Design of multiband microstrip patch antenna for wireless communication

[1]Rajashree Thakare, [2]Ujjaval Mehta, [3] Siddhesh Mayekar, [4] Dhanshree Salekar

[1] Assistant Professor, [2] Student, [3] Student, [4] Student
[1]Electronics and Telecommunication,
[1]Bharati Vidyapeeth College of Engineering, Navi Mumbai, India

Abstract : Over the past few decades, due to fast advancement in wireless communication technology, use of small size antenna has rapidly increased. Not only the size of the antenna but its cost, performance, ease of installation everything have been taken care while designing the antenna. To meet this entire requirement, micro-strip patch antenna is proposed. The main objective of this paper is to design and to simulate micro strip antenna for multiband applications. In this work Microstrip line-feed feeding technique is used. The antenna is designed using FR-4 epoxy substrate which has a dielectric constant of 4.4 and loss tangent of 0.02 along with dimensions of 48x40x1.5 mm3.The proposed antenna calculations are done for the frequency 2.4GHz, 5.8GHz, 24GHz, 60GHz. The Return loss, Impedance, VSWR, Efficiency, Gain and Radiation pattern are simulated & comparison of all these parameters for strip line is studied. HFSS software is used for simulation and design of micro strip patch antenna using line feed where its version is 15.0. High Frequency Structure simulator (HFSS). This software was launched by the ANSOFT. It's main objective is used for MIMO applications, WLAN, Wi-MAX mobile communications, satellite space communications. The antenna resonates at 2.46 GHz, 5.78 GHz, 24.125 GHz and 61.25 GHz. Prototype for the antenna is fabricated and measured. The antennas meet the requirements specifications for 802.11 WLAN along with the Bluetooth standards.

Index Terms **–Microstrip antenna, line feed, multiband antenna, HFSS, compact antenna.**

I. INTRODUCTION

Over the past few years, the trend of wireless communication systems has increased tremendously and as a vital part of these systems, antenna is one of the most important designs used in modern mobile communication systems. So an antenna can be defined as, metallic device used for transmitting or receiving the EM waves. Antenna works like a transducer which converts electrical energy into EM energy at transmitter side and it converts EM energy to electrical energy at receiver side. There are different types of antennas used in practical life which are as follows – Wire Antennas, Aperture Antennas, Microstrip antennas, Array antennas, Reflector Antennas and Lens Antennas. Now a days in Mobile communication, wireless technology there is an increased demand for compact and low profile antennas. For that microstrip antennas are best choice for use and handling because of its attractive features such as Miniaturized structure , light weight, easy designing & fabrications, inexpensive to manufacture using modern printed-circuit technology, simple geometry and compatibility with monolithic microwave integrated circuits(MMIC)[1]-[2]. A Microstrip antenna in its simplest form consists of a radiating patch on one side and ground plane on the other, which is separated by a layer of dielectric substrate. However, the MSA of different shapes are used such as the square, circular, triangular, semicircular, sectoral, and annular ring shapes. Microstrip antennas have important applications especially in the field of medical, military, mobile and satellite communications [3]-36.

II. MICROSTRIP ANTENNAS

An MSA in its simplest form consists ofa ground plane on the one side of a dielectric substrate and a radiating patch on other side. The top and side views of a rectangular MSA (RMSA) are shown in Figure 1 [2]

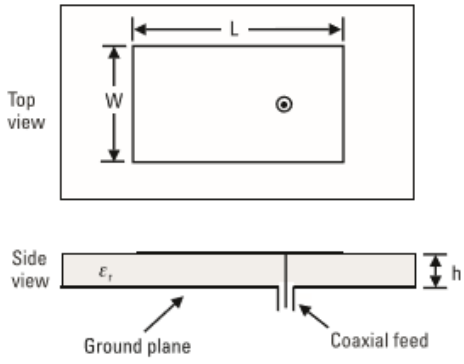

Fig.1 : Top view and Side View Of RMSA

1. FEEDING TECHNIQUES

Micro strip patch antennas are fed in four different techniques 1) Contacting and 2) Non-contacting. In contacting method RF power is fed directly to the radiating patch using a connected element, they are micro strip feed and coaxial feed [1-3]. In non-contacting method electromagnetic coupling is done to transfer the power between the feed line and radiating patch they are aperture coupled feed and proximity coupled feed. In this micorstrip line feed technique, a conducting strip is connected directly to the edge of the microstrip patch. In coaxial feeding technique the inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane.

III. LITERATURE SURVEY

Various papers related to multiband microstrip antenna were related in the proposed project. The basic information and knowledge about various types of antenna was gained. The following are the papers about various antenna.

In the book "Antenna Theory" analysis and design 3rd edition published by Wiley By Constantine .A. Balanis It told us about various antenna like the linear wire antenna, loop antenna, dipole antenna etc. It also showed the design parameters of the antenna and told us how we can design our antenna and the measuring formulas for it**[1]**.The smart antennas basically focus on the radiation pattern of the antenna and improving it but our project was on the bandwidth enhancement of the proposed antenna. The paper basically told us about the smart and the adaptive techniques for the mobile communication antenna. It presented brief idea about the antenna for futuristic use in mobile handset communication application**[4].** A space-time processor (smart antenna) is capable of forming transmit/receive beams towards the mobile of interest. At the same time it is possible to place spatial nulls in the direction of unwanted interferences. This capability can be used to improve the performance of a mobile communication system. Finally studying some papers on antennas for mobile communication application we decided to to prepare our antenna on mobile communication application. So we started finding various papers related to the microstrip patch antenna**[5]**.A single feed microstrip antenna was proposed which was designed at frequencies obtained by this antenna were 2.16GHz, 2.68GHz, 3.22GHz &4.37 GHz. Since our project was based on the frequencies of 2.45GHz, 5.8GHz, 24.25GHz ,61.25GHz. so for that the expected shape for the antenna was rectangle. After deciding the type and shape of the antenna i.e. rectangular microstrip patch antenna. We started finding out various designing software for our project. Some were HFSS and IE3D. We decided to start the process of designing on the HFSS software **[6]**.

IV. DESIGN OF COMPACT MULTIBAND MICROSTRIP PATCH ANTENNAS

In this design, antenna for important wireless applications which lie in the band starting from 900MHz to 5.5GHz which includes the GSM (880-960) GPS (1568-1592MHz),(1710-1880MHz),and PCS (1850-1990MHz), UMTS (1920-2170MHz), IEEE 802.11 b/g(2400-2484) and WLAN IEEE802.11a bands (5.155.35GHz, 5.725-5.825GHz). In this design different type of antenna such as i) multi-standard patch antenna ii) rectangular fractal antenna iii) circularly polarized microstrip patch antenna iv)multi standard patch antenna v)E-shape and U-shape. Gain and directivity is calculated for each antenna. This antenna will cover the wide band operation and can be applied to multiband wireless communication system due to its small size and low fabrication cost. Following parameters are considered while designing the microstrip antenna:

1. Width of patch(W)	$W = \frac{C_0}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}}$
2. Effective permittivity	$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-1/2}$
3. Effective length of patch	$L_{eff} = \frac{C_0}{2f_r\sqrt{\varepsilon_{reff}}}$
4. $\frac{\Delta L}{h}$	$0.412\frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)}$
5. Actual length of patch (***L)***	$=L_{eff}-2\Delta L \quad \frac{C_0}{2f_r\sqrt{\varepsilon_{reff}}} - 2\Delta L$
6. Feed position(χ_f)	$\frac{L}{2\sqrt{\varepsilon_{eff}(L)}}$
7. Length of substrate(L_g)	$6h + L$
8. Width of substrate(W_g)	$6h + W$

Table 1: Antenna Measurement Parameters

Antenna Parameters	Dimensions (in mm)
Lg(Length of Substrate)	40
Wg(Width of Substrate)	48
Lp(Length of Patch)	29.5
Wp(Width of Patch)	38
L1(Length of feed line)	11
W1(Width of feed line)	3

Table 2: Design Parameters of Antenna

V. ANTENNA SIMULATION AND RESULTS

After designing the antenna on the HFSS software, here are some of the output results for the same design. Here VSWR graph and Smith Chart, Return Loss, 2D& 3D both Radiation Pattern,

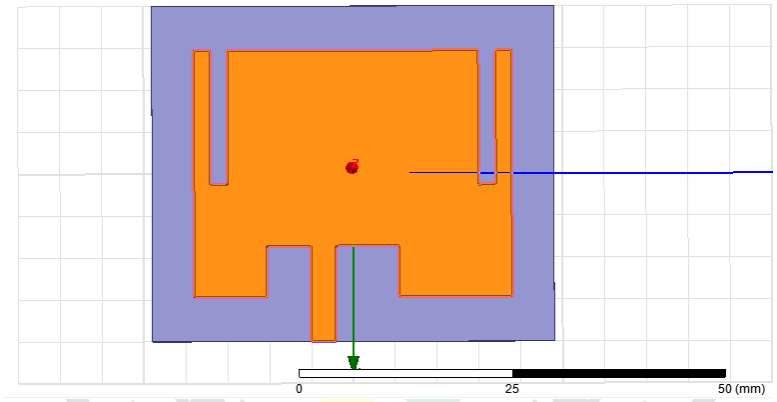

Fig. 2 :Software Design of Microstrip Patch Antenna

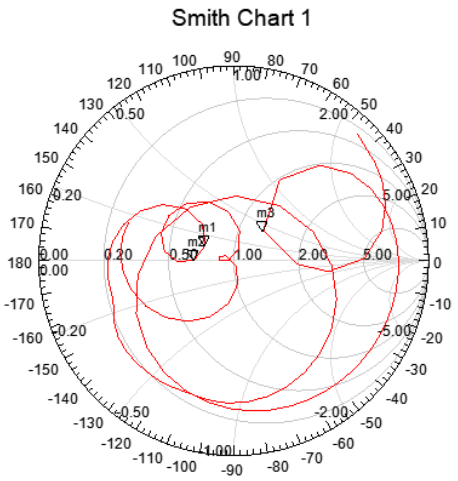

Fig 3: VSWR Smith Chart

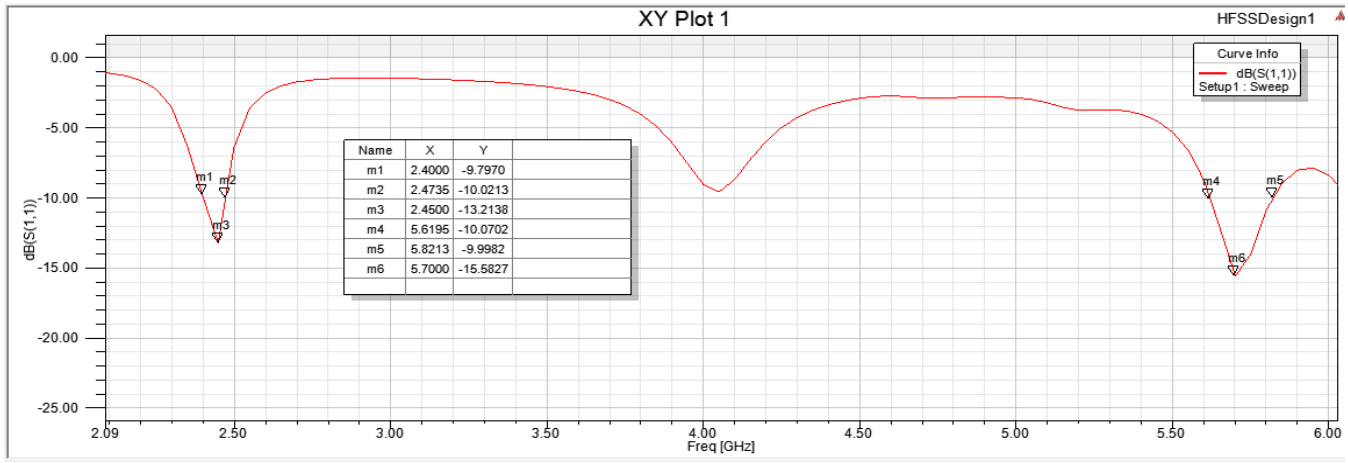

Fig 4: Return Loss, S(1,1)

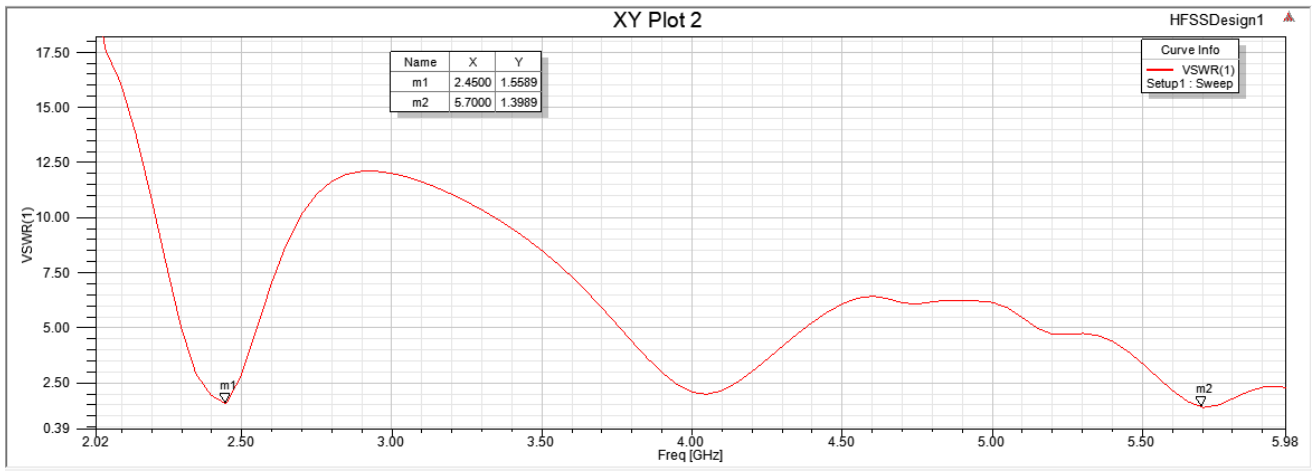

Fig 5: VSWR

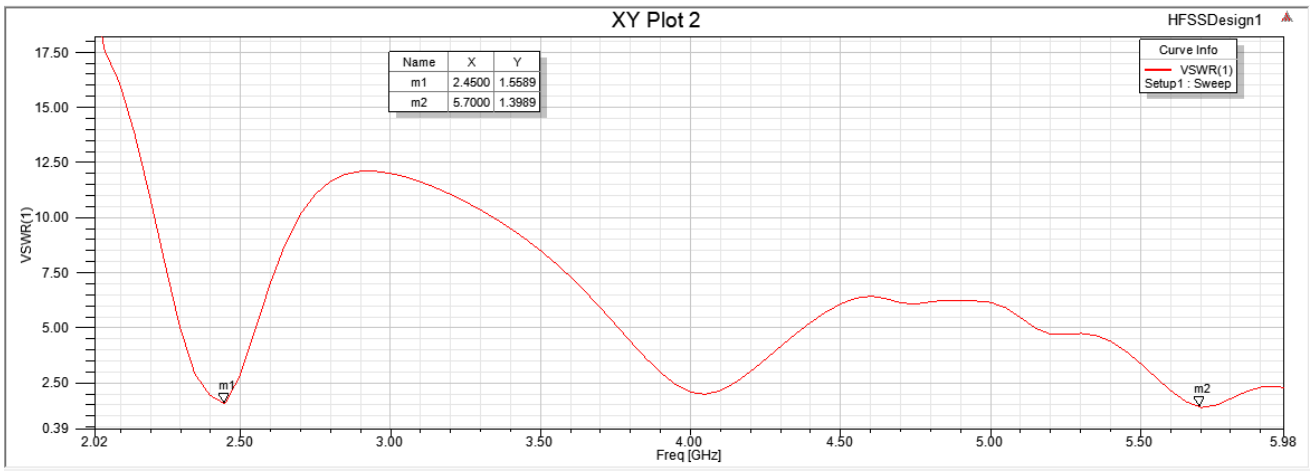

Fig 5: VSWR

VI. EXPERIMENTAL RESULTS:

Fig8 : Front View

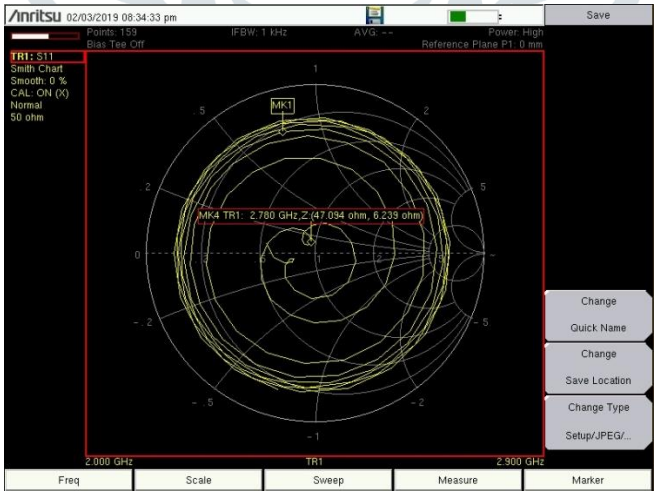

Fig9: Smith Chart (VNA)

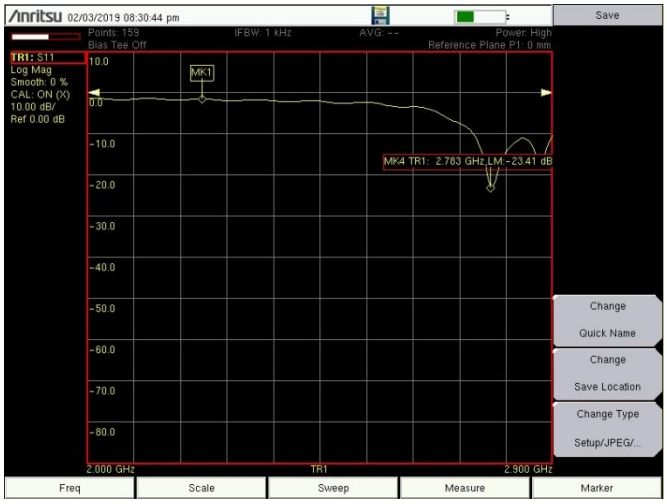

Fig10: Return Loss(VNA)

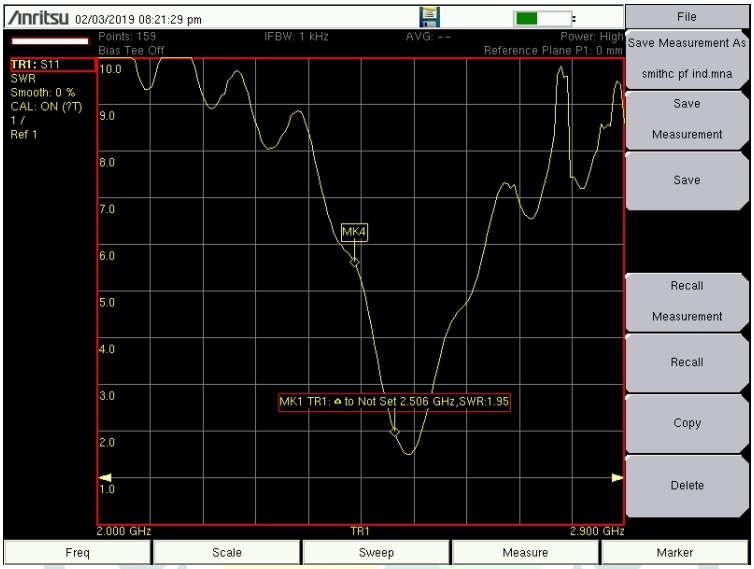

Fig11: VSWR Graph(VNA)

VII. CONCLUSION :

In the given paper the proposed antenna is designed for multiple band of frequencies of 2.45 GHz and 5.8 GHz, 24.125 GHz & 61.25 GHz . The proposed antenna is a rectangular patch microstrip antenna and a ground substrate of FR-4 Epoxy using line feed. Given antenna design is realized through simulation &optimization using Ansoft HFSS 15(High-Frequency Structural Simulator) software. During testing of the Antenna, some deviations from the simulation results was observed. In this paper four types of micro strip slot patch antennas are designed and the designed antennas will work in the area of MIMO applications.

VIII. REFERENCES:

[1] C. Balanis, Antenna Theory, Analysis and Design, second edition (NewYork, John Wiley and Sons, 1997).

[2] K.P.Ray and Girish Kumar, Broadband Microstrip Antenna (Artech House, Boston London).

[3] Analysis of Micro strip patch Antenna Using Coaxial feed and Micro strip line feed for Wireless Application, IOSR Journal of Electronics and Communication Engineering (IOSR-JECE), DOI: 10.9790/2834-1203033641

[4] Smart Antenna for Mobile Communication Application VSRD-IJEECE, Vol. 1 (9), 2011 ByR.K.Jain

[5] Smart Antenna on Mobile Communication Volume 11, Issue 4, Ver. I (Jul.-Aug .2016) ByBakshi Bhagyashri Renukadas (Electronics and communication Department, G.P.Beed,India)

[6] A Compact Microstrip Patch Antenna for Wireless Communication VOLUME 12 ISSUE 5 VERSION 1.0 APRIL 2012ByB.Mazumdar

[7] 6.K.S.Tamilselvan,S.Mahendrakumar,"Design Of Compact Multiband Microstrip Patch Antennas", Journal Of Global Research In Computer Science,Vol-3,No.11,NOV-2012.

[8] Review of Microstrip Patch Antenna for WLAN and WiMAX Application

[9] Neha Parmar et al Int. Journal of Engineering Research and Applications: 2248-9622, Vol. 4, Issue 1(Version 1), January 2014, pp.168-171