COMPARISON OF FEEDING TECHNIQUES FOR THE DESIGN OF MICROSTRIP RECTANGULAR PATCH ANTENNA FOR X-BAND APPLICATIONS

Sumeet Singh Bhatia[1], Jagtar Singh Sivian[2], Manpreet Kaur[3]

[1]M.Tech Student , [2]Associate Professor , [3]Assistant Professor , ECE Deptt.,

Yadavindra College of Engineering, Guru Kashi Campus, Talwandi Sabo, Bathinda - punjab (India)

ABSTRACT

A microstrip patch antenna is presented for wireless communication system. In this paper two different feeding techniques of microstrip rectangular patch antenna like direct line feed and proximity coupled feed is designed for the same dimensions of patch, feed and substrate. The designed antennas are resonating at the frequency of 7.5 GHz which is desired frequency for X-band applications. The frequency range for X-band application is 7 to 8 GHz. The Ansoft/Ansys HFSS V13 software is used to analyze the different results and some of them like return loss, bandwidth and gain is compared and discussed in this paper.

Keywords: Bandwidth, Gain, HFSS, Microstrip Patch Antenna, Return Loss.

I INTRODUCTION

Microstrip antennas have many attractive features that are draws the attention of researchers over the past work [1-2]. Microstrip antennas are used in number of applications like biomedical diagnosis and wireless communication [3]. With the rapid growth of the wireless communication system the future technologies need very small, compact and multiband antennas. Nowadays, people demand multiband wireless phone supporting more than one network, having different frequencies and simultaneous transmission of video, audio and data. These services are possible with the help of microstrip patch antenna having multiband characteristics. Modern wireless communication system also requires low profile, light weight, high gain, ease of installation, high efficiency, simple in structure to assure reliability and mobility characteristics. Microstrip antennas satisfy such requirements. Research on microstrip antenna in 21st century aims at size reduction, increasing gain, wide bandwidth, multiple functionality and system level integration. Significant research work has been reported on increasing gain and bandwidth of microstrip antennas. Many techniques have been suggested for achieving wide bandwidth [4-5]. Main advantage of microstrip antenna includes low profile easy to fabricate (use etching and photolithography), easy to feed (proximity coupled, microstrip line, etc.) and easy to use in array of incorporate with other microstrip circuit elements [6].

In this paper two feeding techniques microstrip line feed and proximity coupled feed are compared.

The remaining paper is organized as follows section 2 gives information about types of feeding techniques. Section 3 shows the design of microstrip rectangular patch antenna using two different feeding techniques. Section 4 gives the comparative analysis of microstrip line feed and proximity coupled feed antennas with its results. Section 5 and 6 gives conclusions and references respectively.

II FEEDING TECHNIQUES

There are many techniques are used to feed or transmit electromagnetic energy to a microstrip patch antenna. The feeding is very important for the efficient operation of antenna to improve the antenna input impedance matching. The two feeding techniques used in this paper are microstrip line feeding and proximity coupled feeding.

2.1 Microstrip Line Feeding

Microstrip line feeding is a technique in which a conducting strip is connected directly to the edge of the microstrip patch as shown in figure 1. The width of conducting strip is smaller as compared to the patch. This type of feeding arrangement has the advantage that the feed and patch can be etched on the same substrate to provide a planar structure. The inset cut is introduced in the patch to match the impedance of the feed line to the patch; by using inset cut in the patch additional impedance matching element is not required. This can be achieved by controlling the inset position properly. Hence this feeding scheme is easy as compared to others, since it provides ease of fabrication and simplicity in modeling as well as impedance matching. However as the thickness of the dielectric substrate being used increases, which also increases surface waves and spurious feed radiation, and hampers the bandwidth of the antenna [7].

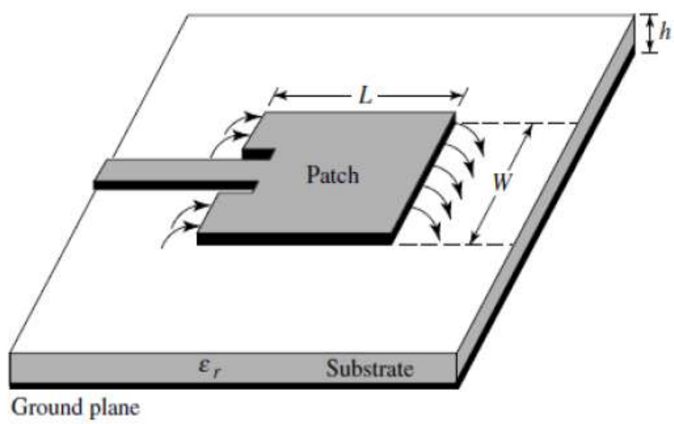


Fig. 1: Rectangular microstrip patch antenna with inset line feeding [7-8]

2.2 Proximity Coupled Feeding

This method uses electromagnetic coupling between the feed line and the radiating patches, printed on separate substrates [7]. Two dielectric substrates are used such that the radiating patch is on top of the upper substrate and feed line is between the two substrates. The advantage of this coupling is that it yields the largest bandwidth compared to other coupling methods, it is somewhat easy to model and has low spurious radiation. This feeding method also provides choices between two different dielectric media, one for the feed line and one for the patch to optimize the individual performances. Matching can be achieved by controlling the width-to-line ratio of the patch and length of the feed line. The major disadvantage of this feeding scheme is that it is difficult to fabricate because of the two dielectric layers which need proper alignment. Also, the overall thickness of the antenna also increases [7].

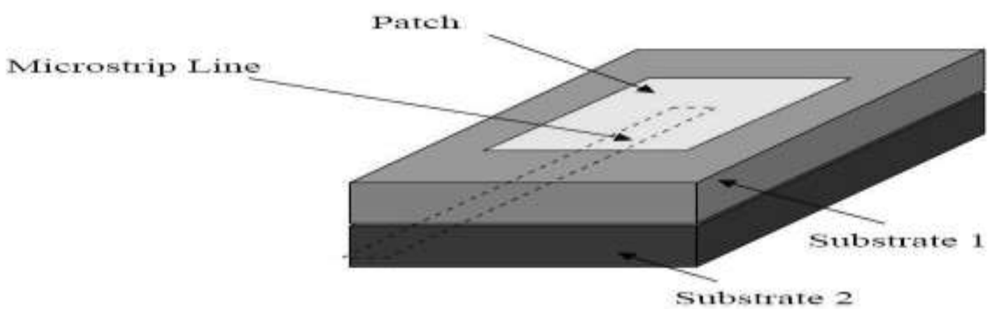


Fig. 2: Proximity coupled feeding for patch antenna [7]

III DESIGN OF RECTANGULAR MICROSTRIP PATCH ANTENNA USING DIFFERENT FEEDING TECHNIQUES

In this the microstrip rectangular patch antenna using two types of feeding techniques is designed using HFSS V13 software. The dimensions of patch and the feed are same in all the feeding techniques. The patch and feed is fabricated on the same substrate (Rogers RT/duroid 5880) whose relative permittivity is 2.2. The dimensions of the patch and feed of feeding techniques are shown in Table 1.

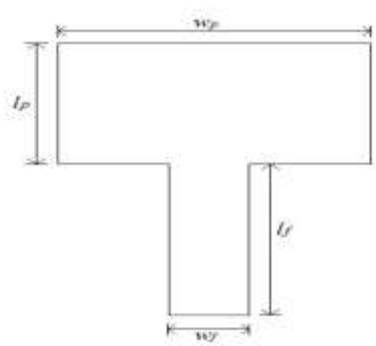


Fig. 3: Geometry of rectangular microstrip patch antenna

Table 1: Dimensions for the rectangular microstrip patch antenna for different feeding techniques

Feeding Techniques	Patch width (*wp*)	Patch length (*lp*)	Feed line width (*wf*)	Feed line length (*lf*)
Microstrip Line	16 mm	12.45 mm	3.9575 mm	15.5 mm
Proximity Coupled	16 mm	12.45 mm	3.9575 mm	15.5 mm

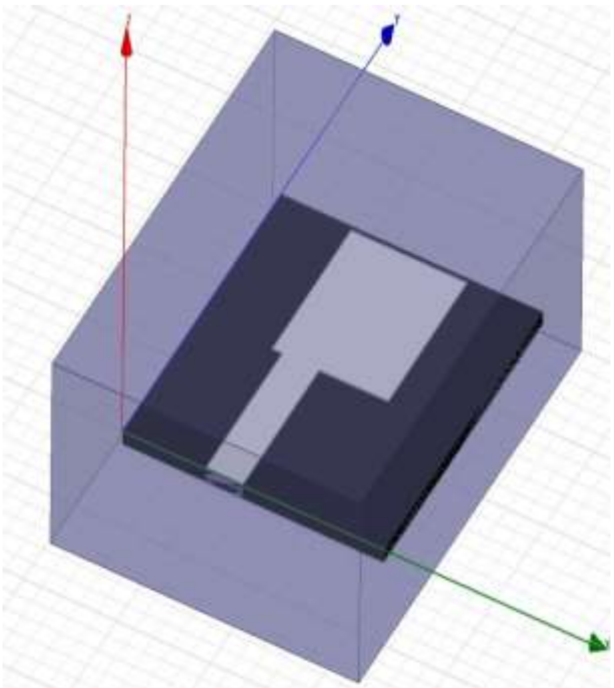


Fig. 4: Design of rectangular microstrip patch antenna using line feed

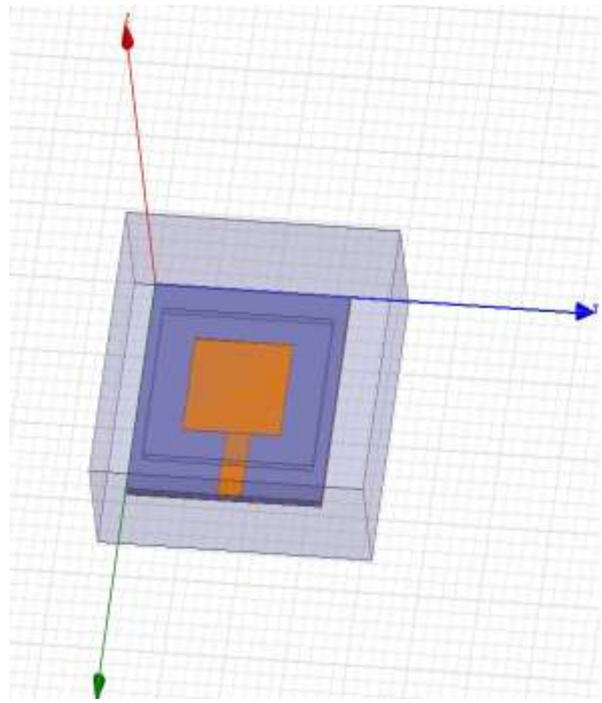


Fig. 5: Design of rectangular microstrip patch antenna using proximity coupled feed

IV RESULTS

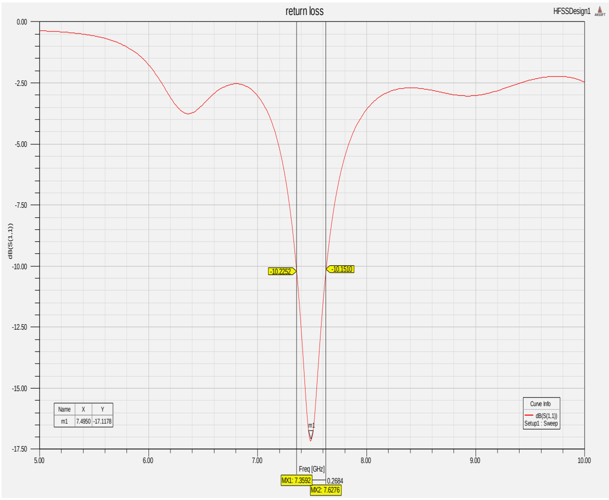
4.1 Return Loss and Bandwidth

Return loss is the difference between forward and reflected power in dB, generally measured at the input to the feed connected to the antenna [9]. If the power transmitted from the source is P_T and the power reflected back to the source is P_R, then the return loss is given by P_R/P_T. For maximum power transfer, the return loss should be as small as possible. This means that the ratio should be as small as possible.

Bandwidth Calculation= f2-f1

Where *f1* and *f2* are lower and upper frequencies.

These upper and lower frequencies are calculated from the Return Loss curve of the feeding techniques discussed in figure 6 and 7. The corresponding bandwidth is shown in Table 2.



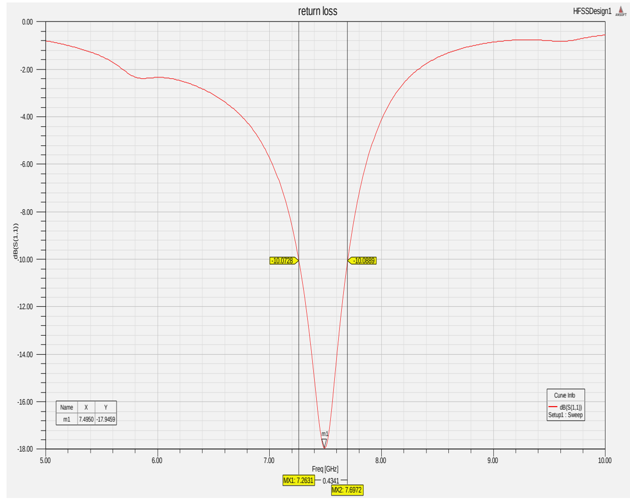


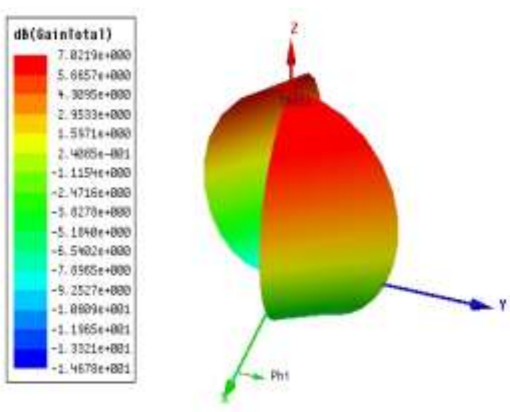
Fig. 6: Return loss (in dB) of microstrip line feed **Fig. 7: Return loss (in dB) of proximity coupled feed**

Table 2: Comparison of Return Loss and Bandwidth of different Feeding Techniques

Feeding Techniques	Resonate Frequency of Antenna	Return Loss	Bandwidth	Gain
Line Feed	7.4950 GHz	-17.11 dB	0.2684 GHz	7.02 dB
Proximity Coupled Feed	7.4950 GHz	-17.94 dB	0.4341 GHz	7.17 dB

4.2 Gain

Gain describes the efficiency and directional capabilities of the antenna [7]. Three dimensional radiation pattern of rectangular microstrip patch antenna with Line feed and Proximity coupled feed are shown in figure 8 and 9 respectively and calculated gain is shown in Table 2.



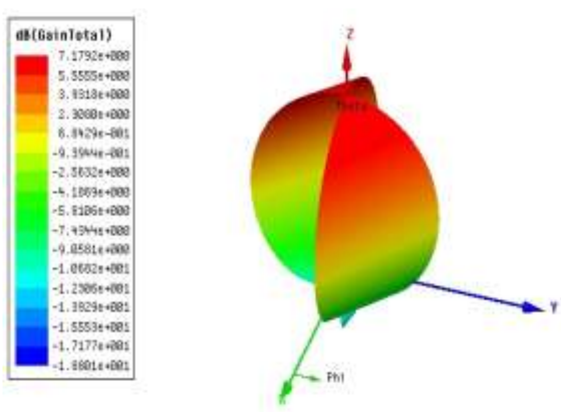


Fig. 8: Gain of microstrip line feed **Fig. 9: Gain of proximity coupled feed**

V CONCLUSIONS

The rectangular microstrip patch antenna of same dimensions using two different feeds has been designed and simulated using HFSS V13 software. The Gain, Bandwidth and return loss of different feeding antennas has been calculated. From the Table 2 it is clear that the Proximity Coupled feed has better gain, return loss and bandwidth then Line feed. Thus the Proximity Coupled feed is more useful for the X-Band applications.

REFERENCES

[1] D. R. Jahagirdar and R D. Stewart. 1998. "Non-Leaky Conductor Backed Coplanar Wave Guide-Fed Rectangular Microstrip Patch Antenna", IEEE Microwave and Guided-Wave Letters. 3 (Mar. 1998), 115-117.

[2] S. S. Pattnaik, G. Lazzi, and O. 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] S. S. Pattnaik, D. C. Panda, and S. Devi. 2004. "Radiation Resistance of Coax-Fed Rectangular Microstrip Patch Antenna Using Artificial Neural Networks", Microwave and Optical Technology Letters, 15 (Jul. 2002), 51-53.

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

[5] D. K. Neog, S. S. Pattnaik, D. C. Panda, S. Devi, B. Khuntia, and M. Dutta. 2005. "Design of a Wideband Microstrip Antenna and the Use of ANN in Parameter Calculation", IEEE Antennas and Propagation Magazine, Vol. 47, No.3, (June 2005).

[6] H. K. Varsheny, M. Kumar, A. K. Jaiswal, R. Saxena, and K. Jaiswal, "A Survey on Different Feeding Techniques of Rectangular Microstrip Patch Antenna" , International Journal of Current Engineering and Technology, Vol. 4, No.3, (June 2014), 1418-1423.

[7] C.A. Balanis, Antenna Theory Analysis And Design, 2nd Edition,John Wiley & Sons. Ramesh Garg,Prakash Bhartie, Inder Bahl, Apisak Illipiboon (2001), Microstrip Antenna Design *Handbook*, pp.1-68,253-316 Artec House Inc. Norwood, MA.

[8] A.P. Singh, J. Singh and T.S. Kamal, "Estimation of Feed Position of Rectangular Microstrip Patch Antenna using ANN" , Journal of Institution of Engineers (IE) Electronics and Telecommunication, Vol. 91, (2009), 20-25.

[9] I.V.S Rama Sastry and Dr. K.J. Sankar, "Proximity Coupled Rectangular Microstrip Antenna with X-Slot for WLAN Applications", Global Journal of Researches in Engineering: F Electrical and Electronics Engineering, Vol. 14, No.1, (2014), 15-18.