# Design of Circular Patch antenna using HFSS

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*Abstract*—This paper presents how a circular microstrip patch antenna is designed using HFSS and also fabrication results. It is designed to operate at 3.7GHz resonant frequency. 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, 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 circular microstrip patch antenna using HFSS which consists of patch radius and permittivity Ɛr is concentrated [3]. Dimensions are calculated using the design equations of circular patch. Only one design equation it consists of. This patch is supported by TM mode. The software used for simulation is HFSS and evaluated return loss of S11 of -23.5dB and VSWR of 1.20 which is < 2. This antenna is designed at frequency of 3.7 GHz. FR-4 Epoxy substrate material is using whose dielectric constant Ɛr=4.4 lies in between 2 and 12 [4] [5] the substrate height is choosen to be around (h) = 1.6mm.
Antenna geometry is shown in fig. 1.

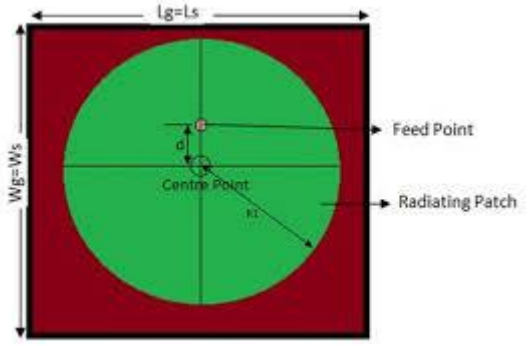


Fig 1. Antenna Geometry

## II. DESIGN METHODOLOGY

It is easy to design when compared to any other design because of its only one parameter i.e., radius of the patch. Its dominant mode is $TM_{110}$. Circular schematic is displayed in fig 2.

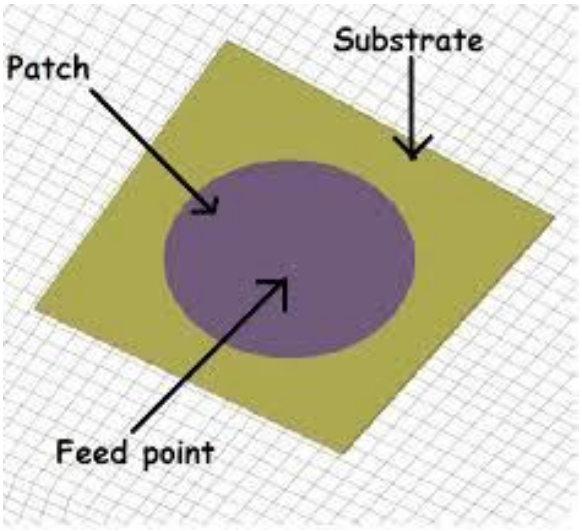


Fig 2. Circular patch schematic

The radius of the patch can be found by the following equation [1]:

$$a = \frac{F}{\left(1+\frac{2h}{\pi\varepsilon_r F}\left[\ln\left(\frac{\pi F}{2h}\right)+1.7726\right]\right)^{1/2}}$$

Where $F = \frac{8.79X10^9}{f_r\varepsilon_r}$

Hence the radius of the patch depends on frequency (Hz), height of the substrate (*h*), dielectric constant of the substrate ($\varepsilon_r$).

## III. HFSS DESIGN OF ANTENNA

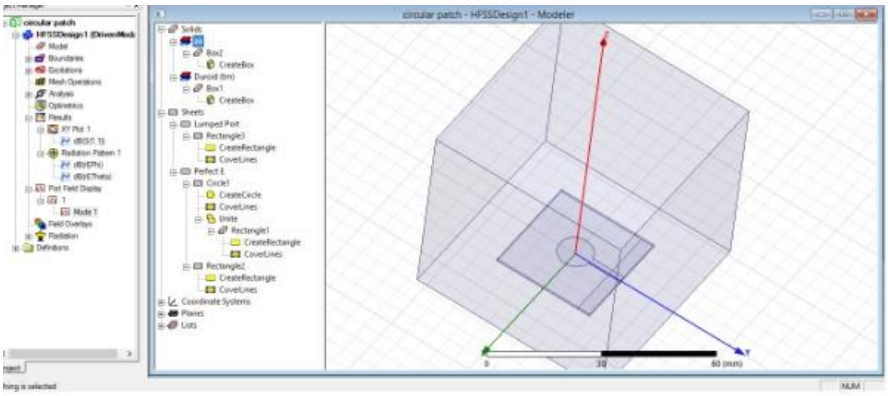

Fig 3. Design of circular patch using HFSS software

Fig 3 shows simulated HFSS software design of patch antenna.

Fig 4 shows return loss of -12.005dB is achieved at 3.7GHz resonant frequency. In fig 5 0.5550 Voltage Standing Wave Ratio (VSWR) is achieved.

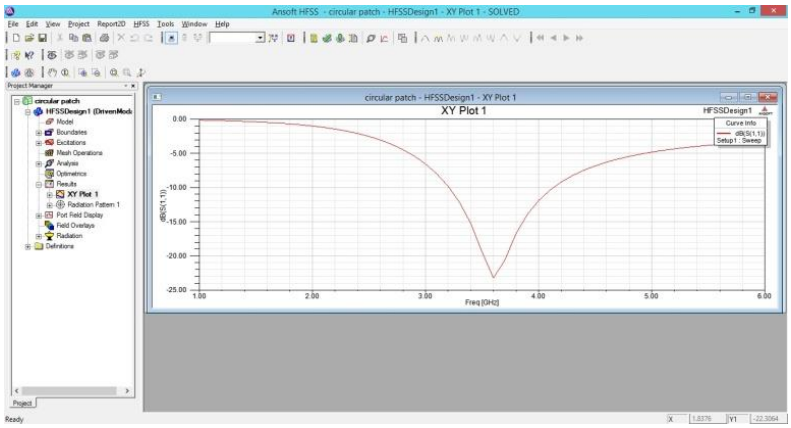


Fig 4. Return loss (S11)

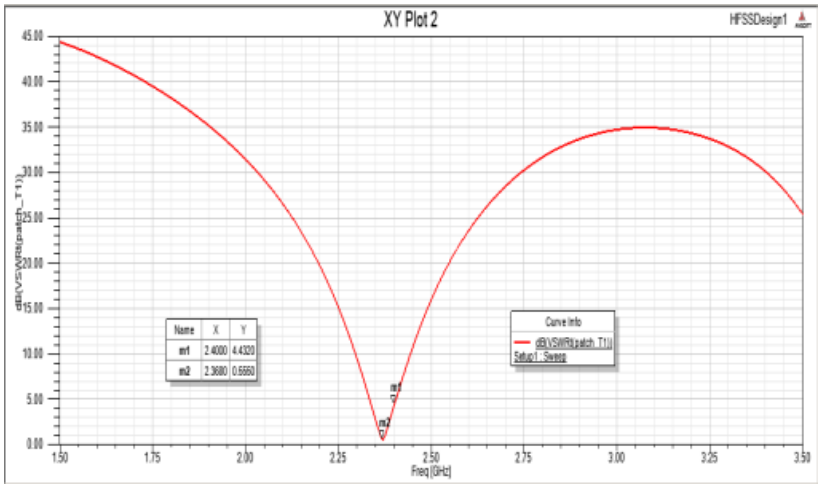


Fig 5. VSWR

Fig 6. Shows the simulated 2D radiation pattern and radiation pattern IN 3D is shown in fig 7. From this it shows in which direction the EM waves radiates from the antenna at 3.7 GHz frequency.

## 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.

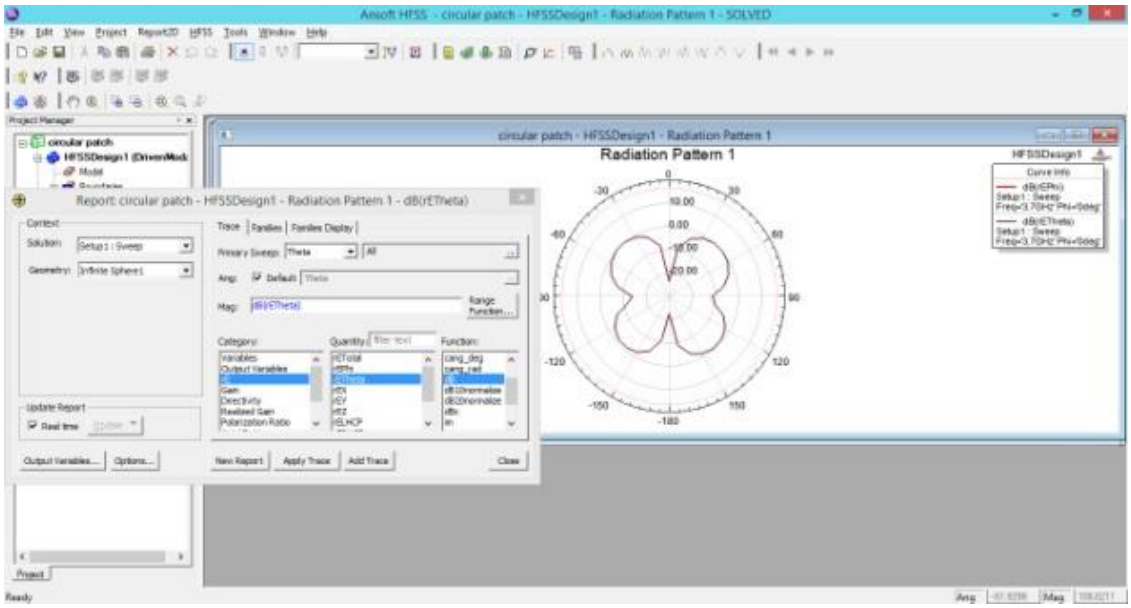


Fig 6. Radiation pattern (2D)

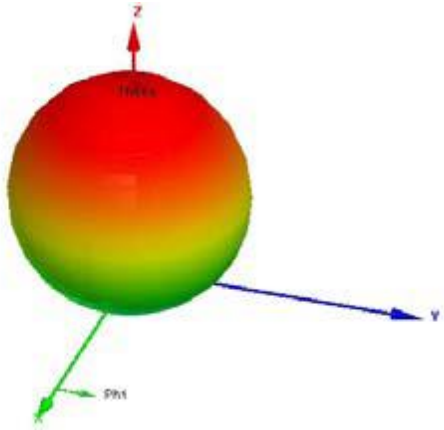


Fig 7. Radiation pattern (3D)

## MICROSTRIP ANTENNA FABRICATION

Using HFSS circular MSA was designed and fabrication was done. Fig 8 shows the MSA (fabricated).

Fig 8. Fabricated MSA

## CONCLUSION

Hence a gain of 9.32dB, return loss of -23.5dB, VSWR of 1.03 is achieved for circular patch for calculated dimensions. Antenna is simulated using HFSS at frequency of 3.7 GHz. Fabrication process is simple with less cost. Results compared with simulated are good.

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