Dual band Microstrip Patch Antenna for MIMO system

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***Abstract*—This work targets design of microstrip patch antenna that will resonate at two different band of frequencies which can be used as elements of array for MIMO system. The proposed dual band antenna operates at ISM band (2.37Ghz-2.48Ghz) and Wimax band (3.46 GHz-3.56 GHz).Bandwidth of operation offered by the given microstrip antenna in ISM band is around 110 Mhz while in Wimax band is 110 Mhz. The designed dual band antenna was optimized using simulation tool CAD-FEKO_v6.2 which works on Method of Moments. Antenna was manufactured on FR4 substrate having εr= 4.4.The results obtained from simulating antenna with the help of simulation software matches with results of manufactured antenna obtained from Antritsu vector network analyzer.**

Keywords-Dual band ,Microstrip, MIMO,Return Loss,VSWR,

I. INTRODUCTION

In today's world the focus is on using a MIMO system rather than a SISO system. MIMO system offers high data rate, high capacity and provides a better spectrum utilization of a communication channel [11 .It works better when the correlation between multipath signals is less. This can be achieved at antenna system by introducing various diversity techniques at the antenna level design. These diversity techniques at antenna systems will definitely improve MIMO performance. So a dual band antenna can provide two diverse signals working at two different frequency bands and will support two different applications in their respective bands being a part of single microstrip patch antenna. This single antenna element further can be used to form an array antenna for a MIMO system. Various dual band techniques are available in literature for example as in [2]dual-band antenna is designed with help of varactordiode. A coaxially fed dual band antenna is designed in [3].Also a multilayer structure can be utilized for generation of dual band as shown in [4].All these designs studied exhibits a bit complicated nature. So a rather simple dual band design is proposed in this paper in which dual band operation is achieved using stub loading of microstrip patch antenna.

II. ANTENNA DESIGN

A. Design Parameters

Designing of dual band microstrip patch antenna is carried out considering that antenna will resonant at frequency 2.4 GHz .The dielectric material for substrate of antenna is epoxy resin(FR-4) which is having 4.4dielectric constant and whose thickness is about 1.6mm.The other dimensions of rectangular patch were derived as given[5].

$$W = \frac{C}{2f_r\sqrt{\frac{\varepsilon_r + 1}{2}}} \tag{1}$$

C = velocity of light in free space.

$$\varepsilon_{reffective} = \frac{4.4+1}{2} + \frac{4.4-1}{2}\left[1 + 12\frac{height}{Width}\right]^{-\frac{1}{2}} \tag{2}$$

Due to the effect of fringing field the length dimension of rectangular patch gets modified with parameter ΔL derived as,

$$\Delta L = 0.412\ h\frac{(\varepsilon_{reffective} + 0.3)\left(\frac{Width}{height} + 0.264\right)}{(\varepsilon_{reffective} - 0.258)\left(\frac{Width}{height} + 0.8\right)} \tag{3}$$

The length L considering the ΔL factor is derived as

$$L_{eff} = \frac{C}{2f_r\sqrt{\varepsilon_{reffective}}} \tag{4}$$

$$L = L_{eff} - 2\Delta L \tag{5}$$

Dual band antenna was further optimized to achieve the operation at two bands of frequencies. The patch length dictates the lower band of operation while width of the patch controls the resonant upper band operation. Top edges of the patch are slant that optimizes the results. The feed used is the offset microstrip line feed which also serve as a quarter wave stub loading to generate the dual band operation of the given

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antenna. Microstrip line feed is also chosen as the patch antenna proposed is to form an array antenna. The designed and optimized dual band antenna using stub loading is shown in fig.1 below.

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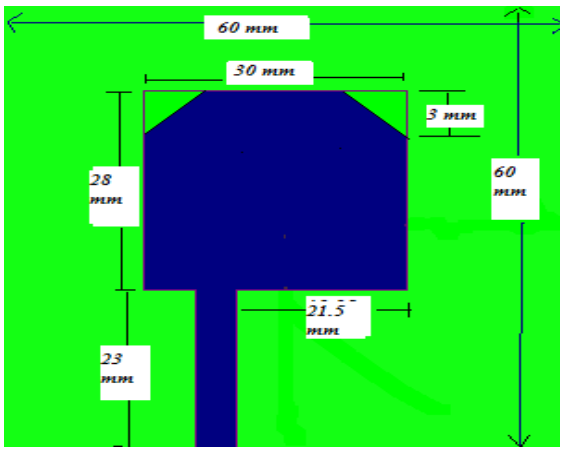

Fig.1.Geometry of dual band antenna (Top View)

III. SIMULATION RESULTS& DISCUSSION

Optimization of dual band antenna was carried out with the help of powerful EM simulation tool CAD FEKO v6.2 which works on method of moments.

A. Return Loss

Return loss bandwidth obtained from simulation is 122Mhz and 101Mhz for ISM and Wimax band respectively as shown in fig 2. This bandwidth is far more sufficient for various applications supported by both the bands.

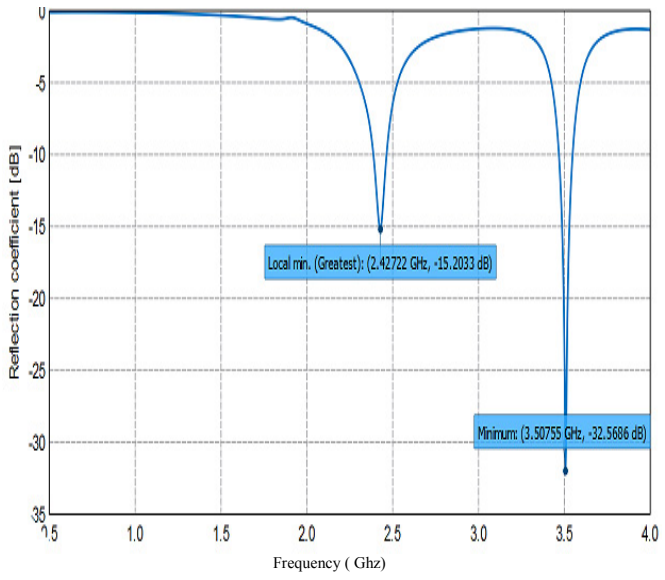

Fig.2.Graph of return lossVs frequency of dual band antenna

band while it exhibits 102 Mhz for Wimax band of operation as shown in fig.3.

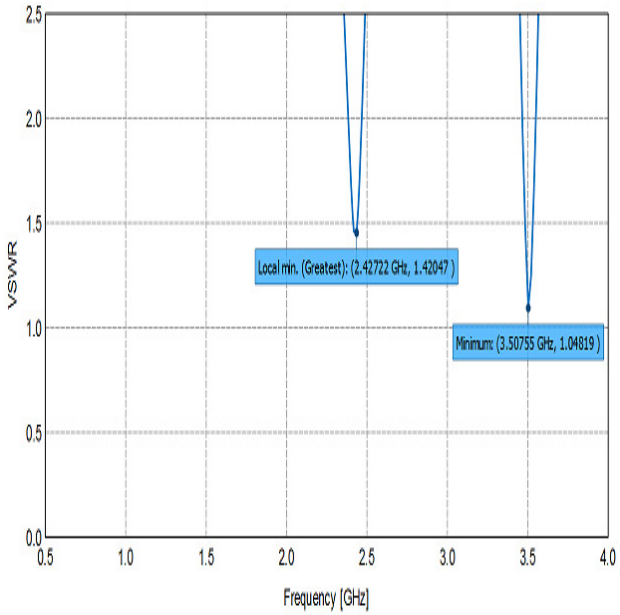

Fig.3.Graph of VSWRVs frequency of dual band antenna

C. Impedance.

The impedance obtained from smith chart is 50.625Ω as shown in fig 4.

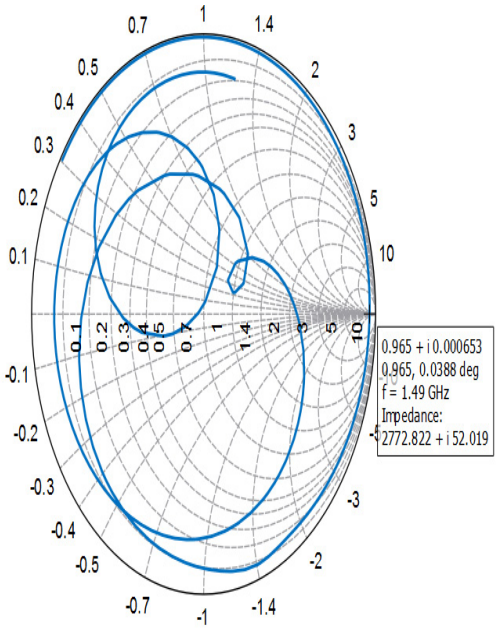

Fig.4.Smith chart of dual band antenna

D. Gain.

Gain of dual band antenna is found to be 1.5 as shown in fig 5.The gain can be improved by forming an array of given patch antenna.

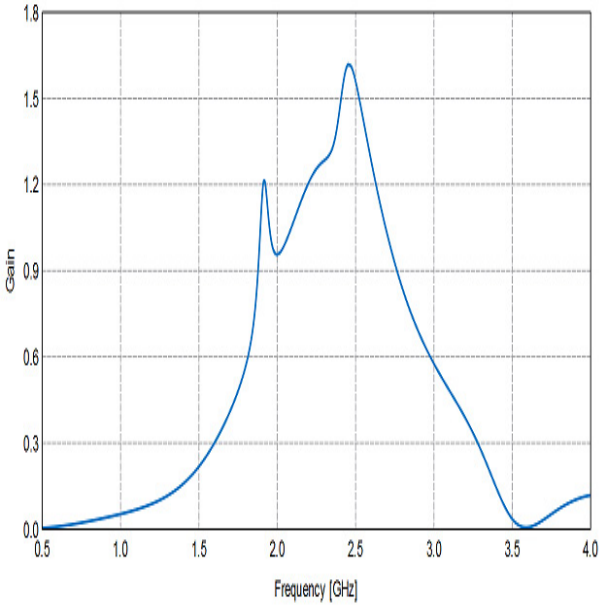

Fig.5 Graph of Gain Vs Frequency

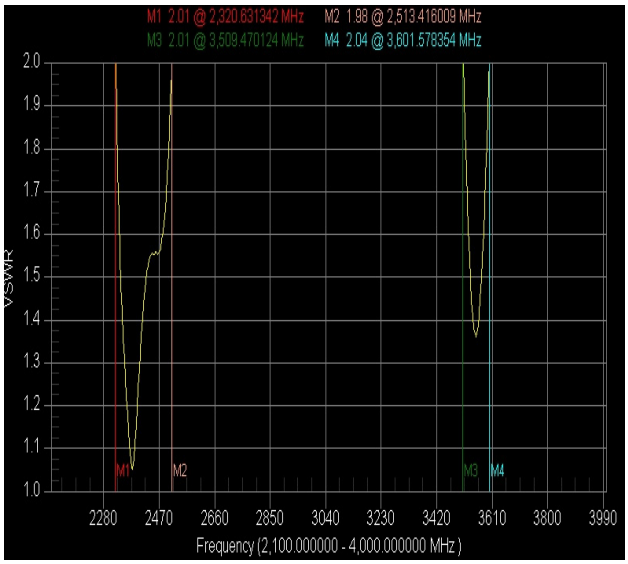

Fig. 7FrequencyVsVSWR measured with help of Antritsu VNA

IV. MEASURED RESULTS &DISCUSSION

A. Return Loss

Fig 6shows measured return loss obtained with the help of Antritsuvector network analyzer (VNA) which operates between 25 Mhz to 4 GHz. The measured return loss is found matching with the simulated results. The return loss Bandwidth is found to be 120 Mhz for ISM band whereas 90 Mhz for Wimax band of operation.

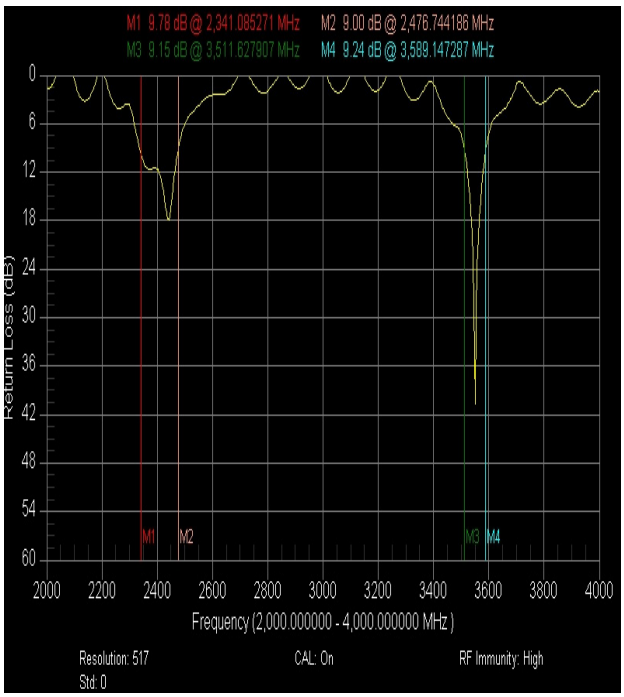

Fig. 6.FrequencyVs Return loss measured with Antritsu VNA

C. Radiation Pattern

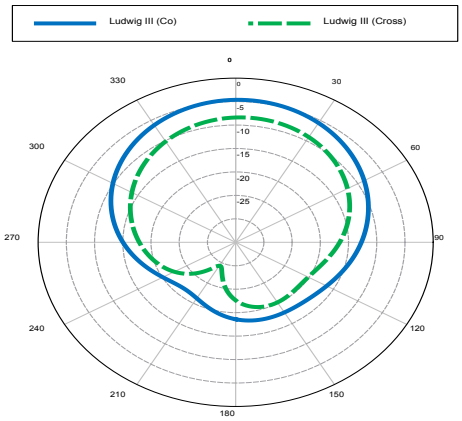

Fig. 8a) Radiation pattern at frequency = 2.42 GHz; Phi = 0 deg

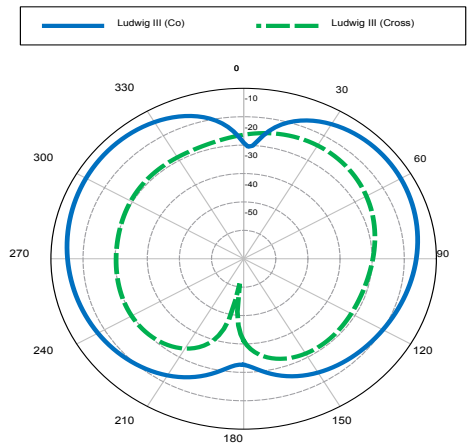

Fig. 8b) Radiation pattern at frequency = 3.5 GHz; Phi = 0 deg

Fig 8a and 8b shows that a stable radiation pattern in E plane is obtained at both resonating bands with a very low cross polarization level.

D Prototype of designed dual band antenna

The prototype of dual band antenna is shown in fig.9.

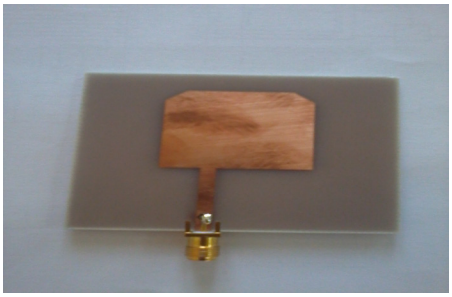

Fig.9. Photograph of manufactured dual band antenna.

V. CONCLUSION

Thus a dual band microstrip patch antenna that may be used as elements of array has been designed. It works satisfactorily at ISM band (2.37 GHz-2.47 GHz) and Wimax (3.46 GHz-3.56 GHz).The return loss bandwidth obtained for both the bands is sufficient to support various applications in both the bands. The optimization of the designed dual band antenna was obtained using commercial simulation tool CAD-FEKO_v6.2 which works on Method of Moments. The dual band antenna was manufactured. The test results were obtained using Antritsu vector network analyzer .The simulation and experimental results are found to be matching with each other for the given design.

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