L- Slot Rectangular Microstrip Patch Antenna for WLAN Application

Tandel Tejal [#1], Shingala Nikunj [*2]

[#1]*Assistant Professor, Electronic and Communication Department (EC), Madhuben And Bhanubhai Patel Institute Of Engineering, For Studies And Research In Computer And Communication Technology. , New V.V. Nagar, India.*
[*2]*Assistant Professor, Electronic and Communication Department (EC), Madhuben And Bhanubhai Patel Institute Of Engineering For Studies And Research In Computer And Communication Technology. , New V.V. Nagar, India.*

***Abstract:* - This paper presents performance of a coaxially feed L- shape microstrip patch antenna for WLAN application. The proposed antenna has been designed by etching L-shaped structure on a rectangular patch. In order to achieve the desired bandwidth, the proposed antenna is designed using thick substrate FR4. CST simulation showed that the proposed design exhibits return loss of -25.39dB, VSWR < 2 and a gain of 4.77dB at 5.15GHz. The observed characteristics suggest that the proposed antenna can be employed in a modern communication system having constraints in size and weight.**

***Keywords*—Microstrip antenna; CST Microwave Studio; L slot; VSWR;return loss.**

I. INTRODUCTION

The study on microstrip patch antennas has made a great progress in the recent years.Compared with the conventional antennas, microstrip patch antennas have more advantages and better prospects. A microstrip patch design of a probe- fed antenna is presented for simultaneously Wireless Local Area Network (WLAN).The growth of wireless systems and booming demand for a variety of new wireless applications such as WLAN (Wireless Local Area Network), it is important to design broadband and high gain antennas to cover a wide frequency range. The design of an efficient wide band small size antenna, for recent wireless applications, is a major challenge. In applications like high performance aircraft, satellite, missile, mobile radio and wireless communications small size, low-cost fabrication, low profile, conformability and ease of installation and integration with feed networks are the main constraints. Also, with advancement of the technology, the requirement of an antenna to resonate at more than one frequency i.e. multi-banding is also increasing day by day.

Here microstrip patch antenna is the best choice to fulfill all the above requirements. Along with that a microstrip patch antenna offers many advantages above other conventional antennas like low fabrication cost, supports both, linear as well as circular polarization etc.Microstrip patch antenna have some disadvantages also like surface wave excitation, narrow bandwidth etc.But bandwidth of a microstrip patch antenna can be improved by various methods like cutting U-slot [4], increasing the substrate height, decreasing $\in r$ of substrate etc. Antenna array can also be used to improve the bandwidth [3].Here, to start with, a simple microstrip patch antenna with coaxial feed is designed [1-2]. In this feeding technique, the inner conductor of the coaxial connector extends from ground through the substrate and is soldered to the radiating patch, while the outer conductor extends from ground up to substrate.the patch in order to properly match with its input impedance. This feed method is easy to fabricate and has low spurious radiation. However, its major drawback is that it provides narrow bandwidth and is difficult to model since 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. But the bandwidth can be improved by various methods written above. Recently many microstrip patch antenna for different applications with coaxial-feed have been presented [7-10]. Figure 1 shows the co-axial feeding technique.

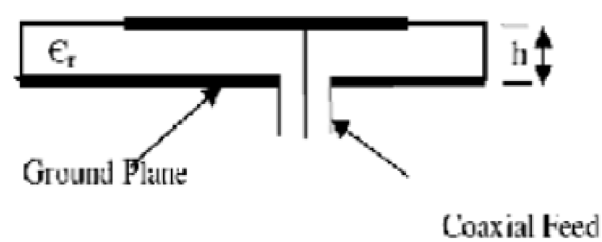


Figure.1 Co-axial feeding technique

However, these antennas have a large size with respect to the space usually provided in a mobile wireless device. Researchers have been working on slot structures in order to reduce the size of an antenna. In [6], the author used U-slots with an L-probe feed to realize dual and multiband operations. In this paper, an antenna has been proposed which is capable to operate at single frequency band. In the proposed design, an L-shape is etched in a rectangular patch to achieve singleband operation. It also provides a simpler structure and smaller size for mobile devices. The performance of the antenna is checked by simulating its response in CST Microwave studio software. Antenna structure and geometry guidelines are presented in

Section 2. Results are presented in Section 4 and a brief conclusion is given in Section 5

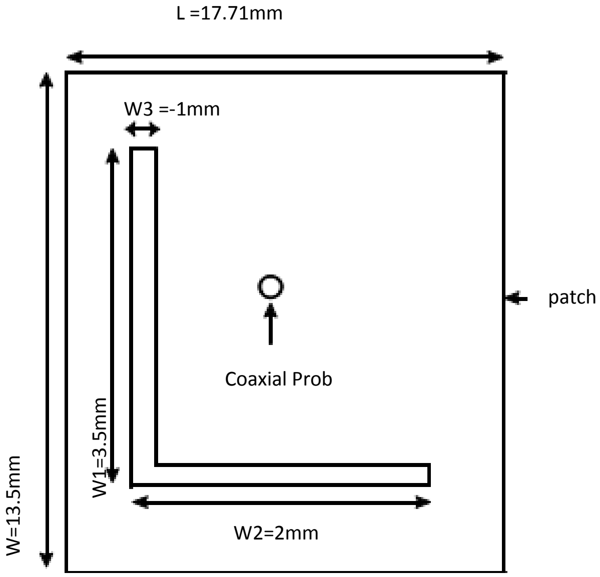


Figure. 2 Geometry of the Proposed Antenna

II. ANTENNA DESIGN

To design a rectangular microstrip patch antenna following parameters such as dielectric constant (€r), resonant frequency (fr), and height (h) are considered for calculating the length and the width of the patch[1].

Width of patch (W):

$$W = \frac{c}{2fo\sqrt{\frac{\epsilon r+1}{2}}} \text{…………………………..} \quad (1.1)$$

Effective dielectric constant of antenna (€r):

$$\in eff = \frac{\epsilon r+1}{2} + \frac{\epsilon r-1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}} \text{……} \quad (1.2)$$

Effective dielectric length of antenna:

$$Leff = \frac{c}{2fo\sqrt{\epsilon reff}} \text{………….…….……} \quad (1.3)$$

The extended length of antenna (ΔL):

$$\Delta L = 0.421h\frac{(\epsilon reff+0.3)\left(\frac{W}{h}+0.264\right)}{(\epsilon reff-0.258)\left(\frac{W}{h}+0.8\right)} \text{…………} \quad (1.4)$$

The length is:

$$L = Leff - 2\Delta L \text{……………………………………} \quad (1.5)$$

The antenna design shown in figure.2 proposed modified L-shaped rectangular microstrip patch antenna having dimension length (L) =17.71mm, width (W) =13.5mm, and thickness (t) =0.035mm. The substrate of the patch is FR-4 having dielectric constant =4.4. It is fed by a 50Ω coaxial probe at x =-4mm and y = 0mm with inner conductor diameter of 0.6mm [5].The patch is cut into slot w1 =3.5mm, w2=2mm, w3=-1mm for the L-shape.

Table I
Optimized Antenna Parameters

Antenna Parameter	Value
Dielectric constant	4.4mm
Length of patch(L)	17.71mm
Width of patch(W)	13.5mm
Thickness of patch(t)	0.035mm
Height of subtract(h)	2.4mm
Cut Width w1	3.5mm
Cut Width w2	2mm
Cut Width w3	-1mm

III. DESIGN PARAMETERS

Figure.3 shows the designed structure of the designed micro strip patch antenna with single band operation for the WLAN band on the CST Microwave Studio software. The feed point location and the dimensions for the designed antenna have been optimized.

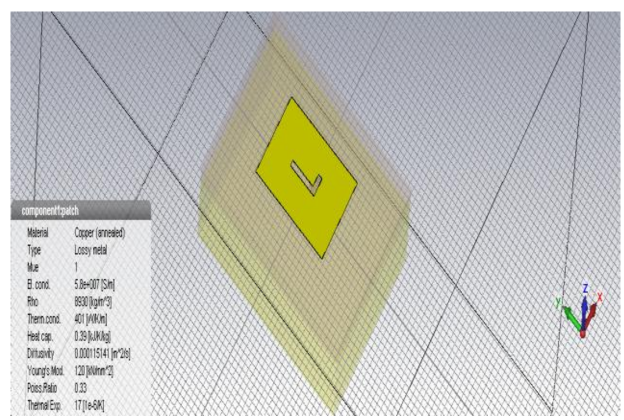


Figure.3Designed structure on CST microwave studio

The proposed antenna simulated using CST simulator is operated at frequency5.15 GHz.

IV. RESULT

A. Return Loss

The S11 parameter for the proposed antenna was calculated and the simulated return loss results are shown in Figure 4. Return loss is a convenient way to characterize the input and output of the signal sources or when the load is mismatched, not all the available power from generator is delivered to the load. This "loss" is termed as the return loss (RL). The value of return loss is -25.39 dB in this proposed antenna. The achieved return loss value is small enough and frequency is very closed enough to the specified frequency band for 5.15 GHz WLAN applications. The value of return loss is -25.39dB shows that at the frequency point i.e. below the -10 dB region there is good matching a negative value of return loss shows that this antenna had not many losses while transmitting the signals.

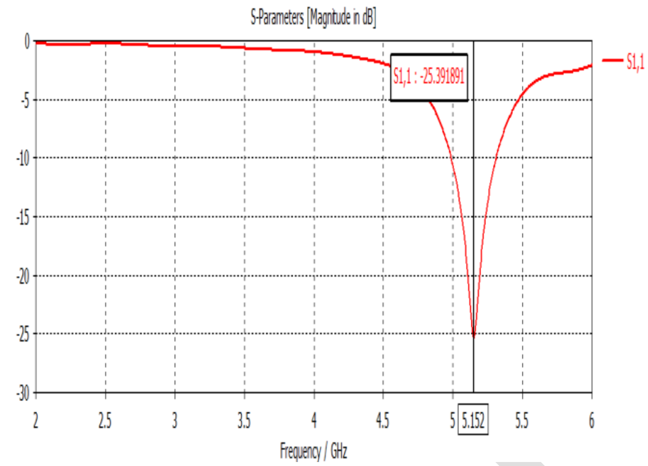


Figure .4 Stimulated return loss curve

B. Bandwidth

The bandwidth at the resonating frequency of 5.15 GHz is 313 MHz with corresponding value of the return loss as -25.39 dB as shown in Figure. 5 Several approaches have been used to enhance the bandwidth of the antenna but in this design the bandwidth of 313 MHz(4.99-5.31GHz) is achieved by using L Slot Structure.

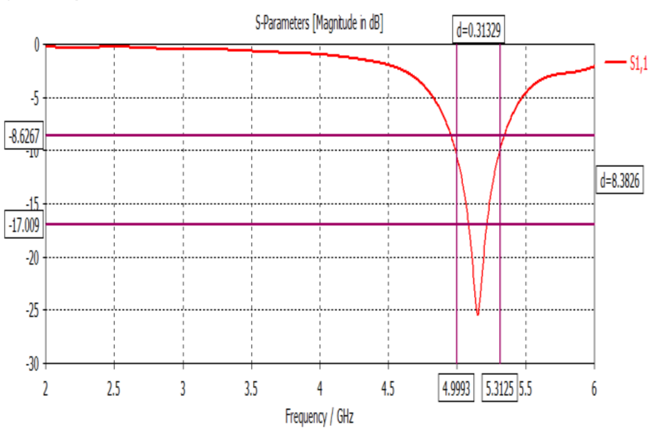
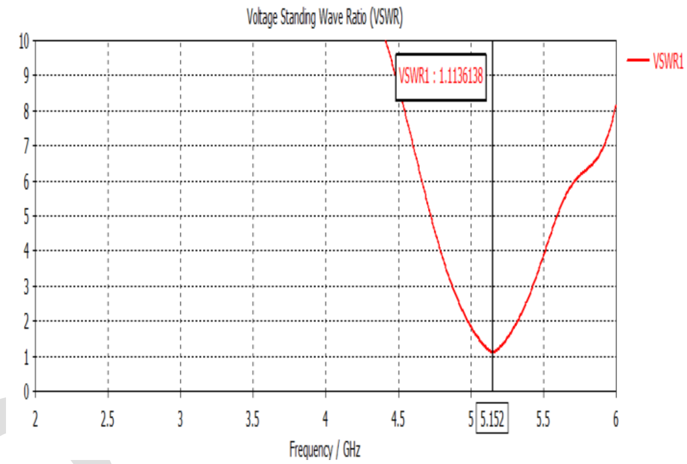


Figure. 5 Bandwidth plot

C.VSWR

VSWR (Voltage Standing Wave Ratio) is a measure of impedance mismatch. The VSWR ratio of proposed antenna is 1.113 as shown in Figure. 6, which should lie in between 1 and 2.



Fiureg.6 VSWR curves.

D. Directivity

It is desirable to maximize the radiation pattern of the antenna response in a fixed direction in order to transmit or receive power. Likewise, the directivity is dependent only on the shape of the radiation pattern. The achieved directivity of proposed antenna is 6.35dBi at resonating frequency of 5.15 GHz as shown in figure.7. It shows that proposed antenna radiates in Omni-directional nature.

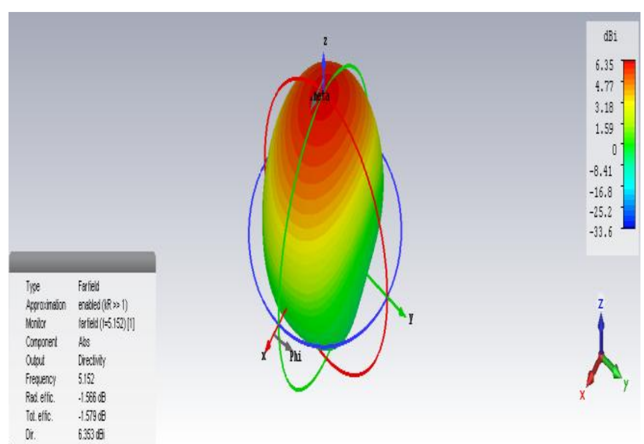


Figure.7 Directivity of designed antenna

E. Gain

Gain is a very important parameter of every antenna. Basically, the gain is the ratio of the radiated field intensity by test antenna to the radiated field intensity by the reference antenna. Antenna gain, usually expressed in dB, simply refers to the direction of maximum radiation. In this study, the gain of the proposed antenna at frequency of 5.15 GHz is 4.77dB as shown in Figure.8.

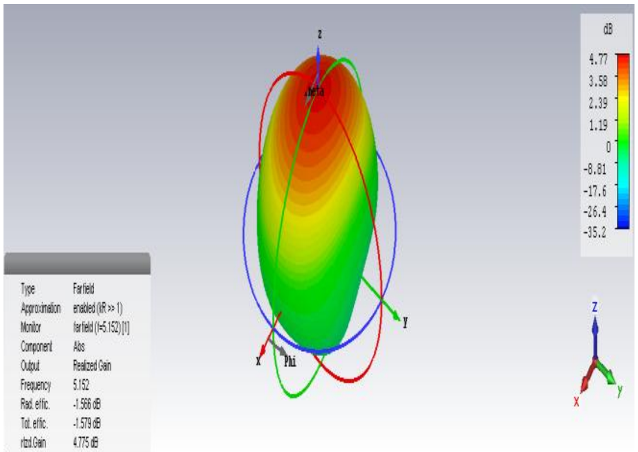


Figure.8 Gain of designed antenna

V. CONCLUSION

In this paper we investigated Micro strip Patch Antenna with L shaped etched structure for WLAN applications.The proposed antenna is designed on FR-4 substrate by etching an L-shaped simple structure in a rectangular patch. It offers a return loss of -25.39dB at 5.15 GHz and the resultant bandwidth at 5.15 GHz frequency is around 313 MHz(4.99-5.31GHz). Its VSWR is 1.113 whereas its gain is 4.77 dBand the directivity of the proposed antenna is 6.77 dBi at 5.15.

REFERENCES

[1]. C. A. Blains, Antenna Theory: Analysis and Design. Third Edition, New York: Wiley, 2005.
[2]. R. Garg, P. Bhartia, I. Bahl and A.I tipiboon, “Microstrip antenna design handbook”, Artech House, Boston – London, 2000.
[3]. A. B. Smolders, “Broadband microstrip array antennas” Antennas and Propagation Society International Symposium, 1994.
[4]. M. Mahmoud, “Improving the Bandwidth of U-slot Microstrip Antenna Using a New Technique (Trough-Slot Patch)” Region 5 IEEE Conference.
[5]. Jaswinder Kaur*Rajesh Khanna “Co-axial Fed Rectangular Microstrip Patch Antenna for 5.2 GHz WLAN Application”Universal Journal of Electrical and Electronic Engineering1(3):94-98, 2013http://www.hrpub.orgDOI: 10.13189/ujeee.2013.010306
[6]. Lee, K. F, S. L. S. Yang and A. A. KIshk, “Dual and multiband U-slot patch antennas,” IEEEAntennas Wireless Propag. Lett.,Vol. 7, 645-647, 2008.
[7]. Jun-Hai Cui, Shun-Shi Zhong, “Compact microstrip patch antenna with C-shaped slot” Microwave Conference, Asia-Pacific, 2000.
[8]. N. A. Murad, M. Esa and S. Tukachil, “Microstrip U-Shaped Dual-Band Antenna” Asia-Pacific conference on Applied Electromagnetics Proceedings, 2005.
[9]. K. Kumar and N. Gunasekaran, “A Novel Wide Band Planar n Shaped Base Station Antenna”, International Conference on Communications and Signal Processing (ICCSP), 2011.
[10]. J. Kaur, R. Khanna and M. Kartikeyan, “Design of co-axial fed broadband single layer rectangular microstrp patch antenna for wireless applications” J. Engg. Technol., Vol. 3, No. 2, pp. 71-75, 2013.