JOURNAL OF INFORMATION, KNOWLEDGE AND RESEARCH IN ELECTRONICS AND COMMUNICATION

OPTIMINZATION AND DESIGN IN AT FEED RMPA FOR 10GHZ, FOR VARYING INSET FEED WIDTH AND LENGTH

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ABSTRACT: *Micro strip patch antenna has drawn attention of researchers over the decade due to there Low profile, light weight ,ease of integration with printed technology and low cost. They have a wide range of applications from cell phones to live saving biomedical applications. The research on patch antenna basically depends upon on size reduction, wide bandwidth, increasing gain and system level integration. Geometry of antenna and substrate material defines the electrical properties of an antenna. Here we are analysis that for a Inset feed antenna, the inset gap along y-axis and inset length along x-axis plays an important role in the overall performance of patch antenna. CST Micro strip EMC properties are used to stimulate both the antenna.*

KEYWORDS: *Rectangular micro strip patch antenna, Substrate materials, Inset feed gap, Length and Width, Parameters.*

1. INTRODUCTION

In the years ago the development in communication systems requires the development of low cost, minimal weight and low profile antennas that are capable of maintaining high performance over a wide spectrum of frequencies. The objective of this paper is to optimization and design in inset feed RMPA for 10 GHz for varying inset feed width and length. The electrical properties of inset rectangular micro strip path antenna by varying inset and inset gap for proper impedance matching to achieve efficient operation. The purpose of inset cut in the patch is to match feed line impedance to the patch without adding any additional matching element. The conventional method of design have been used to design and development of Rectangular Micro strip Patch Antenna. To design the patch antenna first step is to calculate the required parameters which involved in designing. After getting these required values, the Simulated Results obtained. If the substrate parameters are specified, there are three design parameters; the patch length, the patch width and the inset feed point that controls the resonant frequency and the resonant resistance. The resonant nature of micro strip antennas also means that at frequencies below UHF, the size of the antennas become excessively large. The micro strip antennas are typically used at frequencies from 1 to 100 GHz Major operational disadvantages of micro strip antennas are their low efficiency, low power, high *Q* (sometimes in excess of 100), poor polarization purity, poor scan performance, spurious feed radiation and very narrow frequency bandwidth, which is typically only a fraction of a percent or at most a few percent. In some applications, such as in government security systems, narrow bandwidths are desirable. However, there are methods, such as increasing the height of the substrate, that can be used to extend the efficiency (to as large as 90 percent if surface waves are not included) and bandwidth (up to about 35 percent). However, as the height increases, surface waves are introduced which usually are not desirable because they extract power from the total available for direct radiation(space waves). The surface waves travel within the substrate and they are scattered at bends and surface discontinuities, such as the truncation of the dielectric and ground plane and degrade the antenna pattern and polarization characteristics. The inset-fed micro strip antenna provides a method of impedance control with a planar feed configuration [1-2]. The experimental and numerical results showed that the input impedance of an inset-fed rectangular patch varied as a *Cos*4 function of the normalized inset depth [1]. A more recent study proposed a modified shifted *Sin*2 form that well characterizes probe-fed patches with a notch [3]. It is found that a shifted *Cos*2 function works well for the inset-fed patch [4][5].

2. BASIC SHARACTERISTICS OF MICRO-STRIP PATCH

The micro strip patch is designed such that its pattern maximum is normal to the patch (broadside radiator). This is accomplished through proper choice of the mode (field configuration) of excitation beneath the patch. End-fire radiation can also be accomplished by judicious mode selection. The ones that are most desirable for antenna performance are thick substrates whose dielectric constant is in the lower end of the range. This is because they provide better efficiency, larger bandwidth, loosely bound fields for radiation into space, but at the expense of larger element size [6]. Thin substrates with higher dielectric constants are attractive for microwave circuitry because they require tightly bound fields to minimize undesirable radiation and coupling, which lead to smaller element sizes; however, because of their greater losses, they are less efficient and have relatively smaller bandwidths [6]. Since micro strip antennas are often integrated with other microwave circuitry, a compromise has to be reached between good antenna performance and circuit design.

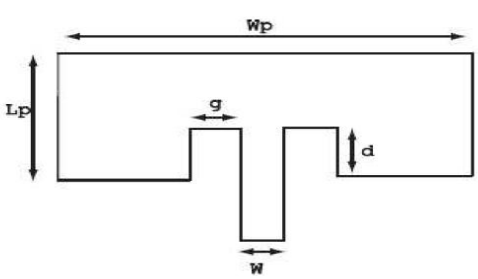

Fig.1: Geometry of inset-fed micro strip patch antenna.

Often micro strip antennas are referred to as patch antennas. The radiating elements and the feed lines are habitually photo etched on the dielectric substrate. The radiating patch may be square, rectangular, thin strip, circular, elliptical, triangular or constituting any other configuration. Square, rectangular, thin strip and circular micro strip patch configurations are the most common because of their ease of analysis, fabrication, and their attractive radiation characteristics, especially the low cross-polarization radiation. There are many configurations that can be used to feed micro strip antennas. The four most popular feeding techniques are the micro strip line, coaxial probe, aperture coupling and proximity coupling [6] [7-13]. In our paper, we have chosen inset feed micro strip line with rectangular micro strip patch.

3. DESIGN PROCEDURE FOR PATCH

To ensure a fair comparison between the techniques all feeds are designed to feed a rectangular-shaped micro strip patch antenna. The antenna is designed to resonate at the ISM Band frequency of 10 GHz. A suitable and similar substrate and simulation tool is also chosen to ensure uniformity with least alteration to the feeds' original structure. The substrate used is FR- 4, which has a dielectric constant (εr) of 4.4, and a single layered substrate height (h) of 1.5 mm. Verification of the comparisons are done by generating simulation results using CST Software. In order to design a patch resonating at a similar frequency of 10 GHz with the following equations are used.

The initial values (at low frequencies) of the effective dielectric constant are referred to as the static values, and they are given by:

$$\frac{\Delta L}{h} = 0.412 \frac{(\epsilon_{\text{reff}} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\epsilon_{\text{reff}} - 0.258)\left(\frac{W}{h} + 0.8\right)} \qquad 3.1$$

= 4.4

Normalized extension of the length:

$$W = \frac{1}{2f_r\sqrt{\mu_0\epsilon_0}}\sqrt{\frac{2}{\epsilon_r+1}} = \frac{\upsilon_0}{2f_r}\sqrt{\frac{2}{\epsilon_r+1}} \qquad 3.2$$

= 0.7085

$\underline{W/h > 1}$

$$\varepsilon_{\text{reff}} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-1/2}$$

3.3

= 9.1287 mm

The actual length of the patch:

$$L = \frac{1}{2 f_r \sqrt{\epsilon_{\text{reff}}} \sqrt{\mu_0 \epsilon_0}} - 2\Delta L \quad 3.4$$

= 6.489 mm

4. FEED TECHNIQUES

Micro strip patch antennae can be fed by a variety of different methods [1]. The four most popular feed techniques used for the micro strip patch are:-

1 Strip line feed
2 Pin feed
3 Aperture Coupling
4 Proximity Coupling

4.1 Micro strip Line Feed

In this type of feeding technique, a conducting strip connected directly to the edge of the micro strip patch. 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 on the same substrate to provide a planar structure [7]. This is an easy feeding scheme, since it provides ease of fabrication and simplicity in modeling as well as impedance matching. However as the thickness of the dielectric substrate being used, increases, surface waves and spurious feed radiation also increases, which hampers the bandwidth of the antenna [7]. The feed radiation also leads to undesired cross polarized radiation.

However, this method of feeding is very widely used because it is very simple to design and analyze, and very easy to manufacture. Figure 3 shows rectangular patch antenna with micro strip line feed.

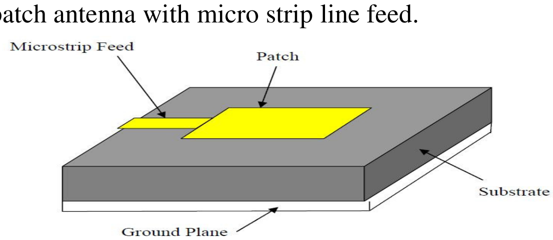

Fig 2: Micro strip Patch Antenna with Line Feed

4.2 Coaxial Feed (Pin Feed)

The Coaxial feed or pin feed is a very common technique used for feeding Micro strip patch antennas. 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. 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 [7, 10]. This feed method is easy to fabricate and has low spurious radiation. However, its major disadvantage is that it provides narrow bandwidth and is difficult to model slice a hole has to be drilled in the substrate and the connector protrudes outside the ground plane, thus not making it completely planar for thick substrates (h>0.02 λ0) [1]. Also, for thicker substrates, the increased probe length makes the input impedance more inductive, leading to matching problems [7, 8].

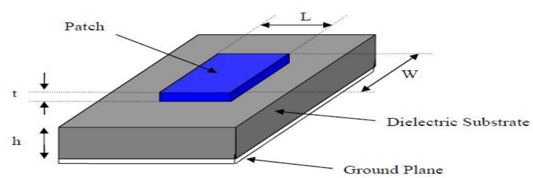

Fig 3: Micro strip Patch Antenna with Coaxial Feed

5. RESULTS AND DICUSSION

The software used to model and simulate the micro strip patch antenna. It's working on CST MICROSTRIPS Software It has been widely used in the design of patch antenna, wire antenna, and other RF/wireless antenna designs. It can be used to determine and plot the reflection parameters, Voltage Standing Wave Ratio (VSWR), current distributions as well as the radiation patterns.

Table 1: Physical Dimensions of Microstrip patch Antenna

Operating frequency	10 GHz
Dielectric Constant	4.4 (FR-4)
Length of the patch L	6.48 mm
Width of the patch W	9.128 mm
Thickness (*t*) of the Substrate	1.5mm
Model for Analysis	Transmission Line TLM
Substrate Length	15.48 mm
Substrate Width	18.12mm

Table 2. Iteration Results for RMPA using Different Inset Length and Inset Width

Iteration Patch No.	Inset Gap X (mm)	Inset Length Y (mm)	Resonance Frequency (f_r) (GHz)	Return Loss S11 (dB)	Antenna Efficiency (%)	Radiation Efficiency (%)	Directivity (dbi)	Gain (dbi)	Bandwidth (%)
1	0	0	10.571	-11.353	80.216%	99.150%	6.553	5.595	4.9
2	0.3	0.2	10.634	-11.555	78.634%	99.133%	6.565	5.521	5.3
3	0.4	0.2	10.646	-11.778	78.330%	99.129%	6.566	5.505	5.5
4	0.5	0.2	10.664	-11.996	77.814%	99.122%	6.566	5.477	5.8
5	0.6	0.2	10.683	-12.328	77.133%	99.118%	6.566	5.439	6.1
6	0.7	0.2	10.698	-12.654	76.773%	99.113%	6.566	5.418	6.5
7	0.8	0.2	10.796	-15.065	72.921%	99.109%	6.568	5.197	6.5
8	0.9	0.2	10.783	-14.672	73.713%	99.108%	6.559	5.235	6.8
9	0.3	0.3	10.675	-12.550	77.175%	99.124%	6.569	5.443	6.3
10	1	1	10.850	-19.081	69.497%	99.099%	6.563	4.983	7.6
11	1.5	0.5	10.782	-17.887	72.637%	99.050%	6.569	5.180	7.5
12	5.7	0.2	9.711	-20.482	91.007%	98.905%	6.592	6.183	6.3
13	6	0.2	9.650	-30.159	91.422 %	98.980%	6.585	6.196	7.7

5.1 Graphical Representation for different Iteration of Patch

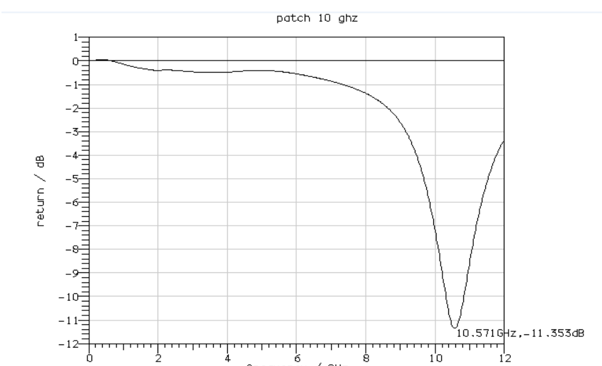

Fig.4: Return Loss for Patch 1

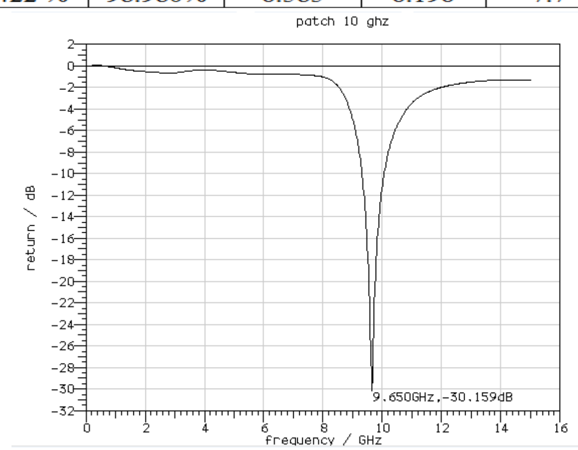

Fig.6: Return Loss for Patch 1

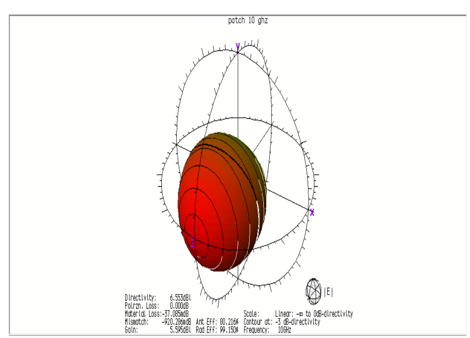

Fig. 5: Radiation pattern for Patch 1

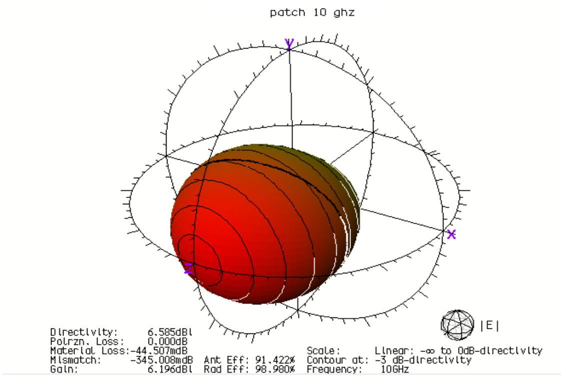

Fig. 7: Radiation pattern for Patch 13

6.CONCULSION

For better analysis, input impedance of patch antenna plays an important role as it will decide the performance of an patch antenna. It can be easily concluded that Inset gap stimulate length and width which affect the performance of antenna.

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