ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 2, February 2013

Effect of Feeding Techniques on the Radiation Characteristics of Patch Antenna: Design and Analysis

K. Praveen Kumar[1], K. Sanjeeva Rao[2], T. Sumanth[3], N. Mohana Rao[4], R. Anil Kumar[5], Y.Harish[6]

Associate Professor Dept of ECE, Sri Vani School of Engineering, Chevuturu, A.P, India[1, 2]

Project Students, Dept of ECE, Sri Vani School of Engineering, Chevuturu, A.P, India[3,4,5,6]

ABSTRACT: **: Micros strip rectangular patch antennas are attracting the attention of antenna designer, because of attractive advantages such low profile, light weight, easy of fabrication etc. but it also suffering with some drawbacks of low gain, narrow band width. These drawbacks can be overcome by some extent by taking care in design of antenna. There are many parameters effecting the radiating characteristics of antenna but in present project we are considering feeding of power to antenna because this plays important role. Here we are considering three different feed methods such as coaxial feed, inset feed and cut feed and their effects on radiating characteristics were analyzed on comparing with one to each other all the antenna parameters. The design was done in Ansoft HFSS version 13. The results of return loss, gain, bandwidth and FBR are presented.**

Keywords: coaxial feed, strip feed, cut feed, band width, return loss, gain, FBR

I. INTRODUCTION

The increasing popularity of indoor wireless LAN capable of high-speed transfer rate is prompting the development of efficient broadband antennas. Due to increased usage in residential and office areas, these systems are required to be low profile, aesthetically pleasing and low cost as well as highly effective and efficient. Microstrip patch antennas are well suited for wireless LAN application systems due to their versatility, conformability, low cost and low sensitivity to manufacturing tolerances. Conventionally patch antennas have showed a narrowband response, implicating low bit rate transfer. Recently importance has been placed upon creating patch antennas that show broadband properties, capable of high-speed data transfer. The aim of this project is to design and analise the effect of feeding metods on radiation characteristics of patch antenna, their parameters are compared. So that antenna designer can get an opportunity to choose better feed as per their application. Here design was done on Ansoft HFSS v13.

II. DESIGN OF MICROSTRIP PATCH ANTENNA

The microstrip patch antennas are better analyzed as the transmission line model, cavity model, and full wave model (which include primarily integral equations/Moment Method). The transmission line model is the simplest of all and it gives good physical insight. Hence in present paper we are considered the transmission line model for explanation of our proposal.

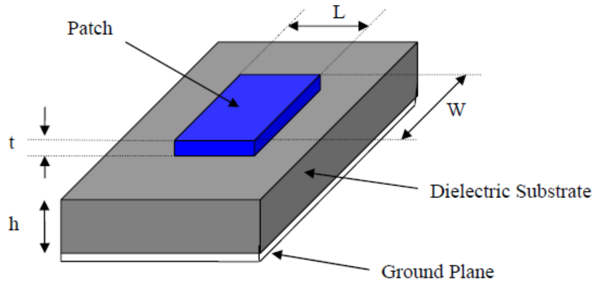


Fig 1:Microstrip patch antenna

A. *Transmission line model:*

This model represents the microstrip antenna by two slots of width W and height h, separated by a transmission line of length L. The microstrip is essentially a nonhomogeneous line of two dielectrics, typically the substrate and air.

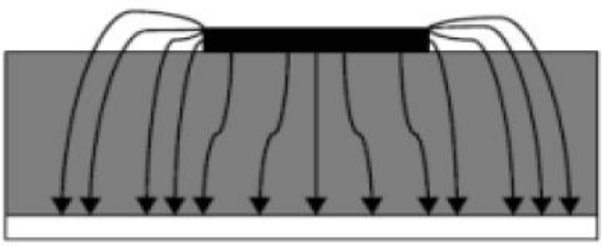


Fig 2: Electrical field lines between ground and plane

By observing field distribution diagram shown above in which most of the electric field lines reside in the substrate and parts of some lines in air. As a result, this

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 2, February 2013

transmission line cannot support pure transverse electric- magnetic (TEM) mode of transmission, since the phase velocities would be different in the air and the substrate. Instead, the dominant mode of propagation would be the quasi-TEM mode. Hence, an effective dielectric constant must be obtained in order to account for the fringing and the wave propagation in the line. The value of effective dielectric constant is slightly less than dielectric constant of substrate, because the fringing fields around the periphery of the patch are not confined in the dielectric substrate but are also spread in the air as shown in Figure above.

The expression for effective dielectric constant is

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

ε_{reff} = Effective dielectric constant

ε_r = Dielectric constant of substrate

h = Height of dielectric substrate

W =Width of the patch

the microstrip patch antenna is represented by two slots, separated by a transmission line of length L and open circuited at both the ends. Along the width of the patch, the voltage is maximum and current is minimum due to the open ends. The fields at the edges can be resolved into normal and tangential components with respect to the ground plane.

The normal components of the electric field at the two edges along the width are in opposite directions and thus out of phase since the patch is λ/2 long, hence they cancel each other in the broadside direction. The tangential components which are in phase, means that the resulting fields combine to give maximum radiated field normal to the surface of the structure. Hence the edges along the width can be represented as two radiating slots, which are λ/2 apart and excited in phase and radiating in the half space above the ground plane. The fringing fields along the width can be modeled as radiating slots and electrically the patch of the microstrip antenna looks greater than its physical dimensions. The dimensions of the patch along its length have now been extended on each end by a distance ΔL, which is

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

The effective length

$$L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{reff}}}$$

Actual Length

$$L = L_{eff} - 2\Delta L$$

Patch width

$$W = \frac{c}{2f_o\sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

Ground plane dimensions

$$L_g = 6h + L$$

$$W_g = 6h + W$$

III FEED TECHNIQUES

Microstrip patch antennas can be fed by a variety of methods. These methods can be classified into two categories- contacting and non-contacting. In the contacting method, the RF power is fed directly to the radiating patch using a connecting element such as a microstrip line. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch. The three most popular contact feed techniques are presented in my proposal of work in comparison with each other.

A. *Coaxial Feed*

The Coaxial feed or probe feed is a very common technique used for feeding Microstrip patch antennas. As shown in below figure. Where the inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to ground plane. The main advantage of this type of feeding scheme is that the feed can be placed at any desired location inside the patch in order to match with its input impedance However, its major disadvantage is that it provides narrow bandwidth and is difficult to model since a hole has to be drilled in the substrate and the connector protrudes outside the ground plane, thus not making it completely planar for thick substrates. Also, for thicker substrates, the increased probe length makes the input impedance more inductive, leading to matching problems. It is seen above that for a thick dielectric substrate, which provides broad bandwidth, the microstrip line feed and the coaxial feed suffer from numerous disadvantages.

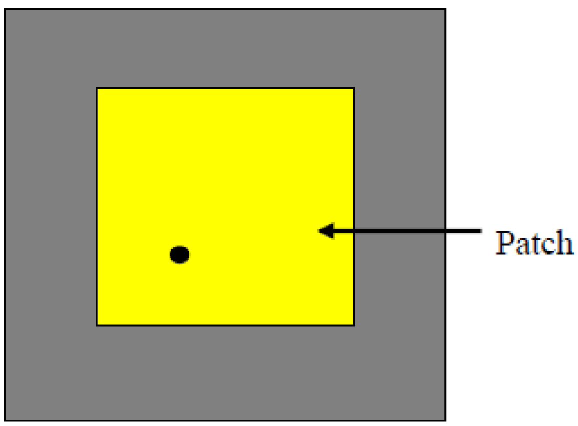


Fig 3:Top view of coaxial feed

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 2, February 2013

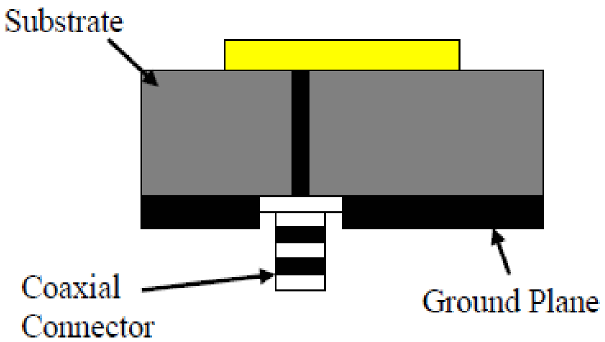


Fig 4: Side view of coaxial feed

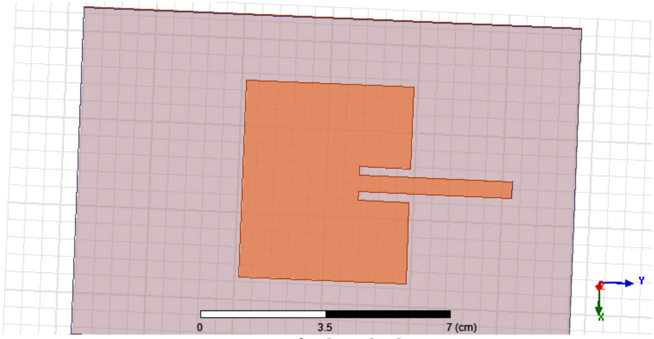


Fig 6: Cut feed method

B. Micro Strip Feed

In this type of feed technique, a conducting strip is connected directly to the edge of the microstrip patch as shown in below Figure . The conducting strip is smaller in width as compared to the patch and this kind of feed arrangement has the advantage that the feed can be etched on the same substrate to provide a planar structure.

Mi

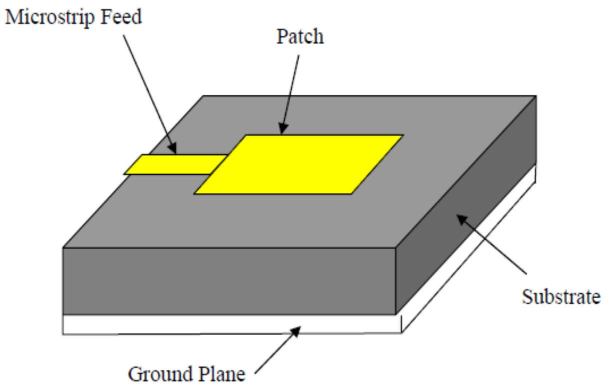


Fig 5:Microstrip line feed

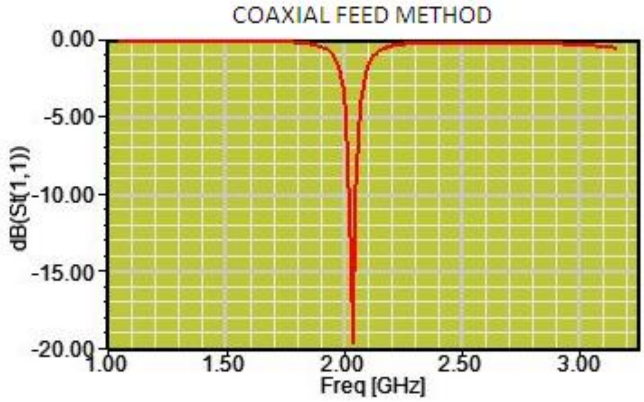
C. Cut Feed

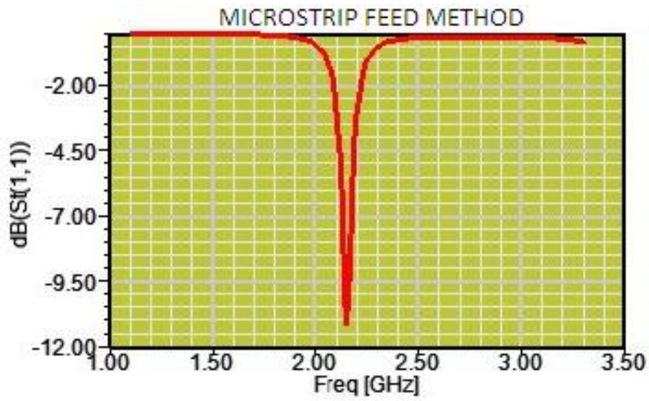
The purpose of the inset cut in the patch is to match the impedance of the feed line to the patch without the need for any additional matching element. This is achieved by properly controlling the inset position. Hence this is an easy feeding scheme, since it provides ease of fabrication and simplicity in modelling as well as impedance matching. However as the thickness of the dielectric substrate being used, increases, surface waves and spurious feed radiation also increases, which hampers the bandwidth of the antenna. The feed radiation also leads to undesired cross polarized radiation.

IV RESULTS & DISCUSSION

A. Return Loss

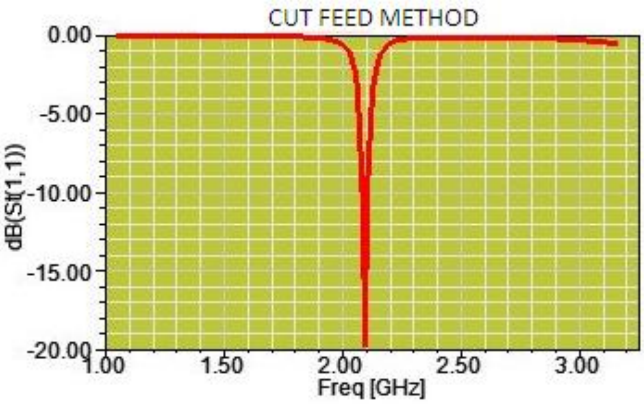
Return loss is a parameter which explains amount of power from feed point to radiating element is supplied effectively. The return loss value of coaxial feed microstrip patch antenna is -18.8037 at operating frequency of 2.0420GHz, for microstrip feed -11.1503 at 2.1503GHz, for cut feed -19.7630 at 2.0947GHz. Hence by above information we can say that cut feed is giving good results comparing with remaining two.

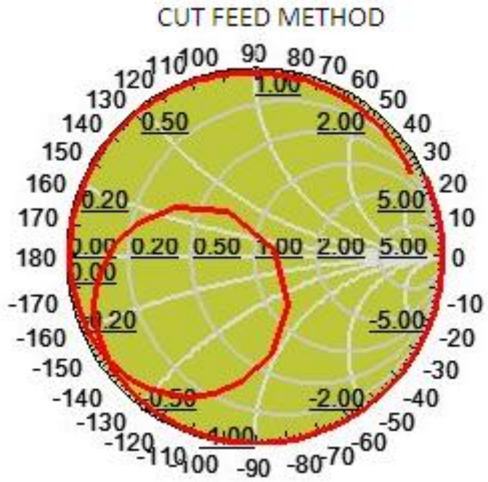




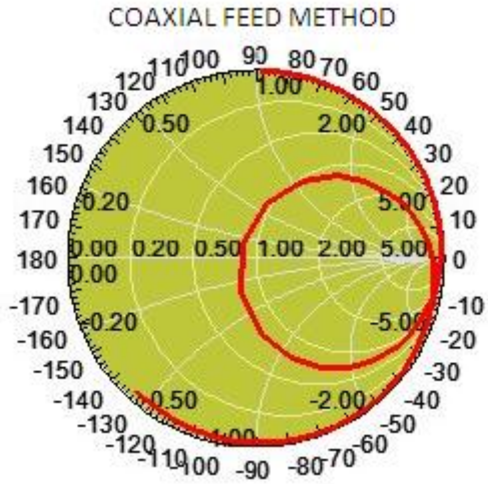
ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

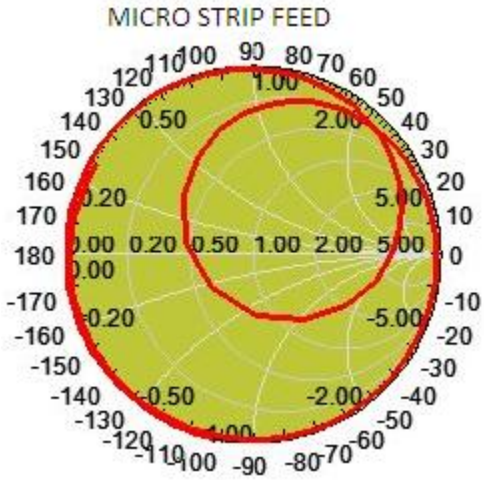
International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 2, February 2013





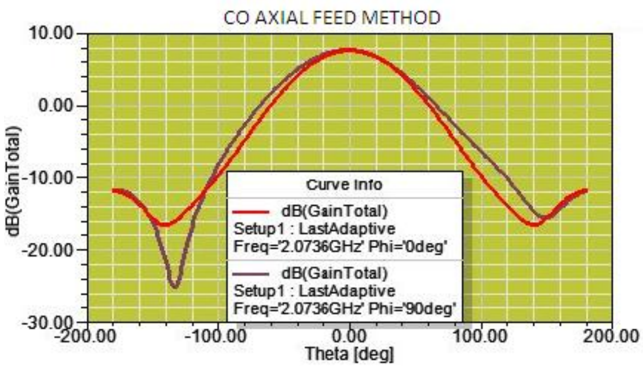
B.Impedance

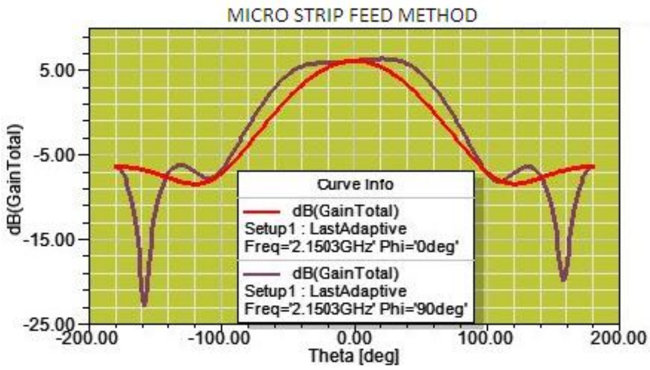




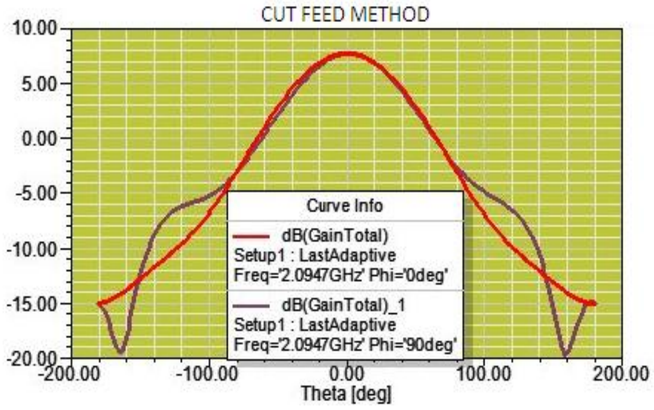
C.Gain_2D

This is a parameter which is giving figure of merit of antenna. This two dimensional gain is plot of teta vs total gain of antenna which gives phi 0 deg and 90 deg.



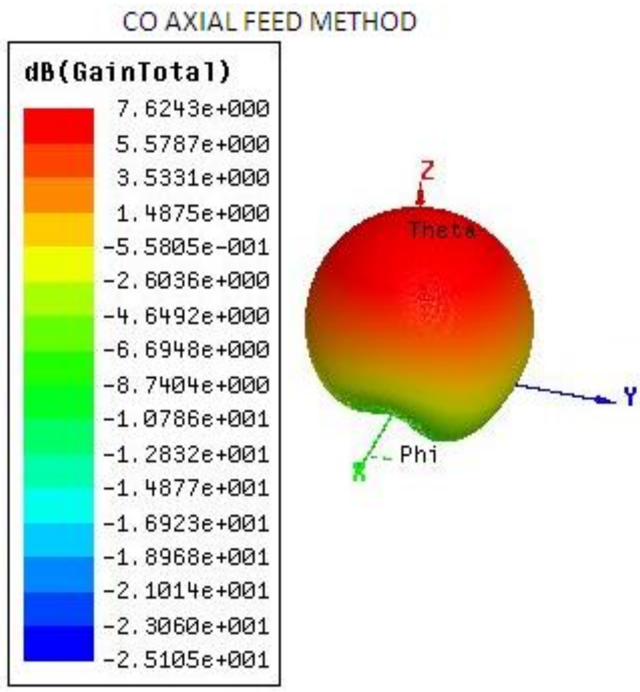


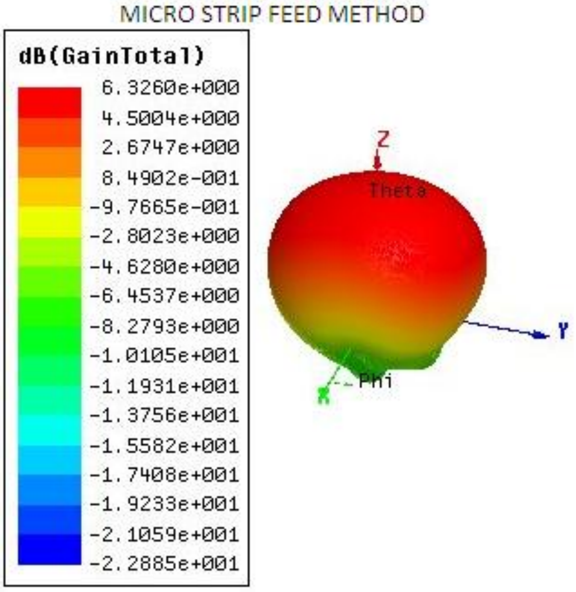
ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021
International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 2, February 2013



D.Gain_3D

This 3D gain clearly showing the peak value of gain of antenna for coaxial feed 7.6243dBi, for strip feed 6.3260dBi and cut feed 7.6867dBi respectively





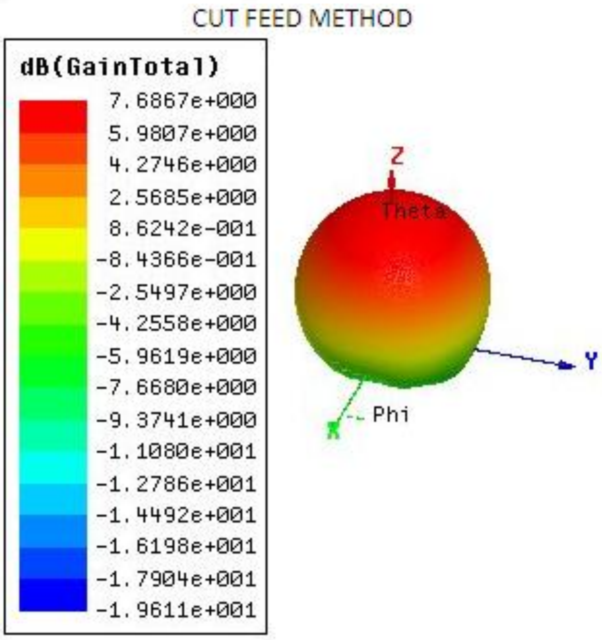


TABLE I
ANTENNA PARAMETER

Parameter/feedType	**Coaxial**	**Strip**	**Cut**
Max U	0.0028368	0.0031544	0.0046223
Peak Directivity	6.0168	4.5092	6.1806
Peak Gain	5.7867	4.2914	5.8705
Peak Realized Gain	3.5976	3.964	5.8087
Radiated Power	0.005925	0.008791	0.0093989
Accepted power	0.0061605	0.009237	0.0098947
Incident Power	0.0099091	0.01	0.01
Radiation Efficiency	0.96176	0.95171	0.94989
FBR	88.703	704.05	188.01

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 2, February 2013

After observing the obtained results and antenna parameters we can clearly say that out of three feed techniques i.e coaxial feed, Microstrip feed and Cut feed, the cut feed is giving efficient results. The gain, directivity are higher on comparing with others.

III. CONCLUSION

The feed of microstrip antenna also effecting the radiation characteristics of radiating element, hence while designing antenna a care must taken while deciding the proper feed.

ACKNOWLEDGMENT

The author wants to thank the Dr.Habibulla Khan, Professor & HOD-ECE, Dept of ECE, KL University. K.sanjeeva Rao and J.Doondi Kumar Assist. Proff dept of ECE Sri Vani School of Engg.

REFERENCES

[1] Constantine A. Balanis; Antenna Theory, Analysis and Design, John Wiley & Sons Inc. 2nd edition. 1997.
[2] Y.T. Lo. and S.W. Lee, editors, Antenna Handbook Theory, Applications and Design, Van Nostrand Reinhold Company, New York, 1988.
[3] Stutzman Warren L. and Thiele Antennas and propagation Magazine, vol.52, Feb 2010)
[4] Broadband Microstrip Antennas, Girish Kumar and K. P. Ray, Artech House, 2002.
[5] Daniel H. Schaubert, "A review of Some Microstrip Antenna Characteristics" Microstrip Antennas - The Analysis and Design of Microstrip Antennas and Arrays, edited by David M. Pozar, Daniel H. Schaubert, John Wiley & Sons, Inc., 1995, ISBN 0-7803-1078-0.
[6] A Derneryd, "Linearly Polarized Microstrip Antennas", IEEE Trans. Antennas and Propagation, AP-24, pp. 846-851, 1976
[7] D.M.Pozar Microwave Engineering, 3rd ed. NewYork, John Wily & Sons, 1998.
[8] J.A.Kong, Electromagnetic wave theory., EMW Publishing, 2008, p 268.

Biography

K.Praveen Kumar was born in india, A.P in 1980. He received B.E (ECE) from Visveswaraiah Technological University, Belgaum. And M.Tech(Microwave Engg) Acharya Nagarjuna University, Guntur.He has a 10 years of teaching experience. 11 International Journals, 01 International Conference in his credit. He is a research scholar of JNT University, Hyderabad. In the dield of Microwave Antenna. Presently holding the responsibility as HOD dept of ECE at Sri Vani School of Engineering, Chevuturu.

K.Sanjeeva Rao was born in 1983. He received M.Tech (ECE) from Sathyabhama University, Chennai. He has 07 years of teaching experience. In various Engg.,Colleges & Universities in TN & AP Currently Working as Associate Professor in Dept of ECE at Sri Vani School of Engineering. Microwave antennas, Transmission lines, waveguide are his area of interest.




T.Sumanth, N.Mohana Rao, R.Anil Kumar,Y.Harish are the under graduate [B.Tech (ECE)] project students of Sri vani school of engineering. JNT University Kakinada.

.