Microstrip Rectangular Patch Antenna

Renu Kumari[1] Mrs. Vijeta[2]
[1]M Tech Student [2]Assistant Professor
[1,2]R.N College of Engineering, Madlauda, Panipat, Kurukshatra University, Haryana, India

Abstract— In telecommunication, a microstrip antenna normally way an antenna fabricated the usage of photolithographic strategies on a published circuit board. This paintings analyzes the overall performance enhancement of microstrip patch antenna via way of means of reading the numerous papers. The antennas are separated the usage of the distinctive antenna parameters like Radiation pattern, Gain, Return loss, Directivity and Radiation pattern.This paper characteristic the layout of Microstrip Patch Antenna and indicates the numerous feeding strategies this is microstrip feed line and coaxial probe feed. These antennas are designed on a skinny dielectric substrate for the numerous software of microstrip antenna.

Keywords: Microstrip antenna, feeding methods, Analysis, Patch, Characteristics

I. INTRODUCTION

Microstrip antenna encompass a patch of steel foil of various shapes (a patch antenna) at the floor of a published circuit board, with a steel foil floor aircraft at the some other facet of the board. Most microstrip antennas have quantity of patches in a two-dimensional array. The antenna is attached to the transmitter or receiver with the assist of foil microstrip transmission lines. The radio frequency contemporary is distributing (or in receiving antennas the acquired sign is produced) among the antenna and floor aircraft. Microstrip antennas have emerge as very well-known in lately because of their skinny planar profile which may be integrated into the surfaces of client products, plane and missiles; their clean of fabrication the usage of published circuit strategies; the clean of integrating the antenna at the identical board with the relaxation of the circuit, and the circumstance of including energetic gadgets which include microwave included circuits to the antenna itself to make energetic antennas.

II. STRUCTURE OF MICROSTRIP ANTENNA

Patch antennas are low cost have a low profile and are easily fabricated. In its simplest form a microstrip antennas consists of a patch of metal, usually rectangular or circular on top of a grounded substrate.

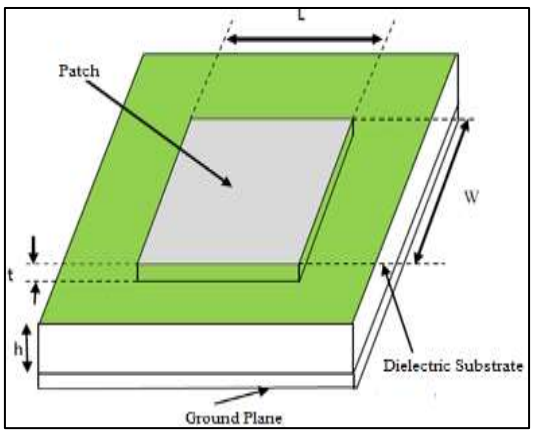

Fig. 1.1: Structure of rectangular microstrip patch antenna

A. Patch:

Patch is a very thin, radiating metal strip located on one side of a thin no conducting substrate.

B. Ground:

Ground is a metallic surface located on the other side of the substrate. The size of the ground should always be more for practical considerations. It should be greater than patch of six times substrate thickness.

C. Substrate:

The substrate is mainly used for providing spacing and mechanical support between the patch and the ground plane. It is many times used with dielectric constant material in order to load the patch and to reduce the size .According to dielectric constant ε_r the substrate can be divided into three categories:-Having a relative dielectric constant ε_r in the range 1.0 to 2.0. This type of material can be air, polystyrene foam, or dielectric honeycomb. Having ε_r in the range 2.0 to 4.0 with the material consisting mostly of fiberglass reinforced Teflon. With an or between 4 to 10.

III. FEEDING METHODS

As we recognize the microstrip antenna radiates from one facet of the substrate, so it is simple to feed it from different facet of the substrate or from the facet of the detail. The crucial factor which must be stored in thoughts is the most electricity transfer. Microstrip patch antenna may be fed with the aid of using numerous strategies.Feeding strategies are divided in categories.

In the contacting method, the RF electricity is fed withinside the direct manner to the radiating patch the usage of a connecting detail together with a microstrip line, while withinside the non-undertaking scheme, electromagnetic discipline coupling is performed to transport electricity among the microstrip line and radiating patch.

A. Microstrip Line Feed:

In this method, the microstrip patch is immediately related with the undertaking microstrip feed line. It is simple to manufacture and healthy. The microstrip line feed is as proven in Figure.It is the very best of the feeding strategies to manufacture as it's far only a undertaking strip related to the patch and may be taken into consideration as an extension to the patch. The benefit of this method is that there's no want for any greater matching detail to healthy the impedance of the feed line to patch. However because the thickness of the dielectric substrate will increase spurious radiation will increase which boundary fringe of the bandwidth.

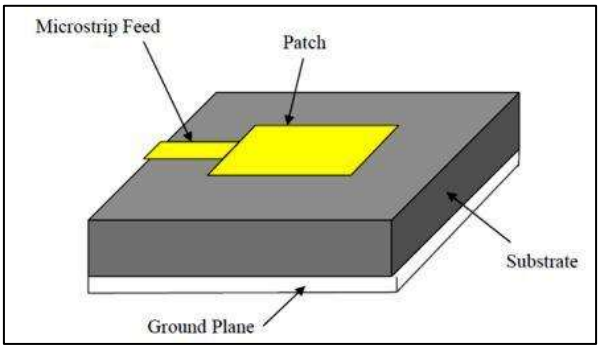

Fig. 1.2: Microstrip line feed

B. Coaxial Feed:

In this feeding approach the internal conductor extends thru the dielectric and is then joint to the radiating patch, whilst the outer conductor is attached to the floor aircraft. The function of the feed may be adjusted suit with the enter impedance. This feeding approach is simple to manufacture and has low spurious radiations. However it has a few dangers such because it presents slim bandwidth and is hard to version as a hollow needs to be drilled due to which the connector that extends past the floor aircraft hence now no longer making it absolutely planer for thick substrates.

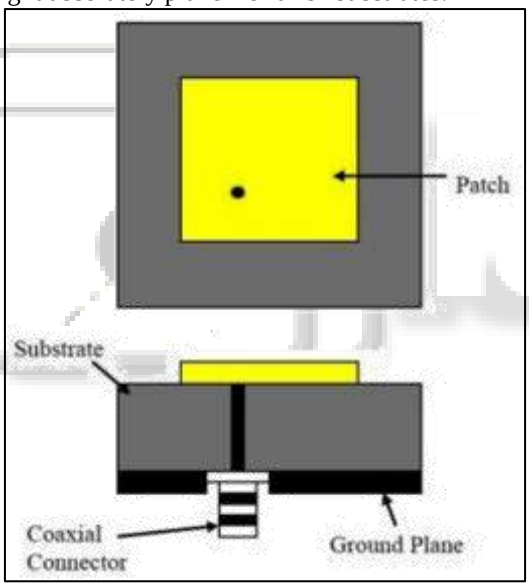

Fig. 1.3: Coaxial feed of microstrip patch antenna

C. Proximity Coupling:

This type of coupling technique is also called as electromagnetically coupling scheme. In this technique the 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. Proximity coupling uses two substrates ε_{r1} and ε_{r2}. The patch is at the top, the ground plane in the bottom and the microstrip line is connected to the power source lying between the two substrates as shown in figure (1.4) below.

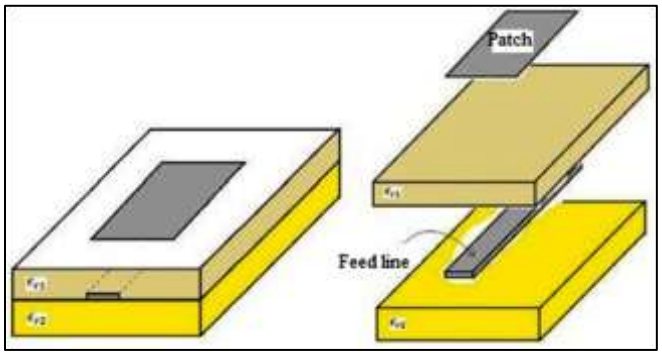

Fig. 1.4: Proximity coupling feeding method

The principle of this mechanism is that the behavior between the patch and the microstrip feed line is capacitive.

D. Aperture Coupling:

This feed is having two substrates, which are different from each other and are separated by a ground plane. In this method, the microstrip patch and feed line are coupled through a slot in the ground plane. Aperture coupling, the radiating patch and the microstrip fed line is separated by ground plane. The ground is in shape of a circle or rectangle and separates two substrates, the upper substrate ε_{r1} with the patch on it and lower substrate ε_{r2} with the microstrip feed line under it. The amount of coupling from the feed line to the patch is determined by the shape, size and location of aperture. This type of coupling technique has an advantage of higher bandwidth and improved polarization purity. The main disadvantage of such coupling technique is that it is difficult to fabricate such antenna due to the formation of a number of layers. A detailed structure of aperture coupling is shown in the figure (1.5)

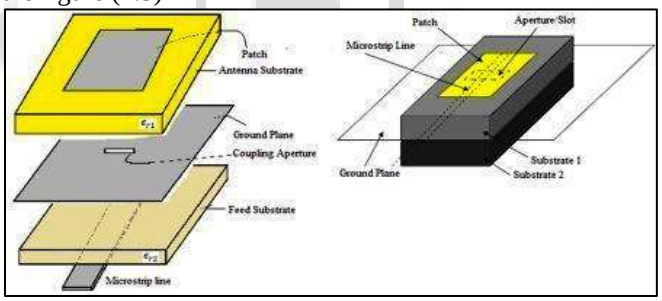

Fig. 1.5: Aperture coupling feed method

IV. DESIGN AND METHODOLOGY

Nowadays, wireless devices support more and more wireless standards. And each standard requires a different antenna, so this makes the device bulky hence fractal geometry is used to provide multiband behavior. This makes the wireless device to support several standards with a single antenna built within it. If antenna is to be designed for mobile use, then it is required to design antenna for GPS, Wi-max, Bluetooth, PCS and many other applications.

The three design parameters of an antenna are resonance frequency, height of dielectric substrate and dielectric substrate. These are discussed below.

A. Resonance Frequency:

It is that frequency at which the antenna operates and the return loss is maximum at this particular frequency. Different microwave bands have different resonant frequencies.

Impedance matching takes place at this frequency, so the current is maximum and impedance is minimum at this frequency.

B. Substrate's Dielectric Constant:

it is the ratio of permittivity of substance and free space permittivity. As the value of dielectric constant increases, the antenna size decreases. This should be selected properly. In this work, FR-4 has been used as dielectric substrate.

C. Height of Dielectric Substrate (h):

It is essential that the antenna should be light weight and small in size. So the height of dielectric substrate for this work is taken as 2.4 mm. Now the dimensions of the patch are calculated using these parameters. Then different fractal iterations are done on the patch. Sierpinski carpet fractal geometry is used here and antenna parameters are analyzed. Coaxial feed has been used to feed the antenna.

Variable	Value
Length of patch	25mm
Width of patch	25mm
Length of ground	30mm
Width of ground	30mm
Thickness of substrate	2.4mm
Feeding technique used	Coaxial Feeding Technique
Substrate used	FR-4
Dielectric constant	4.4
Loss Tangent	0.02
Feed point	X=-11, y=-11, z=0
First iteration cut	8mm
Second iteration cut	3mm

Table 1: Dimensions of Patch

V. METHODS OF ANALYSIS

There are many strategies antenna analysis. The maximum essential of those strategies is the transmission line version. This approach is handiest of all however is much less correct. Another approach is the hollow space version. The hollow space version is extra correct and offers exact perception however is extra complicated than the transmission line version. The complete wave version can deal with finite and endless arrays, unmarried elements, and stacked elements. They are a long way extra complicated than the opposite strategies. In transmission line version the microstrip antenna is provided with the aid of using slots of width W and peak h, pass aside with the aid of using a transmission line of period L. As a result, the transmission line can't be natural TEM mode of transmission and dominant mode of transmission is quazi-TEM mode. Rectangular version may be implemented to simplest square and rectangular patches. Basic transmission line version is proven withinside the Figure 1.6. Here figure 1.6(a) indicates the microstrip line and the electrical discipline traces are proven in Figure1.6 (b). Compared to transmission line version the hollow space version is extra correct however on the identical time it's far extra complicated and is hard to version. Transmission line version is the handiest to layout and implement.

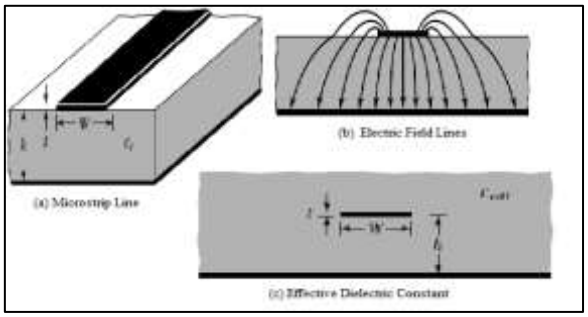

Fig. 1.6: Transmission Line Model

VI. RESULTS AND DISCUSSION

The antenna characteristics are explained in terms of return loss, bandwidth, resonant frequency, gain and directivity. Return loss should have more negative value. Ideally it is defined having more value than -10dB because this is the return loss for isotropic antenna. The return loss versus frequency graph as shown in figure 1.7.By applying fractal geometry, multiband characteristics are obtained. And to improve the bandwidth, U slot DGS is applied on the ground plane of the mushroom shaped patch antenna. Hence we obtain wideband antennas. There are many different DGS configurations which can be applied. We use that configuration which produces the best results for our design. Return loss versus frequency graph with DGS is shown in figure.

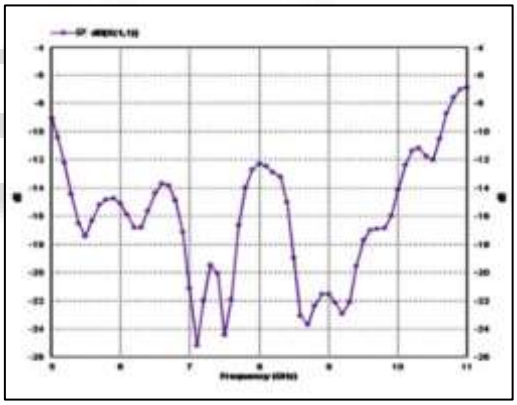

Fig. 1.7: Return loss Vs Frequency using DGS

Iteration Number	Resonance Frequency (GHz)	Return Loss (dB)	Gain (dBi)	Directivity (dBi)	Bandwidth
2nd iteration design	5.5	-13	2.29	5.82	200MHz
	8.2	-28.26	1.33	7.62	2GHz
	9.4		2.65	8	
	9.7		1.93	6.8	
	10		2.18	7.4	
U- slot DGS	5.3	-24	1.17	5.86	3.5GHz
	7.8		2.26	7.885	
	10.3		1.62	7.17	
	11		1.87	8.6	

Table 2: Comparison of results of antenna design with or without DGS

VII. CONCLUSION

An introduction to antenna is presented. Microstrip antenna with its four feeding techniques has been discussed. Different limitations of the microstrip antennas and the methods to overcome these limitations have been studied.

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