Review of Feeding Technique in Microstrip Patch Antenna

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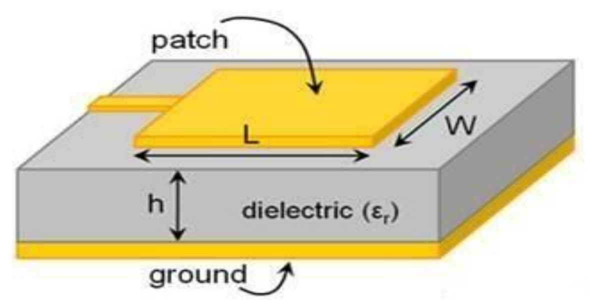
Abstract -The basic design of microstrip patch antenna consists of a metallic patch printed on a grounded substrate. The microstrip patch antenna can be easily understood by various approaches. These approaches can be verified in two categories viz., contacting and noncontact. In the contacting approach, the patch is straight fed with RF power by means of the contacting element such as microstrip line or coaxial line. Electromagnetic field coupling is done in the non-contacting method to transfer power between the radiating patch and the microstrip line. Microstrip line, Coaxial probe, Aperture coupling and Proximity coupling are the four most popular feeding techniques. Basics of the microstrip antenna, different feeding methods, and antenna constraints are presented through this literature survey.

Keywords- Microstrip Antenna, Feeding Techniques, Radiation Pattern, VSWR

I. Introduction

Here insert a microstrip antenna includes two major sides of a metallic configuration one fitted on the dielectric substrate and ground plane on the further side of the substrate as displayed in Figure 1. Copper, gold is used for making a patch. Since they are eligible to make some probable arrangement. The radiating patch and the feed line are displayed generally on the dielectric substrate. There are various types of patch forms such as rectangular, circular, annular-ring, and Equilateral triangle. The patch antenna impression was major planned in patch shapes such as rectangular, circular, annular ring and Equilateral triangle. Under the guidance of dense dielectric substrate that has less dielectric constant, this offers higher bandwidth and improves radiation and efficiency. However, this configuration causes a large size of the antenna. In order to decrease the antenna size a higher dielectric constant is used the early 1950 [1] compatibility with integrated circuit technology low case of manufacture and small profile are the advantage of the microstrip antenna. Its main demerits are fine



thickness of the dielectric material rises which fetters the bandwidth of the antenna. Its results are an undesirable cross polarization.

The texts on MPAs are huge, containing several research articles in archival journals. In the Distinctive Topic of IEEE Proceedings in 1992, titled “Antenna”, Prof. D. M bandwidth which is usually less than 5%. The low profile benefit was mostly good for fast running vehicle such as missile, aircraft ‘s. Inorder to make simpler and easier analysis and performance estimation.

Pozar wrote a review article on microstrip antennas [2]. In the review article published in the Henry G. Booker Memorial Issue in 1989 [3], Lee predicted that “We can appear onward to sustained research in MPAs for quite some time to come.” There were also numerous assessment articles, and records, a limited list is given in [4]–[9]. Practically the microstrip antenna made useful by the development of Printed Circuit Board (PCB), microwave techniques and many kinds of low attenuating media materials. Feeding designing in microstrip patch antenna is main task in antenna designing for compatibility.

III. Feeding Techniques

The function of the feed is to radiate by the direct or indirect connection. The feed of microstrip antenna consists of various arrangements viz., offset microstrip line, coaxial feed, aperture coupling feed and proximity coupling feed. In fact, coaxial feeds and microstrip line are comparatively easier to fabricate. Coaxial feed is easily operated at 50Ω at several points. These points are obtained with the aid of mathematical method The figure 2 shows a conducting strip is associated straight to the verge of the microstrip patch. The conducting strip is thicker than the patch. The benefit is that the feed can be easily engraved on the similar substrate to outcome a perfectly balanced planer structure. Hence this is an informal feeding technique since it offers simplicity in modeling and ease of fabrication and impedance matching also. Surface waves and false feed radiation rises when the thickness of the dielectric material rises, which fetters the bandwidth.

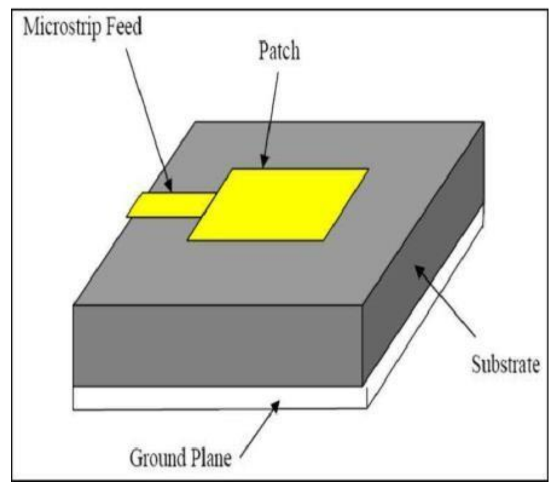


Figure 2 Microstrip Line Feed

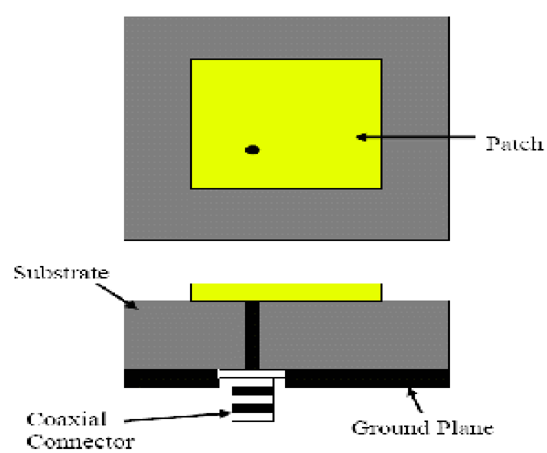


Figure 3 Coaxial Feed

3.2 Coaxial Feed

Another name of this technique is the probe feed and is one of the utmost mutual techniques. Figure 3 show the outer conductor is connected to the ground plane and the inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch. The merit of this feeding arrangement is that the feed can be situated at some location inside the patch in order to obtain impedance matching. This is informal to operate and has fewer radiation effects. The main demerit of this method is that it offers narrow bandwidth and is tough to operate.

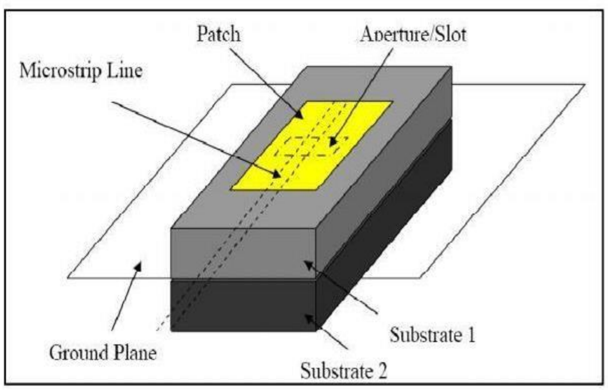


Figure 4 Aperture Coupled Feed

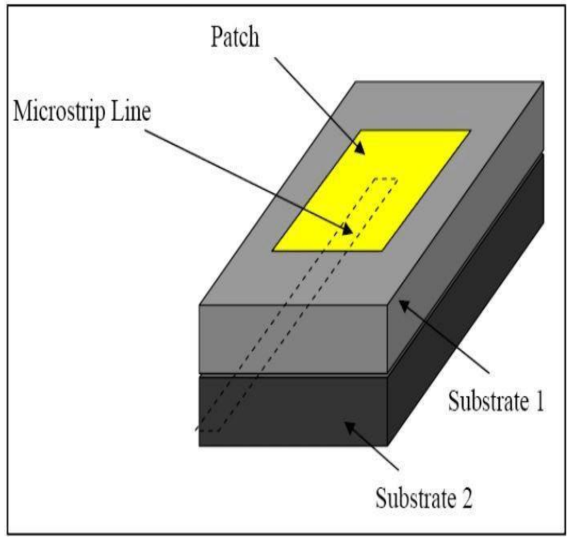


Figure 5 Indirect Feed

3.3 Aperture Coupled Feed

Figure 4 shows the hard surface of the top of antenna substrate contains the radiating microstrip patch element and the bottommost hard surface of the feed substrate contains the microstrip feed line. The width and the dielectric constant of these two substrates optimize the different electric function of radiation and circuitry. It is hard to manufacture due to several layers, which also leads to increase in antenna thickness and this is the chief disadvantage of this feed technique.

3.4 Proximity Coupled Feed

Another name of this technique is electromagnetic coupling arrangement. Figure 5 shows, two dielectric substrates are arranged in such a manner so that a fixed feed line is between the two substrates. The upper substrate contains the radiating patch. But this method is helpful since it provides right feed radiation and very high bandwidth. The two dielectric layers that need proper alignment are difficult to fabricate and this is a major disadvantage. Also, the overall thickness of the antenna is increased.

VI. Antenna Parameters

Return Loss, Voltage Standing Wave Ratio, Antenna Gain, Directivity, Antenna Efficiency, and Bandwidth are the different antenna parameters.

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4.1 Gain

The gain is not an amount which can be well-defined in relations with physical quantity such as Watt or Ohm. It is a dimensionless ratio. The gain of the antenna in a particular path is the amount of energy radiated in the provided direction as compared to the energy of an isotropic antenna that would radiate in the same direction under same input power. Gain is given by:

$$G = 4\pi . U(\theta, \Phi) / P_{in} \qquad \text{.................. (1)}$$

Where, U (θ, Φ) represents intensity in a particular direction and Pin is the input power.

4.2 Radiation pattern

A graphical demonstration of the comparative supply of the radiated power in space is known as Radiation pattern.

4.3 Antenna efficiency

The ratio of the complete power radiated by an antenna to the complete input power of the antenna.

4.4 VSWR

A new way to understand what method the system is matched, VSWR (Voltage Standing Wave Ratio) can be used. VSWR is the fraction of the maximum voltage and minimum voltage in the transmission line, and can be defined as follows:

$$VSWR = 1 + \rho / 1 - \rho, \qquad \text{.................................. (2)}$$

Where ρ is the scale of |Γ|. The reflection coefficient is nearly 0 when the system is matched, while the VSWR is nearly 1.

4.5 Return loss

Return loss is defined as the power of the reflected signal in a transmission line. It can be computed by the following equation:

$$RL\ (dB) = -20\log 10\ \Gamma \qquad \text{.......................... (3)}$$

The return loss is also stated as the S11 of the Sparameters and is given in dB.

4.6 Bandwidth

Antenna bandwidth is the range of operational frequencies of the antenna nearby the resonance frequency.

V. Study of Antenna Designing Parameters

The three crucial constraints for designing of a rectangular microstrip Patch Antenna are as follows. Initially, the resonant frequency (f0) must be picked out correctly. The second essential constraint of the antenna is substrate width, the height of dielectric substrate (h). The third main parameter of good antenna project is a dielectric substrate (Ɛr). A dense dielectric substrate which is having small dielectric constant is needed which delivers better efficiency, bandwidth, and radiation. The small amount of dielectric constant increases the fringing arena at the patch boundary and consequently lower the quality factor Q and increases the radiated power. Patch is acted as a conductor. This configuration of the antenna having a length of patches L, thickness W, the height of dielectric substrate h and Loss tangent. The main project parameter is a dielectric constant of the substrate substance. These are located on an endless ground level. The transmission line method is used to calculate antenna parameters [10].

5.1 Width of the Patch:

$$W = \frac{c}{2f\sqrt{\frac{\varepsilon r + 1}{2}}} \qquad \text{........................... (4)}$$

James et al, determine the antenna width in 1989, where, c = speed of light in free-space.

5.2 Resonant Frequency:

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$$f_o = \frac{c}{2L_e\sqrt{\varepsilon_r}}$$ ………………………… (5)

The length Le, Effective length is given by,

$$L_e = L + 2\Delta L$$ ……………….…………. (6)

The actual patch length, L is given as (Pozar et al, 1995). The extended length ΔL due to fringing effect is calculated by the following equation:

$$\Delta L = 0.412\left[\frac{(\varepsilon_{reff}+0.3)\left(\frac{w}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left(\frac{w}{h}+0.8\right)}\right]$$

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left(1+\frac{12h}{w}\right)^{-\frac{1}{2}}$$

………………………… (7)

Where, h = Height of dielectric substrate

W = Width of the patch

VI. Conclusion

This paper presents a theoretical study on microstrip patch antenna and it concluded that lower power control capacity and lower gain can be surpassed by an array structure and inserted patch. The review of this paper is to designing steps and antenna design parameters are involved in this. It means designing approach of any microstrip patch antenna is basically depends upon mainly substrate, shape of the antenna. But according to applications it is basically depends upon feeding method also. It is clear that antenna designing technique has also involved the feeding technique because of conductor loss.

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