IJRECE VOL. 7 ISSUE 2 (APRIL- JUNE 2019) ISSN: 2393-9028 (PRINT) | ISSN: 2348-2281 (ONLINE)

Rectangular Microstrip Patch antenna using HFSS

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Abstract—This paper presents how a rectangular microstrip patch antenna is designed using HFSS and also fabrication results. It is designed to operate at 2.4GHz resonant frequency. This choice of frequency has created the antenna an ideal alternative to be used within the wireless Local Area Network [WLAN]. The dielectric material used is epoxy material FR-4 having $\in_r$=4.4. The antenna is fabricated using HFSS results (return loss, VSWR, gain) and after fabrication results are checked and compared. Fabrication is very easy and appropriate for the appliance in the WLAN applications. All the results are clearly shown in this paper.

Keywords— *Microstrip, WLAN, VSWR, Frequency, Patch, VSWR, Return loss.*

I. INTRODUCTION

Microstrip patch antennas are easily mounted, light weight, compact, easy fabrication, low profile and on any surface [1]. These antennas are introduced in 1950 and brought in to practice in 1970's [2].In this paper, the design of rectangular microstrip patch antenna using HFSS which consists of patch of length [L] and width [W] of the patch and permittivity Ɛr is concentrated [3]. Dimensions are calculated using the design equations of rectangular patch. The software used for simulation is HFSS and evaluated return loss of S11 of -29.69dB and VSWR of 1.20 which is < 2. This antenna is designed at frequency of 2.4 GHz. FR-4 Epoxy substrate material is using whose dielectric constant Ɛr=4.4 lies in between 2 and 12 [4] [5].

Antenna geometry is shown in fig. 1consisting of dimensions. Table 1 shows values of design parameters.

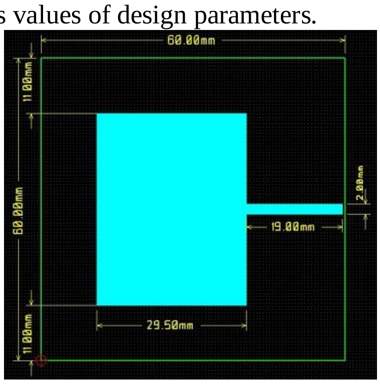

Fig 1. Antenna Geometry

Table I Design parameters

Parameters	Values in mm
H	1.5
L0	60
W0	60
L1	29.5
W1	38
L2	19
W2	2

II. DESIGN EQUATIONS

All the values in the tabular column are calculated using the following equations [6] [7].

1. Width of patch (W) = $\dfrac{c}{2f_r\sqrt{\dfrac{\varepsilon_r+1}{2}}}$

2. $$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+\frac{12h}{W}\right]^{-\frac{1}{2}}$$

3. $$L_{eff} = \frac{c}{2f_r\sqrt{\varepsilon_{eff}}}$$

4. $$\Delta L = 0.412h\frac{\left(\varepsilon_{eff}+0.3\right)\left(\dfrac{W}{h}+0.264\right)}{\left(\varepsilon_{eff}-0.258\right)\left(\dfrac{W}{h}+0.8\right)}$$

5. Length of the patch (L) = $L_{eff} - 2\Delta L$

6. Length of the substrate (L0) = 6h + L

7. Width of substrate (W0) = 6h+W

For prediction of resonant frequency, width, patch thickness and dielectric constant these equations are used.

III. HFSS DESIGN OF ANTENNA

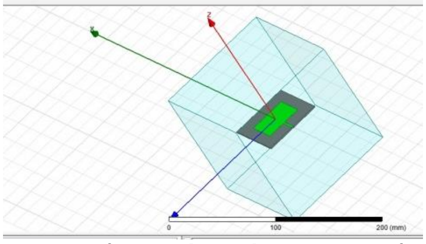

Fig 2. Design of rectangular patch using HFSS software

Fig 2 shows simulated HFSS software design of patch antenna.

IV. SIMULATED RESULTS IN HFSS

Design of patch antenna is done in software called HFSS and got the results of parameters return loss, radiation pattern, VSWR and gain.

Fig 3 shows return loss of -12.005dB is achieved at 2.4GHz resonant frequency. In fig 4 0.5550 Voltage Standing Wave Ratio (VSWR) is achieved.

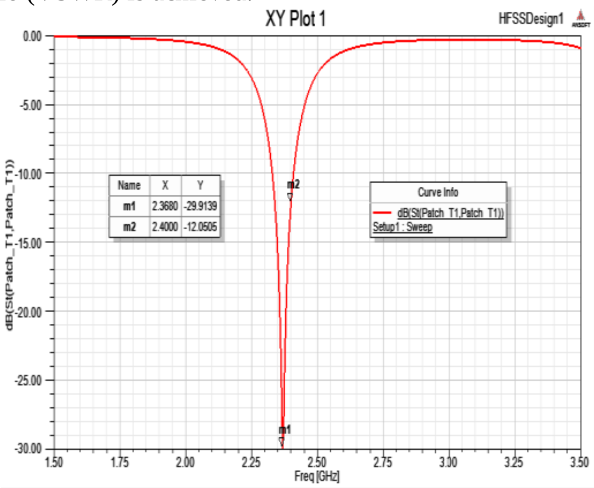

Fig 3. Return loss (S11)

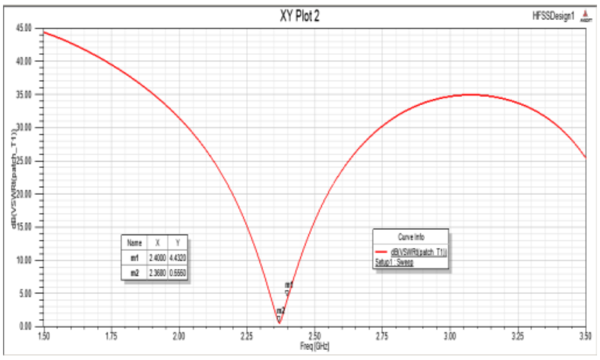

Fig 4. VSWR

Fig 5. Shows the simulated 2D radiation pattern and 3D radiation pattern is shown in fig 6. From this it shows in which direction the EM waves radiates from the antenna at 2.4 GHz frequency.

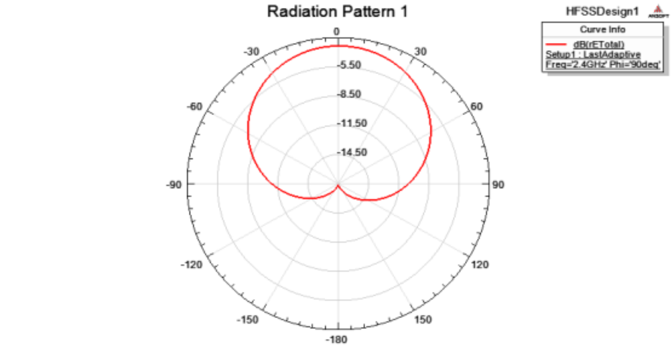

Fig 5. Radiation pattern (2D)

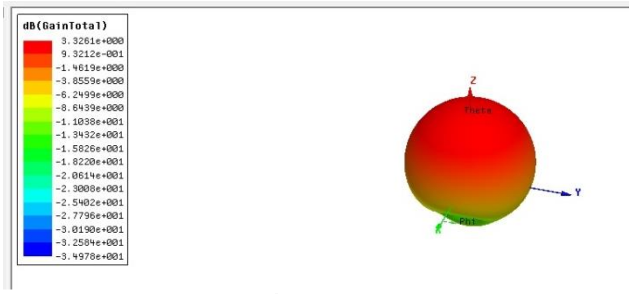

Fig 6. Radiation pattern (3D)

V. MICROSTRIP ANTENNA FABRICATION

Using HFSS rectangular MSA was designed and fabrication was done. Fig 7 shows the MSA (fabricated).

Fig 7. Fabricated MSA

VI. RESULTS OF FABRICATION

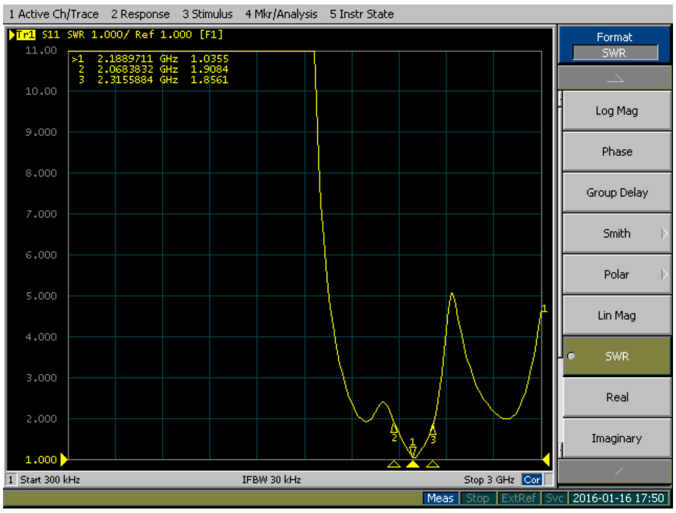

Fig 8. Return loss

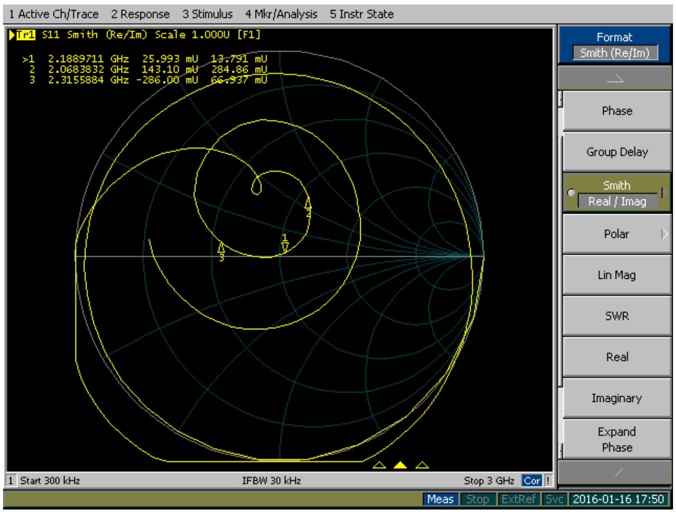

Fig 9. Voltage Standing Wave Ratio (VSWR)

Above (fig 8 and fig 9) result shows VSWR of 1.03 and Return loss of 54.3 dB is achieved using VNA.

VII. CONCLUSION

Hence a gain of 9.32dB, return loss of -13.5dB, VSWR of 1.03 is achieved for rectangular patch for calculated dimensions. Antenna is simulated using HFSS at frequency of 2.4 GHz. Fabrication process is simple with less cost. Results compared with simulated are good.

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