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Comparative study of different Feeding Techniques for Rectangular Microstrip Patch Antenna

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Abstract: A Microstrip Patch Antenna is a type of radio antenna with a low profile, which can be mounted on a flat surface. It is a narrowband, wide-beam fed antenna fabricated by etching the antenna element pattern in metal trace bonded to an insulating dielectric substrate such as a printed circuit board with a continuous metal layer bonded to the opposite side of the substrate which forms a ground plane. It's various applications are biomedical diagnosis, mobile radio, remote sensing, wireless and satellite communications. A good impedance matching condition is required between the line and patch without any additional matching elements. This condition can be provided using various feeding techniques. In this paper, a comparative study between inset feed, microstrip feed and co-axial feed, on a rectangular microstrip patch antenna are done on the basis of S-parameter, Reflection gain, VSWR and Radiation Pattern using Hyperlynx 3D EM software.

Keywords: Microstrip patch antenna, feeding techniques, reflection gain, radiation pattern, VSWR, S-parameter, Hyperlynx 3D.

I. INTRODUCTION

Microstrip antenna has drawn the attention of researchers over the past work because of their many attractive features. The microstrip patch structures are relatively easy to manufacture and have turned microstrip analysis into an extensive research problem. Research on microstrip antenna in the 21st century aimed at size reduction, increasing gain, wide bandwidth, multiple functionality and system-level integration. [3-4]. With the wide spread proliferation of wireless communication technology in recent years, the demand for compact, low profile and broadband antennas has increased significantly. To meet the requirement, the microstrip patch antenna have been proposed because of its low profile, light weight and low cost.[1] Microstrip Patch Antenna consists of a conducting rectangular patch of width "W" and length "L" on one side of dielectric substrate of thickness "h" and dielectric constant "ε_r". Common microstrip antenna shapes are square, rectangular, circular and elliptical, but any continuous shape is possible.

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

The role of feeding is very important in case of efficient operation of antenna to improve the antenna input impedance matching.[7] The various types of feeding techniques are:-

A. Microstrip line Feed:-

In this type of feed technique, a conducting strip is connected directly to the edge of the Microstrip patch. 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. [8]

B. Inset Feed

In is a type of microstrip line feeding technique, in which the width of conducting strip is small as compared to the patch and has the advantage that the feed can provide a planar structure. [2] The purpose of the inset cut in the patch is to match the impedance of the feed line to the patch input impedance without the need for any additional matching element. This can be achieved by properly adjusting the inset cut position and dimensions. [6]

C. Co-axial Feed

The Coaxial probe feeding is a very common technique used for feeding Microstrip patch antennas. The inner

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conductor of the coaxial cable extends through the dielectric and is soldered to the radiating metal patch, while the outer conductor is connected to the ground plane. The advantage of this feeding scheme is that the feed can be placed at any desired location on the patch in order to match cable impedance with the antenna input impedance.[5]The main aim to use probe feeding is it enhances the gain, provides narrow bandwidth and impedance matching. [6]

D. Aperture coupled Feed

In this type of feed technique, the radiating patch and the microstrip feed line are separated by the ground plane. Coupling between the patch and the feed line is made through a slot or an aperture in the ground plane.

E. Proximity coupled Feed

This type of feed technique is also called as the electromagnetic coupling scheme. Two dielectric substrates are used such that the feed line is between the two substrates and the radiating patch is on top of the upper substrate. The main advantage of this feed technique is that it eliminates spurious feed radiation and provides very high bandwidth (as high as 13), due to overall increase in the thickness of the microstrip patch antenna.

III. DESIGN EQUATIONS

The equations involved in calculating the values of the above mentioned design parameters are:-

- $\lambda_0 = \frac{c}{f_r}$ ………………………………… (1)
- $W = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}}$ ………………………... (2)
- $\varepsilon_{eff} = \frac{\varepsilon_r+1}{2}\frac{\varepsilon_r-1}{2}\frac{1}{\sqrt{\left[1+12\frac{h}{W}\right]}}$ ……………… (3)
- $\Delta L = 0.412h\frac{(\varepsilon_{eff}+0.3)}{(\varepsilon_{eff}-0.258)}\frac{(\frac{W}{h}+0.264)}{(\frac{W}{h}+0.8)}$ …….. (4)
- $L = \frac{1}{2cf_r\sqrt{\varepsilon_{eff}}} - 2\Delta L$ …………………..... (5)
- $Z_{in} = 90\left(\frac{\varepsilon_r^2}{\varepsilon_r-1}\right)\left(\frac{L^2}{W^2}\right)$ .... (6)

IV. DESIGN MODEL

The design models for the microstrip line feed, inset feed and co-axial feed are as follows:-

A. Microstrip line Feeding

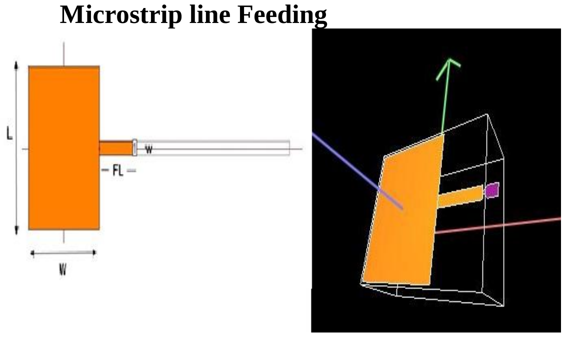

Fig 1: Rectangular Microstrip patch antenna with a Microstrip line feeding.

A rectangular patch of length 'L' and width 'W' is designed. Then a microstrip line feed of length 'FL' and width 'w' is formed.

B. Inset Feeding

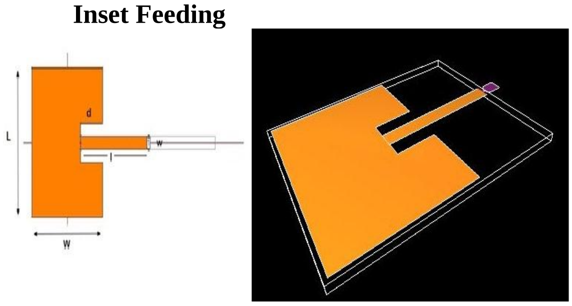

Fig 2: Rectangular Microstrip patch antenna with an Inset feeding.

A rectangular patch of length 'L' and width 'W' is designed. The patch is cut at a depth 'd'. Then inset feed of length 'l' and width 'w' is formed. The port is defined at the end of the feed line. This technique is simple to model and easy to match by controlling the inset position.

C. Co-axial Feeding

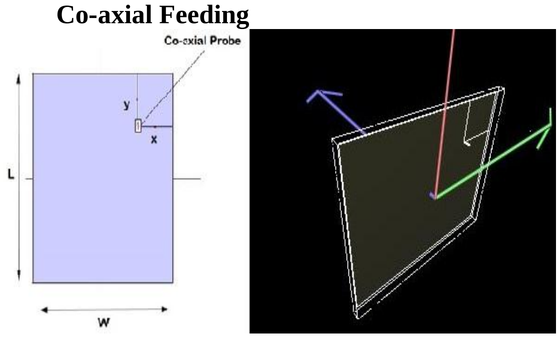

Fig 3: Rectangular Microstrip patch antenna with a Co-axial feeding.

Co- axial feed can be placed at any desired location inside the patch in order to match with its input impedance. This feed method is easy to fabricate and has low spurious radiation. A rectangular patch of length 'L' and width 'W' is designed. The location of probe is defined by the X-coordinate 'x' and the Y- coordinate 'y'. The probe is in direct contact with the antenna and it is located at the point of minimum return loss.

V. DESIGN PARAMETERS

These are the design parameters which we used in designing the microstrip patch antenna with the three different feed techniques.

TABLE 1: DESIGN PARAMETERS

S.No	Parameter Name	Designed Values
1.	Dielectric Constant, ε_r	4.4
2.	Resonant Frequency, f_r	1.9 GHz
3.	Loss Tangent	0.001
4.	Patch Length, L	37.20mm
5.	Patch Width, W	48.05mm
6.	Substrate Height, h	2.0mm
7.	Feed Width, w	4.178mm
8.	Feed line Length, FL	18.819mm
9.	Inset Depth, d	11.7284mm
10.	Inset feed Length, l	35.7534mm
11.	Co-axial X- coordinate,x	9.199
12.	Co-axial Y- coordinate,y	12.0125

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VI. SIMULATED RESULTS

A. S-PARAMETER

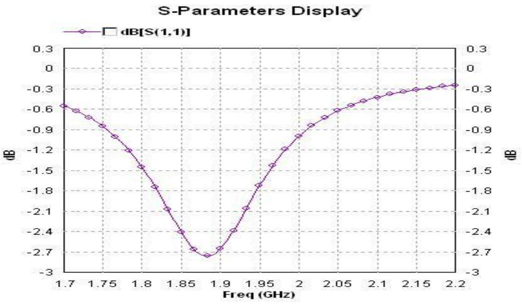

Fig 4: S-parameter for Microstrip line Feed at S(1,1)

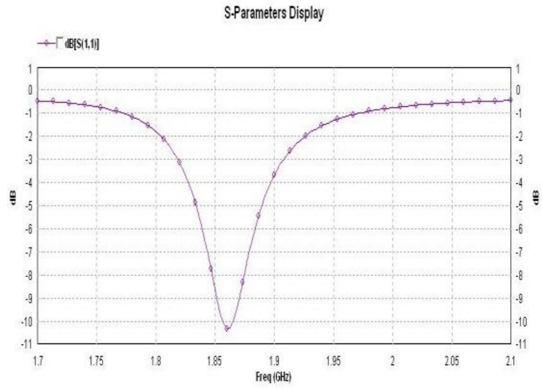

Fig 4: S-parameter for Inset Feed at S(1,1)

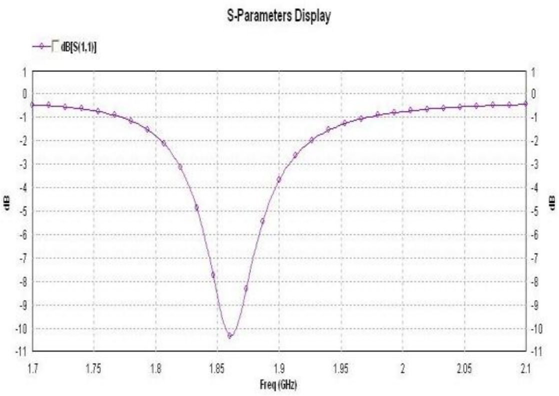

Fig 5: S-parameter for Co-axial Feed

B. VSWR

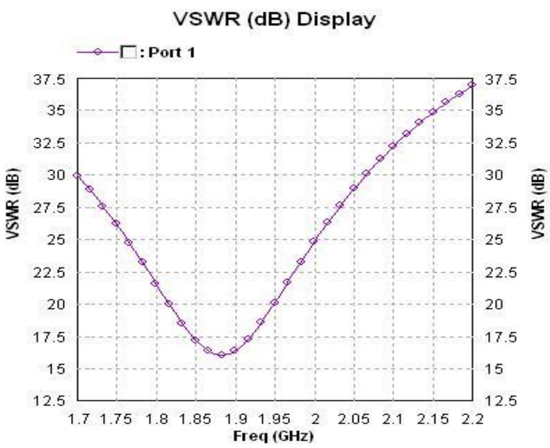

Fig 6: VSWR for Microstrip line Feed

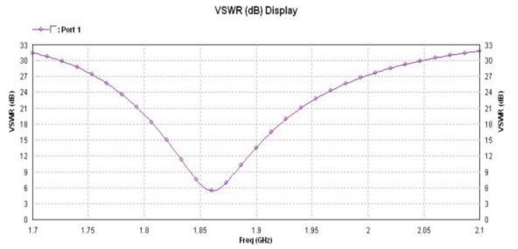

Fig 7: VSWR for Inset Feed

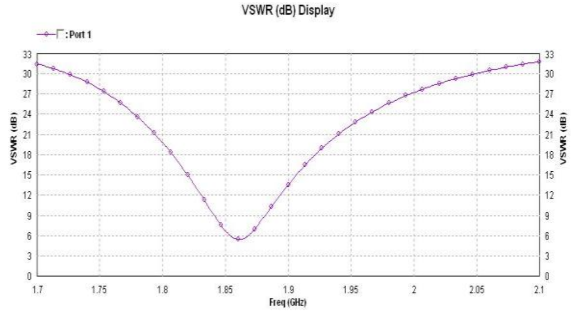

Fig 8: VSWR for Co-axial Feed

C. REFLECTION GAIN

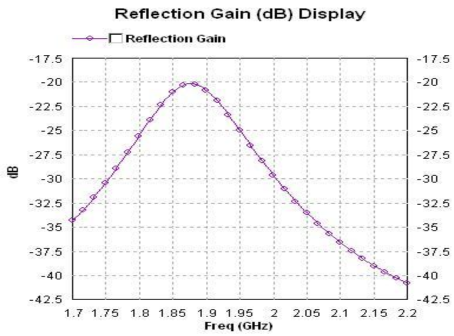

Fig 9: Reflection gain for Microstrip line Feed

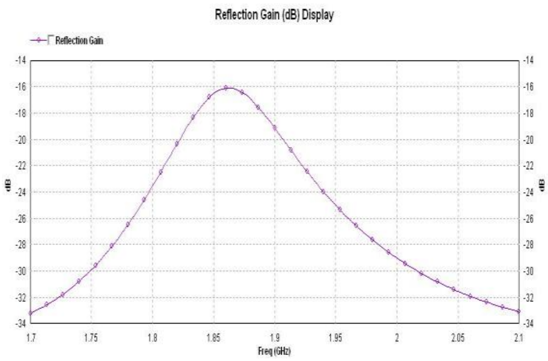

Fig 10: Reflection gain for Inset Feed

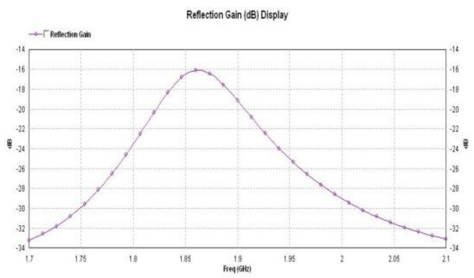

Fig 11: Reflection gain for Inset Feed

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D. RADIATION PATTERN

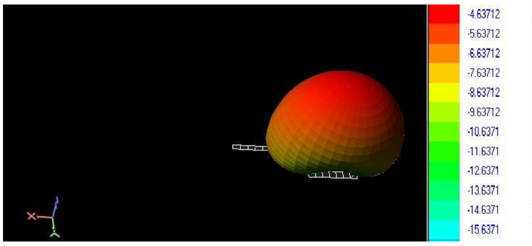

Fig 12: Radiation pattern for Microstrip line Feed

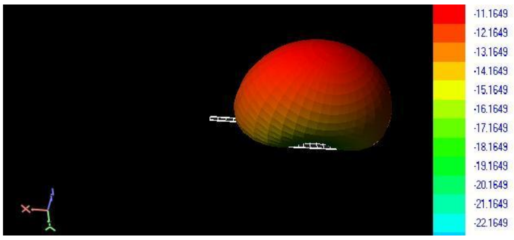

Fig 13: Radiation pattern for Inset Feed

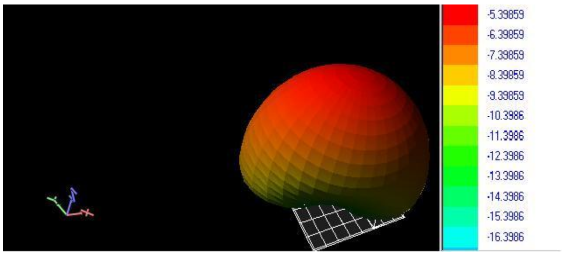

Fig 14: Radiation pattern for Co-axial Feed

VII. COMPARATIVE STUDY OF FEEDING TECHNIQUES

We have studied that Inset Feed when applied to Rectangular Microstrip Patch Antenna gives lowest VSWR and return loss at a specific frequency of 1.9GHz as shown in Table 2.

TABLE 2: COMPARISION OF DIFFERENT PARAMETERS FOR THE THREE FEEDING TECHNIQUE

Feeding Technique	S-parameter (dB)	VSWR (dB)	Reflection Gain (dB)
Microstrip line Feed	-2.644	16.390	-20.839
Inset Feed	-7.263	8.059	-15.860
Co-axial Feed	-3.686	13.594	-19.147

VIII. CONCLUSION AND FUTURE SCOPE

In this paper, a comparative study between different feeding techniques for a Rectangular Microstrip Patch Antenna is done. The microstrip line feeding, inset feeding and coaxial probe feeding are compared on the basis of the Radiation Pattern, VSWR, Reflection gain and S-parameter. The simulation of the Microstrip Patch Antenna for the three feeding techniques is performed on Hyperlynx 3D EM software. The comparison of feeding techniques shows that the Rectangular Microstrip Patch Antenna with the Inset Feed has the highest gain, lowest VSWR and return loss for the dielectric material FR4 at a specific frequency of 1.9GHz. Thus it states that inset feed provides better impedance matching than the co-axial feed and microstrip line feed.

REFERENCES

[1]. N. Herscovici. 1998. New considerations in the design of microstrip antennas. IEEE Transactions on Antennas and Propagation, AP-46, 6 (Jun. 1998), 807-812.

[2]. S. S. Pattnaik, Gianluca Lazzi, and Om P. Gandhi. 1998. On the Use of Wide-Band High-Gain Microstrip Antenna for Mobile Telephones. IEEE Antennas and Propagation Magazine 40, 1 (Feb. 1998), 88-90.

[3]. D. Sanchez-Hernandez and I. D. Robertson. 1996. A Survey of Broadband Microstrip Patch Antennas. Microwave Journal, (Sep. 1996), 60-84.

[4]. Dipak K. Neog, Shyam S. Pattnaik, Dhruba. C. Panda, Swapna Devi, Bonomali Khuntia, and Malaya Dutta, "Design of a Wideband Microstrip Antenna and the Use of Artificial Neural Networks in Parameter Calculation", IEEE Antennas and Propagation Magazine, Vol. 47, No.3, June 2005

[5]. C. A. Balanis, Antenna Theory, Analysis and Design, John Wiley and Sons, New York.

[6]. Prof. Mahesh M. Gadag, Mr. Dundesh S. Kamshetty, Mr. Suresh L. Yogi "Design of Different Feeding Techniques of Rectangular Microstrip Antenna for 2.4GHz RFID Applications Using IE3D", Proc. of the Intl. Conf. on Advances in Computer, Electronics and Electrical Engineering.

[7]. Jagdish. M. Rathod, Member, IACSIT, IETE (I), IE (I), BES (I) "Comparative Study of Microstrip Patch Antenna for Wireless Communication Application", International Journal of Innovation, Management and Technology, Vol. 1, No. 2, June 2010 ISSN: 2010-0248

[8]. Gurdeep Singh, Jaget Singh." Comparative Analysis of Microstrip Patch Antenna With Different Feeding Techniques". International Conference on Recent Advances and Future Trends in Information Technology (iRAFIT2012) Proceedings published in International Journal of Computer Applications® (IJCA).