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A Review of Different Feeding Techniques for Microstrip Patch Antenna Enhancement

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Abstract – Microstrip Patch Antenna is one of the most popular device of printed antenna. The study of the microstrip antennas has made great progress in over the past decade. They have light weight, low profile configuration, low volume, low cost, smaller in dimension and ease of fabrication. Through decades of research, it was identified that the performance and operation of microstrip antenna is driven mainly by the its geometry, characteristics of substrate materials and feeding techniques onto which the antenna is printed. This paper provides a comprehensive review of research work done in the recent past years on the basis of different feeding techniques of microstrip patch antenna. The operating principles, structural configuration, advantages and limitations of these techniques are discussed and compared.

Key Words : Microstrip Patch Antenna, Feeding technique, Bandwidth, Gain, configuration.

1. Introduction – The concept of Microstrip antenna was first proposed by USA scientist Deschamps and France scientist Baissiont (1) in year 1953.However the practical antennas were developed by Munson (2) and Howell in the year 1970.The numerous advantages of Microstrip Patch Antenna, such as its low profile, low weight, small volume and ease of fabrication using printed circuit technology, led to design of different configurations for various applications. With increasing requirement for wireless communication, the demand for low profile antenna has brought the Microstrip antenna to the forefront. A Microstrip Antenna in its simplest form consists of a radiating patch on one side of di- electric substrate and a ground plane on the other side as shown in fig. (1). The patch is normally made up of conducting materials such as copper or silver and can take any possible shape. The radiating patch and feed lines are usually photo etched on the di – electric substrate. There are many shapes i.e. square, rectangular, circular, triangular and elliptical or some other shape patches are used for designing a microstrip antenna. Radiation from microstrip patch antenna can occur from the fringing fields between the periphery of the patch and the ground plane. So they are widely used in the micro-wave frequency ranging between 300 MHz to 300GHz. However, the Microstrip Patch Antenna inherently has a low gain and a narrow bandwidth. To overcome its inherent limitations of narrow bandwidth and low gain, many feeding techniques have been suggested and investigated (3) for achieving wide bandwidth and high gain (4). There are numerous and well- known methods to increase the gain of antennas including decrease of the substrate thickness, feeding techniques (5). In our review paper, antenna feeding is to be classified in two types, one is microstrip line feeding and coaxial is another feeding. There are many other feeding techniques are used in microstrip antenna but they are so complex i.e. L-probe feeding, aperture coupled feeding and non-contact feeding etc.

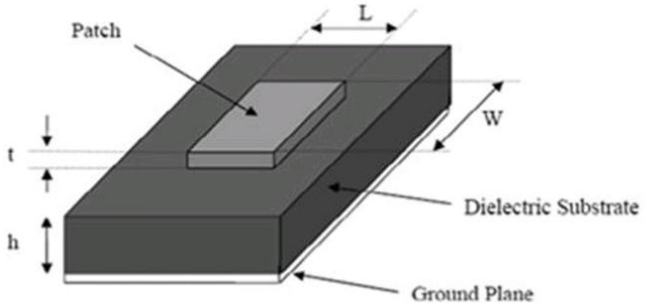


Fig. 1 Microstrip Patch Antenna

2. Feeding Techniques- Feeding techniques play a very important role in determining the overall performance and radiation characteristics of microstrip antenna. There are many feeding techniques available to fed or transmit electromagnetic energy to a microstrip patch antenna (6). The

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three main commonly used feeding techniques are 1- Microstrip line, 2- Coaxial probe, 3- Aperture coupling.

2.1- Microstrip Line Feeding: In this feeding technique, a conducting strip is connected directly to the edge of microstrip patch as shown in figure (2). The width of conducting strip is very small as compare to the patch and this type of feed arrangement has the advantage that the feed can be etched on the same substrate for a planar structure (7). The purpose of the insert cut in the patch is to match the output impedance of feed line to the patch input impedance without the need for any additional matching element (8). This is an easy feeding technique because it provides ease of fabrication and simplicity in modelling and impedance matching.

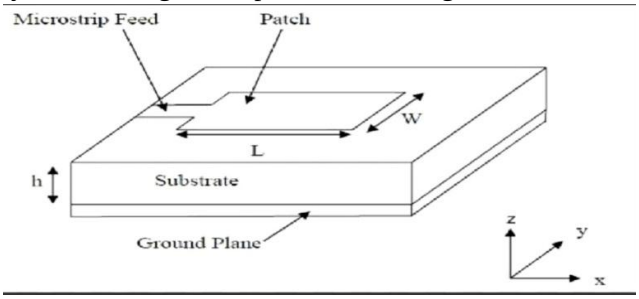


Fig.2, Microstrip Line Feeding

2.2- Coaxial Probe Feeding: This coaxial probe feeding technique is one of the most commonly used method for exciting a microstrip patch antenna (9). In this technique, the inner conductor of a coaxial probe is connected to the radiating patch, while the outer conductor is connected to the ground plane as shown in a figure (3). The feeding point can be selected at a suitable location on the patch to obtain the desired input impedance and improve impedance matching (10). These antennas are used in wireless communication, radar technology and various microwave frequency applications.

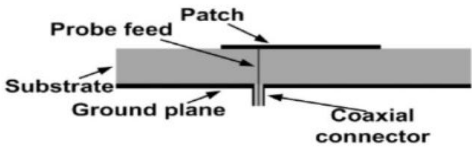


Fig. 3, Coaxial Feeding of Microstrip Patch Antenna

2.3- Aperture coupling technique: This is an indirect method technique of exciting a microstrip patch antenna. This works on the principles of electromagnetic coupling through a slot in the ground plane (11). It is widely used in microstrip patch antenna because it provides good isolation between the feeding network and the radiating patch. In this technique, the radiating patch and the feed line are placed on opposite sides of a ground plane is shown in fig. (4). A small aperture is created in the ground plane to transfer electromagnetic energy from the feed line to the radiating patch.

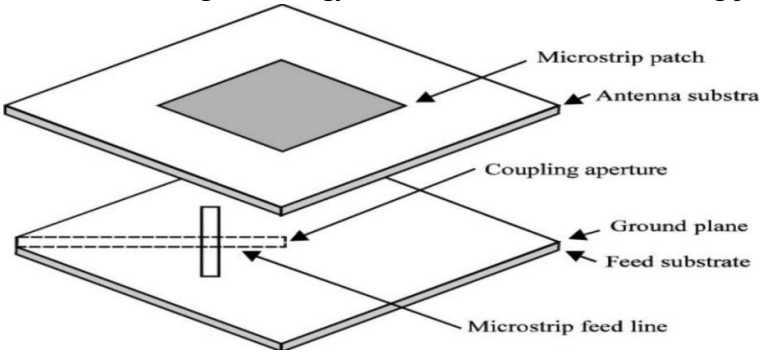


Fig. 4, Aperture- Coupled technique of Microstrip Patch Antenna

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3. Comparative Analysis of Microstrip line, Coaxial probe and Aperture coupling Feeding-

Parameter	Microstrip Line Feeding	Coaxial Probe Feeding	Aperture-Coupled Feeding
Feeding status	Direct	Direct	Electromagnetic
Structural complexity	Low	Moderate	High
Feed point	Patch edge	Selected point on patch	Slot in ground plane
Fabrication	Simple PCB	Drilling & probe connection	Multilayer fabrication
Radiation efficiency	Depends on losses	Depends on losses	Depends on losses & back radiation
Substrate	Usually single	Usually single	Typically two substrate
Impedance matching	Inset depth & line geometry	Probe position & geometry	Aperture & feed line geometry
Gain enhancement	Depends on design	Depends on design	Depends on coupling & substrate
Feed radiation	May be significant	Generally low	Good isolation from patch
Bandwidth	2-5%	2-5%	21%

4. Return Loss in Microstrip Line Feed- Return loss is an antenna is a measurement (expressed usually logarithmic in dB) of power that is reflected back toward the source because of the an impedance mismatch (12). It is ratio of incident power to reflected power in radio frequency system. Higher values indicate a better impedance match and less reflected energy. Fig. (5) shows that return loss for rectangular microstrip patch antenna with line feed without optimization. Without optimized dimensions, the return loss should decrease to -25 dB at 2.4 GHz at the reference frequency given in fig. (6).

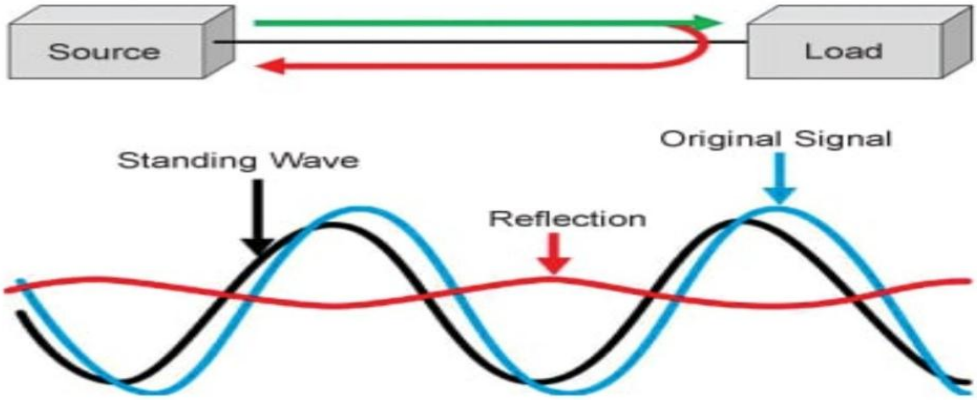


Fig.5, Return loss of Rectangular Microstrip Patch Antenna.

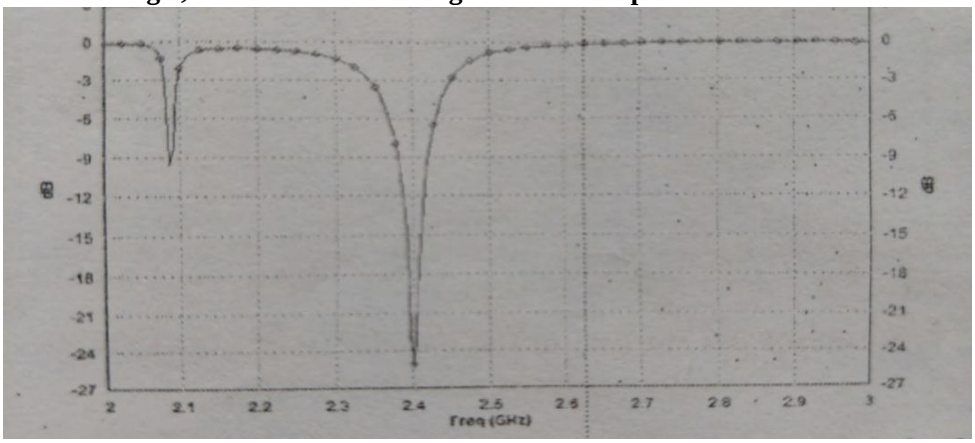


Fig. 6 Return loss in dB of the Microstrip Line Feed without Optimization

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5. Return Loss in Coaxial Probe Feed- Return loss in coaxial probe feeding is an important parameter for evaluating the impedance matching characteristics of a coaxial probe fed microstrip patch antenna. Fig. represents a return loss response of a coaxial probe fed microstrip patch antenna operating near 2.4 GHz. At resonance, the antenna's input impedance typically closest to its intended matched condition. The return loss is decreases to -62 dB at 2,397GHz reference frequency as shown in fig. (7)

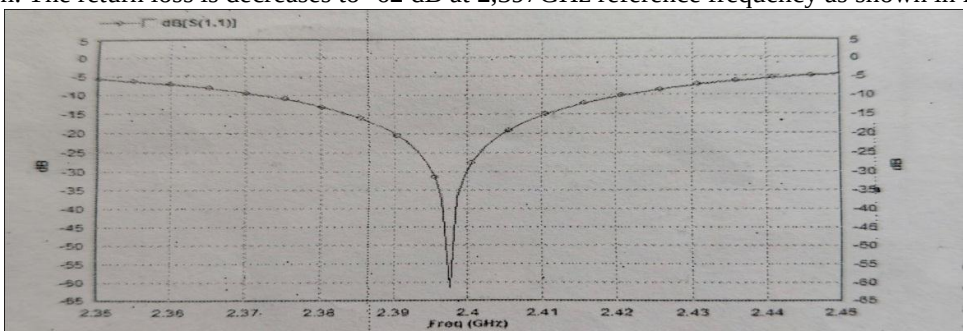


Fig.7, Return loss in Coaxial Probe Feed

6. Return Loss in Aperture Coupled Feeding- Return loss in an aperture – coupled microstrip patch antenna is about -30dB at 3.75 GHz fig. (8) which is very much better value for improvement of various parameters of the antenna.

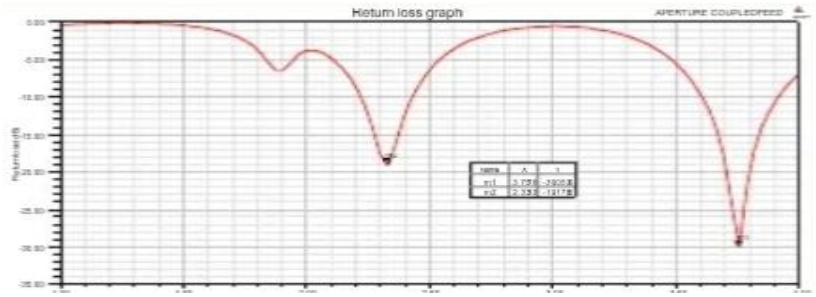


Fig.8, Return loss of Aperture – Coupled Feed.

7. Conclusion- In this paper, the comparative study of microstrip line feeding, coaxial probe feeding and aperture coupled feeding techniques gives their respective advantages and limitations in microstrip patch antenna design. Microstrip line feeding is simple, economical and easy to fabrication, it better for low cost applications. Coaxial probe feeding offers flexible feed point positioning, good impedance matching and reduce unwanted feed line radiation. Aperture coupled feeding provides better isolation between the feeding network and the radiating patch. It is advantageous for high performance antenna applications. The return loss characteristics of all three techniques should be evaluated by using electromagnetic simulation and experimental measurements. Ultimately, the most suitable feeding technique depends on the required bandwidth, fabrication and application specific design requirements.

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