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A Study Of Different Feeding Mechanisms In Microstrip Patch Antenna

Navpreet Kaur
M.Tech Scholar
Department of Electronics & Communication Engineering,
Amritsar College of Engineering & Technology, Amritsar
komal_ramgharia@yahoo.com

Narinder Sharma
Associate Professor
Department of Electronics & Communication Engineering,
Amritsar College of Engineering & Technology, Amritsar
narinder.acet@gmail.com

Navdeep Singh
Associate Professor
Department of Applied Sciences,
Amritsar College of Engineering & Technology, Amritsar
arora_navdeep@rediffmail.com

***Abstract* –This paper describes the feeding techniques for various Microstrip patch antennas. The various methods are used for feeding the Microstrip patch antennas. These methods are divided into two categories i.e. contacting and non-contacting. In general contacting methods are microstrip line feed and co-axial plane feed. On other hand, non- contacting techniques are aperture coupled feed and proximity coupled feed. These techniques give better understanding of design parameters of antenna and their effect on its characteristics i.e. VSWR, bandwidth, resonant frequency and return losses. In this study, perfect matching can be done by changing the feed point Coaxial feeding technique, and microstrip line feed gives less return losses, reliable, easy to fabricate aperture couple feed is used for achieving maximum bandwidth whereas, proximity coupled gives least impedance matching and radiation efficiency.**

***Keywords* —** *Microstrip patch antenna, feeding techniques, return loss and gain*

I. INTRODUCTION

Antennas are very much essential components of all equipment that are using radio. They are widely used in different types of communication systems. Antenna consists of an arrangement of number of conductors and they are connected electrically to the transmitter or receiver. An oscillating current of electrons imposed through the antenna by a transmitter will create an oscillating magnetic field around the antenna elements, while the charge of the electrons will also create an oscillating electric field along the elements and these time-varying fields discharge away from the antenna into space as a moving transverse electromagnetic field wave[1]. Again at the time of reception, the oscillating electric fields and magnetic fields of an incoming radio wave or microwave apply force on the electrons in the antenna elements, prompting them to move back and forward, creating oscillating currents in the antenna. There are many type of antennas are used for various purpose of communication [1]. As compared with conventional antennas the microstrip patch antennas have more advantages. The circular and rectangular shape patches are most commonly used microstrip patch antennas.

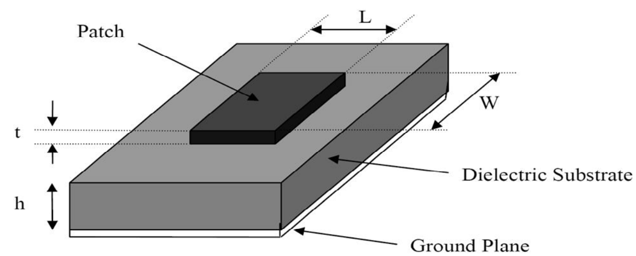


Figure 1: STRUCTURE OF MICROSTRIP PATCH ANTENNA

Microstrip patch antenna has patch which is conducting in nature. The conducting patch geometry is planar and non-planar in nature. The structure of microstrip patch antenna has dielectric substrate, which has patch on one side and ground plane on other side [14]. The microstrip patch antennas are most widely used for the last few years in the field of wireless communications dueto their light weight, low cost, high performance, ease of installation and fabrication, low profile etc . The input impedance of these antennas depends on their geometric shape,

dimensions, the properties of substrate material used, feeding type and feeding location etc[6] . With high permittivity substrate the size of antenna can be reduced up to great extent but these technique reduce the radiation efficiency of antenna and impedance bandwidth of antenna also reduced. The typical bandwidth of microstrip antenna is between 1% to 3%, to overcome these limitations many optimization techniques has been introduced. The radiating patch has different shapes such as square, rectangular, circular, elliptical, triangular, dipole, ring etc. The shape of patch is very important to analyse the performance and different parameters of antenna.

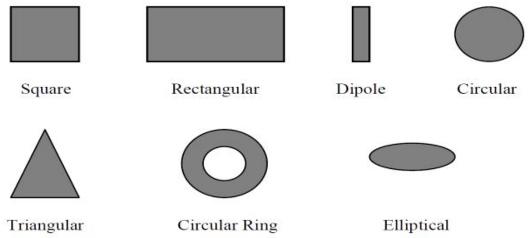


Figure 2: Common shape of microstrip patch element

II. FEEDING 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[15]. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch. Feeding technique is governed by the factor of efficient power transfer between the radiation structure, feeding structure and their impedance matching [6].

A. Microstrip Line Feed

In this type of feed technique, a conducting strip is connected directly to the edge of the microstrip patch as shown in Figure 3. 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[17].

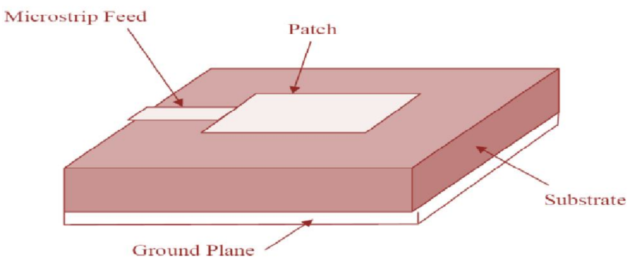


Figure 3: Microstrip Line Feed

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 as in figure 4.

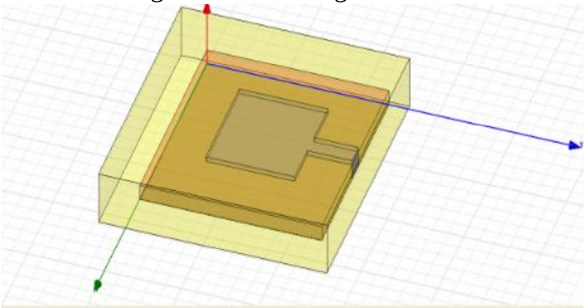


Figure 4.Design using Microstrip Line Feed

Observation from return loss at or below -10dB as shown in figure 5.
1.Resonant frequency : 5.54GHz at -11.29dB
2.Band width = f2-f1 = 5.72-5.35= 0.37GHz= 370MHz

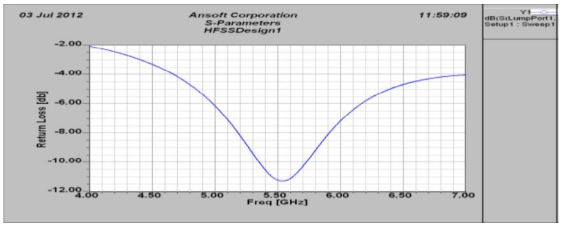


Figure 5: Return loss plot using Microstrip Line Feed

Observation of VSWR(1.36) of MSL as shown in Figure 6 .

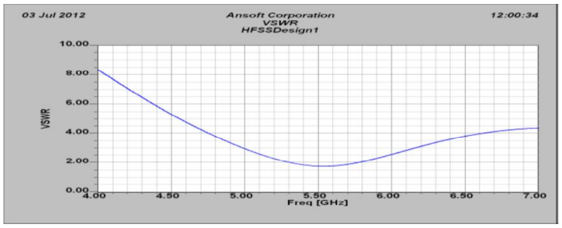


Figure 6: VSWR plot using Microstrip Line Feed

B. Coaxial Feed

The Coaxial feed or probe feed is a very common technique used for feeding Microstrip patch antennas. As seen from Figure 7, 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 the ground plane [17].Probe fed Rectangular Microstrip Patch Antenna 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.

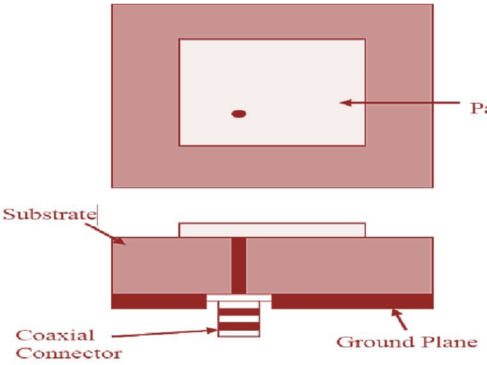


Figure 7: Coaxial Feed

This feed method is easy to fabricate and has low spurious radiation. However, its major disadvantage is that it connected to Ground Plane Connector as shown in figure 8.

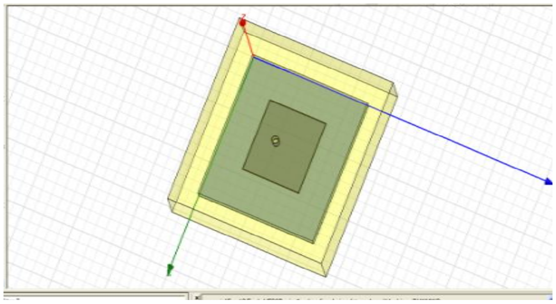


Figure 8: Design using Coaxial Feed

Observation from return loss at or below -10dB as shown in figure 9.
1. Resonant frequency=5.55GHz at -19.77dB
2. Band width= f2-f1= 5.69-5.43= 0.26GHz = 260MHz

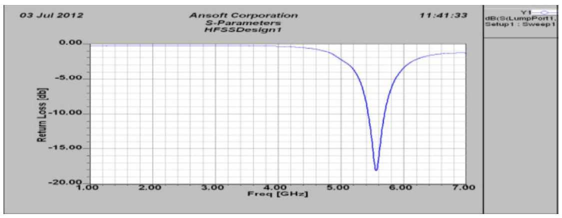


Figure 9:VSWR plot using Coaxial Feed

C. Aperture Coupled Feed

In this type of feed technique, the radiating patch and the microstrip feed line are separated by the ground plane as shown in Figure 10 and Figure 11 respectively. Coupling between the patch and the feed line is made through a slot or an aperture in the ground plane [13].

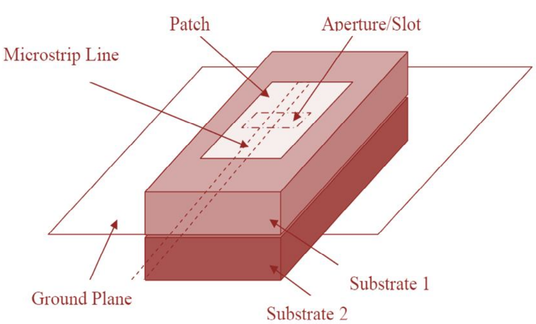


Figure 10: Aperture-coupled feed

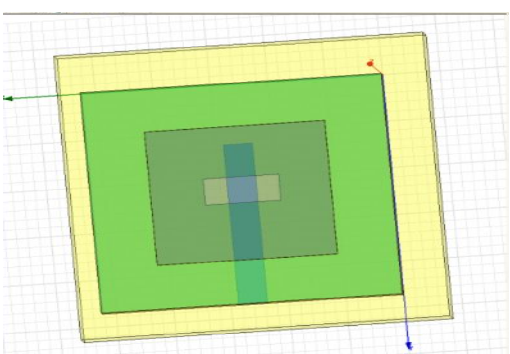


Figure 11: Design using Aperture Coupled Feed

Observation from return loss at or below -10dB as shown in figure 12.
1. Resonant frequency=5.49 GHz at -31.29dB
2. Band width= f2-f1= 5.79-5.21=0.58GHz=580MHz

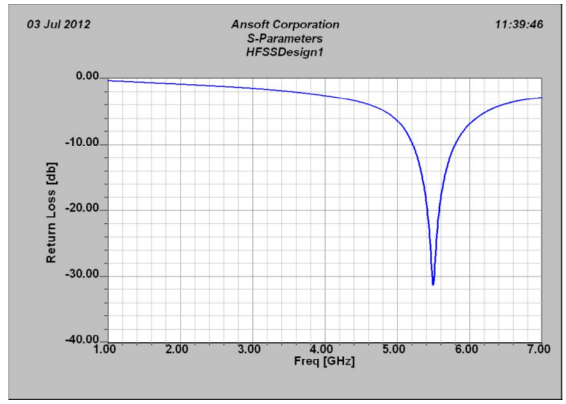


Figure12: Return loss plot using Aperture Coupled Feed

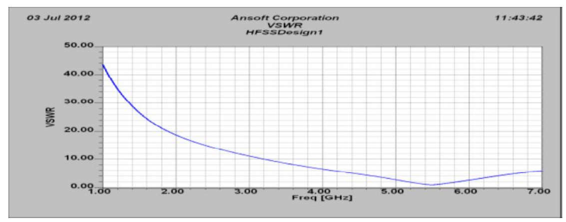


Figure13: VSWR plot using Aperture Coupled Feed

VSWR is plotted between 0 and 1 as in figure 13. which is quiet satisfactory.

D. Proximity Coupled Feed

This type of feed technique is also called as the electromagnetic coupling scheme. As shown in Figure 14 and Figure 15 respectively. 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%) [5], due to overall increase in the thickness of the microstrip patch antenna [17]. This scheme also provides choices between two different dielectric media, one for the patch and one for the feed line to optimize the individual performances.

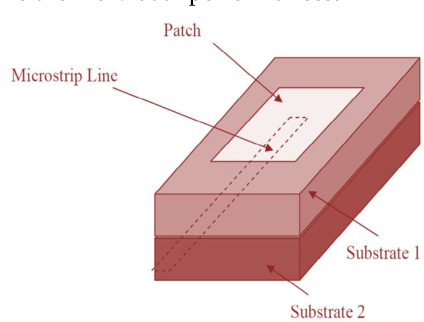


Figure 14: Proximity-coupled Feed

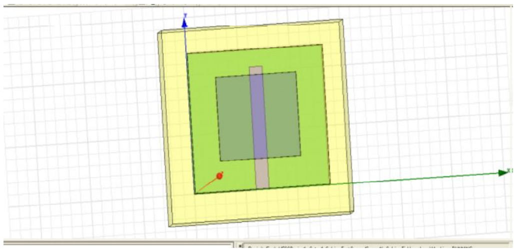


Figure 15: Design using Proximity Coupled Feed

Observation from return loss at or below -10dB as shown in figure 16.
1. Resonant frequency=5.47 GHz at -48.89dB
2.Bandwidth=f2-f1= 5.63-5.22=0.41GHz=410MHz

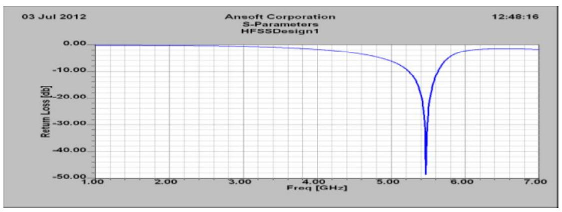


Figure 16: Return loss plot using Proximity Coupled Feed

Observation of VSWR (1.11) of Coaxial feed as shown in figure 17.

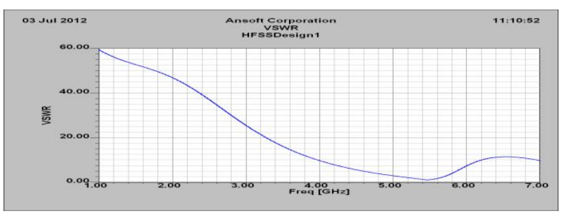


Figure 17: VSWR plot using Proximity Coupled Feed

III. Comparison Of Different Feeding Techniques

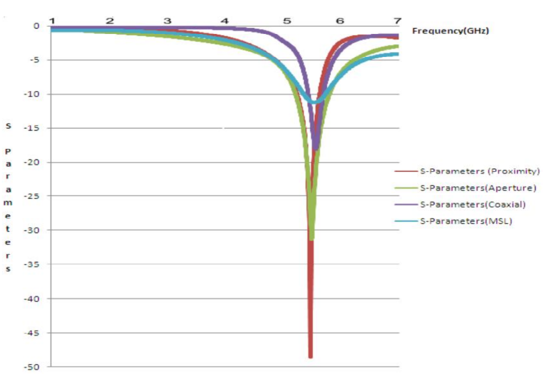
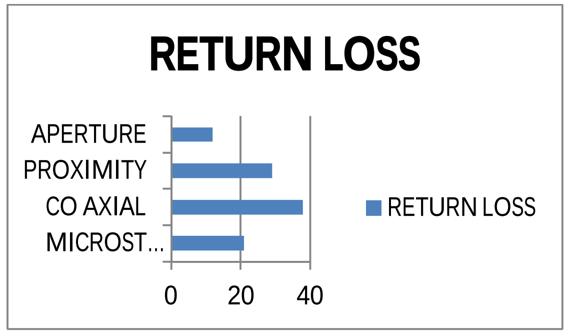
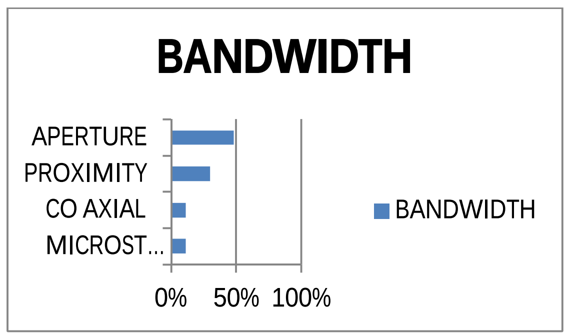


Figure18. Combined return loss differentiating four feeding techniques

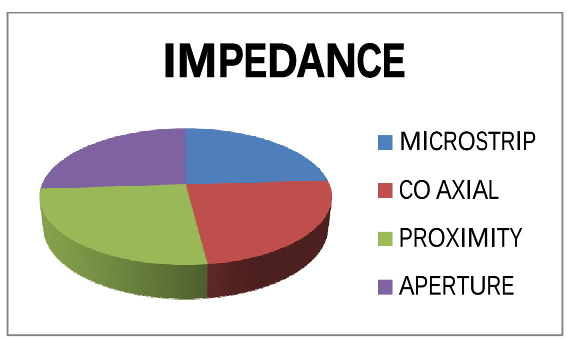
We can obtain the approximate result of Return Loss, Bandwidth and Impedance of all feeding techniques. Those feeding techniques are Microstrip Line, Co-axial, proximity and Aperture which describe the comparison of Return Loss, Bandwidth and Impedance .These feeding techniques are given below.



MICROSTRIP	21
CO AXIAL	38
PROXIMITY	29
APERTURE	12



MICROSTRIP	5%	11%
CO AXIAL	5%	11%
PROXIMITY	13%	30%
APERTURE	21%	48%



MICROSTRIP	24%
CO AXIAL	24%
PROXIMITY	26%
APERTURE	26%

III. CONCLUSION

It is analysed that selecting feeding technique for patch antenna is important because it affects various parameters of antenna i.e. bandwidth, return loss, VSWR, patch size, smith chart.The maximum bandwidth can be achieved by aperture coupling, on other hand proximity coupling gives the best impedance matching and radiation efficiency. We can do perfect matching by changing the feed point Coaxial feeding technique. The high return loss can be achieved at resonant frequency by changing the feed point. The inset fed micro strip antenna provides the best result because the impedance matching is good in inset fed antenna. Overall microstrip line feed gives less return losses, reliable, easy to fabricate, and VSWR is less than 1.5. Bandwidth performance is better in using non-contacting techniques as compared to contacting techniques.The performance properties are analysed for the optimized dimensions and the proposed antenna works well at the required (5.25-5.85) GHz Wimax frequency band.

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