Design and Optimization of M- Shaped Microstrip Patch Antenna

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Abstract— The proposed antenna is fabricated with substrate RT duroid 5880 and overall patch dimension of 62×64mm. In this paper, we design and implementation of 1x1 microstrip patch antenna array of given specifications using HFSS v15 software. The design have a dielectric material with dielectric substrate permittivity of 2.2 and height of 1.6 mm. The microstrip patch antenna is designed for WLAN and Radio Frequency applications, at an operating frequency of 2.32GHz, 4.78GHz and 8.5GHz with microstrip line feed and power dividers. A new and improved approach for the design of the asymmetric M-shaped patch antenna which works in WLAN and RF application is proposed. Antenna includes of a main patch with sub patches having resonating slots. Main patch is fed with a 50Ω microstrip line and proposed antenna operates with multiple operational frequencies covering the bands from 2GHz to 10GHz with good impedance matching.

Key words: Multiband Structure, Slotted Structure Etc

I. INTRODUCTION

Communication is the movement of data or any information between two or more members so as to pass on or get the proposed implications through a common arrangement of signs and semiotic guidelines.

Microstrip patch antenna are used in wireless devices such as mobile phone and in satellite communication (Radar system). Numerous favorable advantages like light weight, low creation cost, multi frequency operation, effortlessly worked with coordinated circuit of microstrip patch antenna which can be contrast it to other traditional reception antennas [1].

An asymmetric M – shaped microstrip patch antenna with dual / triple bend was introduced by Lin Peng, Cheng-Li Ruan, and Xiao-Hua Wu. After that, the design is studied by many researchers. A new approach is introduced to design triple-band antenna. The aim of this antenna is to design and implementation of multiband microstrip patch antenna for wireless application such as ISM (Industrial scientific and medical application), Bluetooth, Wi-Fi, WLAN application. The design may include slots, slit, and other techniques for optimizing the response. This multiband antenna is designed with transmission line feed technique .The proposed antenna designed and simulated in HFSS v15 software and return loss, radiation pattern and gain results are shown

II. ANTENNA GEOMETRY

Antenna is designed which is shown in figure 1. The parameter of designed parameter is shown in figure 1. We study the simulated result of antenna of single band. We get an improved return loss as compare to base paper [1]. There is a cutting slot of L shape in ground of dimension of 35*4mm. Substrate material (duroid 5880(tm)) of 2 mm height is used.

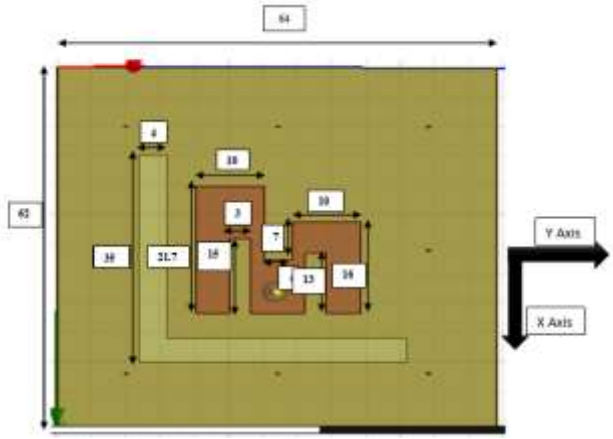


Fig. 1: Geometry Single Band Antenna (All Dimensions are in mm)

Here, coaxial feed is used [2]. In this antenna, ground and substrate, both are in same size that is 62×64mm. The patch size is 21.7×14mm. For the increment in current path gain, I cut L slot of 34×5mm in ground. Here, I worked on the variation of length of L slot for optimization. There is used of two asymmetric arm of M shape in patch which is in measurement of 15×3mm and 13×3 respectively, which is shown in figure 1.

III. SIMULATION AND RESULTS

After simulate this geometry, a single band is found. Which shown in return loss figure (2). Now there is more efficient result in compare to based paper antenna [1]. Which is shown in table (1), and the result of gain shown in figure (3).

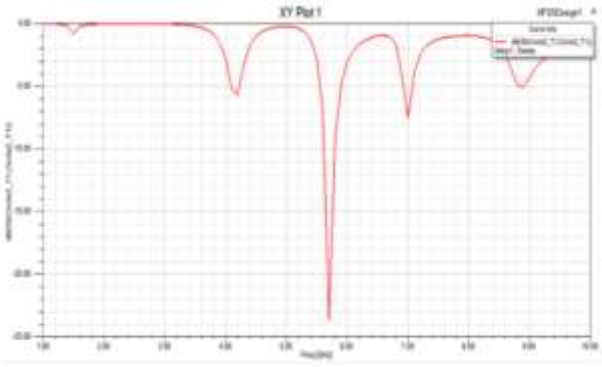


Fig. 2: Return loss band diagram (in dB)

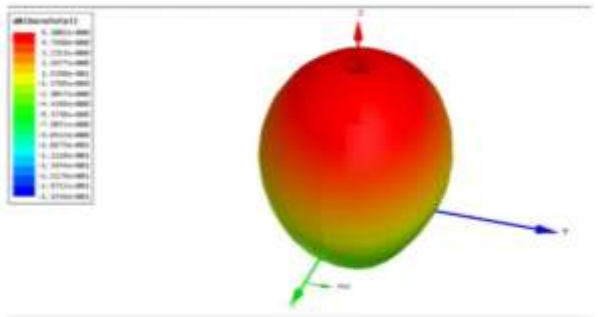


Fig. 3: 3D Gain diagram (in dB)

There is a -23.5 dB return loss at 5.3GHz. And other parameters also simulated which is shown in table (1).

Parameters	Proposed work	Base paper
Return loss (S_{11})	-23.5dB	20dB
Bandwidth	200MHz	125MHz
Bandwidth (%)	8.33%	5.2%
Gain (G)	6.3dB	7dB

Table 1: Values of Parameters

After variation in the length of both asymmetric arms of M shape of patch and L slot's length in the ground. I studied the effect of variation in length of arms of M shape [3]. And I can optimize the Length for achieving a perfect result. This effect is clearly shown in below figure (4) and figure (5). From this variation, we can study the behavior of antenna.

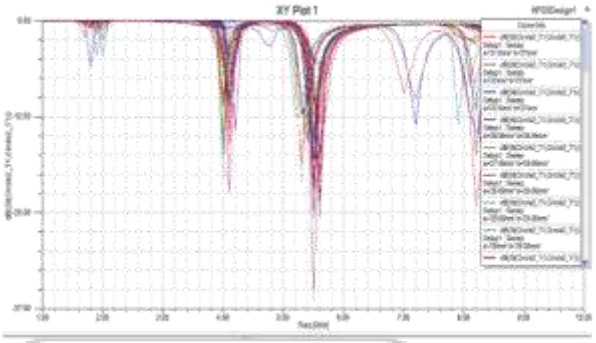


Fig. 4: Variation in arms of M

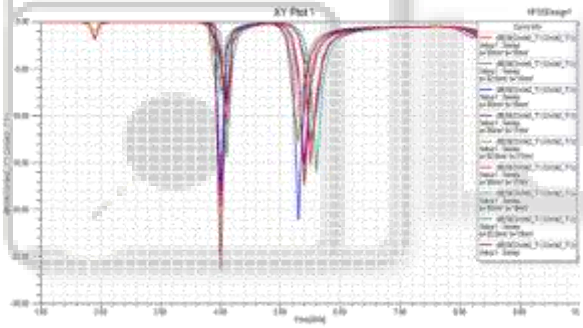


Fig. 5: Variation in L slot

After the study of variation and behavior of antenna, now we can design a triple band antenna

IV. Geometry of Triple Band Antenna

Geometric view of triple band antenna is shown in figure (6), here is a decrement in substrate thickness [4].

Substrate and ground size –

L – 62mm and W – 64mm,

L slot size – L1 = 35mm and W1 = 4mm,

Patch size

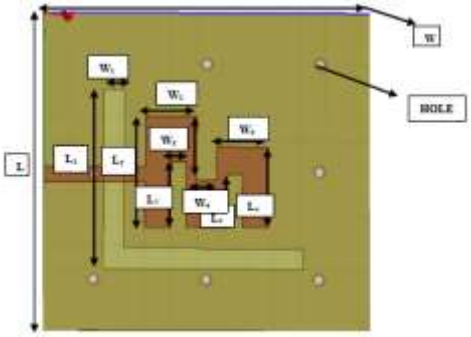


Fig. 6: Geometric view

Optimized value is shown in table (2).

L_2	21.7mm
L_3	12.85mm
L_4	10.35mm
L_5	15.7mm
W_2	10mm
W_3	3mm
W_4	4mm
W_5	10mm

Table 2: Dimension of antenna

By creating hole in antenna in order to increase current path we create some hole of radius of 1mm which is shown in figure (6).

V. Simulation of Triple Band Antenna

The VSWR graph of simulated design is shown in the figure 7. There are three values of VSWR at three different operating frequencies that are 1.0761 at 2.32GHz, 1 at 4.78GHz and 1 at 8.5GHz.

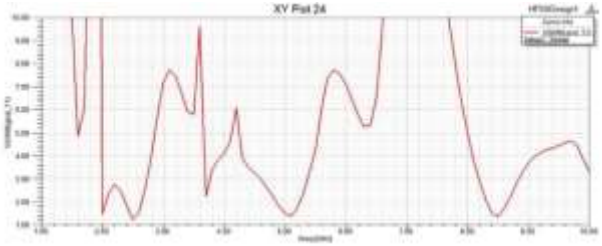


Fig. 7: VSWR of simulated design

VI. Fabrication

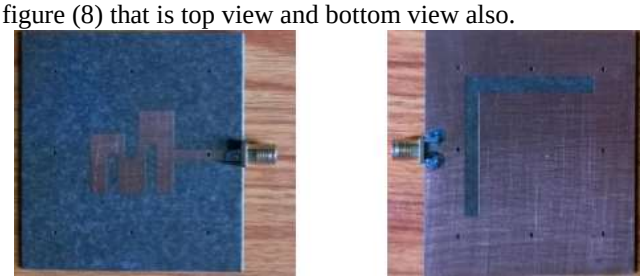
This antenna design can be easily fabricate in lab. And we get desirable values, which are shown in table (3).

Frequency (GHz)	Measured Return loss (dB)	Simulated Return loss (dB)
1.0	-0.26	-0.7188
1.5	-0.67	-1.3383
2.0	-4.85	-5.12
2.19	-10.0	-5.2086
2.32	-19.0	-17.2809
2.46	-10.6	-15.0927
2.5	-18.6	-18.5804
3.0	-2.74	-2.5731
3.5	-0.8	-2.4435
4.0	-6.3	-4.4107
4.44	-10.2	-4.922
4.5	-12.1	-5.4084
4.78	-24.6	-25.632
5.0	-11.8	-7.8801
5.07	-10.1	-7
5.5	-5.22	-4.3298
6.0	-5.9	-2.5301
6.5	-3.37	-2.9482
7.0	-4.01	-0.5568
7.5	-4.8	-1.12
8.0	-5.4	-3.4237
8.29	-10.0	-8.6943
8.49	-17.1	-18.5015
8.5	-17.0	-18.6175

Table 3: Measured and Simulated values of Return Losses

Here, we find that we get three good return loss values -19.0dB, -24.6dB, -17.0dB at resonant frequency at 2.32GHz, 4.78GHz, and 8.5GHz respectively, which will be very beneficial.

Fabricated view of triple band antenna is shown in figure (8) that is top view and bottom view also.



Top view bottom view

Fig. 8: Fabricated View

Figure (9) shows the comparison between the return losses measured and simulated values. It is a good result.

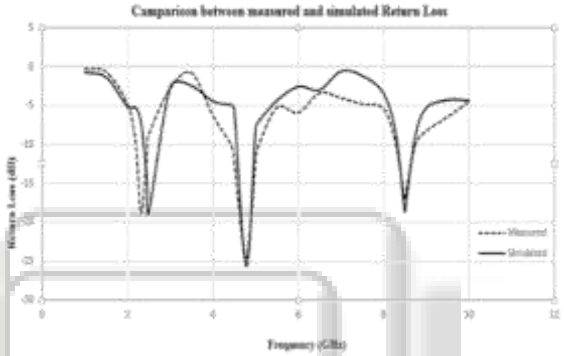


Fig. 9: Comparison between measured and simulated values

VII. RESULT

This antenna is a triple band antenna which can operate at three operating frequency at 2.32GHz, 4.78GHz, and 8.5GHz respectively. All the parameters and simulations results are shown in table 4.

Antenna Parameter	At 2.32GHz	At 4.78GHz	At 8.5GHz
Return Loss (dB)	-17.2dB	-25.63dB	-18.6dB
VSWR	1.07	1	1
Gain(dB)	1.5dB	1.4dB	2.4dB

Table 4: various antenna parameters and their results

VIII. CONCLUSION

An M-shaped microstrip patch antenna with L slotted ground structure has been realized. The projected antenna comprises of M shape patch structure with some modified asymmetric arms in M shape on patch and L shaped slot on ground. The simulation and analysis of antenna is executed through structure simulator software solver HFSS 15.0. The measured result of fabricated antenna shows good impedance matching, larger bandwidth and better returns loss with the four bands. The antenna parameter which is a desirable result and the bandwidth which we got increased from the work previously done. The achieved bands are widely used in Wi-Fi, mobile communication and all types of radar system application and these bands come under 2.32GHz, 4.78GHz and 8.5GHz range too which makes it even more useful.

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