Analysis of E-Patch Microstrip Antenna for Wireless Applications

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Abstract—This paper describes the performance of a Microstrip patch antenna using coaxial feeding method . The type of patch designed is E-patch with frequency range of (5-8 GHz) C-band. As the C-band frequency is close to the terrestrial radio frequency it will get disturbed so the frequency considered here is the higher limit of C-band. The main applications of this antenna are Wi-Fi, WiMAX and GPS. Various parameters describe the performance of the antenna like return loss, VSWR, Gain, Band Width, Radiation Pattern etc. They are determined, and the simulation software used to obtain the results is Ansoft HFSS version 17.1

Keywords—Microstrip Patch Antenna, E-shaped Patch, C-Band, Return loss, Gain, Coaxial Feeding, Ansoft HFSS

I. INTRODUCTION

Advances in technology allows more things to discover and the evolution of Microstrip patch antenna is rapid and the use of this makes less space and more Gain. For wireless applications different types of antennas were discovered and among all of them Microstrip antennas plays major role. The main Features of Patch antennas are like low cost, low space and easy to design, low weight and especially for narrow bandwidth and bandwidth enhancement. This paper covers the C-band frequency for wireless applications, and the Microstrip Patch antennas used from 3-12 GHz frequencies. So, they are called Ultra Wide Band(UWB) antennas. And there are many types of feeding methods used in exciting the Microstrip Patch antenna and they are Microstrip line feeding, Coaxial feeding, Tapered edge feeding, Aperture coupling, Proximity coupling. In this paper coaxial feeding method is used.

II. MICROSTRIP PATCH ANTENNA GEOMETRY AND DESIGN

In designing the Microstrip Patch antenna the height of the substrate and the dielectric constant are very important. And the patch antenna is mounted on the top of the substrate with planar ground and the radiation box surrounding it with the $\lambda/4$ distance from edges of the antenna. The dielectric constant can be taken from $2.2<\varepsilon r<12$. And the dielectric constant can be varied in order to obtain different Return loss and Gain values. E-Patch is designed by using the substrate material as Rogers RT/Duroid. Laminates are easily cut, sheared and machined to shape, and resistant to all solvents and reagents normally used in etching printed circuits or plating edges and holes. RT/duroid 5870 and 5880 laminates have the lowest electrical loss of any reinforced PTFE material, low moisture absorption, are isotropic, and have uniform electrical properties over frequency.

Rogers RT/duroid 5880(tm) high frequency laminates are used in commercial airline broadband antennas, Microstrip and strip line circuits, Millimetre wave applications, Military radar systems, Missile guidance systems, Point-to-point digital radio antennas.

E-Shaped Microstrip antenna cover 5-6 GHz range in wireless applications as the range of the Microstrip antenna is 3-12 GHz and here the frequency considered is 6.2 GHz and it satisfies the IEEE802.11.The antenna dimensions are L=25.6mm, H=3.5mm, W=35mm, Ls=18.4mm, Lo=11.4mm, W1=8.5mm, W2=8.0mm, T=6.8mm.

The positions of the patch are

Main patch : (-12.8,-17.5,3.3), dx=25.6, dy=35.

To obtain the E-shape of the patch the subtracted parts are of following dimensions

Subtract_1: (-5,2.5,3.3),dx= 18.8, dy= 5,

Subtract_2: (5.6,-5.5,3.3), dx= 7.2, dy= 8,

Subtract_3: (-5,-10,3.3), dx=18.8, dy= 4.5

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And the positions of the ground and substrate are

(-22.3,-26.5,0),dx=44.6, dy= 53

And the height of the substrate is 1.6 and the dielectric constant is 2.2 .

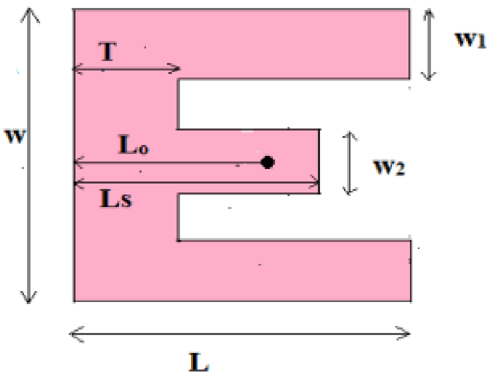

Fig: E-patch design.

And the designed antenna with overall picture and the coaxial feed is shown below

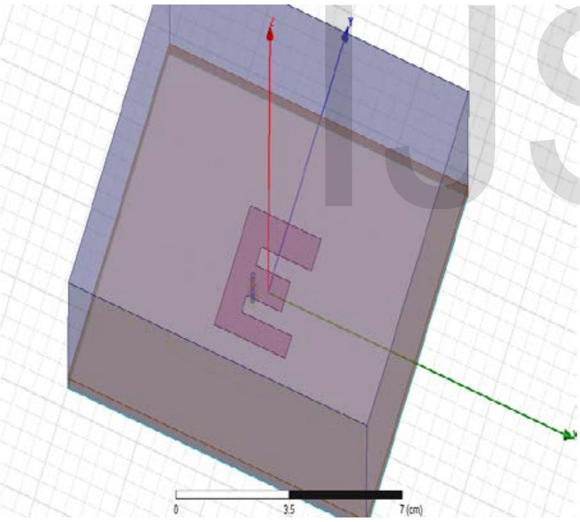

Figure:(1) Designed Antenna

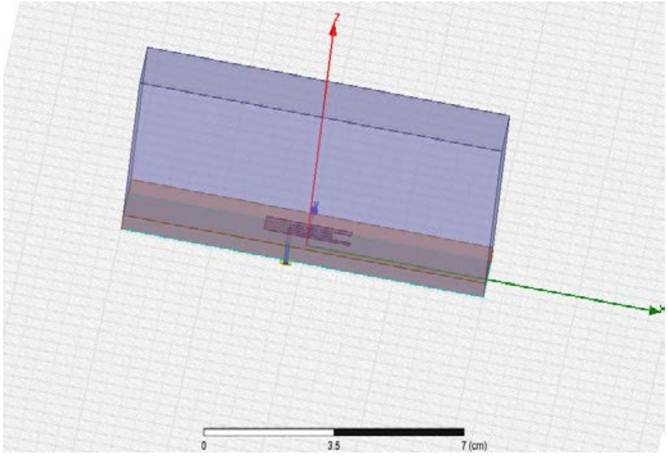

Figure:(2)Showing the Coaxial Feeding of Design

III. Design Cosiderations

To design the antenna there are certain formulas and measures to take. They are:

A. *Effective Dielectric Constant*

2.2, Rogers RT/Duroid 5880(tm)

B. *Fringes factor,*

0.8023

C. *Length of the patch and width of the patch ,*

25.6mm and 35mm

D. *substrate thickness,frequency of operaton.*

3.3 mm, 6.2 GHz

E. *Units*

- Millimeters(mm) are taken as the units for designing width and length and height.
- For Frequency GHz is taken.

IV. Results and Discussion

The antenna is designed and simulated using HFSS version 17.1. Plots are generated for Return loss, Gain, VSWR and Radiation Pattern.

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A. Figures

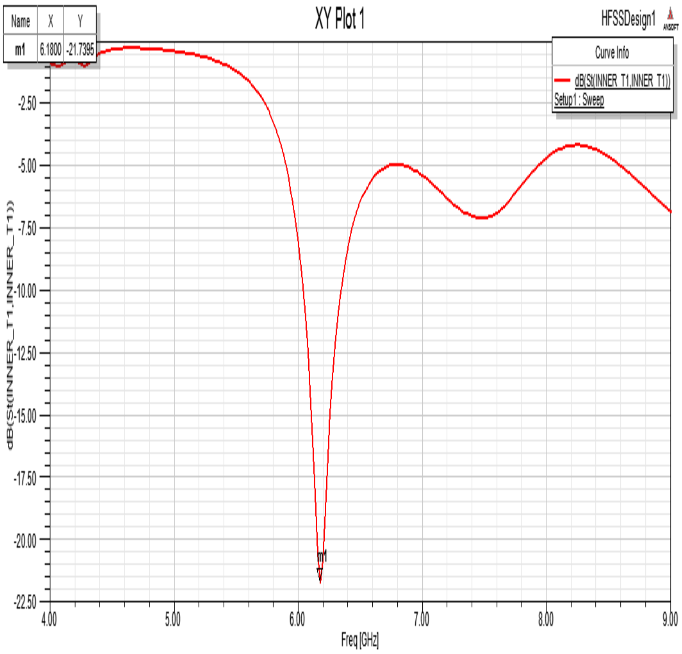

Fig. 1. Return loss of Microstrip patch antenna with the dielectric constant €r =2.2 Rogers RT/Duroi 5880(tm).

The Radiation coefficiant is also defined as the S_{11} or Return loss.

If return loss is high, impedance matching is good and results in low insertion loss. The return loss obtained for the frequency of 6.2 GHz is -21.73 dB. High return loss prevents the reflections caused by impedance discontinuities, may be due to connectors, installation and improper geometry of antenna.

The return loss obtained in the E-patch antenna is -21.73 dB at the frequenncy 6.2 GHz. The increase in the return loss will effect the overall performance of the antenna and have the appropriate effect on the gain.

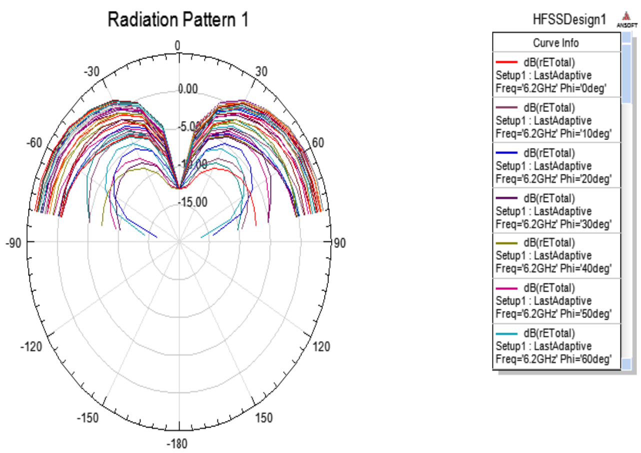

Fig.2. Radiation pattern of the E-patch microstrip patch antenna for the frequency range 6.2 GHz, phi (-180 to 180) degrees.

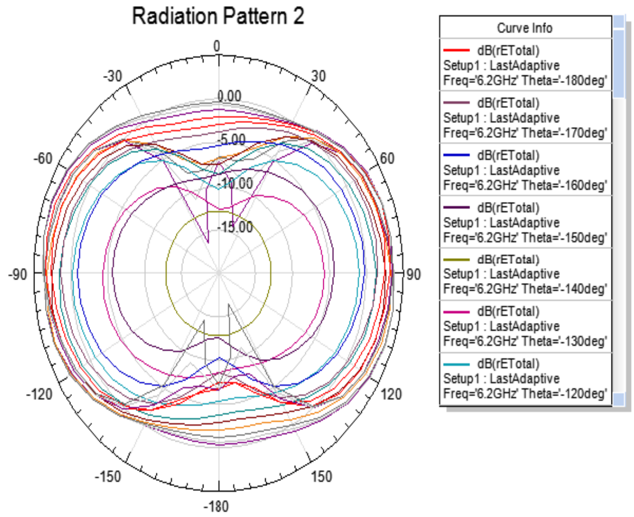

Fig.3. Radiation pattern of theE-patch microstrip patch antena for frequency 6.2 GHz, Theta value ranging from 0 to 360 degrees.

Radiation pattern of Microstrip antenna with total Gain varies in accordance with bandwidth. Radiation patterns are obtained by varying theta (ɵ) and phi (ф) angles. Here, only theta values are varied but phi remains constant to zero value. This shows variation of gain value with respect to theta. As the, gain is the ratio of radiation intensity of antenna in particular direction to radiation intensity of isotropic antenna, Radiation intensity is directly related to phi and theta values.

A radiation pattern defines the variation of the power radiated by antenna. This power variation as a function of the direction away from the antenna. This power variation as a function of the arrival angle is observed in the antenna' s far field.

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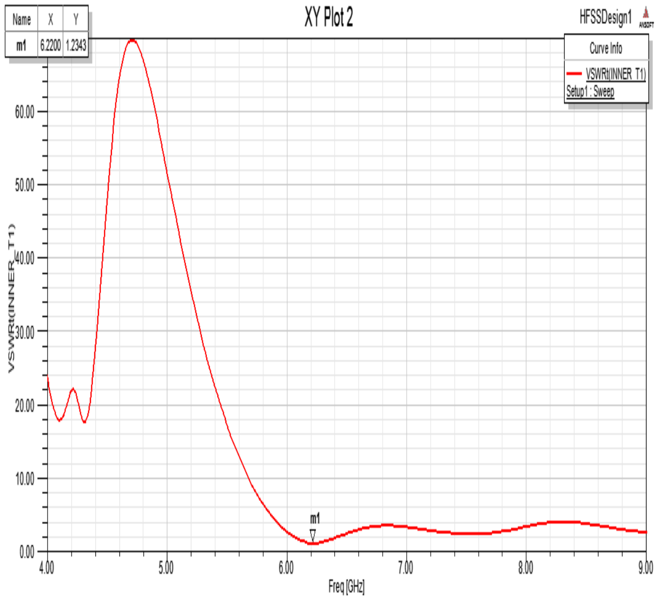

Fig.3. VSWR of the E-patch Microstrip antenna for the frequency 6.2 GHz

VSWR is a measure that numerically describes how well the antenna is impedance matched to the radio or transmission line it is connected to. VSWR describes the reflected power from the antenna. The smaller the VSWR is, the better the antenna is matched to the transmission line and more power is delivered to the antenna. The minimum VSWR is 1.0. In this case, no power is reflected from the antenna, which is ideal case.

The VSWR for the designed antenna with the E-patch operating at the centre frequency of 6.2 GHz and the return loss of -21.73 dB VSWR is 1.2343 which is good result for the antenna. This result shows that the antenna has very good efficiency.

Gain of the antenna is simply defined as the total power given to the total power delivered to the destination. The gain of the Microstrip patch antenna is around 6-9 dBi. The gain obtained for the VSWR 1.2343 is 6.84 dBi.

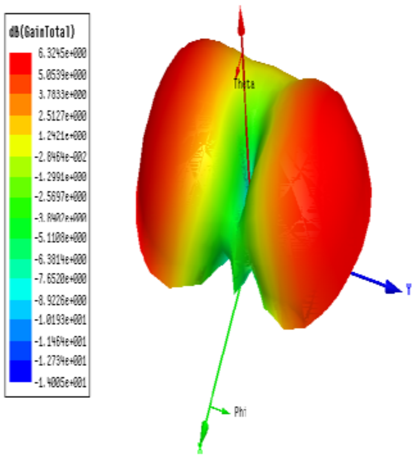

Fig.4. Gain of the E-patch microstrip patch antenna with the operating frequency 6.2 GHzand the Gain is 6.32 dBi.

V. Conclusion

A Wideband E-shaped Microstrip antenna is designed for the frequency range of 5 – 8 GHz. The return loss obtained for the frequency 6.2 GHz is -21.73 dB and the radiation pattern of the antenna is plotted. The VSWR obtained for the E-shaped Microstrip patch antenna is 1.23 with the Gain of 6.32 dBi. Usually the range of the E-patch is 5-6 GHz with 6 dBi for WLAN application. As the range of the C-band near to the Terrestrial radio frequency range there are some disturbances observed in the lower C-band. So, the higher limit of the C-band is close to the Ku- band which is the main frequency band used for the satellite communications. The antenna is designed for the applications such as Wi-Fi, WiMAX and WLAN and also can be used for the GPS. The plots for the Return loss, Radiation Pattern and VSWR and Gain are obtained for the E-shaped Microstrip patch antenna. The E-shaped patch antenna can also be used over the radio frequencies.

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