Performance Analysis of Square Shaped Microstrip Patch Antenna

Pradeep Kumar Sharma[1], Ritesh Saraswat[2], Siddharth Singh Chouhan[3]
Assistant Professor[1], Associate Professor [2],B. Tech. Student [3] ,
Department of ECE, JIET Group of Institutions,
Jodhpur, Rajasthan, India

***Abstract*—Microstrip patch antenna is a narrowband and wide beam antenna which is generally fabricated by etching process in which the antenna element pattern will be bonded with metal trace to an insulating dielectric surface. For forming the ground plane on the other side, there will be continuous metal layer bonded with substrate. Microstrip antenna has square, rectangular, circular, elliptical and annular ring which are general shapes.In this research we have studied the effect of antenna dimensions Length (L), and substrate parameters relative Dielectric constant (ε_r) on the Radiation parameters of Bandwidth and Return Loss. For this purpose, CST platform has been used.The frequency band 2-4 GHz is assigned as S band which is used in the applications such as satellite, Wi-Fi, Bluetooth ,cellular phones etc.The proposed method has been applied on the square Microstrip patch antenna and conclusions have been drawn on the frequency of 3.055 GHz on which both the antenna has been tuned. The results have been shown for the antenna in simulated manner as well as practical results.**

Key words: Band width, Radiation, Return Loss.

I. INTRODUCTION

Microstrip antennas are attractive due to their light weight, conformability and low cost. A microstrip patch antenna consists of conducting patch on a ground plane which is separated by dielectric substrate. [1][2] But this concept was undeveloped till the revolution in electronic circuit miniaturization and large-scale integration in 1970. After that there were so many authors who have described the radiation from the ground plane by a dielectric substrate for different configurations. The work which was done by Munson on micro strip antennas for use as a low profile flush mounted antennas on rockets and missiles represented that this was a practical concept for use in many antenna system problems. After that various mathematical models were developed for this antenna and its applications were realized to many other fields. Its importance can be seen by counting the number of papers, articles published in the journals for the last ten years show the importance gained by this antenna. The micro strip antennas are considered as the present day antenna designer's choice.

II. DESIGNING

As we are going to deal with the two shapes such as square shaped microstrip patch antenna in this paper. So we must have the knowledge about the designing equations which will be used while designing them. The designing equations consist of the variation in the width and length of the antenna.

The proposed length l = 23 mm, w = 31 mm designed on FR4-epoxy substrate with relative permittivity = 4.4 and thickness h =0.8 mm. This square patch antenna has been resonated at 3.055 GHz frequency.

It also has the use of permittivity which plays an important role in the designing of the antenna.

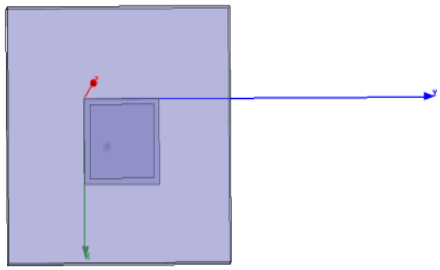

Figure.1 Square shaped Microstrip patch

The value of L for Square shaped Microstrip patch antenna will be calculated by the use of transmission line model equation:

$$L = \frac{c}{2fo\sqrt{\varepsilon_r}}$$

The effective dielectric constant can be given by the equation as:

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{(\varepsilon_r-1)}{2}(1 + 12h\backslash w)^{-½}$$

III. RESULTS

The results have been obtained for this antenna both on simulation basis and practical basis. For simulation CST platform has been used and for the practical results vector network analyzer has been used.

Square Patch Resonance Frequency:

The figure 2 below is representing the value of parameter S_{11} as it is called reflection parameter. Since we know that S parameters are preferred at the high frequency analysis because

(i) At high frequency Z, Y, h parameter become complex in nature.

(ii) It is difficult to obtain short and open circuit condition at high frequency that is why we use s parameters at high frequency because in S parameters we utilize the condition of matching the impedance. In the figure given below at the 3.055 GHz frequency, S_{11} has been obtained as -27.26507 dB.

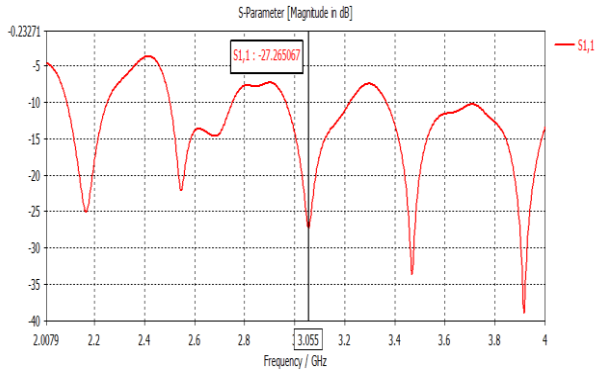

Figure 2 Resonance Frequency of Square Shape Microstrip Patch Antenna

S Parameter Value:

The figure 3 below is representing the variation of S parameter as we are changing the frequency. As we know that we prefer the value of magnitude which is below -10 dB in magnitude. Since we know that the return loss also depends upon the value of S_{11} parameter. The return loss is defined as the loss of signal power due to discontinuity in the transmission line or the optical fiber. It also refers to that part of the signal which cannot be absorbed by the end of transmission line.S_{11} has been obtained as -27.26507 dB.

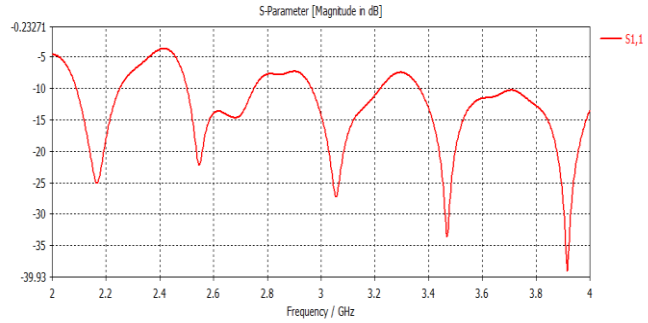

Figure 3 S Parameter Value of Square Shape Microstrip Patch Antenna

Bandwidth:

As we know the value of bandwidth plays an important role in determining the efficiency of any device. The bandwidth of the antenna depends on various parameters such as shape of the patch, resonant frequency, dielectric constant and thickness of the substrate which has been used for the designing of the patch. If we want enhance the bandwidth than we will have to improve the impedance bandwidth of the antenna element. So the figure 4 is representing the value of bandwidth around my frequency of interest at which square patch antenna has been resonated. From the figure the value of bandwidth is 0.25237 GHz.

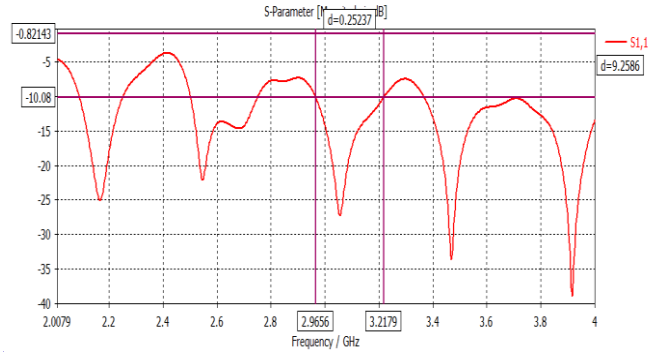

Figure 4 Bandwidth of Square Shaped Microstrip Patch Antenna

Practical Result:

Square Shaped Microstrip Patch Antenna:

The result which has been shown in the figure 5 is the result obtained from network analyzer. This result shows that the value of S_{11} parameter is around -17.78325461 dB at frequency of nearly 3.15710696 GHz. By seeing this response we can easily see that there is a difference between the results obtained practically and by simulation.

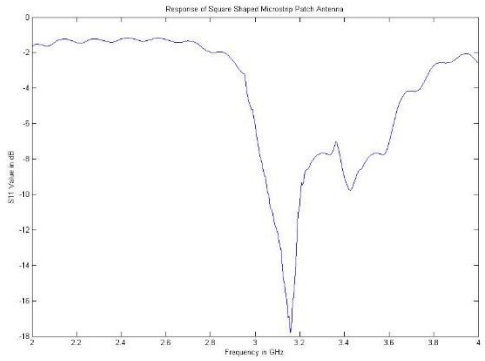

Figure 5 Response of Square Shaped Microstrip Patch Antenna

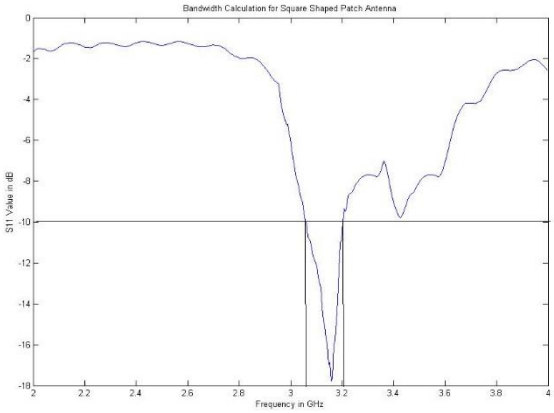

Figure 6 Bandwidth of Square Shaped Microstrip Patch Antenna

The figure 6 is giving information about the bandwidth of Square shaped microstrip patch antenna and the value of bandwidth for this antenna is around 0.156210 GHz. As we know that higher the bandwidth better will be for the antenna analysis.

Table 1
Representing the Values for Square Shaped Microstrip Patch Antenna

S. No.	Parameters	Value
1	S_{11}	-17.78325461dB
2	Bandwidth	0.156210 GHz

IV CONCLUSION

The practical result that has been obtained with the help of Vector Network Analyzer is not calibrated because of the limitations of the resources. These results are also indicating the behavior of these antennas and we can conclude from the practically obtained result is that there is a variation in both the result.
As from the result we can conclude that:

(a) Impact of Shape on Return Loss:
Based on the value of return loss which is -27.26507 dB for the Square shaped microstrip patch antenna and -24.27 dB for the Annular Ring microstrip patch antenna, the Square shape is having higher value than annular ring.

(b) Impact of Shape on Bandwidth:
The Square Shape Microstrip Patch antenna is having higher bandwidth than Annular Ring Microstrip Patch antenna. The practical result are also indicating that square shaped antenna is having higher bandwidth than annular ring microstrip patch antenna,

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