IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)
e-ISSN: 2278-2834,p- ISSN: 2278-8735.Volume 12, Issue 3, Ver. II (May - June 2017), PP 31-39
www.iosrjournals.org

Aperture Coupled Rectangular Microstrip Patch Antenna for S Band Applications

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Abstract: *In recent years the development in communication system requires the development of low cost, minimal weight and low profile antennas that are capable of maintaining high performance over a wide spectrum of frequencies. Microstrip patch antennas are the most common antenna types in frequency range of 2 to 4 GHz (S-band).Generally these antennas uses different feeding techniques like micro strip line feed, co-axial feed and proximity coupled feed methods. In this paper a rectangular microstrip patch antenna has been designed using Aperture coupled Feed Technique to improve the antenna parameters like Front to Back Ratio (FBR), Return Loss and VSWR. It is designed and simulated on HFSS (High Frequency Structural Simulator) software*

Keywords: *Aperture coupled feed, Front to back ratio, Return loss(db), Rectangular micro strip ,VSWR.*

I. Introduction

In the present communication, antennas are widely used in various areas like mobile communication, internet services, satellite navigation, auto-mobiles and radars. Now a day's IEEE 802.15 standards are working with high data rates in the frequency spectrum of 1 to 10 GHz for the wireless communication. Wide band antennas are very popular for their compact size, simple structures, and low manufacturing costs and easily integrated with other devices. The frequency range of S-Band is reserved for IEEE 802.16 standard for WiMAX (Worldwide Interoperability for Microwave Access) and WLAN (Wireless Local Area Network) applications.

The S-Band is the part of the Microwave band of the electromagnetic spectrum. It is defined by an IEEE standard for radio waves with frequencies that range from 2 to 4 GHz, crossing the conventional boundary between UHF (Ultra High Frequency) and SHF (Super High Frequency) at 3 GHz. The S-Band is used by weather radar, surface ship radar, and some communications satellites, especially those used by NASA (National Aeronautics Space Administration) to communicate with the Space Shuttle and the International Space Station.

II. Microstrip Patch Antenna

1. Introduction

In a most basic form a microstrip antenna comprises of two thin metallic layers ($t \ll \lambda o$) one as radiating patch and second as ground plane and a dielectric substrate sandwiched between them. The conductor patch is placed on the dielectric substrate and used as radiating element. On the other side of the substrate there is a conductive layer used as ground plane. Copper and gold is used normally as a metallic layer. Radiating patch can be of any shapes like Square, rectangular, dipole, triangular, elliptical, circular .A variety of dielectric materials are available for the substrate purpose with dielectric constants $2.2 \leq \varepsilon_r \geq 12$. The height of substrate plays an important role in antenna characteristics generally are in the range $0.003\lambda o \leq h \geq 0.05\lambda o$.The top view and side view of micro strip patch antenna are shown below .

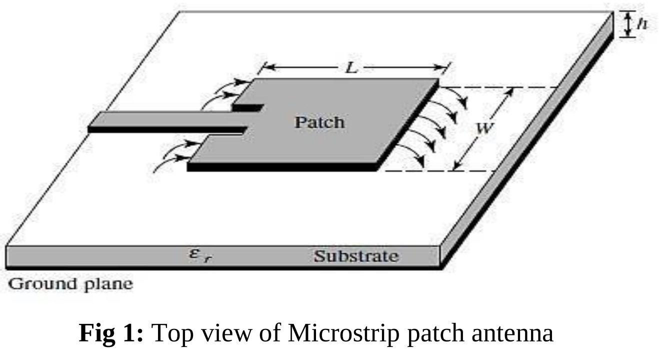


Fig 1: Top view of Microstrip patch antenna

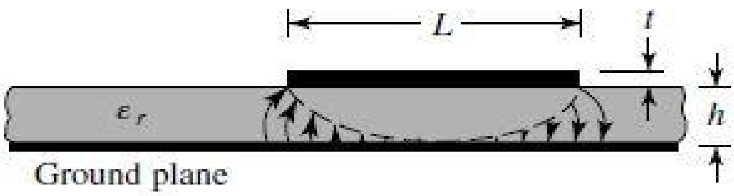


Fig 2: Side view of Microstrip patch antenna

Microstrip antenna suffers from very Narrow frequency bandwidth. Bandwidth of microstrip antenna is directly proportional to height of substrate . To couple power to a microstrip antenna is as important as the selection of a suitable geometry for a particular application. The different types of feeding techniques are micro strip line feed, co-axial feed, proximity coupled feed and aperture coupled feed. The disadvantage of microstrip line feed method is spurious feed radiation and co-axial feed method is narrow bandwidth and is difficult to model. The proximity coupled fed microstrip antenna is difficult to fabricate as it requires accurate alignment between two substrates. The proposed method Aperture Coupled Feed Technique is to improve the antenna parameters like FBR, VSWR and RETURN LOSS.

2. Antenna Design

2.1Existing Methods

2.1.1microstrip Line Feeding

In this, the radiating patch is directly fed by the microstrip feed line has a narrow width as compare to patch. It is the simple and mostly used. But it has some drawbacks, as the thickness of the dielectric substrate increases it suffers from spurious feed radiation, surface wave losses, and it also has low bandwidth.

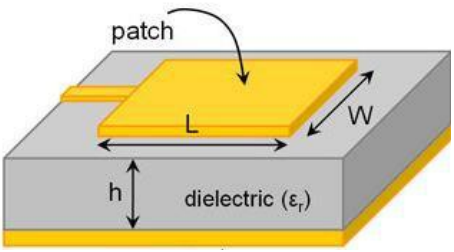


Fig 4: Microstrip line feed

2.1.2 Coaxial Probe Feed

In this type of feeding core of coaxial cable is directly connected to the patch and the outer cable is connected to the ground. The main advantage of is low spurious radiation. The drawbacks are narrow bandwidth and it is difficult to model since a hole has to be drilled in the substrate.

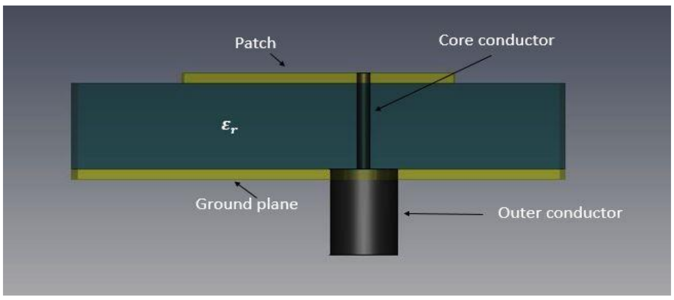


Fig 5: Coaxial probe feed

2.1.3 Proximity Coupled Feed

In this two types of dielectric substrates are used. Microstrip line is not directly connected to patch and is sandwiched between the substrates. Energy from feed line is coupled electromagnetic to the radiating patch.Thick Material with low dielectric constant is selected for Upper substrates because lower the dielectric constant more the fringing field and thin substrate with high dielectric constant is selected for lower substrate. It is easy to model and has low spurious feed radiation but its fabrication is more difficult.

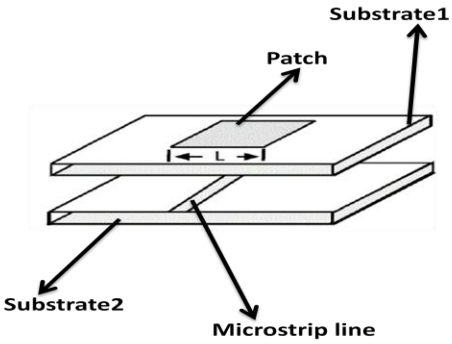


Fig 6: Proximity coupled feed

2.2 Proposed Method

2.2.1 Aperture Coupled Feed

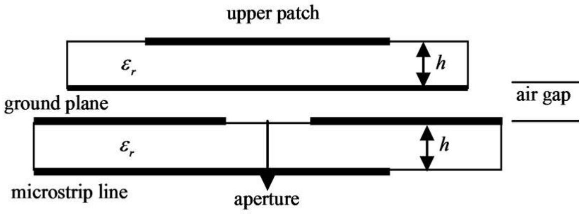


Fig 7: Aperture coupled feed

3. Desingned Antenna Parameters:

The dimension of rectangular radiating patch is given in table1

Table 1: Parameters of designed antenna

S.NO	ANTENNA PARAMETERS	VALUES
1	LENGTH OF THE PATCH(L)	24.34MM
2	WIDTH OF THE PATCH(W)	31.00MM
3	LENGTH OF THE FEED LINE(L_F)	12.86MM
4	WIDTH OF THE FEED LINE (W_F)	6.33MM
5	THICKNESS OF THE SUBSTRATE (H)	3.2MM
6	FREQUENCY OF OPERATION (F_R)	3GHZ
7	DIELECTRIC CONSTANT OF SUBSTRATE (E_R)	4.2

4. Designed Antenna Models Using Different Feeding Techniques

4.1 Microstrip Line Feed Method:

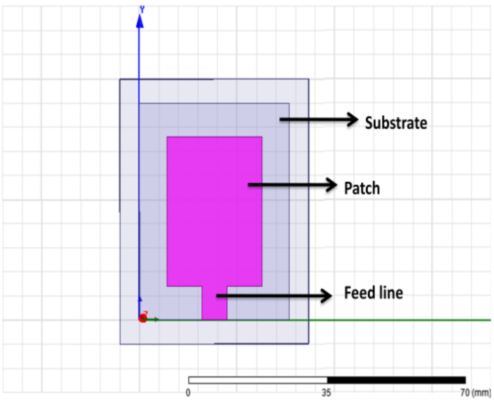


Fig 8: Designed model of Microstrip line feed method in HFSS software

4.2 Coaxial Feed Method

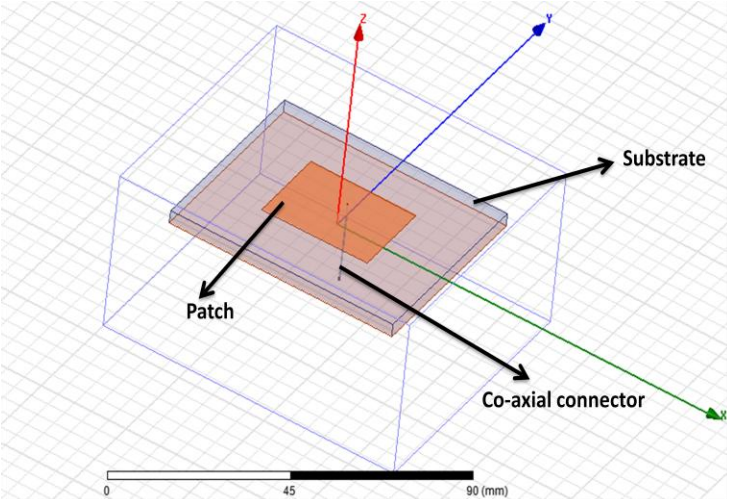


Fig 9: Designed model of Coaxial feed method in HFSS software

4.3 Proximity Coupled Feed Method

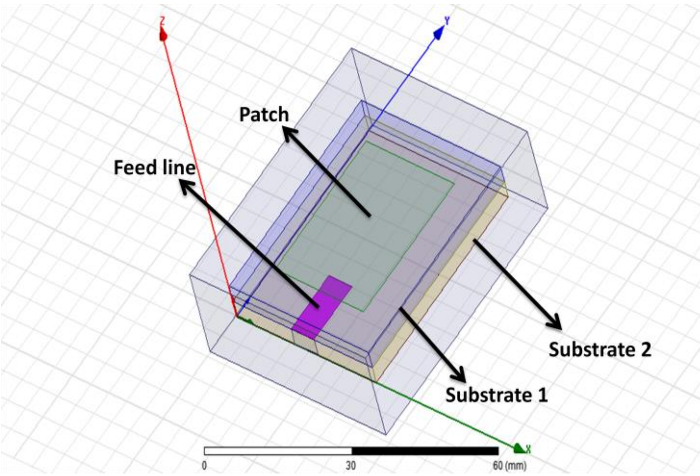


Fig 10: Designed model of Proximity coupled feed method in HFSS software

4.4 Aperture Coupled Feed Method

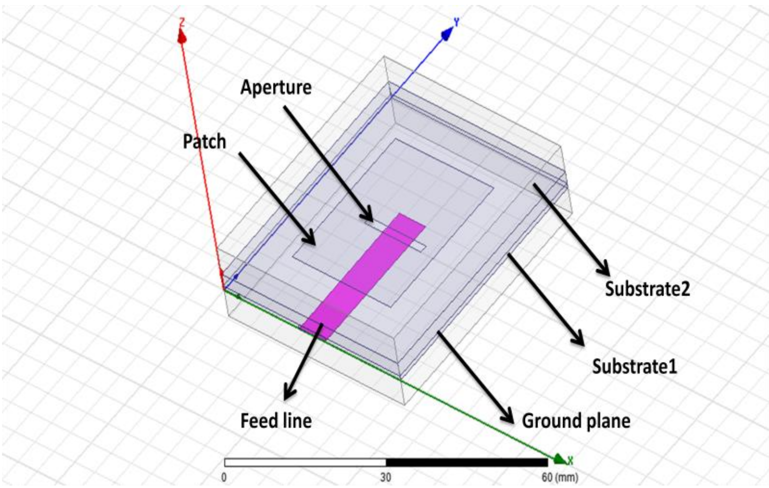


Fig 11: Designed model of Aperture coupled feed method in HFSS software

III. Simulation Results

1.Results of Microstrip line feed method

1.1Return Loss

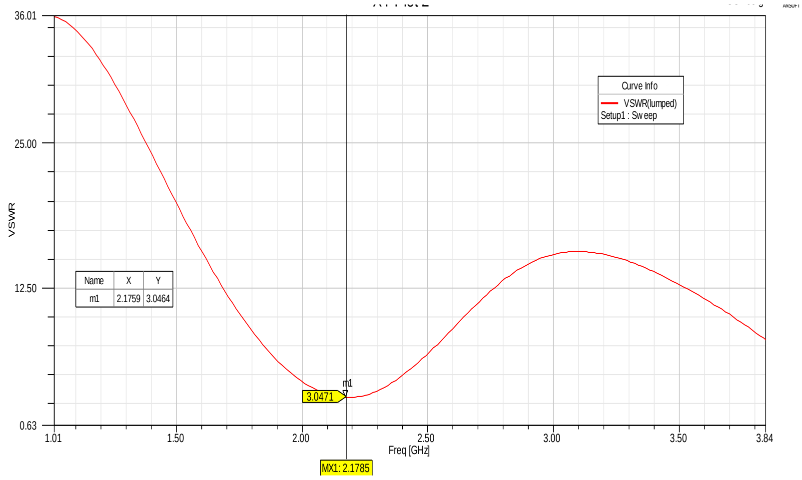


Fig 12: Return loss of the antenna using micro strip line feed method is -5.9443dB at 2.17GHz which is not very optimal.

1.2. VSWR

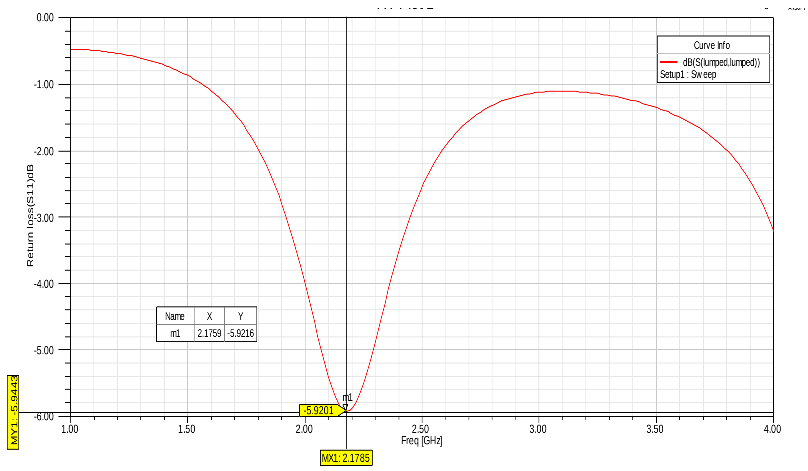


Fig 13: VSWR of Micro strip line feed technique is 3.0471 at 2.17GHz**.**

1.3 Radiation Pattern and Gain

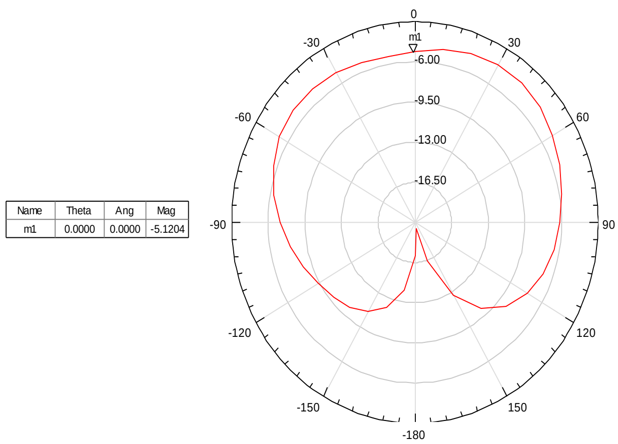
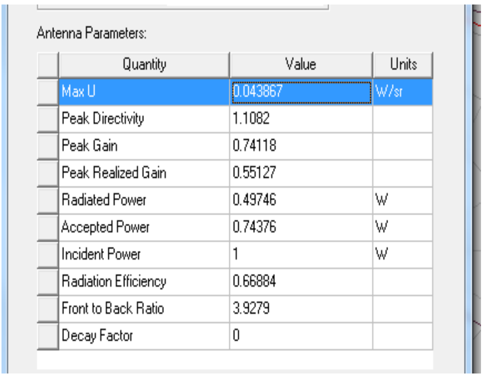


Fig 14: Radiation Pattern Of Microstrip Line Feed Method

- Radiation Pattern at 2.17GHz.
- Gain obtained is -5.12dB.

1.4 Front to back ratio



Antenna Parameters:

Quantity	Value	Units
Max U	0.043867	W/sr
Peak Directivity	1.1082	
Peak Gain	0.74118	
Peak Realized Gain	0.55127	
Radiated Power	0.49746	W
Accepted Power	0.74376	W
Incident Power	1	W
Radiation Efficiency	0.66884	
Front to Back Ratio	3.9279	
Decay Factor	0	

Fig 15: Antenna parameters

- Front to back ratio obtained is 3.9279

2.Coaxial Line Feed Method
2.1. Return loss

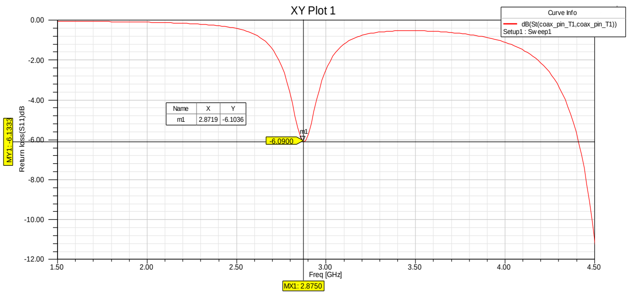


Fig 16: Return loss of the antenna using coaxial feed technique is -6.103dB at 2.87GHz which is not very optimal.

2.2 VSWR

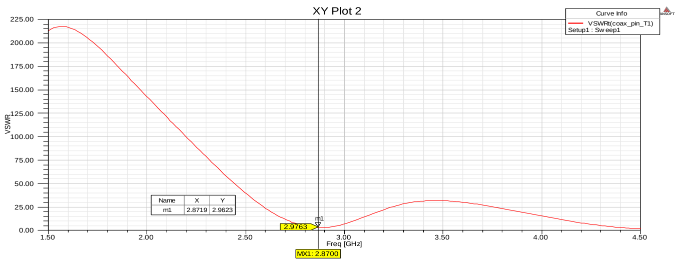


Fig 17: VSWR of Coaxial feed technique is 2.9623 at 2.87GHz.

2.3. Radiation Pattern and Gain

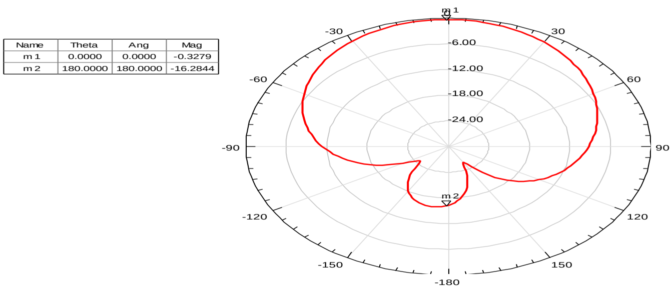


Fig 18: Radiation pattern of coaxial probe method

- Radiation Pattern at 2.87GHz
- Gain obtained is -0.32dB.

2.4. Front to back ratio

Antenna Parameters:

	Quantity	Value	Units
	Max U	2.7519E-005	W/sr
	Peak Directivity	2.98	
	Peak Gain	1.1742	
	Peak Realized Gain	0.03498	
	Radiated Power	0.00011605	W
	Accepted Power	0.00029451	W
	Incident Power	0.0098865	W
	Radiation Efficiency	0.39404	
	Front to Back Ratio	7.5619	
	Decay Factor	0	

Fig 19: Antenna Parameters

- Front to back ratio obtained is 7.5619

3.Proximity Coupled Feed Method

3.1.Return loss

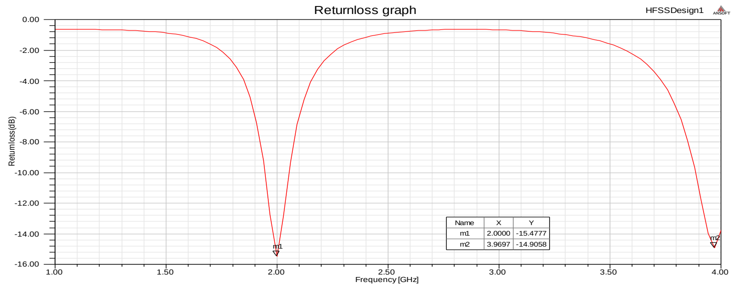


Fig 20: Return loss of the antenna using Proximity coupled feed method is -15.477dB at 2GHz which is very much better value.

3.2 VSWR

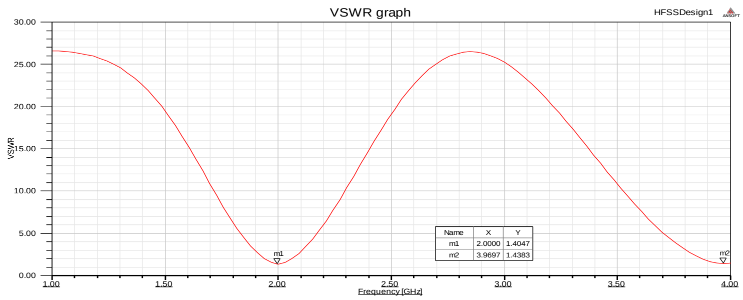


Fig 21: VSWR of Proximity Coupled feed technique is 1.4 at 2GHZ

3.3. Radiation pattern and Gain

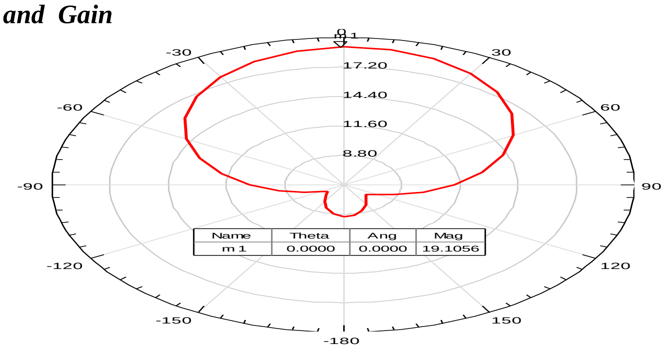


Fig 22: Radiation pattern of proximity coupled feed technique.

- Radiation Pattern at 2GHz
- Gain obtained is 19.105dB.

3.4. Front to back ratio

Antenna Parameters:

Quantity	Value	Units
Max U	0.10794	W/sr
Peak Directivity	1.948	
Peak Gain	1.423	
Peak Realized Gain	1.3565	
Radiated Power	0.69632	W
Accepted Power	0.95323	W
Incident Power	1	W
Radiation Efficiency	0.73049	
Front to Back Ratio	10.2	
Decay Factor	0	

Fig 23: Antenna parameters

- Front to back ratio obtained is 10.2

4. Aperture Coupled Feed Method

4.1. Return loss

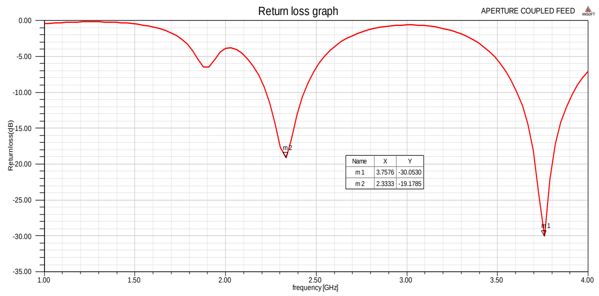


Figure 7.13: Return loss of the antenna using aperture coupled feed method is -30dB at 3.75GHz which is very much better value.

4.2. VSWR

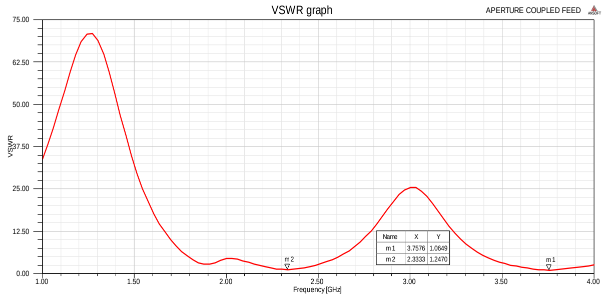


Figure 7.14: VSWR of Aperture Coupled feed technique is 1.06 at 3.75GHz.

4.3. Radiation pattern and Gain

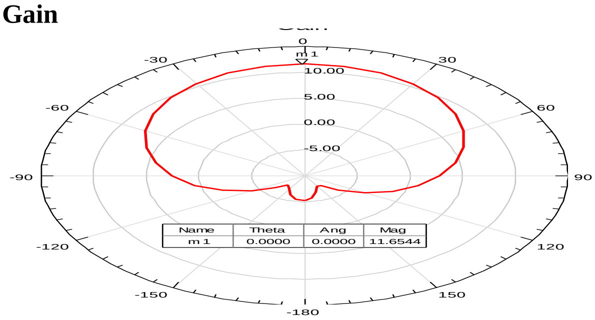


Figure 7.15: Radiation pattern of aperture coupled feed technique.

- Radiation Pattern at 3.75GHz
- Gain obtained is 11.5dB

4.4. Front to back ratio

Antenna Parameters:

	Quantity	Value	Units
	Max U	0.019412	W/sr
	Peak Directivity	0.63285	
	Peak Gain	0.35336	
	Peak Realized Gain	0.24394	
	Radiated Power	0.38547	W
	Accepted Power	0.69034	W
	Incident Power	1	W
	Radiation Efficiency	0.55837	
	Front to Back Ratio	48.976	
	Decay Factor	0	

Figure 7.16: Antenna parameters

- Front to back ratio obtained is 48.976.

IV. Comparison of Feeding Techniques

Table 2: Comparison table of feeding techniques

TECHNIQUE PARAMETER	MICROSTRIP LINE FEED	COAXIAL FEED	PROXIMITY COUPLED FEED	APERTURE COUPLED FEED
RETURN LOSS(DB)	-5.94	-6.10	-15.477	-30
VSWR	3.04	2.96	1.46	1.06
GAIN(DB)	-5.12	-0.32	19.505	11.55
FRONT TO BACK RATIO	3.92	7.56	10.2	48.97

- From the above table it is clear that, both the Non-contacting techniques(Proximity and Aperture coupled) are better than the contacting techniques in terms Return loss, VSWR, and Front to back ratio.
- If gain is the main criteria of an antenna, it is better to use proximity coupled feed method, and if antenna performance must be improved without any reflections in the system then aperture coupled feed method can be used to design an antenna.
- In comparing all the four methods, it is proved that Aperture coupled feed method is best method.

V. Conclusion

In this, a Rectangular micro strip patch antenna is designed which operates in between 2-4GHz frequency. It has emphasized a major aspect of the recent developments in microstrip antenna technology i.e. new configurations of microstrip antennas for improved electrical performance and manufacturability. The existing feed techniques for the rectangular microstrip patch antenna are microstrip line feed, co-axial feed, proximity coupling feed and the proposed is aperture coupled technique. These are implemented to feed the antenna and the results are obtained for these four configurations. Finally, it's been concluded that, by using Aperture coupled feeding technique, the antenna performance can be increased by reducing the reflections and increasing the front to back ratio. The simulation of rectangular micro strip patch antenna using different feeding techniques is carried out using HFSS software. The return loss, VSWR, radiation pattern, gain, and front to back ratio are observed for all the four feeding techniques and a comparison is made between them to identify a best feeding method for microstrip patch antenna.

References

[1] "Microstrip Antennas" David M. Pozar, IEEE, volume.80, No. 1, January 1992.

[2] Lo, Y.T., Solomon D. and Richards, W.F. "Theory and Experiment on Microstrip Antennas," IEEE Transactions on Antennas and Propagation, AP-27, 1979 pp. 137-149.

[3] "Antennas and Wave Propagation" Fourth edition by John D Kraus, Ronald J Marhefka, Ahmad S khan.

[4] I.J. Bahl and P. Bhartia, Microstrip Antennas. Dedham, MA: Artech House, 1980.

[5] D.H. Schaubert , D.M. Pozar and A. Adrian, "Effect of microstrip patch antenna substrate thickness and permittivity : Comparison of theories and experiment," IEEE Trans. Antennas Propagation, vol. 37, pp. 677-682, June 1989.

[6] D.M. Pozar and B. Kaufman, "Increasing the bandwidth of a microstrip antenna by Proximity coupling," Electron. Lett., vol.23, pp. 368-369, Apr. 1987.

[7] D.M. Pozar, "A microstrip antenna aperture coupled to a microstrip line," Electron. Lett., vol.21, pp. 49-50, Jan.1985