Design of Microstrip Patch Antenna using for Wireless System

Ravinder Kaur[1], Ruchi[2]

[1]*M.Tech (ECE), Desh Bhagat University Mandi Gobindgarh, Punjab, India*

[2]*A.P. (ECE), Desh Bhagat University Mandi Gobindgarh, Punjab, India*

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Abstract-This paper presents the design and simulation results of a design to microstrip patch antenna using with two feeding techniques for Wireless (1.9 GHz) applications. The proposed antenna is designed on FR4 substrate with a thickness of 1.6 mm, permittivity of 4.4 and tangential loss of 0.025. The size of the antenna is 37.26 × 48 ×1.6 mm³ and has a Microstrip feed line and Inset feed line. The antenna has a low return loss and VSWR. Our aim to improve the return loss and VSWR using MATLAB and CST Microstrip Studio software and comparison of the MATLAB and CST Microstrip Studio software.

Key Words: Wireless Communication, Antenna, Microstrip Patch Antenna, Feeding Method, MATLAB and CST Microwave Studio software.

1. INTRODUCTION

The exchange of the data between two or more focuses which are not specifically associated is essentially called Wireless communication or correspondence. The expression "Wireless or Remote" came into open use to allude to a radio recipient or handset (can be utilized both as transmitter and collector) building up its utilization in remote correspondence, for example, in cell system and remote broadband web. It is likewise used to allude to an operation that is executed without utilization of wires. It envelops different sorts of settled, versatile and convenient two way radios, cell phones. Different illustrations are satellite TV, remote PC mice, consoles and headsets, telecast TV [1]. Remote operation grants administrations, for example, long range correspondences, that are unimaginable or unreasonable to actualize with the utilization of wires. The most widely recognized utilization of remote systems is to interface the portable workstation/versatile information correspondence clients who head out from area to area. Another essential use is for portable systems that associate through wires, by means of satellite interchanges.

Antennas play a very important role in the field of wireless communications. During the recent years, microstrip antennas have attracted an important interest in modern communication systems because of their significant characteristics of small size, light weight, low cost on mass production and thin profile [2]. There are several techniques available to feed or transmit electromagnetic energy to a microstrip patch antenna. The role of feeding is very important in case of efficient operation of antenna to improve the antenna input impedance matching. The two main commonly used feeding techniques are Microstrip line feeding and Inset feeding. In microstrip line feeding technique, a conducting strip is connected directly to the edge of the Microstrip patch. The conducting strip is smaller in width as compared to the Patch and this kind of feed arrangement have the advantage that the feed can be etched on the same substrate to provide a planar structure [3]. In inset cut in the patch is to match the impedance of the feed line to the patch input impedance without the need for any additional matching element. This can be achieved by properly adjusting the inset cut position and dimensions. Hence this is an easy feeding scheme because it provides ease of fabrication and simplicity in modeling as well as impedance matching. However as the thickness of the dielectric substrate being increases, surface waves and spurious feed radiations are also increases, which hamper the bandwidth of the antenna. The feed radiation also leads to undesired cross polarized radiation [4].

Many attempts have been made in recent times to reduce the antenna size. Another methodology for planning a little size bow formed microstrip patch reception apparatus. The proposed bow shape microstrip patch receiving wire having Benzocyclobutene as a substrate has great thunderous recurrence (4.35 GHz).Also, the size is decreased more than 40% when contrasted with rectangular patch Microstrip radio wire or antenna [5]. The design of a multi-slot hole-coupled microstrip antenna on a substrate of 2 mm thickness that gives multi frequency (wideband) characteristics. The Method of Moments (MoM)-based IE3D software was used to simulate the results for return loss, VSWR, the Smith chart, and the radiation patterns. A new method of using a genetic algorithm (GA) in an artificial neural network his method was used to calculate the resonant frequency of a single-shorting-post microstrip antenna. The resonant frequency calculated using the genetic-algorithm-coupled artificial neural network was compared with the analytical and experimental results [6]. The proposed printed microstrip antennas and arrays are known to have limitations in terms of bandwidth and efficiency, all imposed by the very presence of the dielectric substrate. Microstrip arrays printed on a very thin film and separated from the ground-plane however, the fabrication difficulties associated with the use of foam considerably increases the fabrication cost. A new concept is presented the "printed circuit" is etched out of metal and supported in "strategic points" by (metallic or nonmetallic) posts. The main motivation for this work was to obtain large microstrip arrays, which exhibit a higher efficiency than conventional ones, and can be fabricated using inexpensive large quantity production techniques. However, this technology was also used to develop many new types of microstrip antennas [7].

2. ANTENNA DESIGN

2.1 Design Equations

Microstrip patch antenna is used at 1.9 GHz as resonance is achieved at these points and is feed with microstrip feed line and inset feed line. The design of the proposed microstrip patch antenna was modeled using the classical equations:

Step 1: Calculation of the Width (W):

$$W = \frac{c}{2f_0\sqrt{\frac{\epsilon_r+1}{2}}} \qquad (1)$$

Where, c=3 × 10^8m/s, ε_r=4.4, f= Designed Frequency

Step 2: Calculation of Effective dielectric constant(ϵ_{reff}):

$$\epsilon_{reff} = \frac{\epsilon_r+1}{2} + \frac{\epsilon_r-1}{2}\left[1 + 12\frac{h}{w}\right]^{\frac{-1}{2}} \qquad (2)$$

Where, h=1.6 mm

Step 3: Calculation of the Effective length (Leff):

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}} \qquad (3)$$

Step 4: Calculation of the length extension (ΔL):

$$\frac{\Delta L}{h} = \frac{0.412(\epsilon_{reff}+0.3)\left(\frac{w}{h}+0.264\right)}{(\epsilon_{reff}-0.258)\left(\frac{w}{h}+0.8\right)} \qquad (4)$$

Step 5: Calculation of actual length of patch (L):

$$L = L_{eff} - 2\Delta L \qquad (5)$$

Step 6: Calculation of the length and width of substrate:

$$L_g = 6h + L \qquad (6)$$

$$W_g = 6h + W \qquad (7)$$

TABLE I: Antenna Design Specification

Parameter Name	Designed Values in mm
Dielectric Constant,ε_r	4.4
Resonant Frequency,f_r	1.9 GHz
Loss Tangent	0.025
Patch Length, L	37.26
Patch Width, W	48
Substrate Height, h	1.6
Feed Width, Wf	3
Feed line length, L	6.17
Inset Depth	3
Feed Inset Length	8

2.2 Geometry of the Microstrip patch antenna

The design of the proposed antenna is shown in Figure (1). This figure shows the microstrip rectangular patch antenna and microstrip feed line is used to excite the antenna. The antenna is fabricated on FR4 substrate with a thickness of 1.6 mm, permittivity of 4.4 and tangential loss of 0.025. It was necessary to vary the dimensions of the patch to get the desired output. For the purpose of matching the antenna to 50 Ω impedence of the feed line, the length and width of the feed line was varied. For impedence matching, the width of the feed line has been kept at a value greater than its length.

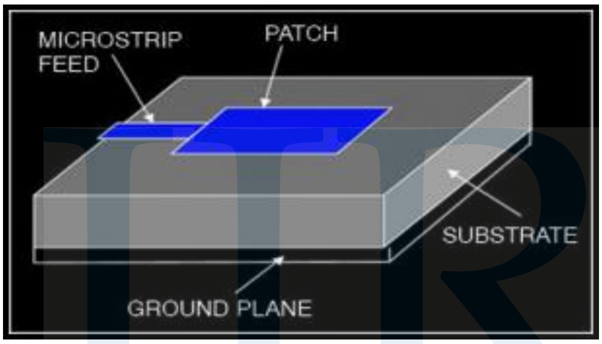

Figure 1: Physical Geometry of Microstrip Antenna.

3. SIMULATIONS AND RESULTS

From the data calculated and optimized, the proposed antenna has Patch dimensions equal to 29.7 × 36 × 1.5 mm3. The antenna dimensions are pretty compact as compared to the design in [57]. The comparison between [10] and the proposed antenna at 5.8 GHz is tabulated in Table II;

TABLE II: Comparison between [57] and the proposed antenna:

Para-meters	Reference paper [4]		Proposed Work at 1.9 GHz with Matlab		Proposed Work at 1.9 GHz with CST	
	Microstrip Feed	Inset Feed	Microstrip Feed	Inset Feed	Microstrip Feed	Inset Feed
Return Loss in dB	-2.64	-7.26	-9	-15	-12.82	-14.92
VSWR	2.7	2.0	1.9	1.8	1.50	1.43

Table II shows the results of two simulators MATLAB and CST. The CST microwave studio shows better return loss that is lower than the -10 dB and VSWR i.e. less than 2 with respect to the MATLAB and inset feed line is the best feeding technique to design microstrip patch antenna.

Results Microstrip Patch Antenna using Matlab

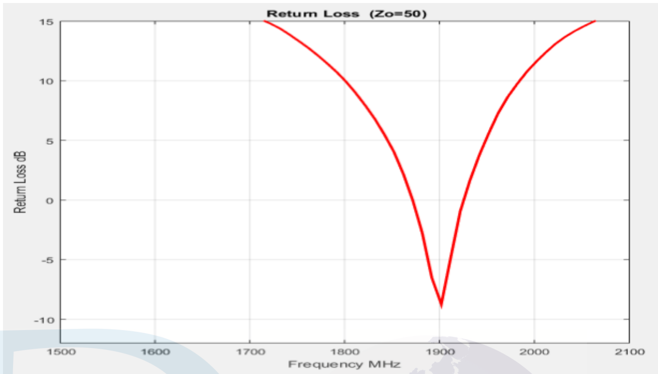

Fig-2: Simulated return loss of the proposed antenna at 1.9 GHz for microstrip feed line

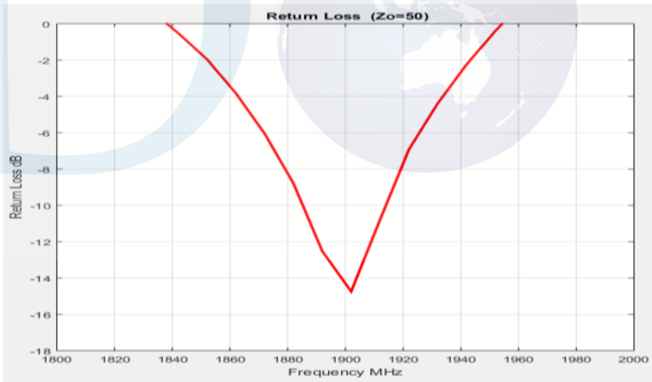

Fig-3: Simulated return loss of the proposed antenna at 1.9 GHz for inset feed line

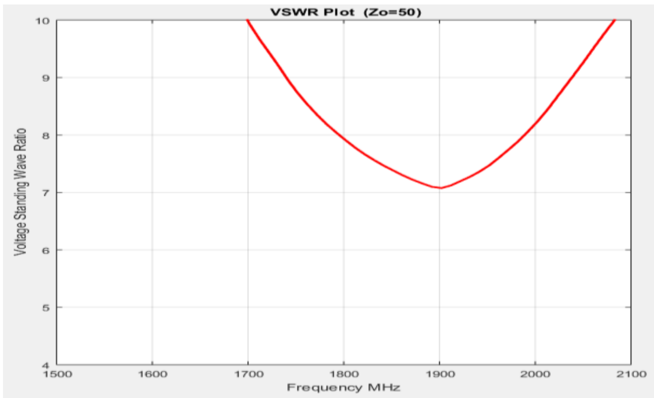

Fig-4: Simulated VSWR of the proposed antenna at 1.9 GHz for microstrip strip feed line

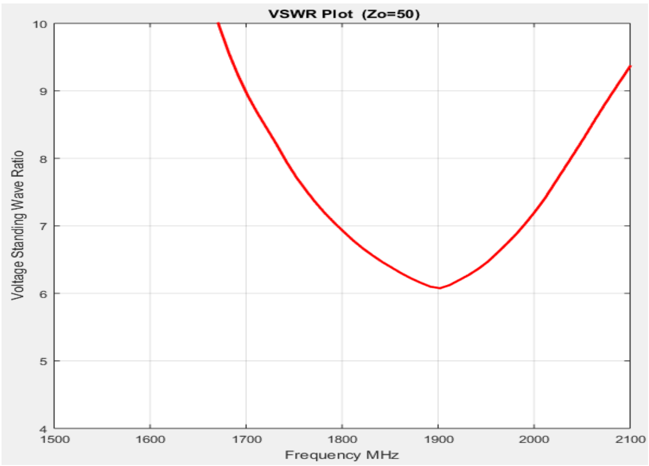

Fig-5: Simulated VSWR of the proposed antenna at 1.9 GHz for inset feed line

Results Microstrip Patch Antenna using CST

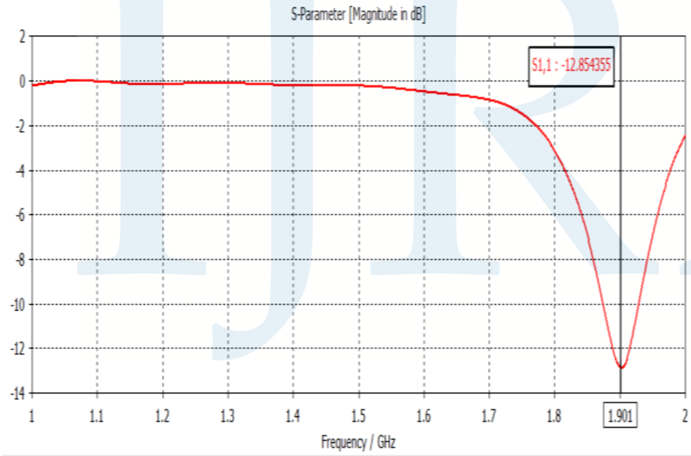

Fig-6: Simulated Return Loss of the proposed antenna at 1.9 GHz for microstrip feed line

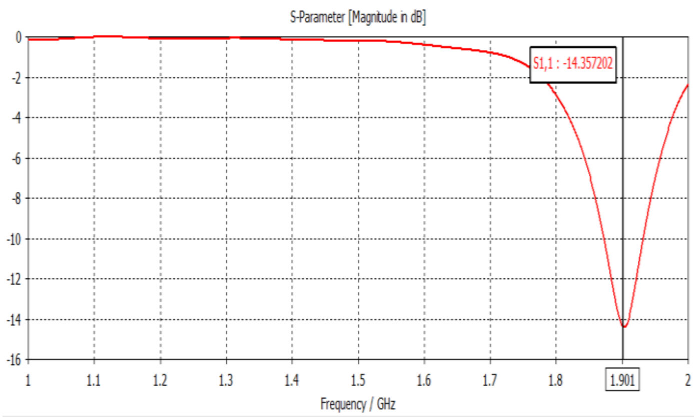

Fig-2: Simulated return loss of the proposed antenna at 1.9 GHz for inset feed line

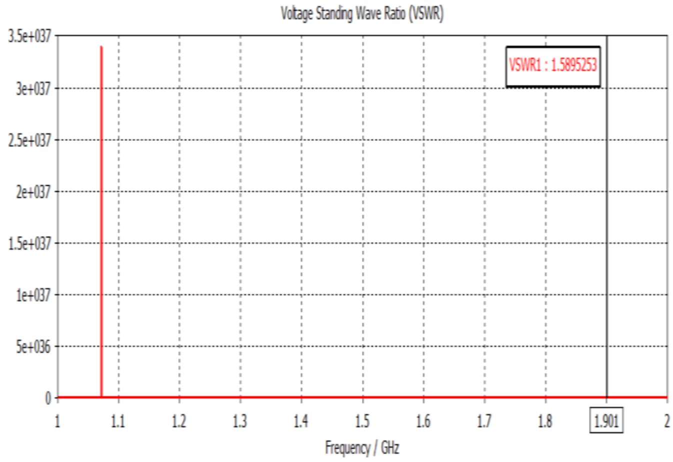

Fig-7: Simulated VSWR of the proposed antenna at 1.9 GHz for microstrip strip feed line

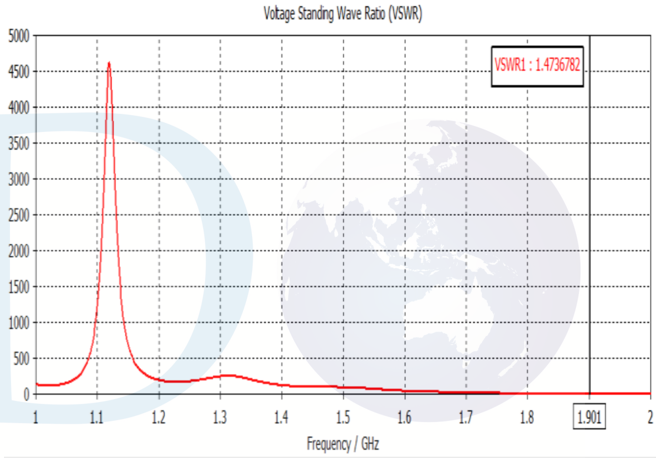

Fig-8: Simulated VSWR of the proposed antenna at 1.9 GHz for inset feed line

The simulation of the proposed antenna is done using CST software and Matlab. From Figures (2-8), it can be seen that the minimum return loss value of the proposed antenna is about -12.82 dB with VSWR of almost 1.59 with microstrip feed line at 1.9 GHz and 14.92 dB return loss and 1.43 VSWR with inset feed line at resonant frequency 1.9 GHz and in Matlab simulation same parameters and same resonant frequency. The antenna has return loss -9 dB and -15 dB and VSWR 1.9 and 1.8 with microstrip feed line and inset feed line at 1.9 GHz with Matlab.

CONCLUSION

Microstrip antenna has become a rapidly growing area of research. Their potential applications are limitless, because of their light weight, compact size and ease of manufacturing. In this paper, design of microstrip patch antenna for wireless applications is reported. The antenna has been designed and simulated using Computer Simulation Technology (CST) and Matlab software. The designing has been done such that we have a reduction in size of the antenna and good return loss and VSWR. The CST shows better return loss i.e. lower than -10 DB and VSWR i.e. less than 2 with respect to the Matlab and inset feed line is the best feeding technique to design microstrip patch antenna .

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