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Design and Fabrication of Micropatch Antenna

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Abstract - In this research we have discussed about micropatch antenna. The antenna is fabricated on 17.6 x 44 x 1.6mm substrate. High frequency structure simulator (HFSS) is used to design and simulate the antenna. FR-4 epoxy dielectric substance is used with dielectric constant of 4.4. After simulation we have found the necessary parameters of antenna like return loss, VSWR, bandwidth and input impedance which is -15db, 1.4, 200MHz and 50Ω respectively. This antenna operates at the frequency of 2.4GHz which is suitable for Industrial, Scientific ,Medical (ISM band) applications.

Key Words: 2.4, FR-4 epoxy, HFSS ,Patch, Feed Port, Micropatch

1. INTRODUCTION

Antenna plays a vital role in world of communication. Antenna is a device which is used to receive and transmit the signals. Structure, design, light weight and efficiency are very important parameters in antenna. The main parameters while simulating antenna are gain, efficiency, polar plot etc. Gain is defined by the ability of the antenna to radiate in any direction[1]. It is measured by calculating the ratio between efficiency of antenna and direactivity. Direactivity is a measure of the concentration of an antenna[2]. A metal patch mounted on a ground level with dielectric material. The height of patch is very small that's why radiation pattern radiates only in the substrate i.e. between patch and the ground. This low radiation ability does allow it to cover only in small area applications. Based of above studies the micropatch antenna is simulated and designed for 2.4GHz wireless communication. The return loss , VSWR, radiation pattern, direactivity, and gain of the antenna is calculated using HFSS software. And the designed hardware model is tested using Vector Network Analyser (VNA) device.

2. ANTENNA CONFIGURATION

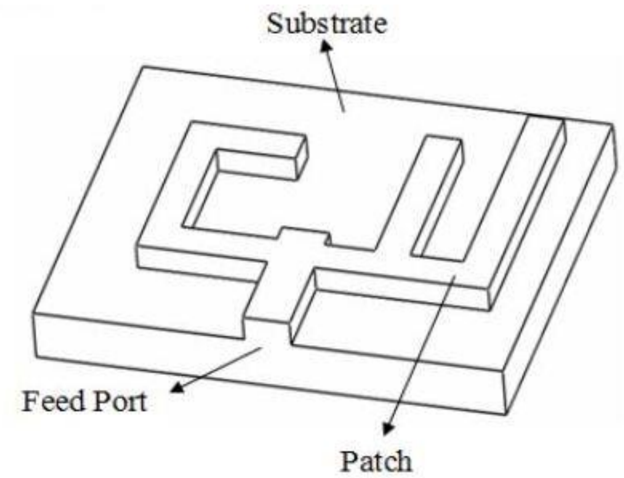

Fig -1: Antenna Geometry

To design this antenna various equations are used to find length(l) width(w) of the antenna. Equation(i) is used to find the width of the antenna and equation(ii) is used to find the length of the antenna

$$\mathbf{W} = \frac{c}{2fr}\sqrt{\frac{2}{Er+1}} \;\textbf{....(i)}$$

$$\mathbf{L = L_{eff} - 2\Delta L....(ii)}$$

Resonant frequency can be calculated by

$$\mathbf{F} = \frac{\mathbf{C}}{\mathbf{2[L+h]\sqrt{\in e}}}$$

Where, F = Resonant Frequency; C = Speed of Light (3×10^8m/s); Relative dielectric Constant∈= Effective dielectric Constant; h = Thickness of the substrate; L = Length of the patch; W = Width of the microstrip Patch antenna.

Antenna Parameters (in mm) are shown in below table

H	1.52
S	2
L_0	13.20
W	1.80
L_1	3.70
L_2	8.90
R_1	10.0
R_2	2.10
R_3	15.20
R_4	22.0

3. SIMULATION RESULTS

High frequency structure simulator (version 2019) is used to design this micropatch antenna. Figure 2, 3, 4 and 5 represents the return loss of -15db, bandwidth of 200MHz(between m2 and m3), VSWR of 1.49, and input impedance of 50Ω which operates at freq of 2.4 resonant frequency.

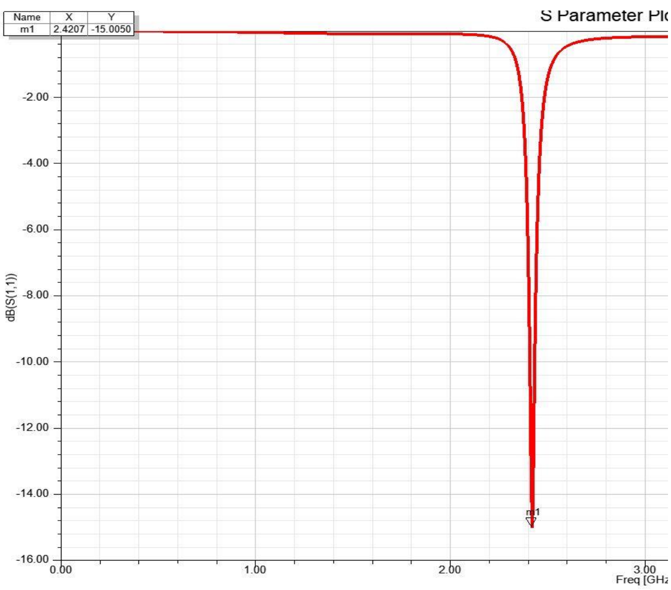

Fig -2: Return loss

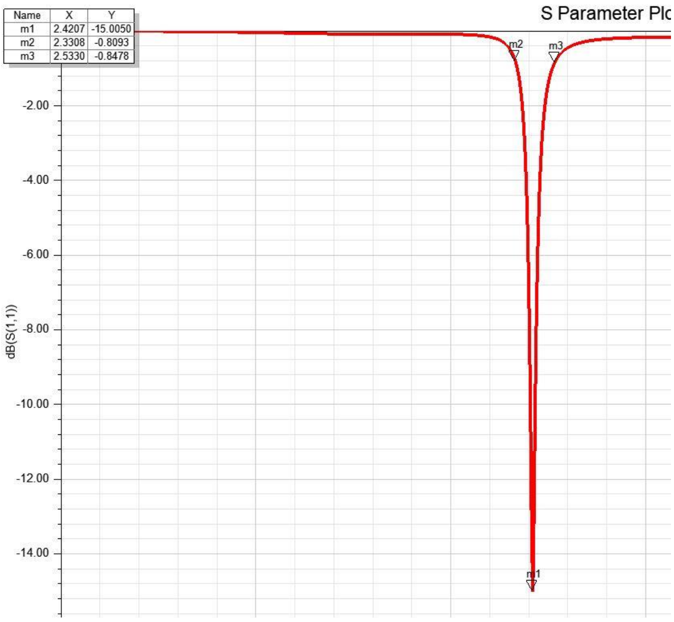

Fig -3: Bandwidth

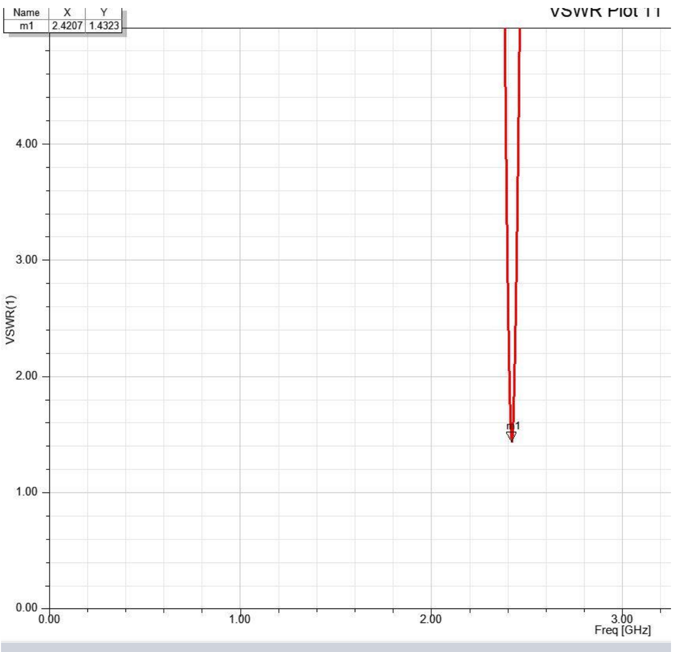

Fig -4: VSWR

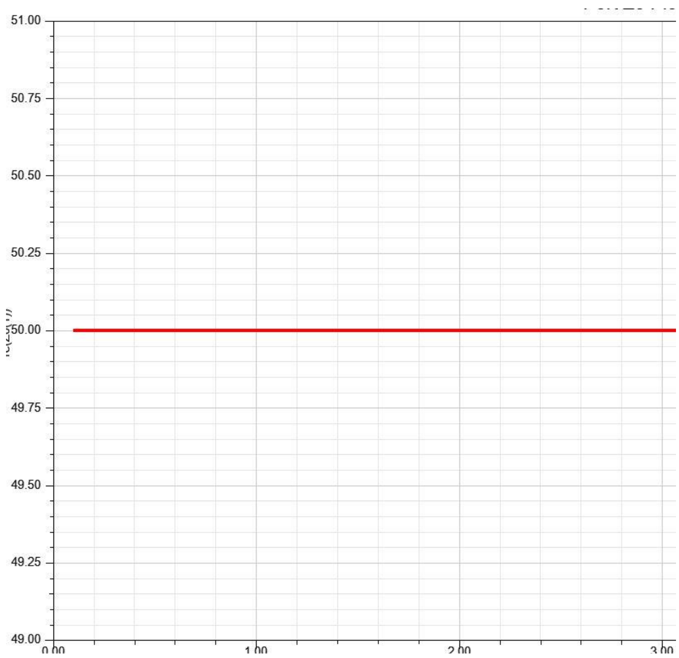

Fig -5: Input impedance

The 3D pattern gain of antenna is shown in Fig 6. Fig 7 shows the polar plot of the gain at **Φ =**0-90º

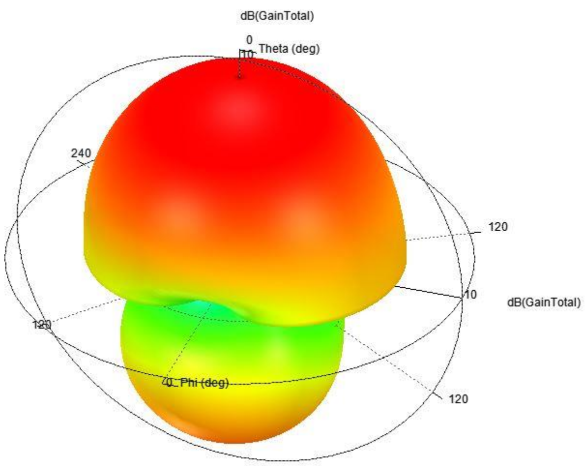

Fig -6: Gain of antenna

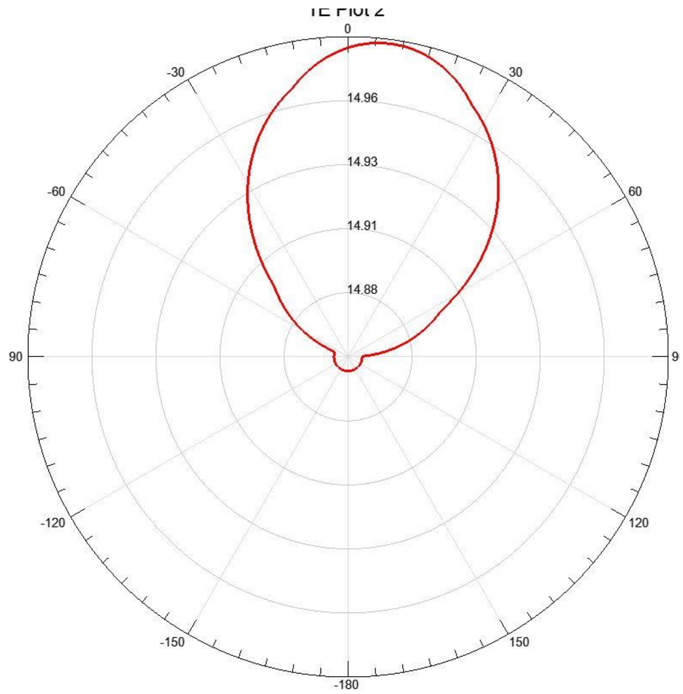

Fig -7: 2D Polar Plot

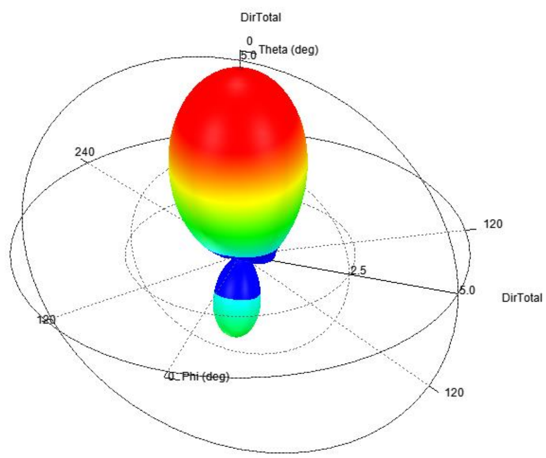

Fig -8: 3D Pattern of Directivity

4. EXPERIMENTAL RESULTS

The design of proposed antenna is fabricated on FR4-epoxy with relative permittivity (ε_r) of 4.4. FR4-epoxy is selected because FR4 are strong, water resistant, and provide good insulation between copper layers that minimizes interference and supports good signal integrity. And this antenna is tested on Vector Network Analzyer (VNA) device. Below fig shows the antenna design and table shows the antenna output.

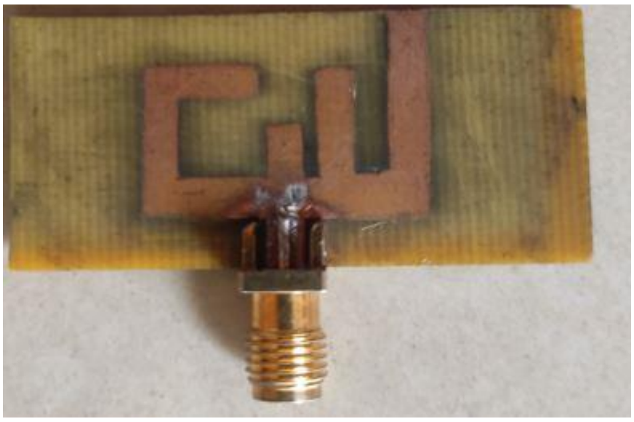

Fig -9: Front View

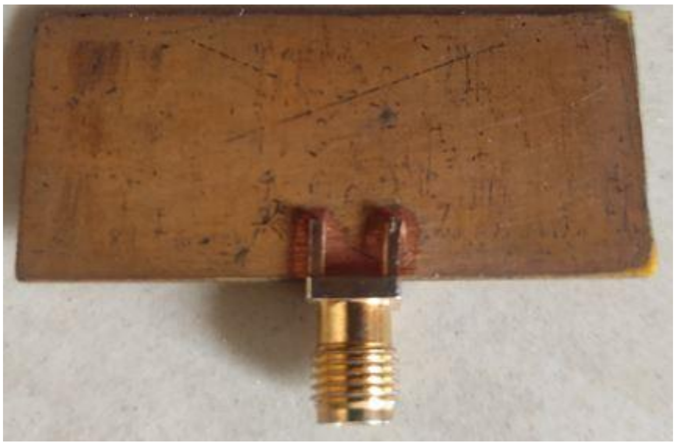

Fig -10: Back view

Parameters	Results
Frequency	2.4GH
Return Loss(in db)	-15db
VSWR	1.4
Input Impedance	50Ω
Bandwidth	200MHz
Gain	10db
Directivity	1.64db
Efficiency	90%

5. CONCLUSION

This micropatch antenna displays good radiating pattern The Micropatch Antenna design described here is simulated and analysed using HFSS (High Frequency Structural Simulator) software. We have studied definition of antenna, , antenna parameters and about the design of micropatch antenna.

A detailed explanation of Microstrip patch antenna is disclosed. The desired radiation patterns, bandwidth of the antenna are achieved.

By seeing simulated results, we can say that the single antenna is designed such that it radiates at the desired multiband resonance frequencies which are suitable for the WLAN & WiMAX applications.

6. FUTURE WORK

In this we have seen about the design a micropatch antenna for ultra-high frequency range whereas; the innovative designs of antenna can be developed further.

Designing of a single antenna for multiple band of frequencies can be developed. Which are useful in satellite communication systems, radar communications, medical applications, military applications.

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