

Comparative Electromagnetic Analysis of Microstrip Inset Fed and Edge Fed Antenna using ADS Software

A. Swarnkar, A. Agrawal, S. Dwivedi

Department of ECE, LNMIIT, Jaipur, Rajasthan, India

Abstract: In the today's world, communication systems using wireless technology is improving a lot and is the most widely researched area. This study of communication systems is incomplete without an understanding of the operations and techniques used in the antennas. Of these, there are many techniques that have been used to feed microstrip patch antennas. Edge feeding and inset feeding are the two among those techniques. We are chosen to compare edge feed and inset feed due to the advantage that it can be easily fabricated and simplicity in modelling as well as impedance matching. The functional characteristics and output parameters like VSWR, Return loss, Radiation pattern of these Microstrip Patch Antennas varies depending upon the technique used. Comparison of above mentioned parameters have been made on the basis of feeding on Microstrip Patch Antennas with their simulated performance characteristics. Both models have been designed and simulated in Advanced Design System (ADS) which is an electronic design automation software system.

Keywords:- ADS, Microstrip Antenna, Edge fed, Return Loss.

I. INTRODUCTION

A patch antenna (also known as a rectangular microstrip antenna) is a type of radio antenna with a low profile, which can be mounted on a flat surface. It consists of a flat rectangular sheet or "patch" of metal, mounted over a larger sheet of metal called a ground plane. The most commonly employed microstrip antenna is a rectangular patch which looks like a truncated microstrip transmission line. The dielectric loading of a microstrip antenna affects both its radiation pattern and impedance bandwidth. As the dielectric constant of the substrate increases, the antenna bandwidth decreases which increases the Q factor of the antenna and therefore decreases the impedance bandwidth. There are several techniques available to feed or transmit electromagnetic energy to a microstrip patch antenna. The role of feeding is very important in case of efficient operation of antenna to improve the antenna input impedance matching. The feeding techniques used in the microstrip antenna are divided into two important classes as given below:-

Contacting Feed- In this method, the patch is directly fed with RF power using the contacting element such as microstrip line or coaxial line. The most commonly used contacting fed methods are Microstrip Feed and Co-Axial Feed.

Non-Contacting Feed- In this method, the patch is not directly fed with the RF power but instead power is transferred to the path from the feed line through electromagnetic coupling. The most commonly used non-contacting feed methods are Aperture Coupled feed and Proximity Coupled Feed.

II. FEEDING TECHNIQUES

A feedline is used to excite to radiate by direct or indirect contact. There are many different methods of feeding and four most popular methods are microstrip line feed, coaxial probe, aperture coupling and proximity coupling.

Edge Feed is one of the easier methods to fabricate as it is a just conducting strip connecting to the patch and therefore can be consider as extension of patch. It is simple to model and easy to match by controlling the inset position. The disadvantage of this method is that as substrate thickness increases, surface wave and spurious feed radiation increases which limit the bandwidth.

Since the above mentioned antenna yields a high input impedance, there is some modification made in the feed. Since the current is low at the ends of a half-wave patch and increases in magnitude towards the centre, the input impedance could be reduced if the patch was fed closer to the centre. This method is done by using Inset feed as shown in the figure.

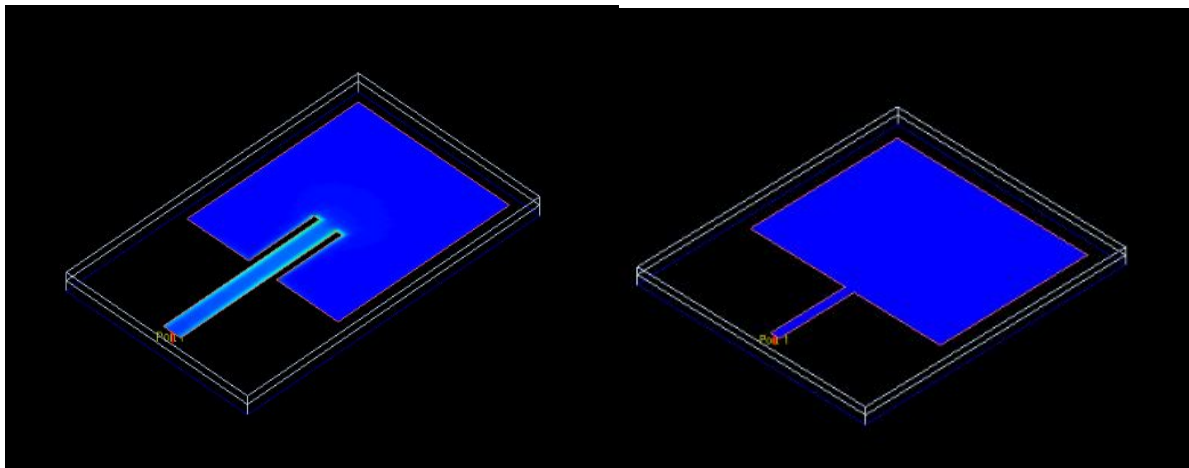


Figure 2(a): Inset Feed

Figure 2(b): Edge Feed

III. SIMULATIONS

This section presents the simulation results of the two different types of antenna discussed above. Both antennas have been designed and simulated on the Advanced Design System (ADS) software.

Table 1: Design Specification used in ADS

Dielectric Constant (ϵ_r)	3.4
Width of Rectangular Patch	30 mm
Length of Rectangular Patch	34mm
Length of Microstrip Feed line	31mm
Width of Microstrip Feed line	3.5mm

3.1: Simulation results of Edge fed Antenna

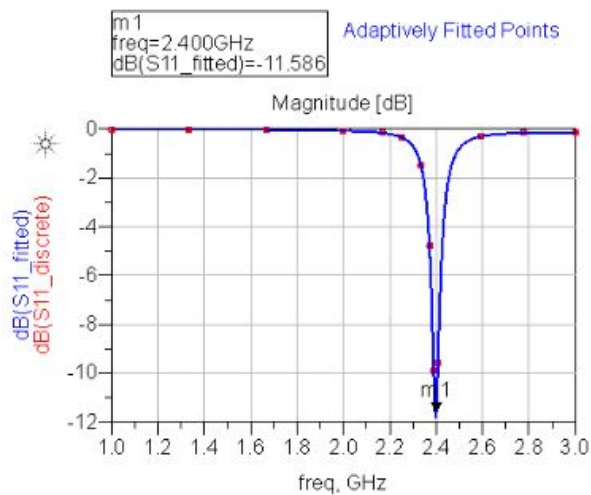


Figure 3.1(a): Return Loss of Edge fed antenna

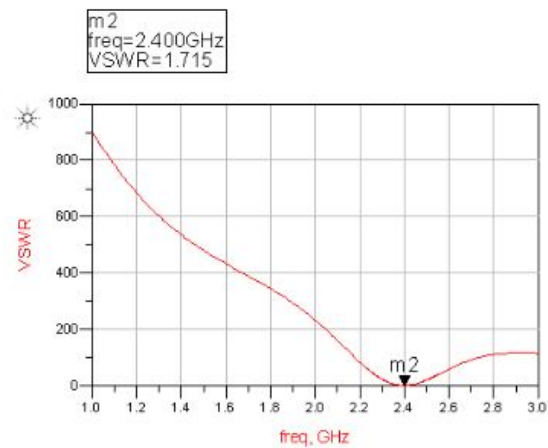


Figure 3.1(b): VSWR of Edge fed antenna

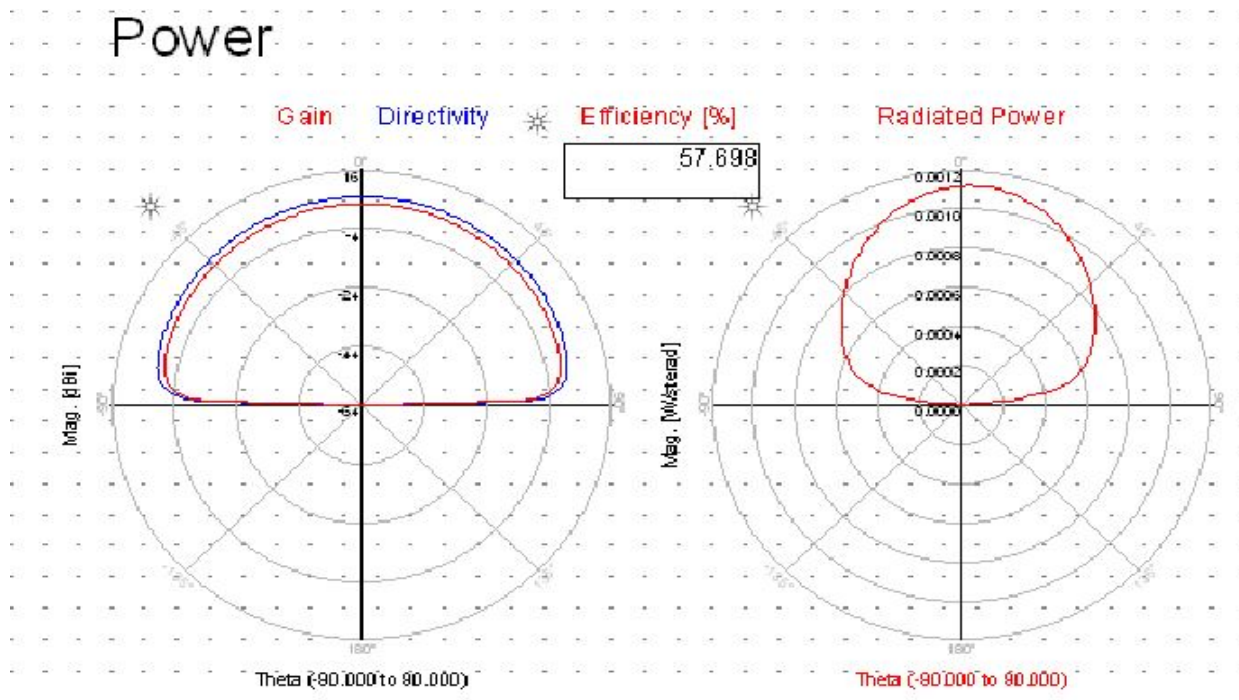


Figure 3.1(c): (i) Gain of Edge fed antenna

(ii) Radiated Power of Edge fed antenna

Antenna Parameters vs Frequency

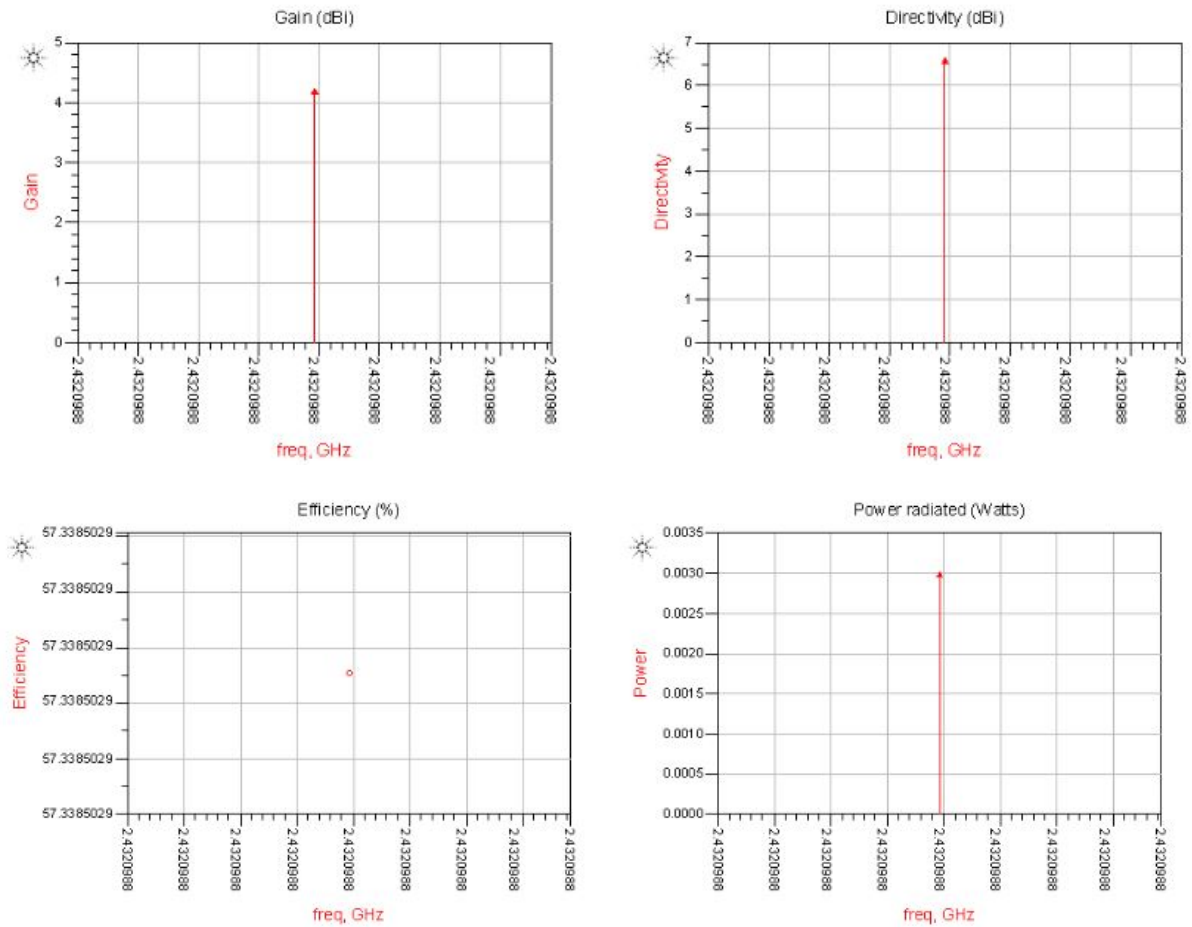


Figure 3.1(d): (i) Gain, (ii) Directivity, (iii) Efficiency, (iv) Radiated Power vs Frequency (Edge fed).

3.2: Simulation results of Inset fed Antenna

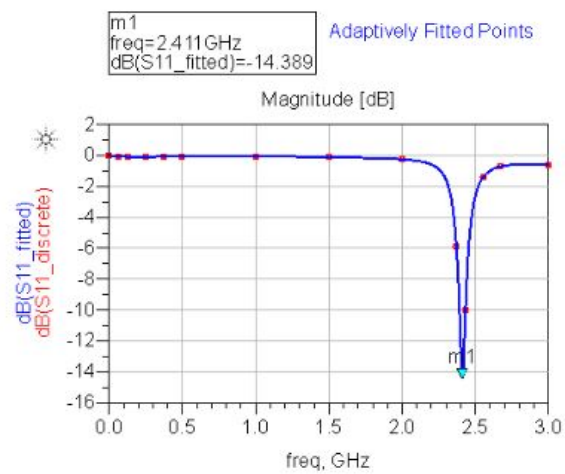


Figure 3.2(a): Return Loss of Inset fed antenna

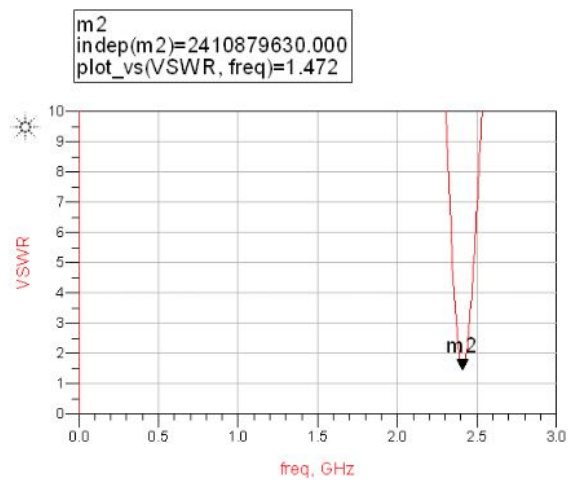


Figure 3.2(b): VSWR of Inset fed antenna

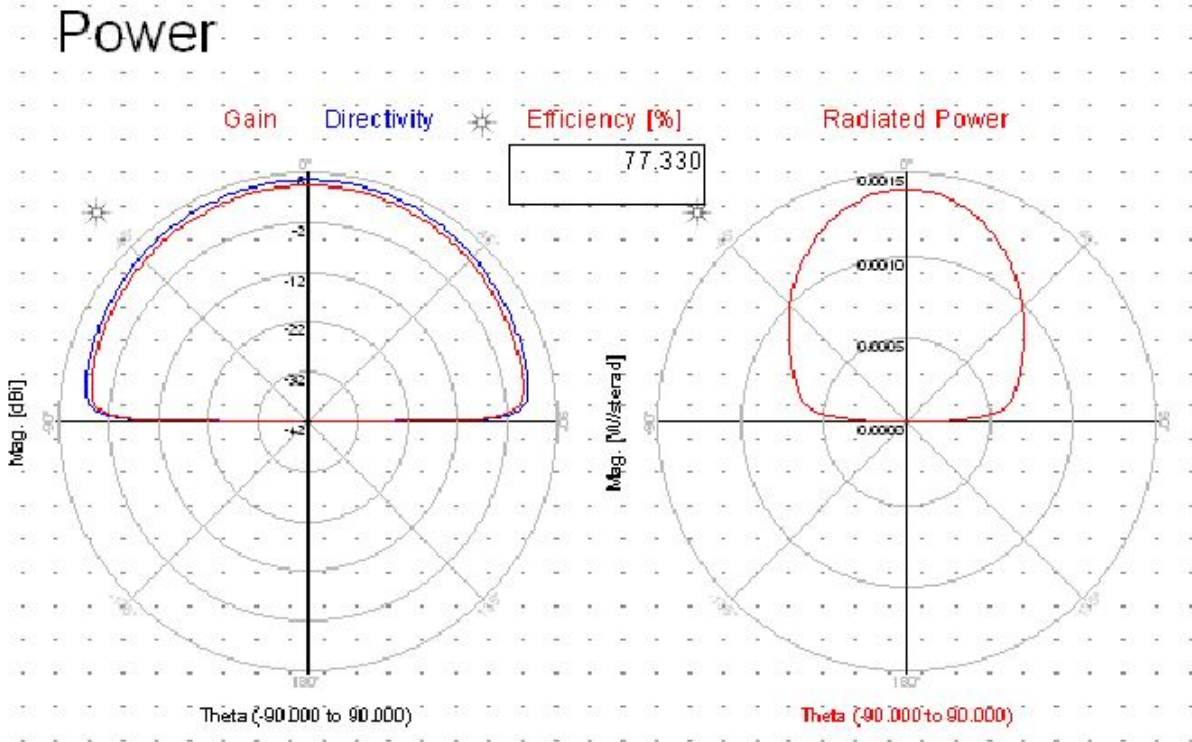


Figure 3.2(c): (i) Gain of Inset fed antenna

(ii) Radiated Power of Inset fed antenna

Antenna Parameters vs Frequency

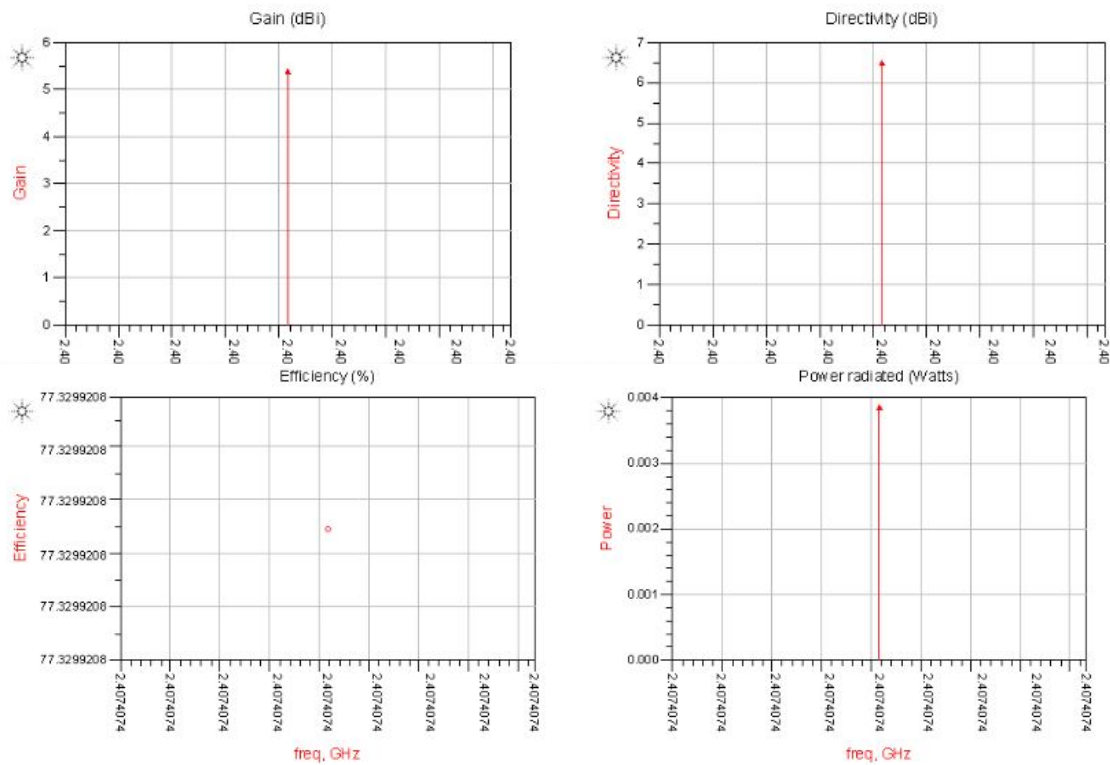


Figure 3.2(d): (i) Gain, (ii) Directivity, (iii) Efficiency, (iv) Radiated Power vs Frequency (Inset fed).

IV. RESULTS AND DISCUSSION

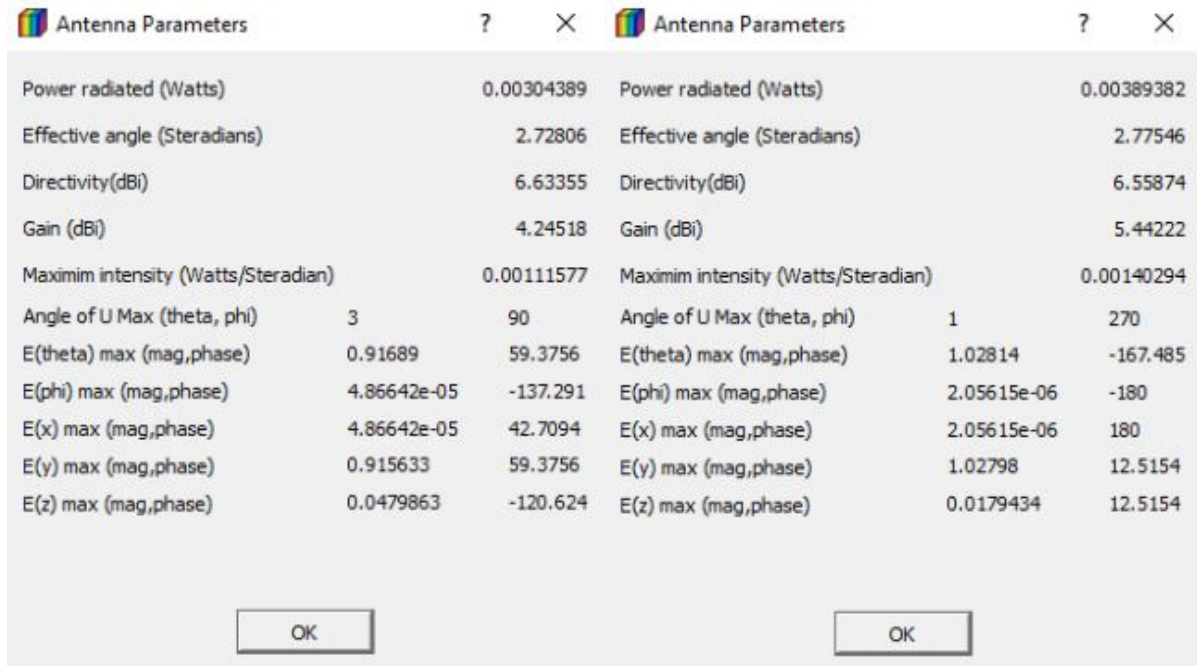


Figure 4(a): Edge fed antenna

Figure 4(b): Inset fed antenna

Table 2: Comparison of Antenna Parameters of Inset Fed and Edge Fed Antennas.

Antenna Parameter Quantity	Edge Fed Simulation Result	Inset Fed Simulation Result
Directivity (dBi)	6.63355	6.55874
Gain (dBi)	4.24518	5.44222
VSWR	1.715	1.472
Return Loss (dB)	-11.586	-14.389
Radiation Efficiency (%)	57.698	77.330
Radiated Power (Watt)	0.00304389	0.00389382
Maximum Intensity (Watt/Sterradian)	0.0011157	0.00140294

The Microstrip Rectangular Patch Antenna with above two feeding techniques has been simulated in ADS and the Antenna parameters calculated in both the feeding techniques are given in Table 2.

All the parameters has been calculated for operating frequency 2.4 GHz. But while calculating a few parameters, the results were obtained at frequency nearer to 2.4 GHz with very slight variation.

V. CONCLUSIONS

The above mentioned two types of feeding techniques are applied to rectangular patch antenna and its performance characteristics are observed at fixed frequency. Inset feeding is giving better return loss and it is giving superior gain compared to the edge feeding. Radiation efficiency is showing better result for Inset feeding and even radiated power is high for the case of inset feeding. Inset feeding antenna has better VSWR compared to Edge feeding. Directivity of Edge fed is slightly greater than Inset fed. Overall, conclusion can be made that Inset Fed Rectangular Antenna is better when compared to Edge Fed Rectangular Antenna, in terms of almost all the antennas parameters.

REFERENCES:

1. Constantine A. Balanis, *Antenna Theory Analysis and Design*, 3rd edition, John Wiley & sons, Inc, 2005.
2. Nader Behdad, “ADS Momentum Tutorial No. 1, Rev. 1,” EEL 6463: Antennas II, Spring 2007.
3. Sarkar, P.P. Sarkar, S.K. Chowdhury, “A New Compact Printed Antenna for Mobile Communication,” 2009 *Loughborough Antennas & Propagation Conference*, 2009, pp 109-11.
4. U. Chakraborty, S. Chatterjee, S. K. Chowdhury, and P. P. Sarkar, “A compact microstrippatch antenna for wireless communication,” *Progress In Electromagnetic Research C*, Vol. 18, pp-211-220. 2011.
5. S. Chatterjee, U. Chakraborty, I. Sarkar, S. K. Chowdhury, and PP. Sarkar, A Compact Microstrip Antenna for Mobile Communication, *IEEE annual conference*, 2011.
6. B. Jyothi, B.T.P. Madhav, V.V.S. Murthy, P. Syam Sundar, VGKM Pisipati, Comparative Analysis of Microstrip Coaxial Fed, Inset Fed and Edge Fed Antenna Operating at Fixed Frequency, *International Journal of Scientific and Research Publications*, Vol. 2, Issue 2, February 2012.
7. D. Bhalla, K. Bansal, “Design of a Rectangular Microstrip Patch Antenna using Inset Feed Technique,” *IOSR Journal of Electronics and Communication Engineering*, Vol. 7, Issue 4, pp 08-13, 2013.
8. P. Agrawal, S. Sanal, G. Gulati, A. Kumar, “Comparative Study of Feeding Mechanism Used in Micro-strip Patch Antenna System,” *International Journal of Emerging Technologies in Computational and Applied Sciences*, pp 377-382, 2013.