Bandwidth Enhancement of Microstrip Patch Antenna Using Bridged V-Shape For Next Communication Generation

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Abstract: A bridged 'V'-shaped micro-strip patch antenna has been planned and fabricated for double-band communication application. In this paper a bridge V-shape U-slot micro strip patch antenna for wireless communication application such WLAN is presented. The proposed antenna is designed using FR-4 substrate which has dielectric constant of 4.4 with micro strip transmission line feeding method. The designed antenna is worked on the center frequency 2.68GHz. The achieved bandwidths from the designed antenna are 220.3MHz respectively. The proposed antenna is analyzed using Ansoft HFSS 15 and simulated result are presented in terms of return loss, VSWR, and bandwidth. The performance of this antenna has been analyzed by modification of bridge width. The return loss characteristic for bands is -30dB at 2.68GHz and -27dB at 3.68GHz respectively which suggest good antenna performance.

Keywords: Bridged v-slot, Bandwidth, transmission feed line, return loss, VSWR.

I. INTRODUCTION

Micro strip patch antennas have worried much attention from researchers because of their good-looking features such as light weight [1]. One of the major operational drawbacks of micro strip antennas is their bandwidth limitation and provides very low gain. This is one of the problems that researchers tried to remove [2]. Finally authors have dedicated their more time to creating new designs and variation to the optimized antenna. Though, dual-band or multi-band antennas provide a choice in which it is work on two different frequency bands as an alternative of a large-bandwidth antenna covering the two frequencies of attention [3]. Dual-band operation can be achieved by cutting slots on the structure, using multiple patches [4]. Use of dual feed technique and planar inverted structures was also reported for dual-band operation [5]. Working on the 'V'-shaped Antenna has been reported for obtaining wideband operation using a Marchand balun. Another technique proposed by Borah et al in which 'V'-shaped micro strip patch antenna design using an external back reflector for a single-band action [6]. In this paper a 'V'-shaped bridged micro strip antenna has been modified and designed to obtain a dual-band frequency operation [7]. The alteration is done by placing a bridge on left hand side near the end of U shape. Here V-shape is designed inside the U- shape which is connected by a thick bridge [8]. Due to this the bandwidth of the antenna is increased highly. The substrate material mainly used for design technique is FR-4.The software tool which is used is HFSS because it is provided a high appearance [9].

II. *Rectangular Micro strip patch antenna*

Micro strip patch antennas have attractiveness properties for use in wireless applications because of their low-profile arrangement and simple design. Therefore this type of antenna is well-matched in wireless devices such as cellular mobile, pagers, Wi-Fi, radios etc. Normally used micro strip antenna is a rectangular patch as shown in Fig. (1) The rectangular patch antenna is concerned with one and half wavelength of rectangular micro strip transmission line. When we used air as the antenna substrate, then the length of the rectangular micro strip antenna is around one and half of a free space wavelength [1]. As antenna is loaded with a dielectric i.e. its substrate, the length of the antenna will be decreases and the relative dielectric constant of the substrate will be increased.

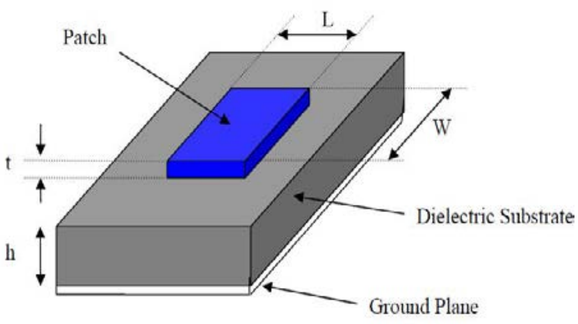

Fig.(1) Micro strip patch antenna

Feeding Technique

There are various types of methods that can be used for feeding in any type of micro strip patch antennas [1]. At this point, we have discussed four most popular and general methods which is in normally used for feeding i.e.

1) Micro strip line

2) Coaxial probe

3) Aperture coupling

4) Proximity coupling

In this paper we used micro strip feeding line technique. In this feeding method, a single strip is directly linked to the edges of the Micro strip patch as shown in Figure 2. The width of strip is kept small as compared to the patch size and this type of feeding has advantage. Here feeding is fixed on the same substrate.

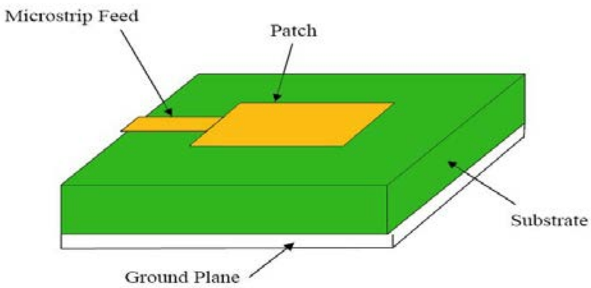

Fig.(2) Micro strip feed line

Methods of Analysis

There are various types of method for analyzed a micro strip antennas. The methods of antenna analysis are mention below:

1) Transmission line model

2) Cavity model

3) Full wave model

The transmission-line analysis model is the simplest model all of the above mention, it provides us good physical approaching, but it has less accurate and it is more difficult to design. As compared to the transmission-line model, the cavity model is more effective and exact but if discuss other hand it is more complex. Though, it also provides good physical imminent and is quite difficult then model coupling, even as it is used successfully. In general when applied full-wave models it is more accurate, more flexible, and can treated as single elements, finite array as well as infinite array. Similarly it is the most complex model and typically provides less physical imminent. In this paper, we started with the transmission-line model because it is easier to show [1].

A micro strip line which is shown in Figure 3, and the characteristic of the electric field lines are shown in Figure 4. It is non-homogeneous line between two dielectrics; it can be expected that the substrate and the air.

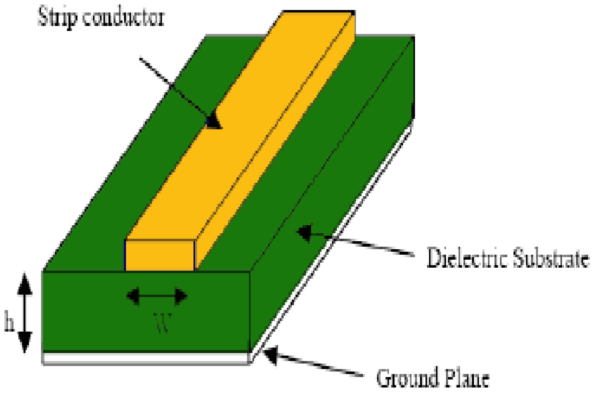

Fig.(3) Micro strip line

As we observed that maximum electric field lines exist in the substrate and some lines exist in air. In such case fringing of the micro-strip line seen wider as compared to it physical size. So, large number of waves travel in the air and some waves in the substrate, an extra element is introducing here i.e. effective dielectric constant (Ɛeff) for calculating of fringing and transmission of the wave.

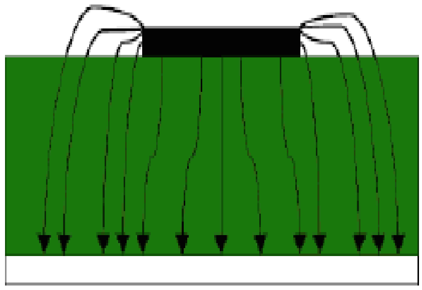

Fig.(4) Electric field line

Design parameter of antenna

Here, the Design Parameters which are used to define the Antenna [1] are shown below:

1).Effective dielectric constant (ε_{re})

It is the most effective and necessary parameter to explanation the fringing effect and transmission of the wave in the antenna. The value of dielectric constant (ε_r) should be greater than the effective dielectric constant (ε_{re}) because the fringing of the fields is around the edge sides of the patch fringing is not restricted in the dielectric substrate but it is also spreads in the air (2).

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}[1 + 12\frac{h}{w}]^{\frac{-1}{2}}$$

Where,

Ɛreff = Effective dielectric constant

ε_r = Dielectric constant of substrate

h = Height of dielectric substrate

W =Width of the patch.

2). Effective path length

$$\Delta L = 0.412h\frac{(\varepsilon_{reff} + 0.3)(\frac{W}{h} + 0.264)}{(\varepsilon_{reff} + 0.3)(\frac{W}{h} + 0.8)}$$

Subsequently, the effective length of the antenna is given as below mention,

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}}$$

Here, f_0 is stand for Operating Frequency of antenna.

Now, the Actual Length of the antenna patch can be designed as mention below,

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

3). *The width of the patch:*

$$w = \frac{c}{2\, f_0\sqrt{\frac{\varepsilon_r + 1}{2}}}$$

III. MOTIVATION

The areas of additional improvement and development include the geometrical shape variations of patch and used V-shape with varies there width and the position of the shape. Also, it is amylase that if we change the dimension of the shape on the patch then we see in results generation of more radiations, thus increasing the power of the radiated signal.

Also the position of the bridge is change and the size of bridge is also varied. This all will be applied in my estimated work. Additional variation like bridge width gives more suitable result.

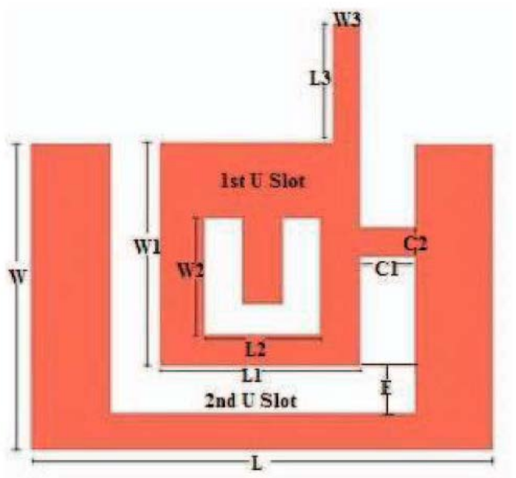

Fig.(5). Reference Antenna

Bridge double U- shaped slot antenna

The Bridge double U-shape Slot Antenna is consider as the Reference antenna in this paper, based on which the comparative studies are permitted out, to bring an enhanced performance from it. The Reference antenna is shown in Fig 2).

Here, the dual u-shape slot antenna presented in base paper which consist the size of substrate is 40mm*47mm*1.6mm and its operating frequency is 2.48 GHz. The dimensions of table are shown below table 1.

Antenna dimensions

Description	W(mm)	L(mm)
Main Patch(W x L)	W=40	L=47
First U-slot (W_2xL_2)	W_2=15	L_2=15
Second U-slot (W_1xL_1)	W_1=30	L_1=25
Feed-line (W_3xL_3)	W_3=2	L_3=20
Bridge (C_1xC_2)	C_1=5	C_2=3

In this antenna they used FR-4 substrate and the thickness of substrate is 1.6mm which has 4.4 dielectric constant and .008 loss tangent.

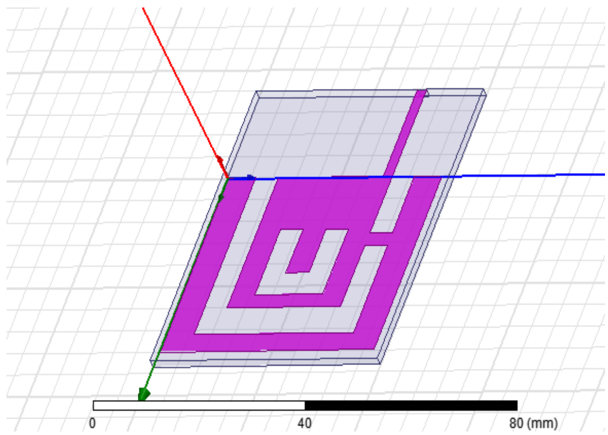

Fig. (6). Reference Antenna as designed in HFSS Software

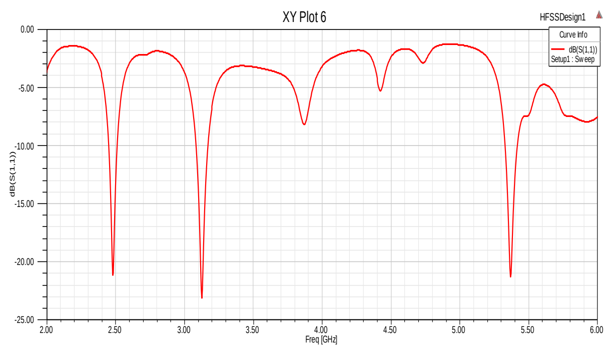

Fig. (7). Return loss plot of Reference Antenna

The design of Reference Antenna is completed on HFSS Software, which is operated 2.48GHz centre frequency, as shown in Fig.(6). The antenna is analyzed whose Return loss plot is plotted against the frequency range, as shown below Fig.(7). 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 7).

Here, also analyzed the value of VSWR for design of an antenna, where VSWR means Voltage Standing Wave Ratio, this is the factor

Which, is used for the study of the Reflection Coefficient of an Antenna? It explains the power reflected by the antenna during its functional operation.

$$VSWR = {}^{1+\Gamma}\!/_{1-\Gamma}$$

Here, Γ stands Reflection Coefficient of the antenna. In other word VSWR is also the ratio of maximum amplitude to the minimum amplitude of a standing wave. The VSWR plot of the Reference Antenna which is used is shown below in Fig (5).

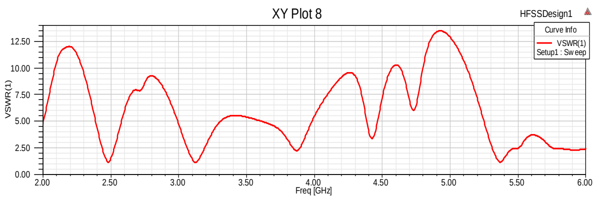

Fig.(8). VSWR plot of Reference Antenna

IV. 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 this antenna changes the internal U-shape into V-shape.

The simulation process of the antenna has been done in ANSOFT HFSS Software, with the centre frequency of the antenna taken as 2.68 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.

(1).BRIDGE POSITION AND THICKNESS VARIATION

Here, the thickness of the Bridge is varied in terms of X-axis, from X = 3mm to X = .5mm, and the position of the Bridge is changed from coordinate (13, 36, 0) to (13, 6, 0), which can be seen as a shift from the Right side of the Antenna to the Left side of the Antenna.

TABLE OF COMPRASION BRIDGE WIDTH VARIATION

Bridge width c2	Deep m1(db)	Deep m2 (db)
4mm	-21	-24
3mm	-27	-37
2.5mm	-20	-26
2mm	-20	-22
1.5mm	-21	-27
1mm	-22	-26
.5	-30	-27

(2).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.

(3).CHANGE THE INTERNAL U-SHAPE TAKE AS V-SHAPE

Here, analysed that when the shape of internal U-shape is replaced by V-shape then they also affected the result of the antenna. Here position of the V- shape are try to put same position as U-shape was previously fixed.
Although we try to change position of V-shape in various places with different dimension but they are not provided appropriate result as required. So finally the position of the V-shape is put on the same position of the internal U-shape.

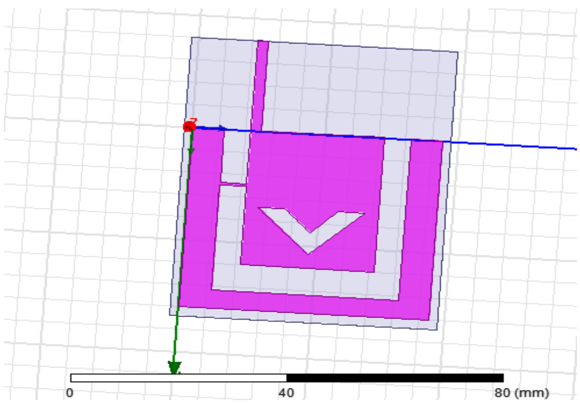

Fig.(9) Optimized Antenna

V. 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 220.3MHz obtained and we get return loss of first peak as -29db and second peak as -27db, 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.

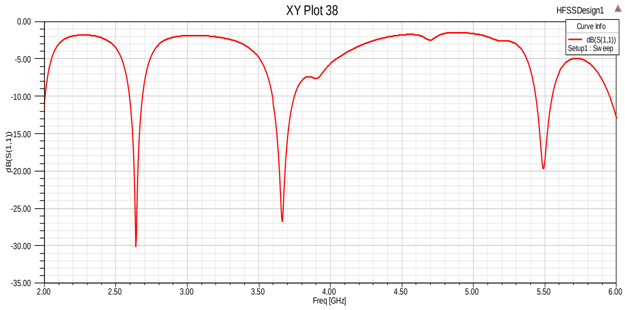

Fig.(10) Return loss of antenna

VSWR RATIO

The Antenna is also analyzed in terms of VSWR, and the so obtained Plot is used to take out the value of the Antenna's VSWR, as shown in Fig (11), and is compared with the VSWR value of the Reference Antenna

From the figure, it is clear that the VSWR value of the Optimized Antenna is 1.14, 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 basically the Antenna VSWR value in the range of 1-2 is measured well in terms of Performance.

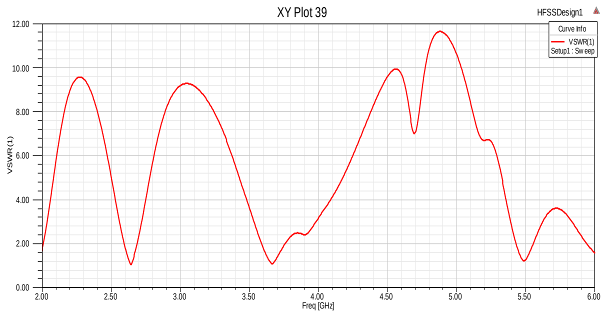

Fig.(11) VSWR

These all results are with esteem to the variations brought on the Bridge position, size of the Bridge, position of the Transmission line, and introduction of shape change of internal U-shape. At judgment of the results, it is found that the Performance of the Optimized Antenna is enhanced compared to the performance of the Reference Antenna

VI. CONCLUSION

The Micro strip Patch antenna faces enormous limitations which has 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 separately from this, we change the shape of the internal U-shape into V-shape. The Optimized antenna is simulated on HFSS simulator. Where we see the optimized antenna demonstrates better results and performance as compare to the reference antenna.

PARAMETER	REFERENCE ANTENNA	OPTIMIZED ANTENNA
BANDWIDTH	139.5MHz	220.3MHz
RETURN LOSS	R1=-21db, R2=-23db	R1=-29db, R2=-27db
VSWR	1.21	1.14

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 internal shape change of antenna effectively improved or increase the performance of the reference antenna, like Bandwidth, Return loss and VSWR. The values obtained are better than the equivalent values of the reference antenna.

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