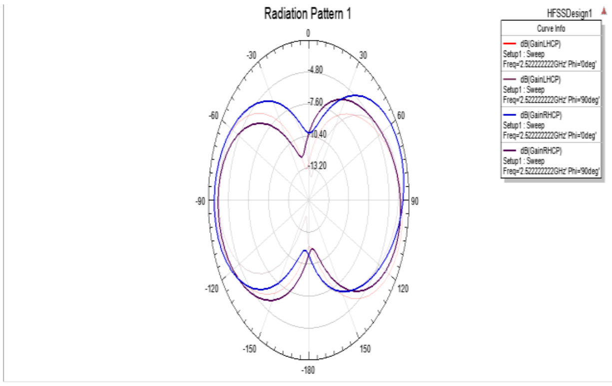
3.3 Radiation Pattern.

The radiation pattern or antenna pattern is the graphical representation of the radiation properties of the antenna as a function of space .That is the antennas pattern describes how the antenna radiates energy out in the space.

The following figure shows the radiation pattern left hand and right hand circularly polarized antenna. Since the antenna is circularly polarized it is not prone to faraday effect. Circular polarization is more resistant to signal degradation.



(a)



(b)

Fig -4:Shows the radiation pattern at 2.5 GHz (a) Left hand polarization (b) Right hand polarization.

3.4 Envelop Correlation Coefficient

Envelop correlation coefficient is an important parameter to be analyzed in MIMO antenna .A correlation value below 0.3 -0.4 is usually considered a good value for MIMO antenna .A value of 0 denotes that the antenna is highly uncorrelated and a value of 1 denotes that antenna is short circuited.

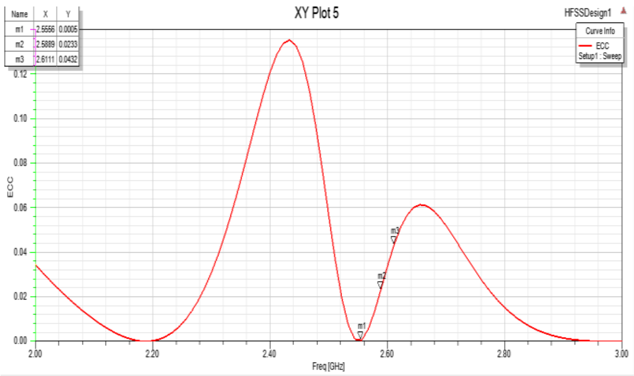


Fig -5: Shows the envelop correlation coefficient of the proposed antenna**.**

4.CONCLUSION

Thus a single band MIMO antenna which operates from 2.3 GHz to 2.5 GHz is proposed which is not only used for WLAN application but also for other wireless application. Thought the proposed antenna is just a single band antenna, it is an MIMO antenna which satisfies the demand for high data rates and spectral efficiencies when compared to conventional antenna. The structure of the proposed antenna is a bowtie antenna which is an another advantage since it falls under the category of frequency independent antennas. The peak gain of the antenna is 1.6..Making the antenna resonate at multiple frequencies may be the future works of the paper.

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BIOGRAPHIES

Mrs K. Kavitha is working as Associate Professor in Department of Electronics and Communication Engineering at Mepco Schlenk Engineering College , Tamil Nadu, India. She has published about 11 International 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.

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