# STUDY OF PRINTED ROTATED WIDE SLOT ANTENNA USING MICROSTRIP FEEDLINE WITH DIFFERENT STUBS FOR BANDWIDTH ENHANCEMENT

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***Abstract*—A Compact Printed slot Antenna with rectangular and fork like tuning stubs fed by microstrip line is presented in this paper.This antenna has a compact dimension of 37x37x1.6 mm$^3$. A square patch as a parasitic element is embedded to increase impedance bandwidth. By using tuning stubs with feedine , additional resonance gets introduced in the high freq range and hence results in enhanced bandwidth for broadband operation .Circular slots are being cut in the patch to compensate return loss. Simulated result shows impedance bandwidth of about 198.73% ranging from (2.38-12.83) GHz using -10 dB reflection coefficient criteria.**

***Keywords*—Printed slot antenna,microstrip line fed,rotating slot.**

## I. INTRODUCTION

Due to attractive features like wide bandwidth, low cost and ease of integration with monolithic ICs, demand for printed slot antenna is increasing rapidly and hence numerous slot antennas have thus been desingned for various application. In [1] a wide slot antenna for broadband application has employed using forklike tuning stub with feedline. By using this configuration an impedance bandwidth of 1.1GHz has been realized using 1:1.5 voltage standing wave ratio threshold. By combining standard coplanar waveguide slot antenna with a capacitive CPW, bandwidth was increased in [2]. It has been shown that a fractional bandwidth of 49% has been realized in [2]. A CPW fed multiband slot antenna is presented in [3] having signal strip of T-shape and conducting strip being shaped in U. Using -10dB impedance bandwidth criteria bandwidth of 4.45 GHz ranging from (1.85-6.3)GHz was realized by this configuration. A modified form of microstrip line of L shape has been choosen to excite the square slot which lead to bandwidth enhancement. Enhancement in bandwith alongwith reduction in size were obtained in [5] using corner truncated protruded ground plane and an offset feedline. The author showed -10 dB impedance bandwidth of 5.21 GHz in [5].The author showed an enhanced bandwidth using fractal shaped slot antenna fed by microstrip feedline in [6].The author found an impedance bandwidth of about 2.4 GHz with center frequency 4GHz. Rotated square slot results in an impedance of about 2.2 GHz in [7]. The author reported an improved bandwidth of 4.29 GHz by just placing parasitic patches on two sides of microstrip feedline. However all these antennas were in large size and a novel antenna using rotated slot and a rotated patch placed at center was proposed. This newly designed antenna achieved higher bandwidth and resulted in reduced size compared to antenna in [7]. But bandwidth obtained through various antennas discussed were not sufficient for various wireless application.

In this paper , a microstrip line fed printed slot antenna is proposed based on the work in [10] and consisting of fork like and rectangular shaped tuning stubs attached to the feedline. By properly choosing parameters of forklike and position of rectangular stubs, good impedance bandwidth can be obtained. Simulated result shows an improved bandwidth of 9.94 GHz ranging from (2.83-12.83)GHz which is higher than those obtained in [10].

## II. ANTENNA GEOMETRY AND DISCUSSION

Fig. 1(a) shows the geometry for proposed antenna and 1(b) is just a simple desing of simulated antenna. This antenna has dimension of 37x37x1.6 mm$^3$.It is fabricated on FR4 substrate ( relative permittivity $\epsilon_r$=4.4) with thickness 1.6 mm$^3$.This proposed antenna has same dimension as that of [10] with addition of a fork like tuning stub attached to the feedline. Thus the proposed antenna consist of a rotated square slot, a rotated patch being rotated at an angle of $45^0$ , and tuning stubs attached to the microstrip feedline.The square slot and square patch are both printed on one side of dielectric substrate while microstrip line of length 15mm and width 3 mm are on other side of the substrate. For all metal part in the simulation, copper with thickness of 0.05mm was being used. An electromagnetic solver ANSYS high frequency structure simulator (based on finite element method (FEM) is used for simulation purpose. The fork like tuning stub consist of three sections in which two branch sections are having length $l_3$ and spacing between their edges is $l_1$ and spacing between straight line section and feed is taken as $l_2$ = 0.5mm.All these sections are having same width as that of feedline. Two circular slot of radius 1 mm are made in patch which results in decrease in the return loss. Distance between center of patch and center of circular slot is taken as 2mm.

As discussed in [9], wide slot size acts as determining element for lowest frequency of operation and the two antenna i.e- the proposed and reference antenna [10] have almost same lowest frequency point. To excite more resonant mode in order to achieve wider bandwidth, stubs are being used in our proposed design. The parameters are listed in table 1. Simulated input impedance of the proposed antenna is also shown in fig 4.

Table 1

| Parameter | Value ( in mm) |
|---|---|
| a | 4 |
| b | 0.5 |
| c | 3 |
| d | 3.7 |
| $L_1$ | 6.8 |
| $L_3$ | 7 |

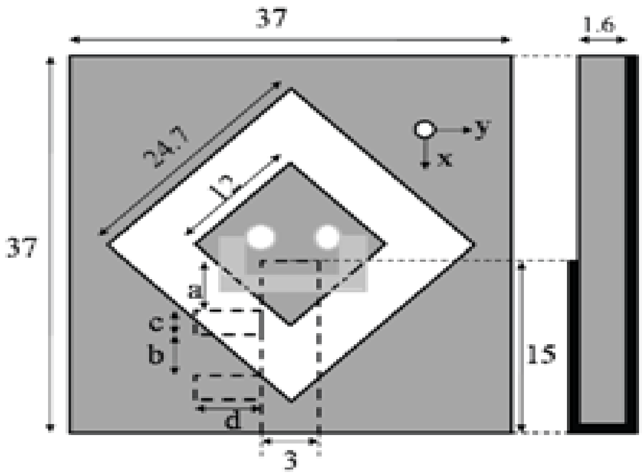



Fig 1 (a).Geometry of the proposed antenna

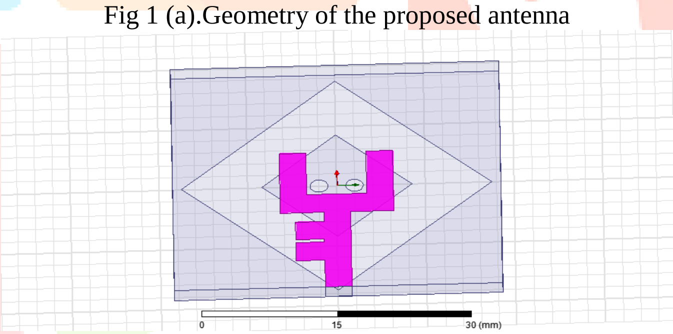



Fig. 1(b). Design for proposed antenna

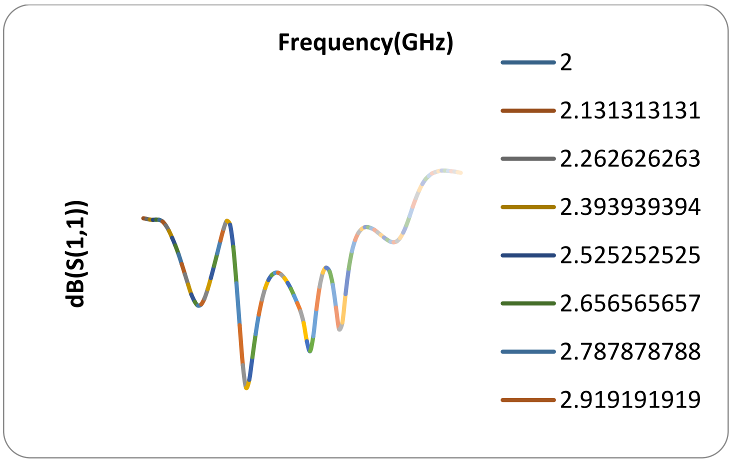



Fig 2 .Simuated Result of Proposed antenna.

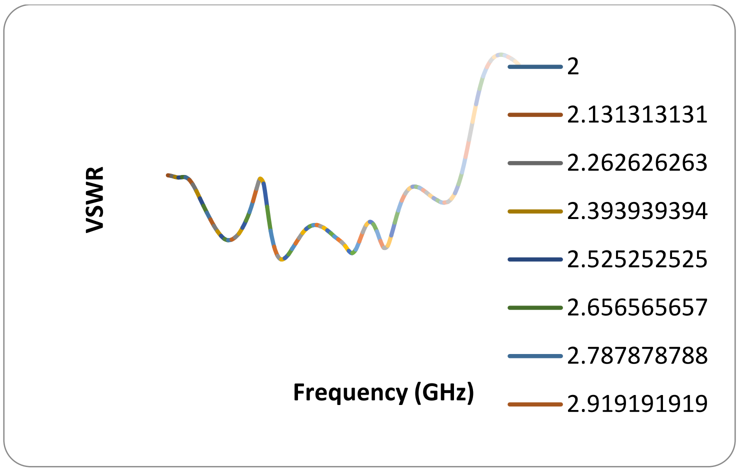



Fig 3. Simulated VSWR for the proposed anenna.

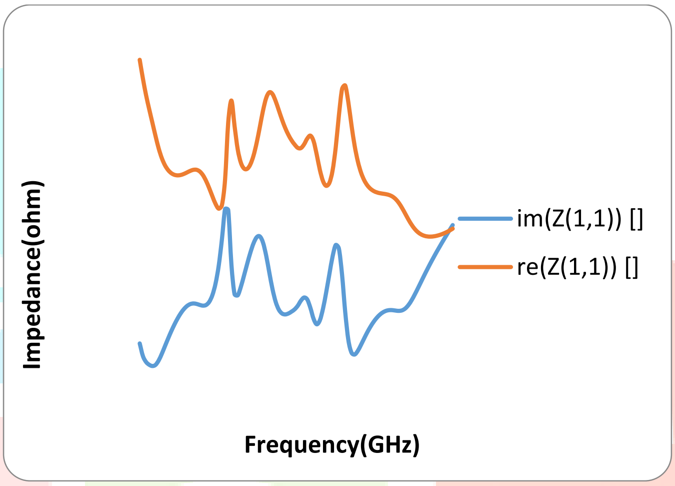


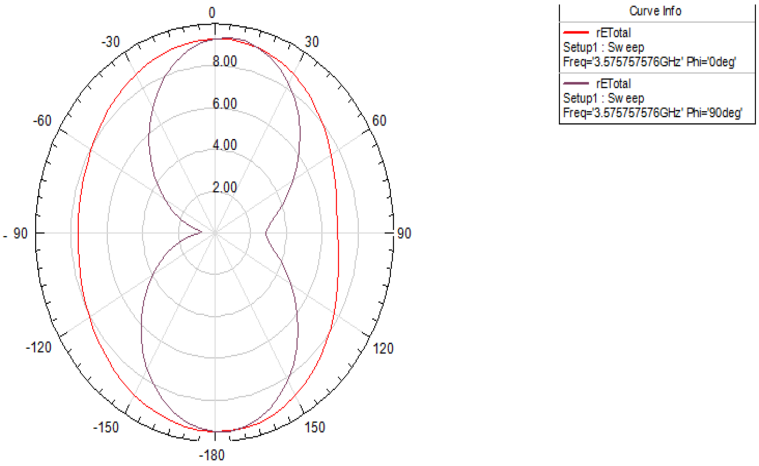

Fig 4. Simulated input impeadnce of proposed antenna.

From [10] it can be analyzed that the current distribution along the length of the antenna changes by making changes in stub lengths. Simulated input impedance for the proposed antenna is depicted in fig 4. By seeing the result obtained in [10] for input impedance we can say that major difference occurs in imaginary part in low frequency range.Since imaginary part is mainly capacitive and hence it can be said that reactance due to stubs are mainly inductive for the proposed antenna.

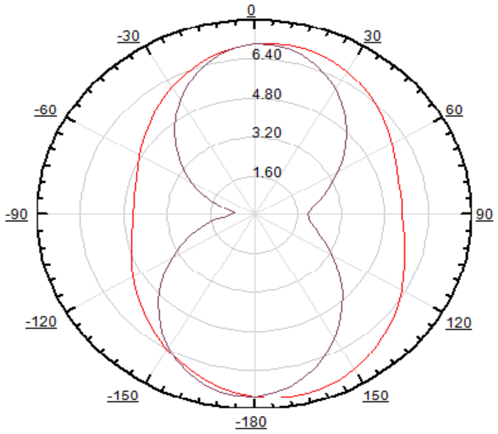
## III RESULTS AND DISCUSSION

(A) *Impedance characteristics of Proposed Antenna*-Simulated result of the proposed antenna is shown in fig 2.It shows that the proposed antenna has wider operating bandwidth of 9.94 GHz which is nearly two times igher than that of the refernce antenna. The simulated result for VSWR is also shown in fig 3.

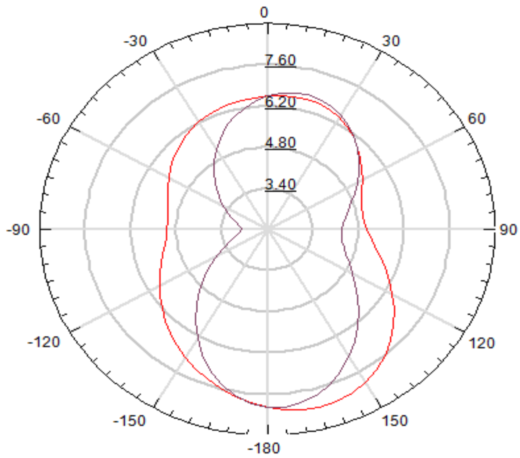
(B) *Radiation characteristics of proposed antenna*- Simulated results for radiation pattern at adifferent frequencies are shown in fig 5. The results are obtained for two principal planeswhich are xz-plane ( phi=$0^0$) and aayz- plane (phi=$90^0$). It is observed that pattern is fairly good at frequency of 3.5 GHz and 4.2 GHz.As it is clear from the patterns that nt only it radiates well at these two frequencies but also it gud radiation strength. The two field i.e- electric and magnetic field are having good strength at 3.5 and 4.2 GHz. And hence by just seeing the pattern we can say that it worsen at higher frequency and radiates better at low frequency range.



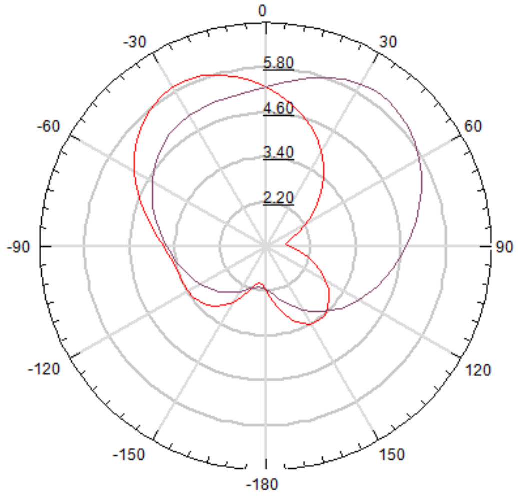

(a) Simulated radiation Pattern at 3.5 GHz



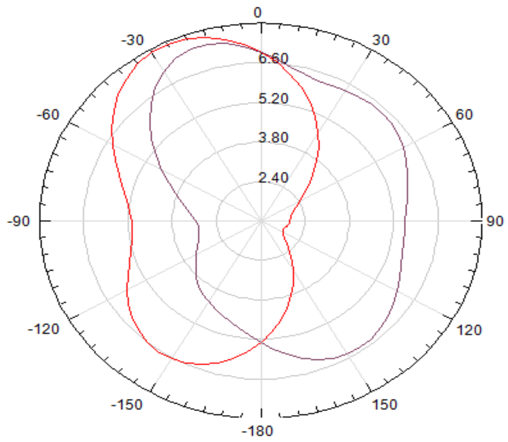

(b) Simulated radiation pattern at 4.2 GHz.




(c) Simulated radiation pattern at 5 GHz.




(d) Simulated radiation pattern at 5.5 GHz.




(e) Simulated result of radiation pattern at 6.5 GHz.

## III CONCLUSION

From the simulated result of proposed antenna we can say that this antenna achieves higher operating bandwidth of 9.93 GHz which is higher than that in [10].The two stubs used helps in increasing bandwidth and reduction in return loss. Radiation patterns at various frequencies has obtained which shows that the proposed antenna radiates well at lower frequencies. This indicates that proposed antenna helps in improving bandwidth and hence can be suitable for broadband operation. In future work focus will be on improving radiation patterns.

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## V REFERENCES

[1] Jia-Yi Sze; Kin-Lu Wong, "Bandwidth enhancement of a microstripline fed printed wide-slot antenna," IEEE Transactions on Antennas and Propagation , vol.49, no.7, pp.1020-1024, July 2001.

[2] Bhobe, A.U.; Holloway, C.L.; Piket-May, M.; Hall, R., "Coplanar waveguide fed wideband slot antenna," Electronics Letters , vol.36, no.16, pp.1340-1342, August 2000.

[3] Lin-Chuan Tsai, "Bandwidth enhancement in coplanar waveguide fed slot antennas designed for wideband code division multiple access/wireless local area network/ worldwide interoperability for microwave access applications," IET Microwaves, Antennas & Propagation, vol.8, no.10, pp.724-729, July 2014.

[4] Sung, Y., "A Printed Wide-Slot Antenna With a Modified L-Shaped Microstrip Line for Wideband Applications," IEEE Transactions on Antennas and Propagation, vol. 59, no.10, pp.3918-3922, October 2011.

[5] Jen-Yea Jan; Chien-Yuan Pan; Feng-Pin Chang; Guo-Jhih Wu; Chih-Yu Huang, "Realization of compact and broadband performances using the microstrip-line-fed slot antenna," *2012 Asia-Pacific Microwave Conference Proceedings (APMC),* pp.1379-1381, December 2012.

[6] Wen-Ling Chen; Guang-Ming Wang; Chen-xin Zhang, "Bandwidth Enhancement of a Microstrip-Line-Fed Printed Wide-Slot Antenna With a Fractal-Shaped Slot," *IEEE Transactions on Antennas and Propagation,* vol. 57, no.7, pp.2176-2179, July 2009.

[7] Jen-Yea Jan; Jia-Wei Su, "Bandwidth enhancement of a printed wideslot antenna with a rotated slot," *IEEE Transactions on Antennas and Propagation,* vol.53, no.6, pp.2111-2114, June 2005.

[8] Jen-Yea Jan; Liang-Chin Wang, "Printed Wideband Rhombus Slot Antenna With a Pair of Parasitic Strips for Multiband Applications," *IEEE Transactions on Antennas and Propagation*, vol. 57, no.4, pp.1267-1270, April 2009.

[9] Sung, Y., "Bandwidth Enhancement of a Microstrip Line-Fed Printed Wide-Slot Antenna With a Parasitic Center Patch," *IEEE Transactions on Antennas and Propagation,* , vol.60, no.4, pp.1712-1716, April 2012

[10] Oteng Gyasi Kwame, Wen Guangjun, Xue Xiao Lin, Muhamma Abdul Basit," Bandwidth Enhancement of a Microstrip-Line-Fed Printed Rotated Wide Slot Antenna With Tuning Stubs"IEEE Conference, 2016.

[11] Junhui Wang and Yingzeng Yin, "Differential-fed UWB microstrip antenna with improved radiation patterns", *Electronics Letters*, Vol. 50, No. 20, pp. 1412–1414, September 2014.

[12] Chiba, Taneaki; Suzuki, Y.; Miyano, Noriaki, "Suppression of higher modes and cross polarized component for microstrip antennas," *International Symposium in Antennas and Propagation Society,* vol.20,