International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 03, March-2016

Bridged Double U-Slot Microstrip Patch Antenna for Wireless Communication

Rajneesh Kumar Patel[1], Mr. Nitesh Kumar[2]
[1,2] Department of Electronics & Communication Engineering,
Sagar Institute of Research, Technology and Science
Bhopal, India

Abstract: **The Micro strip Patch Antenna are widely used in Mobile and Satellite communication, Global Position System Applications, handheld devices etc. Micro strip patch antennas have advantages like light in weight, less volume, inexpensive, small size and ease of fabrication and conformity. Also, the micro strip patch antennas are also capable to provide dual and circular polarizations, dual-frequency operation, broad bandwidth range, etc. Despite the many advantages of micro strip patch antennas, they do have some considerable drawbacks. One of the main restrictions with patch antennas is their naturally narrowband performance due to its resonant nature. So for the antenna miniaturization and bandwidth improvement Bridged double U-slot micro strip patch antenna used. The first is the analysis of single element narrowband rectangular micro strip antenna which operates at the central frequency of 2.39GHz. The second aspect is the analysis and design of slot cut Dual U-shaped micro strip antenna with bridge connection also inserted inverted C shape on ground plane. The simulation process has been done through high frequency structure simulator (HFSS). The properties of antenna such as bandwidth, return loss, VSWR has been investigated.**

Keywords: Bridge double U-slot, Rectangular micro strip patch antenna, Ansoft HFSS, transmission line, Bandwidth, return loss, VSWR.

INTRODUCTION

Now days, micro strip patch antenna is more common because of its advantages, which are low fabrication cost, simple design configuration, ease Of access, mechanically robust and Compatibility with integrated microwave circuits [1].A micro strip patch antenna has a radiating patch on upper side of a dielectric substrate, having a ground plane on the bottom side, as shown in Fig 1).The patch is usually made of conducting material. The radiating patch and feed lines is usually photo etched on the dielectric substrate [2]. Micro strip patch antennas are finely suited for high frequency applications, because the wavelength and resonant frequency of antenna depends on size of the antenna structure. It has been noted that a wireless communication device provides the ability to integrate multiple frequency band operation [3]. However a multiband antenna may not sufficiently cover the required operating band. Consequently an antenna which is able to operate with multiple self-regulating frequency bands is necessary.

The design of U-shape antenna is not only for wideband application but it is also helpful for dual and triple band applications with small and wide frequency ratio. The U shape micro strip patch antenna was introduced in 1995 by Huynh and Lee [4].

The U shape patch antenna uses frequency reconfigurable technique [5]. For obtaining multiband and wideband characteristics different techniques have been used like cutting slot in the patch DGS (deflected ground structure). DGS can be realized by cutting some geometrical shape (slot) from ground plane. Shape can be plain or complex. When DGS has been applied to antenna, equivalent inductive part get increased and this causes high effect to Dielectric constant, so we get the effective dielectric constant, which then makes the bandwidth reduce in value [6].

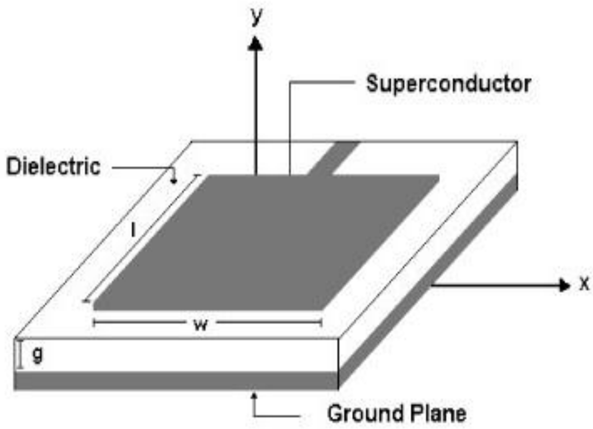

Fig 1).Schematic Diagram of Micro strip Patch Antenna

The various applications of slotted Micro strip patch antennas were discussed in [7]. Theses paper focus on the dual U-slotted patch antenna using ground slot to achieve triple band operation for WIMAX and WLAN application. The design of antenna which is proposed here have two different size U slots which are connected via a bridging element and multiple slot cut in the ground specially inverted C-shape, to obtain WIMAX frequency band and WLAN interoperability. Important feature of this antenna is that it can be used for 2.4 GHz WLAN operation. The proposed antenna is using FR4 substrate having ε_r (dielectric constant) of 4.4. The height (h) of substrate is 1.6 mm and is fed by a 50Ω micro strip transmission line. The simulation of the proposed Dual U slot antenna is performed by using Ansoft HFSS. Dual band characteristic is obtained by using two U slots in the patch and a bridge which connects two U slots. I have taken this design from

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 03, March-2016

[8] as reference antenna and modifying the Structure to get proposed antenna, an improvement is found in return loss and in bandwidth. Various attempts are made to adjust the width of bridge and different shapes of slot in ground plane specially inverted C-shape. After simulation we obtain return loss of -22db at 2.39GHz dB and -24.3 dB at 3.10GHz. Bandwidth obtained at 2.39 GHz is 60.6MHz and at 3.10GHz is 88.9MZz.

DESIGN PARAMETER OF MICROSTIP PATCH ANTENNA

1 Effective dielectric constant ($\mathcal{E}_{re}$)

It is a necessary parameter to account for the fringing effect and the wave propagation in the antenna. The value of effective dielectric constant ($\mathcal{E}_{re}$) is slightly less than the dielectric constant ($\mathcal{E}_{r}$) because the fringing fields acting around the boundary sides of the patch are not limited in the dielectric substrate but also spreads in the air (2).

$$\mathcal{E}_{reff} = \frac{\mathcal{E}_r + 1}{2} + \frac{\mathcal{E}_r - 1}{2}\left[1 + 12\frac{h}{w}\right]^{\frac{-1}{2}}$$

Where $\mathcal{E}_{reff}$ = Effective dielectric constant, $\mathcal{E}_r$ = Dielectric constant of substrate,

h = Height of dielectric substrate, W =Width of the patch.

2 Effective path length

$$\Delta L = 0.412h\frac{(\mathcal{E}_{reff} + 0.3)(\frac{w}{h} + 0.264)}{(\mathcal{E}_{reff} + 0.3)(\frac{w}{h} + 0.8)}$$

Then the effective length will be given as,

$$L_{eff} = \frac{c}{2f_0\sqrt{\mathcal{E}_{reff}}}$$

Where, f_0 stands for Operating Frequency.

Now, the Actual Length of the patch can be calculated,

$$L_{actual} = L_{eff} - \Delta L$$

3 *The width of the patch:*

$$w = \frac{c}{2\,f_0\sqrt{\frac{\mathcal{E}_r + 1}{2}}}$$

LITRATURE SURVEY

World scientists are contently trying to improve the performance of the micro strip antenna

1). Shing-Lung Steven Yang, *Member, IEEE*, Ahmed A. Kishk, *Fellow, IEEE*, and Kai-Fong Lee, *Fellow, IEEE*

Frequency Reconfigurable U-Slot Micro strip Patch Antenna

In this paper they discuss method for getting wider bandwidth and good impedance matching. By adding a U-slot on the patch, a flat input resistance and a linear input reactance is obtained. By adjusting the input reactance could vary the matching frequency. It has been established that a trimmer could control the input impedance of the patch antenna and a frequency ratio between the highest and lowest frequency of about 1.28 is achieved. The main advantage of this technique is it reduces the crosstalk between the multiple channels.

2) Mohamed A. Hassanien and Ehab K. I. Hamad

Compact Rectangular U-Shaped Slot Micro strip patch antenna for UWB applications

In this paper they discuss about increasing Impedance matching which will increase the bandwidth of antenna.

In this antenna has a rectangular patch with U-shaped slot on one side of the substrate and a finite ground plane on the other side. Advantage of using this technique as we reduce size of ground plane return loss will increased.

3) Poorwa Bhagat[1], Prof. Prashant jain[2]

Triple Band Micro strip Patch Antenna with Dual U Slot for WLAN/WIMAX Applications

In this paper they discuss about increasing bandwidth and return loss. Here they use two u slot shape on substrate and single u shape cut on left side of the ground plane. The advantage of this technique is that we get high value of return loss.

MOTIVATION

The areas of further improvement and development include the geometrical shape variations of patch and make a multiple cut slit on ground plane being used. Also, it is observed that if the number of slot on the ground plane are increased [] then it results in generation of more radiations, thus increasing the power of the radiated signal.

Also the position of the bridge is varied and the size of bridge is also change. This all will be applied in my proposed work.

Dual U shape slot antenna

The dual u shape Slot Antenna is taken as the Reference antenna in this paper, based on which the comparative studies are carried out, to bring an enhanced performance from it. The Reference antenna is shown in Fig 2).

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 03, March-2016

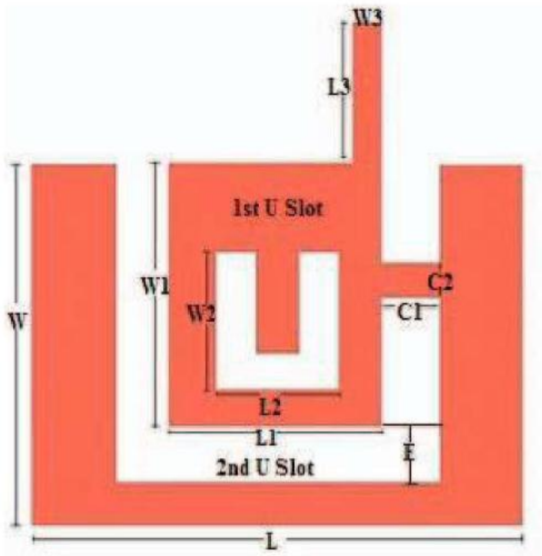

Fig.(2). Reference Antenna

The dual u shape slot antenna show above which has substrate of 40mm*47mm*1.6mm and which is operated at 2.48 GHz operating frequency. The dimension of table is shown below table 1.

TABLE 1

Antenna Dimensions		
Description	*W (mm)*	*L (mm)*
Main Patch (W x L)	W = 40	L = 47
First U-slot (W_2 x L_2)	W_2 = 15	L_2 = 15
Second U-slot (W_1 x L_1)	W_1 = 30	L_1 = 25
Feed-line (W_3 x L_3)	W_3 = 2	L_3 = 20
Bridge (C_1 x C_2)	C_1 = 5	C_2 = 3

The antenna substrate is FR-4 and the thickness of substrate is 1.6mm which has 4.8 dielectric constant and .008 loss tangent.

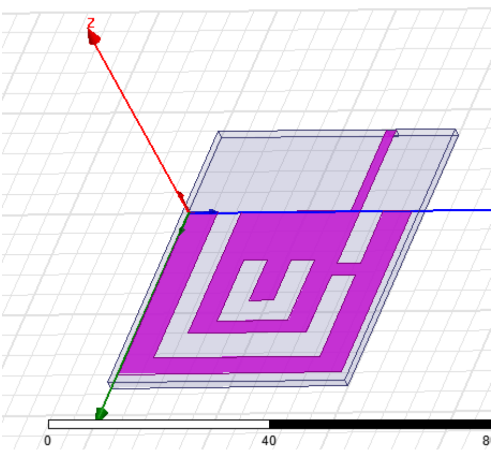

Fig.(3). Reference Antenna as designed in HFSS Software

The Reference Antenna is designed in HFSS Software, at 2.48 GHz centre frequency, as shown in Fig 3). The antenna is analyzed and the Return loss graph is plotted against the frequency range, as shown below Fig. The Return loss value obtained is -21.22 dB, and the bandwidth obtained is 59.2MHz. at 2.39GHz frequency and at 3.23GHz return loss is -23dB which has 81.3MHz bandwidth, as shown in Fig 4).

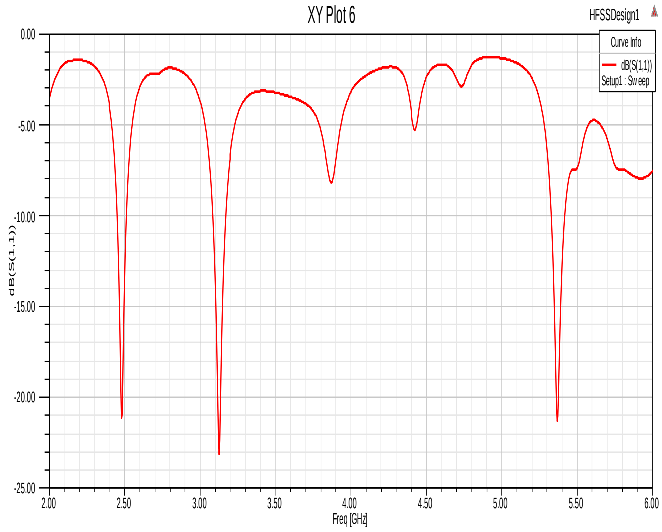

Fig.(4). Return loss plot of Reference Antenna

The Antenna is also analyzed in terms of the VSWR, where VSWR stands for Voltage Standing Wave Ratio, which is used to study the Reflection Coefficient of the Antenna. It describes the power reflected by the antenna during its operation.

$$VSWR = \frac{1+\Gamma}{1-\Gamma}$$

Here, Γ stands for Reflection Coefficient. It is determined from the Voltage being measured along the transmission line leading towards the antenna. VSWR is the ratio of peak amplitude of a standing wave to the minimum amplitude of a standing wave. The VSWR plot of the Reference Antenna is shown in Fig 5).

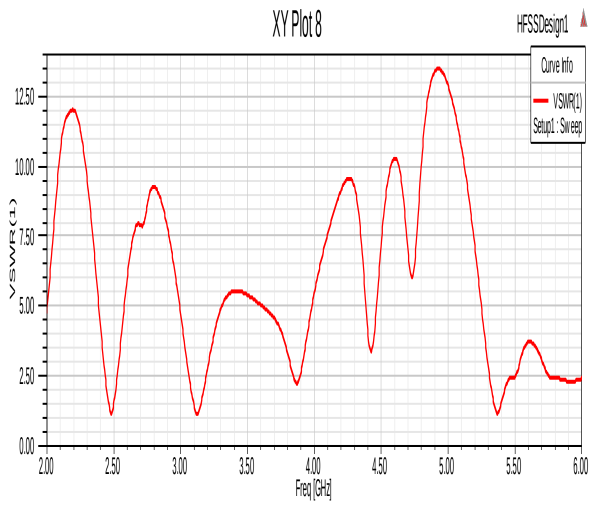

Fig. (5) VSWR plot of Reference Antenna

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 03, March-2016

PROPOSED WORK

In this paper following modifications are proposed

- Dimensions of bridge and the position are varied.
- Transmission feed line point location is varied.
- Addition of multiple slot cuts on the ground plane.

The simulation of the antenna is done in ANSOFT HFSS Software, with the centre frequency of the antenna taken as 2.48 GHz. The design parameters are taken same as the design parameters of the Reference Antenna, i.e., dimensions of the substrate is 40mm * 47 mm * 1.6mm, and that of the dimensions of the patch is 40mm * 47 mm.

The substrate material is same as that of the reference antenna, i.e., FR-4. Now, the antenna is being applied to three types of variations, which are stated below.

A) BRIDGE POSITION AND THICKNESS VARIATION

Here, the thickness of the Bridge is varied in terms of X-axis, from X = 3mm to X = 1mm, and the position of the Bridge is changed from coordinate (13, 36, 0) to (12, 6, 0), which can be seen as a shift from the Right side of the Antenna to the Left side of the Antenna.

B) TRANSMISSION LINE POSITION CHANGE

Here, the Transmission Feed Line position is varied from the Reference position (-20, 36, 0) to the new position (-20, 13, 0). This change is also evident as a shift from the Right side of the Antenna to the Left side of the Antenna.

C) CUTTING SLIT ON GROUND PLANE

Here, multiple slits are cut on the ground plane, which shows a shape of inverted C-shape on the ground plane.

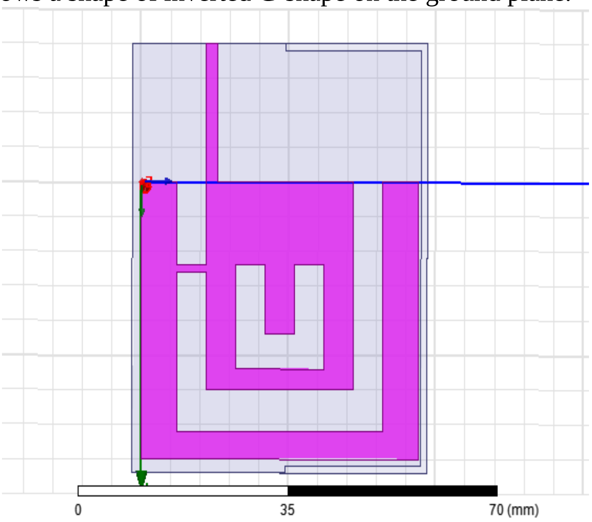

Fig (6). Optimized Antenna

The above variations are applied on the reference antenna and so obtained antenna is shown above in Fig 6).

SIMULATION RESULTS

The changes brought to the reference antenna, have resulted in better performance. The respective results are shown below.

Bandwidth and Return loss:

To analyze the antenna in terms of Bandwidth and the Return loss parameters, the Rectangular Plot is plotted, with the Return loss against the frequency range. In the below graph, the Bandwidth value of 149.5 MHz obtained and we get return loss of first peak as -22db and second peak as -31db, and it is found that the performance of this Optimized Antenna is far better that the performance of the Reference Antenna, where its Bandwidth value is 139.5 MHz and Return loss of -21 dB as first peak and -23 dB as second peak, as shown in Fig 7). The optimized antenna is getting return loss lesser than -10db. So the return loss of optimized antenna is good.

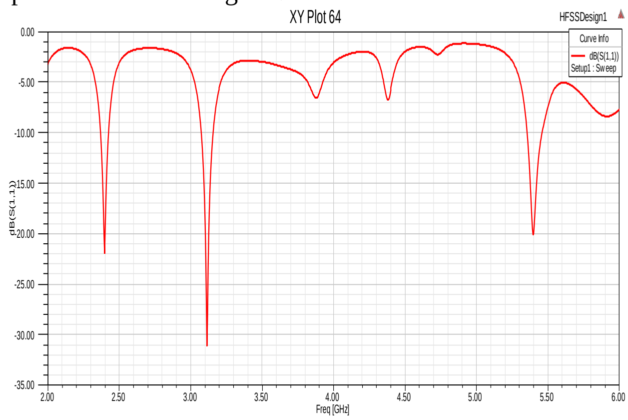

Fig.(7) Return loss plot of Optimized Antenna

VSWR RATIO

The Antenna is also analyzed in terms of VSWR, and the so obtained Plot is used to extract the value of the Antenna's VSWR, as shown in Fig (8), and is compared with the VSWR value of the Reference Antenna.

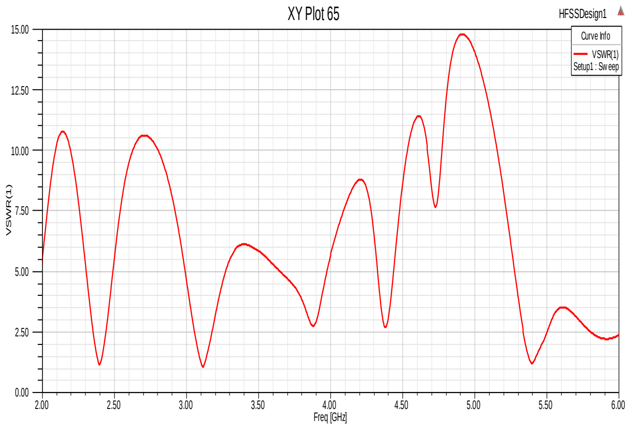

Fig.(8) VSWR of Optimized Antenna

From the figure, it is evident that the VSWR value of the Optimized Antenna is 1.1, which is a good value when compared with the VSWR value of the Reference Antenna, which is about 1.21. Also it is known that Antenna having VSWR in the range of 1-2 is considered good in terms of Performance.

These all results are with respect to the variations brought on the Bridge position, size of the Bridge, position of the Transmission line, and introduction of multiple slits on the ground plane. At comparison of the results, is found that the Performance of the Optimized Antenna is better compared to the performance of the Reference Antenna.

CONCLUSION

The Micro strip Patch antenna faces huge limitations which are low bandwidth range operation and low gain. The Micro strip Double U-shape Patch antenna is taken as the Reference antenna. The position of the Bridge and the transmission line on the Patch is varied, and the size of the Bridge is also changed Apart from this, multiple slits are introduced on the ground plane, which takes up the shape of the inverted C shape. The Optimised antenna is simulated on HFSS simulator. The optimised antenna demonstrates better performance than reference antenna.

TABLE 2

PPARAMETER	REFERENCE ANTENNA	OPTIMIZED A ANTENNA
B BANDWIDTH	139.5 MHz	149.5 MHz
R RETURN LOSS	R1 = -21 Db R2 = -23 dB	R1 = -22 db, R R2 = -31 dB
V VSWR	1. 1.21	1.1.10

The results are summarized in the above table.

On the basis of the above results, it can be said that the changes made to the position of the Bridge, size of the Bridge, variation in the position of the Transmission Feed line, and introduction of multiple slits as in the shape of inverted C-shape on the ground plane have effectively improved the performance of the reference antenna, like Bandwidth, Return loss and VSWR. The values obtained are better than the corresponding values of the reference antenna.

REFERENCE

[1] C. A. Bal anis," antenna theory analysis and design," John Wiley and sons, Inc Newyork 1997.

[2] R. Jothi Chitra and V. Nagarajan, "Design of Dual U slot Micro strip patch Antenna Array forWiMAX"978-1-4673-2636-0/12/$31.00©2012IEEE.

[3] M. Naser -Moghadasi, R .A Sadeghzadeh,M. Fakheri, T. Aribi, T. Sedghi, and B S Virdee, Member, IEEE," Miniature Hook-shaped multiband Antenna for Mobile Application", *IEEE antenna and wirelesspropogation letters*, vol. 11,2012.

[4] Sana Arif, Syeda Areeba Nasir, Muhammad Mustaqim and Bilal A. Khawaja, "Dual U-Slot Triple Band Micro strip Patch Antenna for Next Generation Wireless Network,"978-1-4799-3457-7/$31.00©2013 IEEE

[5] Vinoy J.K. and Vedaprabhu" Double U-slot patch antenna with Dual wideband characteristic" Microwave laboratory, ECE dept., *Indian institute of science, Bangalore, India.*

[6] Shine Lung Steven yang, Ahmed A. kishk, Kai-Fong Lee, "Frequency Reconfigurable u-slot micro strip patch antenna, *IEEE antennas and Wireless propagation Lett.* Vol.7,2008.

[7] K. F. Lee, K. M. Suk, T. Mang and S. Yand, "Dual and triple band stacked patch antennas with U-slots," *Proceedings of Fourth European Conference on Antennas and Propagation (EuCAP)*, Barcelona, Spain, 2010, pp. 1-5.

[8] S. Weigand, G. H. Huff, K. H. Pan, J. T. Bernhard, "Analysis and design of broad-band single layer rectangular U-slot micro strip patch antennas," *IEEE Transactions on Antennas and Propagation*, March 2003.

[9] Sanad. M,"Double C-Patch Antennas having Different Aperture Shapes," *IEEE Proceedings on Antennas and Propagation*, Vol. 4, pp. 2116- 2119, June 1995.

[10] Huynh, T. and K. F. Lee, "Single-layer single-patch wideband micro strip antenna." *Electron. Lett*, Vol. 31, No. 16, pp. 1310-1312, 1995.