Design and Optimization of V-Shaped Microstrip Patch Antenna with enhanced Bandwidth in Broadband Applications

Pritam Singha Roy, Moumita Guha, Samik Chakraborty

Abstract: ***This paper a compact V- shaped slotted microstrip antenna is designed and utilized in the various communication systems. The most common important parameters are improved .The results of the measured and simulated results for V-slotted microstrip patch antenna has been analyzed . The V slotted patch antenna has been designed to tested in laboratory .The measured and simulated results are exhibits good agreement. The proposed antenna achieved 174MHz of bandwidth at resonance frequency of 2.4 GHz with VSWR ≤ 2. The antenna constructed at centre frequency of 2.44 GHz. The antenna has been designed and simulated using Ansoft HFSS software tools. Then, the antenna parameters are varied in a specific intervals and analysis the designed Patch antenna. Then antenna bandwidth can be enhanced by increasing the substrate thickness. The measured resonant frequency is found 2.592 GHz. The measured value of the bandwidth of the antenna is 75 MHz. Then, the variation of parameters and its performance are investigated.***

Index Terms**:** ***V- shape, Microstrip Antenna, Probe Feed, Bandwidth. Ansoft HFSS***

I. INTRODUCTION

The wireless communications systems are the most important part in our daily life. During recent years, there have been an enormous growth in the area of wireless communications with the introduction of new applications like; tagging, wireless computer links, wireless microphones, remote control, radome etc[l]. Present day demand is for a wireless device of more practicable and easily transportable. Now need compact communication devices of light weight, small size, having low energy consumption and have an appealing design. The evolving technology has able to satisfy the need of electronics to reduce the size of wireless devices with the incorporation of small chips which consume less current and are more efficient with a large functionality but at the same time placing a demand for optimal antennas for these devices[l]. The commercial applications in communication, sensing, position location, messaging etc. continue to challenge antenna designer. Advances in technology associated with signal processing, R.F. components and batteries have stimulate more innovative applications in wireless ~at has in turn stimulate for extensive research to find new solutions to the problems in the antenna engineering. Thus, it is safe to say

that the 21st centuries will certainly be one of active research development and production of antenna for various agencies. As the microstrip patch antennas become more complex, the more sophisticated numerical methods such as full wave modeling techniques has become inevitable[1],[2]. However, applications of full wave modeling are more computationally expensive and can easily exceed the capabilities of most personal computers. Therefore, the search for techniques that can reduce the computational complexity of modeling of an antenna is currently a very important research area. The study of microwave antennas has advanced on such extensive lines during the last fifty years that it is now established as a separate subject within the broad field of microwave techniques. This is largely due to the very considerable stimulus to microwave antenna development provided by today's satellite and wireless communication requirements by the fact that centimeter wave oscillators became available and thus enabled high gain, quasi-optical antennas, having reasonably small dimensions, to be constructed.

II. ANTENNA DESIGN AND FEEDING METHOD

In this section, the geometry of the V-shaped microstrip patch antenna is designed and its methodology is also described at 2.44 GHz band i.e. Industrial, Scientific and Research band is used because of its an unlicensed band which is used for wireless application applications like WLAN, Bluetooth, Wi-Fi, etc [3],[4]. The geometry of the V-shaped patch antenna is shown in Fig. 1. In this design of V-shaped conductive metal patch placed on top of a dielectric substrate on the ground. The patch antenna is like a V shape with symmetrical and equal arms. The all-important measuring parts of the patch antenna are given as: -

w: width of the patch.
l_1: inner length of the patch.
l_2: outer length of the patch.
ψ: angle between the patch arms or sides.

The substrate thickness of the dielectric substrate = h and ε_r is its dielectric constant.

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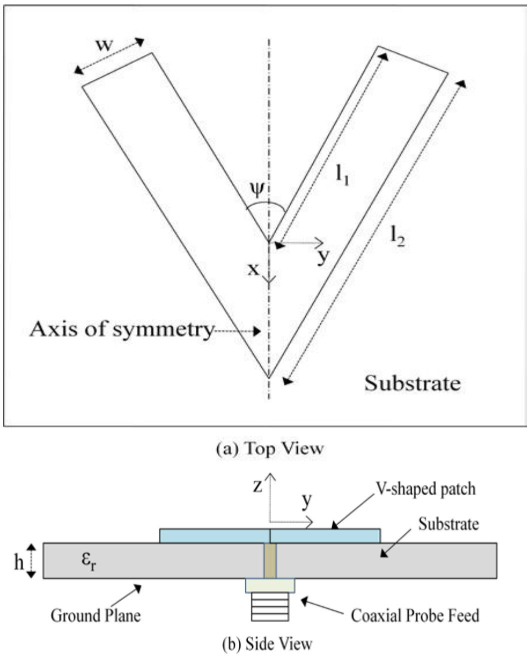

Fig.1 V-Shaped Patch Antenna Geometry

Substrate Selection

The most important to select the proper thickness *h* of the dielectric substrate and loss tangent. For better antenna operation, a thick height of the substrate with a small value dielectric constant is acceptable to get the better efficiency and high range of larger bandwidth. But it provides a large antenna size. For the design of the compact Microstrip patch antenna, always used large dielectric constant value which are less efficient and it shows narrower band width. Hence an optimization is required to design an excellent compact wide band antenna performance. The most common range of dielectric substrate used to design microstrip patch antenna is of 2.2 = ε_r = 12 [5]. For better efficiency and large bandwidth thick substrates with lower dielectric constant is desired. But design cost may be increased due to the large size of the antenna. Antenna efficiency is reduces due to increase the loss tangent value. Another factor of selection of the substrate is its availability in the market. Considering all the above factors, *Glass_epoxy* is chosen as the substrate material [6]. The dielectric constant, er of the material is 4.78 and the loss tangent value is 0.02 and the thickness of the material is selected as h= 1.5 mm.

Angle between sides of patch

Initially, to design the antenna selected the inclined angle is ψ=60° and this value can be varied with the intervals of +15° and -15°.

Feeding Technique

Here, to design the antenna used the coaxial feed method is used to radiated the power. There are many techniques available to feed the antenna. Out of them the coaxial feeding technique is very suitable to feeding the microstrip Patch antennas. As seen in Fig. 1, the upper and side layout of the V shape patch antenna. The inner side of the conductive material of the connector inserted through the dielectric substrate and the outer side of the conductor material is connected to the ground plane. The Coaxial probe cane be inserted any desired proper position in the metallic patch to get the maximum performances. It can be easily synchronized with the impedance. Coaxial feeding can be fabricated easily and another advantage is that it should not provide any undesired radiation. But coaxial feeding techniques produces very low level of bandwidth .It is very critical to drill the thick dielectric patch to insert the coaxial feed trough the ground plane .Due to the thick substrate the impedance matching problem occurs. So this various kinds of limitations can be overcome by introducing the non contact type feeding. This can be solving by introducing contact less feeding methods which has been discussed and overcome these problems.

The radius of the outer conductor is 0.78 mm and inner conductor is 0.36 mm.The characteristic impedance is chosen of 50 Ω.The required angle between the patch arms of the and probe point locations are found to be ψ=16 ° and 15.3 mm respectively. The different values of the antenna patch dimensions at 2.44 GHz antenna has been found given in Table II.

Table II
Dimensions Of The Proposed Antenna

W(mm)	l_1 (mm)	l_2(mm)	ψ
4.5	33.8	65.8	16^0

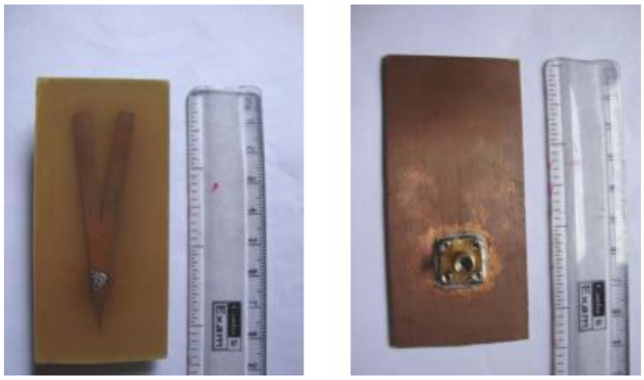

Fig. 2 Snapshot of the V-slotted Patch Antenna

Fig.2 shows the snapshot of the fabricated V-shaped microstrip patch antenna. The cross-section of the substrate is 30mm×80mm.

III. SIMULATED & MEASURED RESULTS

Simulated Results:

When HFSS has completed the solution, the results can be displayed and analyzed. Reports on S-parameters, VSWR, impedance, radiation parameters are generated using *HFSS* . Fig.3 shows the return loss vs resonance frequency characteristics. The return loss is -40.31 dB at resonance frequency of 2.44 GHz .The return loss 10dB is obtained to be 50 MHz .So, the impedance bandwidth is not very high.

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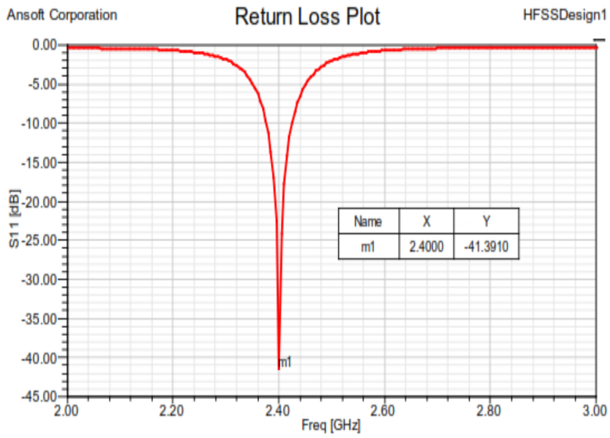

Fig. 3. Simulated Return Loss vs. Frequency Plot.

Also, it is noticed that next higher order mode is obtained at 3.53 GHz.The return loss is -30.5 dB at 3.53 GHz and the return loss is10 dB and bandwidth is 70 MHz (1.9%). Fig.4 shows the simulated VSWR plot and Fig.5 shows the VSWR vs Frequency characteristics of the antenna. The simulated VSWR at 2.42 GHz is 1.01 and the input impedance of the antenna is obtained 49.64 + j0.77Ω. This shows that good impedance matching is achieved.

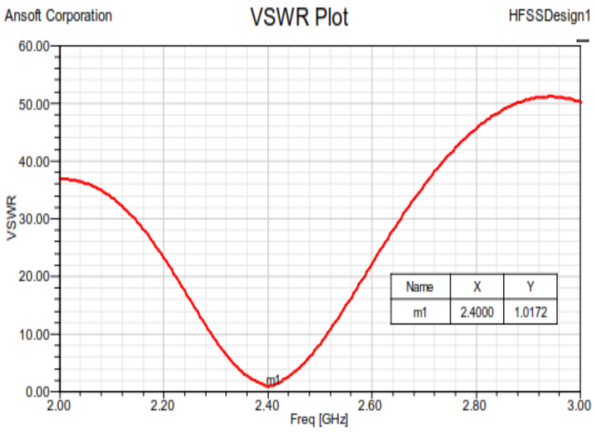

Fig.4. VSWR vs. Resonance Frequency Characteristics.

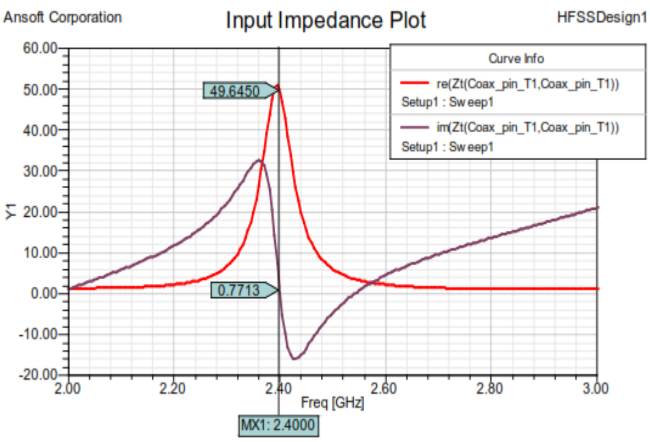

Fig. 5. Input Impedance vs. Frequency Characteristics

Fig. 6 shows the standard Electric-field radiating pattern at 2.44 GHz of the designed patch antenna.

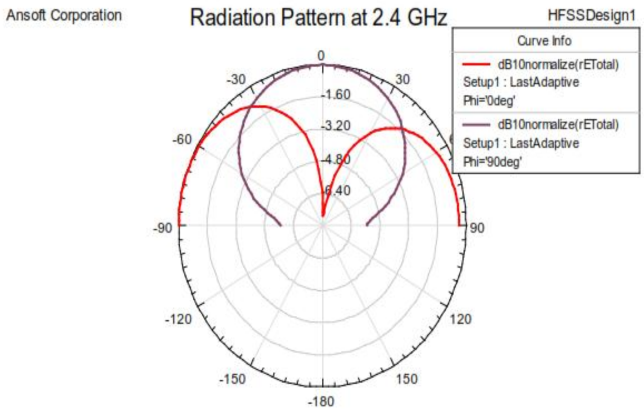

Fig. 6. Normalized E-field pattern at 2.4 GHz.

Measured Results:

The improvement characteristics of the designed V-shaped microstrip patch antenna is utilized using most common Series Network Analyzer having a frequency range from 300 KHz to 8.5 GHz. Fig. 7 shows the measured value of the return loss of the micro strip patch antenna. Here we found, optimum resonance at 2.49 GHz and the return loss is -14.60 dB at 2.59 GHz . The return loss is 10dB in bandwidth of 80 MHz obtained.

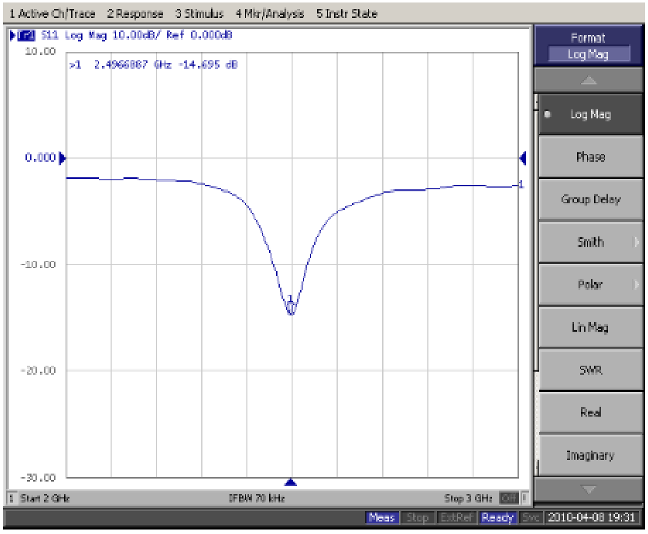

Fig. 7. Measured Return Loss vs. Frequency Plot.

Fig. 8 shows the VSWR vs Frequency characteristics and the measured VSWR(measured) at 2.59 GHz is 1.33. Here we cannot measured directly the value of input impedance using software tools, but can be measured by ploting smith chart shown in Fig. 9. The measured value of the input impedance of the microstrip patch antenna is obtained is 41.07 – j4.9Ω.

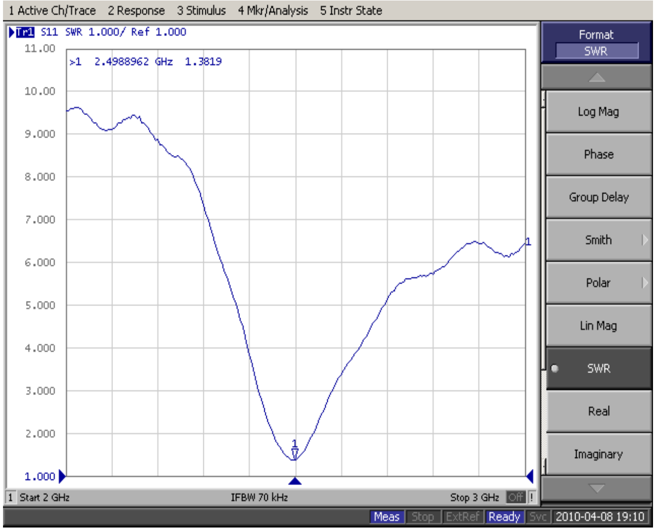

Fig. 8. VSWR Vs Frequency Characteristics.

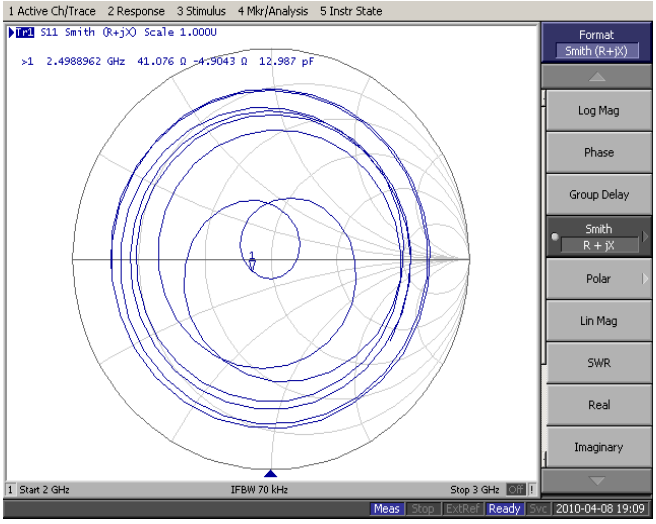

Fig.9. Measured Smith Chart Plot.

Table III

Variation Results of Measured and Simulated Results

Antenna Parameters	Simulated Results	Measured Results
Resonance. Freq ,(in GHz)	2.44	2.59
Return Loss, (in dB)	-40.31	-14.60
Bandwidth (in MHz)	50	75
VSWR	1.03	1.33
I/P Impedance, (in Ω)	49.6+j0.7	41.1+j4.9

From above results it is observed that the resonance measured frequency is very closer to the simulated results of frequency. The simulated result of the resonant frequency is 2.44 GHz with RL= -40.31 dB whereas measured value is 2.59 GHz with return loss is found -40.60 dB. Again the simulated results of the bandwidth is 50 MHz and the measured value is obtained 75 MHz. The simulated VSWR is 1.03 whereas measured value is 1.33.

IV. CONCLUSION

From the above table it is found that the measured and simulated results of the resonance frequency are very nearest to each other. The Return loss value is -40.31 dB at resonance frequency of 2.44 simulated values. Similarly at measured resonant frequency at 2.59 GHz, the return loss is found -14.60 dB. But the band width has been different in simulated and measured result are 50 MHz and 75 MHz respectively. The simulated result of VSWR is 1.03 whereas measured value of the VSWR is 1.33. Here we obtained that the simulated and measured value of the input impedance are (49.5+ j0.8) Ω and (41.1-j4.9) Ω respectively. So the simulated results of input impedance is most efficient than measured value of input impedance. It is most important thing that to match the patch and prob impedance .Due to mismatch of the patch and prob, the undesired radiation occurred .dance mismatch may be occured.Because of improper soldering of prob in patch the impedance mismatch found.. Thus proper soldering the problem can be solved.

REFERENCES

1. C. A. Balanis, Antenna Theory: Analysis and Design, 2nd Edition, Wiley, 2008.
2. I.J.Bahl, P.Bhartia, Microstrip Antennas, Artech House, Inc., 1980.3
3. Ansoft High Frequency Structure Simulator v 11, "Getting Started with HFSS".
4. http://www.wikipedia.org
5. D.M. Pozar, D.H. Schaubert, *Microstrip Antennas*. New York: IEEE press, 1995.
6. S.H. Wi, Y.B. Sun, I.S. Song, S.H. Choa, I.S Koh, Y.S Lee, J.G. Yook,Package-Level integrated antennas based on LTCC technology", IEEE Transactions on Antennas and Propagation. 54(8), 2190-2197, 2006.

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