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A Survey On Micro-Strip Patch Antenna And Its Parameters

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ABSTRACT - Micro strip patch antennas are very popular because of its significant feature such as, low profile planar configuration, light weight, low cost but gain of the antenna is very low, small directivity, similarly very low efficiency and very narrow bandwidth. To overcome this limitations, implementing patch antennas with defected ground plane structures or by introducing slots in the configurations and through increasing substrate thickness as well asthe height of the patch, then decreasing the permittivity of the substrate by the way the bandwidth of the antenna is improved. The designed antennas are fabricated on a high performance FR4 circuit board. To increase the bandwidth of the antenna and also to reduce the size of the antenna fractal structure can be introduced.

Key points: - Antenna radiation pattern, Micro-stripPatch antenna, Fractal structure.

1. INTRODUCTION

Antennas are required everywhere; any wireless communication requires antennas. It is nothing but a transducer designed to receive ortransmit electromagnetic signals. Micro-strip antennas are actually popular these days due to its compactness, low cost, less in weight, mechanically robust,low profile, flexible in terms of resonance frequency and compatibility with the integrated circuits which is connected to it. These type of antenna has a good VSWR and appreciable return loss. It has fewbenefits over other microwave antennas and therefore these antennas are extensively used in many real-time applications.

Micro-strip antennas are very simple in structure, it consists radiating patch printed on one side of dielectric substrate whose dielectric constant is ε_r, thickness of the substrate is h anda ground plane on the others side. If the shape of the radiating elementis rectangular it is known as a rectangular Micro-strip antenna and similarly circular Micro-strip antenna, triangular Micro-strip antenna are the basic and most commonly used Micro-strip antennas [1]. The structure of Micro-strip antenna is illustrated inFigure 1.

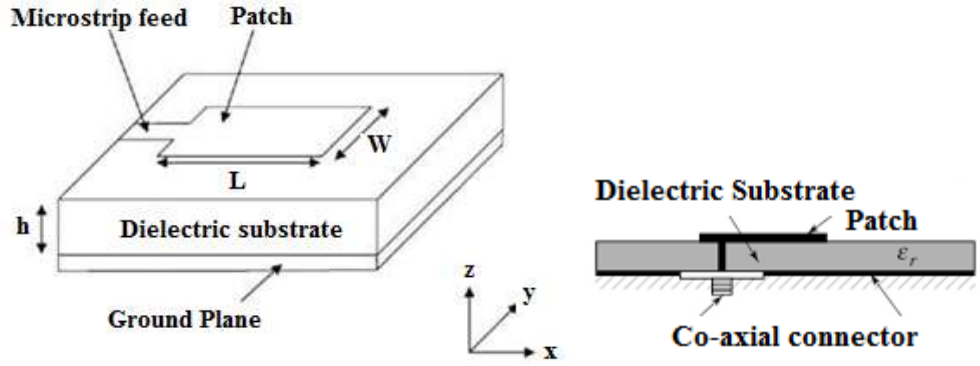

Figure 1: Structrue of Micro-stripPatch Antenna

A rectangular type of Micro-strip antenna is defined by its width (W)and length(L). The length of the size of the patch determines the operating frequency of the antenna. Iflarger the width, larger will be radiation which leads to larger gain as well as larger bandwidth and smaller the width, lesser will be the radiation. Generally, a Micro-strip antennas are fed by Micro-strip line,co-axial probe, electromagnetically coupled(EMC) and aperture coupled.

The radiation takes place with three important parameters. Those are thickness, width of the patch and the dielectric constant ε_r.MostlyMicro-stripantenna prefers ε_r to be small, large thickness and large width to get maximum fringing field [2]. Maximum fringing field leads maximum radiation. If the value of ε_r is increased, the size of the antennareduced which results in reduction of fringing fields and in fact the lowest dielectric constant $\varepsilon_r$also leads to the highest bandwidth, as well as the large gain.If the thickness of the patch is very thin, the fringing field exist but it will be very small.

Linear and/or circular polarization can be accomplished by using Micro-strip antenna and multiple bands of frequencies can also be designed. In fact, one can design antenna for both horizontal and vertical polarization. In addition to that the feed line matching network can be easily integrated with the antenna structure. Now because of these advantages it finds lot of applications, of course, it has disadvantages.The main disadvantages are lesser bandwidth, less gain and low power handling capacity. There are some problems with the isolation between the feed and radiating elementthere will be some coupling. So, it has poor isolation [3]. Presence of surface wave affects the fringing fields. Ifa typical Micro-

strip antenna will radiate in the broad side direction which is perpendicular to the surface of the patch, but, the presence of fringing fields from the patch to the ground plane. These fringing fields which are at the edge they start propagating along the surface and leads to poor radiation. Now, tolerance problem of low cost substrate is the problematic, Polarization purity is difficult to achieve, one of the big disadvantage is size of Micro-strip antenna is large at lower frequency.

2. TYPES OF FEED IN MICRO-STRIP PATCH ANTENNA

There are various feedingtechniques adopted to the Micro-strippatch antenna. The Figure 2 shows a rectangular patch with a coaxial feed. A coaxial wire is connected with the SMA connector or N type connector. The outer shield is soldered to the bottom of ground plane, and then a hole is drilled and soldered into the center pin with patch.

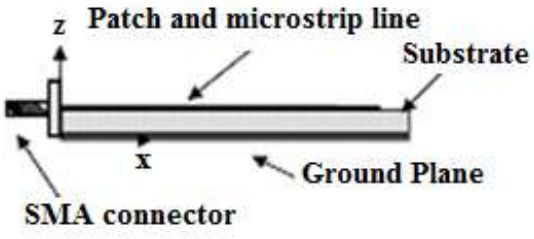

Figure 2: Rectangular Patch with Co-Axial Feed

The coaxial feed is selected such a way that wherever the input impedance is roughly 50Ω and matching obtained directly. So that external impedance matching network not required.Co-axial probe has advantage. It is very expensive for many modern wireless communications, like Radar applications, secure communication, and multi-frequency communication [4].

Another type of the feed is Micro-strip line is shown in figure 3. The Micro-stripline is connected to the patch. In fact this type of feeding system is very widely used, especially for arrays antennas where n number of elements can be connected [5].

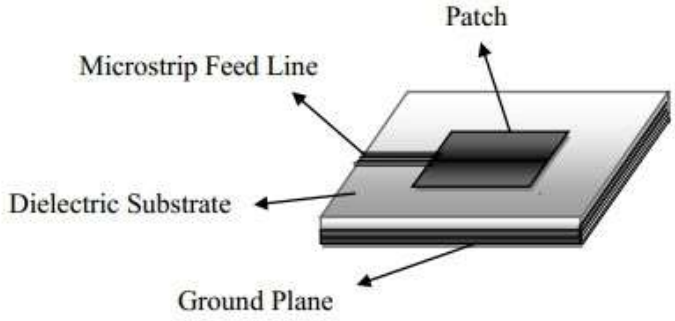

Figure 3: Patch with Micro-stripLine Feed

Another way to feed is electromagnetically coupled feed is shown in figure 4. Actually there are two different substrates are used. The figure shows there is a bottom substrate, which consist of the feed line withhigh dielectric constant and thin substrate. The patch is printed on top of the second substrate, with low dielectric constant. The patch gets excited through magnetic coupling when the feed is given.Hence it is known as electromagnetically coupled field.

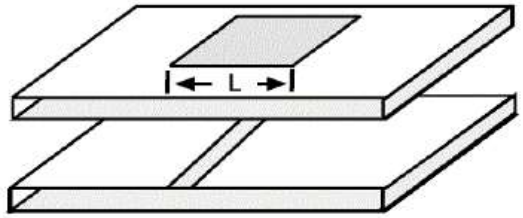

Figure 4: Patch with Electromagnetically Coupled Feed

An Aperture coupled field feed with two substratesis shown in figure 5. Both are coupledthrougha common ground plane.The lowermostone is connected to the feed line and ground plane having a aperture over it. The patch is printed on the top of the substrate. Feeding line will actually have a current distribution over the plane which exhibits magnetic field, that magnetic field will couple through the slot and excites the top patch. The drawback of the aperture coupled feed is that there is a back radiation. Front to back ratio of this is relatively very poor [6].

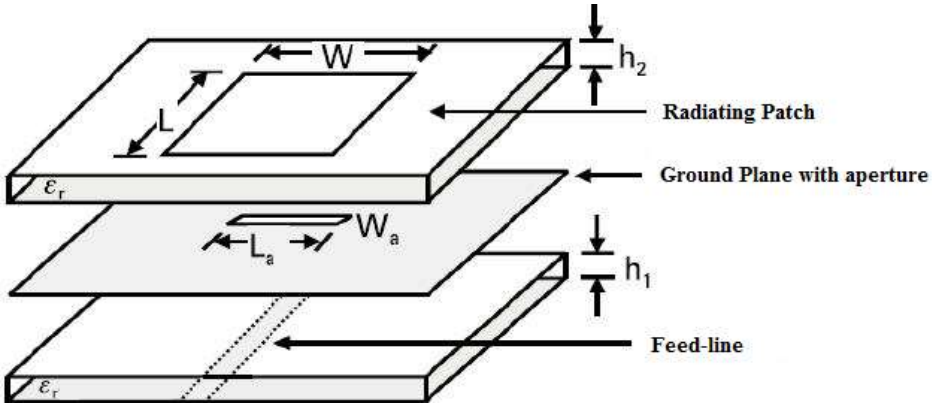

Figure 5: Aperture coupled field feed

3. DESIGN OF RECTANGULAR MICRO-STRIP PATCH ANTENNA (RMSA)

A basic Rectangular Micro-stripAntenna (RMSA) is defined by it is length L and width W to design antenna for a given frequency [7, 8]. Consider a patch, will have a fringing field. The

ground plane (metallic plate) and a patch (metallic plate) is on the backside, there will be fringing fields all around. The total capacitance will be the capacitance of the parallel plate plus the capacitance of the fringing field. While designing of antenna the effective length L_e and effective width W_e should be considered. The equation (1) is the effective length L_e[9]. L_e is nothing but total length L plus ΔL that accounts for the fringing field on one side and ΔL on the other sides

$$\mathbf{L_e = L + 2\,\Delta L} \quad (1)$$

Similarly, the effective widthW_e(2)

$$\mathbf{W_e = W + 2\,\Delta W} \quad (2)$$

The next part is calculation of ΔL that can be calculated by dividing the substrate height or sometimes substrate thickness by$\sqrt{\varepsilon_e}$.

The resonance frequency of this particular antenna can be calculated by the equation (3)

$$f_0 = \frac{c}{2\sqrt{\varepsilon_e}}\left(\left(\frac{m}{L}\right)^2 + \left(\frac{n}{W}\right)^2\right)^{\frac{1}{2}} \quad (3)$$

The length L becomes roughly equal λ/2 that is the resonance frequency for the fundamental mode.

Calculation of effective dielectric constant is depicted in the equation (4). Majority of the time for a rectangular patch a largerwidth(W) is taken. So, ε_e is given by

$$\varepsilon_e = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2}\left[\left(1 + \frac{10h}{W}\right)^{-\frac{1}{2}}\right] \quad (4)$$

Selecting the value of width W is important in design of an antennas. If larger gain is required larger width is selected. If width W increases the aperture area increases resulting the fringing fields will increase so that, there will be more radiation.

3. DESIGN OF CIRCULAR MICRO-STRIP PATCH ANTENNA (CMSA)

In circular Micro-strip patch, the important parameter is radius and its feed point as shown in figure (6). The antenna impedance matching is necessary for calculation of resonance frequency. The resonance frequency of the circular patch can be obtained by the expression (5).

$$f_0 = \frac{K_{mn}\, c}{2\pi a_e \sqrt{\varepsilon_e}} \quad (5)$$

Where K_{mn} is the m^{th} root of the Bessel function derivative of order n. The field variation is defined by sin of sine, which is defined in terms of Bessel function and the entire thing is

governed by the Bessel function of different order [10]. The different modes are 11, 21, 02,and 12 and so on. For the TM21 mode as well asTM02 mode the radiation is obtained in the broadside direction,and for TM21 mode the radiation is obtained in conical direction; however, TM02 mode is very good as a power divider used in broad band applications which is suspended in air. The value of K_{mn} is approximately 1.84118 for fundamental mode. a_e is effective radius and ϵe is effective dielectric constant. For fundamental mode the approximate formula for a_e is shown in equation (6).

$$a_e = a + \Delta a = a + \frac{h}{\sqrt{\varepsilon_r}} \qquad (6)$$

The efficiency and bandwidth of the antenna are associated to the substrate parameter. The increase h and decrease in $\varepsilon_r$bandwidth increases but both leads to poor efficiency. But selection of dielectric constant and using higher order modes can achieve good gain as well as broad bandwidth in desired direction with more amplitude.

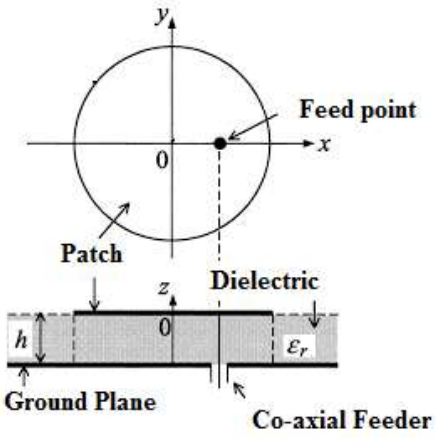

Figure 6:Circular Micro-strip Patch

4. DESIGN OF TRIANGULAR MICRO-STRIP PATCH ANTENNA (CMSA)

The Equilateral Triangular Micro-strip antenna (ETMSA) is existing in figure(7). The equilateral triangle is defined by its length S, and all the three lengths are equal. The angle over the triangle will be equal to 60 degree. If the feed point placed at the center, it becomes symmetrical antenna and the cross polar components get cancel [11].

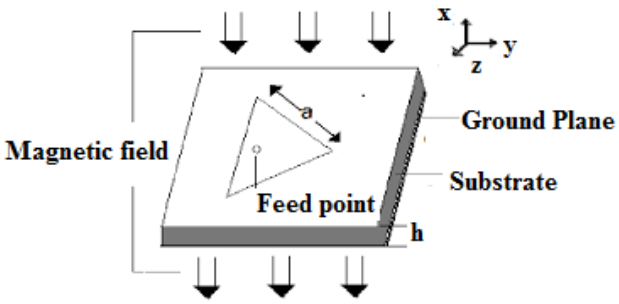

Figure 7: Equilateral Triangular Micro-strip antenna

The feeding point and selection of substrate decides the bandwidth of the antenna. Two resonators configurations are produces large bandwidth for fundamental mode.

4. COMPARATIVE STUDY OF MICRO-STRIP ANTENNA

Table. 1 comparative study

Parameters	Rectangular Micro-strip	Circular Micro-strip	Triangular Micro-strip
Gain	More	Less	More
Bandwidth	More	Less	Moderate
VSWR	Good	Good	Good
Directivity	More	Less	More
Polarization	Linear	Circular	Linear

The comparative study concluded that the Rectangular Patch antenna gives the better result than the circular patch antenna and triangle Micro-strip patch.

5. FRACTAL STRUCTURE

To minimize the size of the antenna by introducing fractal structure into the microstrip antenna. The fractal structure givesimprovedinput impedance matching and also a single antenna can be sufficient to operate in several bands both narrow and wideband applications. Due to the self-similarity in the geometry, the percentage of bandwidth of single band is increased appreciably. The fractal structured antennas such as Sierpinski dipole, Cantor slot patch, and fractal tree dipole can be used as a radiating element.The most important property of fractals geometry is that, with in a finite volume an infinite length can be accommodated.That is, electrical length of the radiator determines the radiation characteristic of the antenna. Using the property of fractal structure, keeping the

volume of antenna remains same andthe electrical length of an antenna can be increased. There are many number of geometries are available to design of fractal Micro-strip patch antenna. Fractal structured antennas are considered to be frequency independent because itprovides stable performance over huge range of frequency[12]. There will be considerable reduction of mutual coupling in array antennas made using fractal geometrical approach. But design complexity and manufacturing the fractal structured antenna is high. It possess very poor gain but the benefits are diminishing by increasing the number of iterations.

6. CONCLUSION

This paper surveys various types of Micro-strip patch antennas. The benefits of Micro-strip Antennas are, low cost, very light in weightand robust, easy to fabricate, the feeding network is easy (Micro-strip line,coaxial cable, etc.) Fractal structures are highly used in an array antennas or it can be incorporated with other Micro-strip circuit elements and multiple frequencies can be achieved easily. It is compatible with MMIC (Microwave monolithic Integrated circuit design.), at the same time,micro-strip feed lines and matching networks are fabricated with the antenna structure. But the limitations such as, low power gain, narrow bandwidth and low efficiency were observed. Polarization purity is difficult to achieve as well.To overcome the limitations of conventional Micro-strip antennas, the fractal structures can be introduced to design and fabricate the Micro-strip patch antennas.

REFERENCES

[1] James j., and P.S. Hall (Eds), Handbook of Micro-strip antenna, Peter Peregrinus, London, UK, 1989.

[2] Ramesh Garg, Prakash Bartia, Inder Bahl, Apisak Ittipiboon, ''Micro-strip Antenna Design Handbook'', 2001, pp 1-68, 253-316 Artech House Inc. Norwood, MA.

[3] Robert A. Sainati, CAD of Micro-strip Antennas for Wireless Applications, Artech House Inc, Norwood, MA, 1996.

[4] G.A. Deschamps, "Micro-strip microwave antennas," presented at the 3rd USAF Sympon Antennas, 1953.

[5] Y.T. Lo, D. Solomon, and W.F. Richards, "Theory and experiment on Micro-stripantennas" "IEEE AntennasPropagat. Soc. Int. Symp., pp. 53-55, 1978

[6] Tahsin Ferdous Ara Nayna, A.k. Baki "Comparative Study of Rectangular and Circular Micro-strip Patch Antennas in X Band " IEEE 978-1-4799-4819-2/14,2014

[7] Vasujadevi Midasala Dr. P. Suddatrth"Rectangular patchAntenna Array design at 13 Ghz frequencyusing HFSS",978-1-4799-3975-6/14,2014

[8] Mr.P.Arunagiri, Naveen Kumar C, Adhavan K. , —A Design of Dual Band Triangular Micro-strip Patch Antenna for WLAN Applications‖, International Journal for Research in Applied Science & Engineering Technology (IJRASET), Volume 4 Issue IV, April 2016

[9] Rajesh K Vishwakarma, J.A Ansari, M.K. Mishram, ―Equilateral Triangular Micro-strip Antenna for circular polarization dual band operation‖, Indian journal of radio and space physics, vol 35, Aug 2006
[10] A Review of Various Types of Patch Antenna. Available from: https://www.researchgate.net/publication/305472034_A_Review_of_Various_Types_of_Patch_Antenna [accessed Mar 15 2019].
[11] A Review of Various Types of Patch Antenna. Available from: https://www.researchgate.net/publication/305472034_A_Review_of_Various_Types_of_Patch_Antenna [accessed Mar 15 2019].
[12] Preeti Srivastava, O.P.Singh, "A Review paper on Fractal antenna and their geometries", Advances in Electrical & Information Communication Technology",AEICT-2015.