Design of MIMO Antenna for Ku Band Applications

B. Satya Priya[1], B. Hema Durga Naga Sri,[2] D. Moulika[3], J.Yamini[4]

[1,2,3,4]Department of Electronics & Communication Engineering, Potti Sriramulu Chalavadi Mallikharjuna Rao College of Engineering & Technology, Vijayawada, India

---

Abstract- In this paper a microstrip patch antenna is designed by using rectangle and two circular structures. This is further implemented to multiple input and multiple output (MIMO). In MIMO multiple antennas are used on a single substrate. This technique helps to increase the signal throughput and link range without requiring extra bandwidth or transmit power. The designed antenna operates in Ku band and is also used for satellite from remote location to a television network studio for editing and broadcasting. An FR4 substrate with εr= 4.4 thickness h=1.6mm is used. The return losses and bandwidth for the designed antenna is -39dB and 3GHz. This antenna is designed using high frequency structure simulator software (HFSS) by which return losses, Bandwidth and VSWR are measured.

Keywords: Microstrip antenna, rectangular patch antenna, HFSS, return loss, bandwidth, VSWR, HCPA, TPADS, TPASS.

1. Introduction

MIMO or Multiple-Input Multiple-Output can be referred to as the communication channel created with multiple transmitters and receivers of an antenna to improve communication's performance. Since their initial development in the year 1990, MIMO Wireless Communications have become integral part of the most forthcoming commercial and next generation [7]

In MIMO the output power is split into each antenna which results in increasing the bandwidth and return losses [1]. A half-cut MIMO patch antenna is designed to increase the bandwidth and to decrease return losses [2]. In this paper, a rectangle shaped microstrip antenna is designed with two circular structures implemented at the corners of the rectangular patch antenna [3].Here we use multiple antennas on the single substrate [4][5]. MIMO systems that utilize multiple antenna elements have been received a growing amount of interests because of overcoming the limited data rate transferred of the conventional systems [6] .The designed antenna operates in Ku band. This band provides reliable high-speed connectivity between the personal organisers and other wireless digital appliances.

To enhance the bandwidth and return losses the design rectangular with two circular structures patch antenna is cut into half which is Half-Cut Patch Antenna (HCPA).Therefore two half cut patch antennas (HCPA) are imposed on single substrate, Further this proposed structure will be applied to MIMO.where (TPASS) Two patch antennas of same structure is used.

2. Design

In this paper a MIMO antenna is designed which operates in Ku band. Initially a rectangular patch antenna is designed with dimensions having 4.7x7mm then circular structures are implemented at the corners of the rectangular patch having radius 2mm and the dimensions of the ground plane is 10x15mm rectangle shape slots are implanted on the patch to get better return losses and is showed in below figure 1 . The return losses obtained for the design is -25dB and the bandwidth is 3GHz.The gain of the proposed antenna is 4dB and is shown in Fig 8. Further a mimo antenna is designed while increasing the length of the substrate but the results obtained are low.

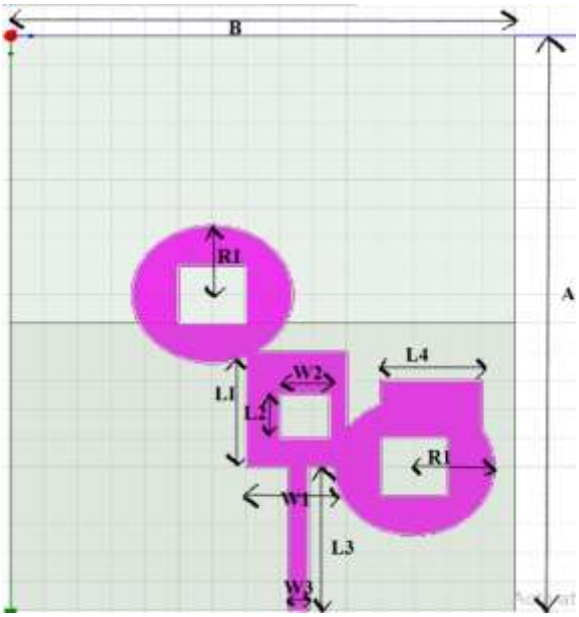


Fig 1: Top view of the patch antenna

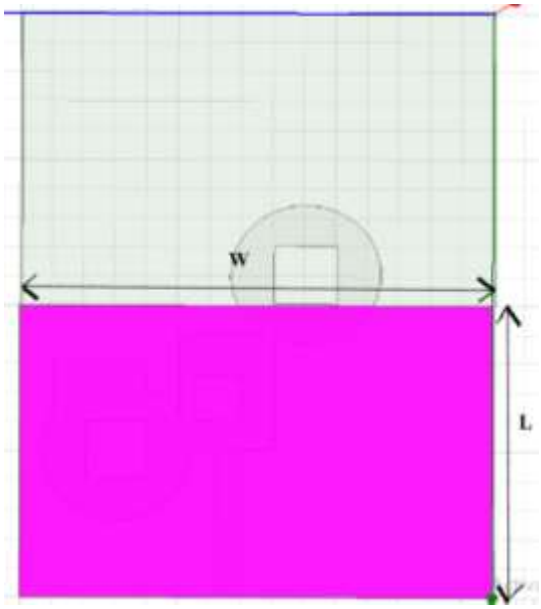


Fig 2: Bottom view of the patch antenna

L	10	L2	1.5
W	15	W2	1.5
A	20	L3	5
B	15	W3	0.6
L1	4.2	L4	3
W1	6.5	R1	2.4

Table1: proposed antenna dimensions

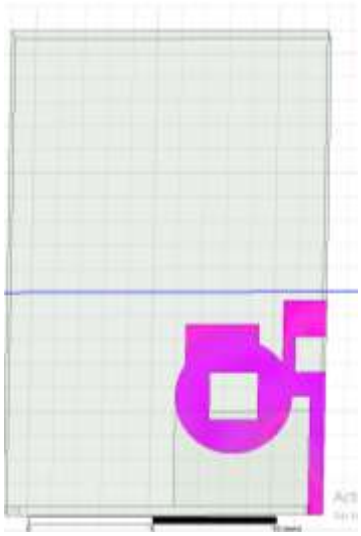


Fig 3: Half-cut patch antenna (HCPA)

To achieve good results the structured antenna is cut into half vertically as shown in fig 3. hence this is given as Half –Cut Patch Antenna (HCPA). The return loss and bandwidth obtained for half cut antenna (HCPA) is -26dB and 3GHz respectively and is shown in Fig 8.

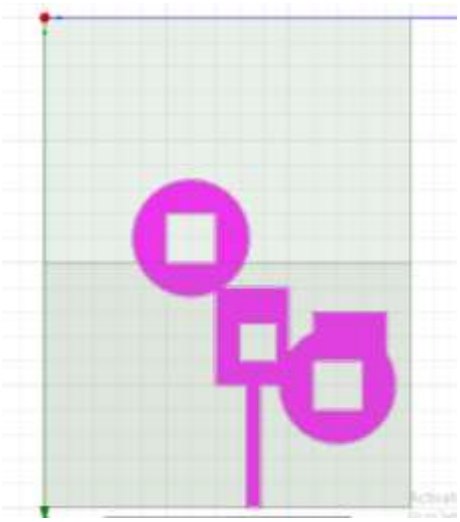


Fig 4: Actual design of the patch antenna

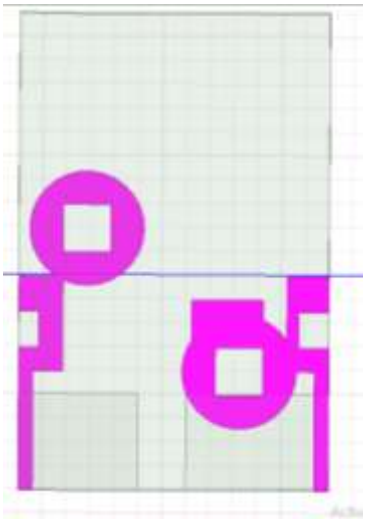
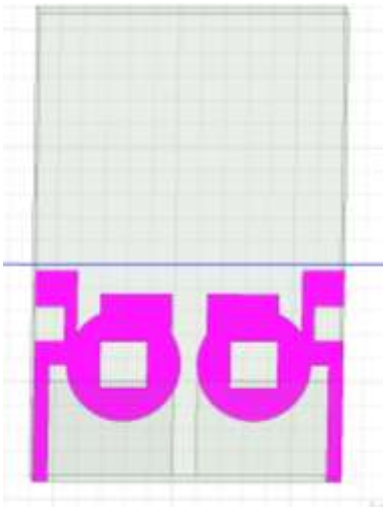


Fig 5: Two patch antennas of different structure (TPADS)

In order to show better results MIMO. Initially two HCPA are used which results in Two Patch Antennas of Different Structure (TPADS) as shown in Fig 5. The return loss and bandwidth of the antenna is -34 dB and 2.27 GHz respectively. Later, on observing the electric field distribution left side of the antenna is not radiating effectively when compared to the other half. So to obtain better results the design is modified and is shown in below figure 6.



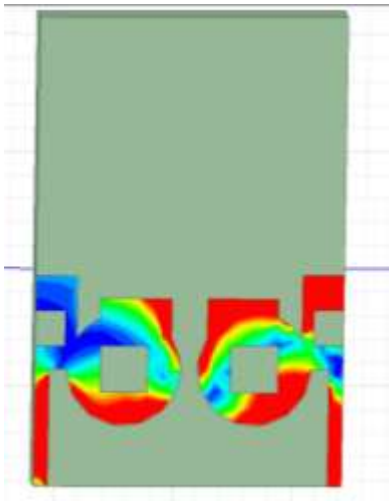


Fig 6: Two patch antennas of same sructure (TPASS). **Fig 7:**Electric Feild distribution of the anenna.

The modified design is Two Patch Antennas of Same Structure (TPASS) .This is having better return losses and bandwidth,where the return losses of TPASS design is at -39dB and bandwidth is 3 GHz. Electric field distribustion of the Two patch antennas of same structure (TPASS) .

3. RESULTS

The simulation results of the proposed antenna are shown in Fig 8 and Fig 9. The results for the initial design is -25 dB and 3GHz of return losses and bandwidth respectivly. Gain of the structured antenna is 4 dB. The designed antenna is cut into half i.e HCPA the results are -35.5 dB and 2 GHz of return losses and bandwidth respectively. VSWR of the antenna is at 1.04.Furture MIMO is implemented .The result of this mimo antenna is -39 dB and 2.71GHz of retrn losses and and bandwidth. VSWR of the mimo is 1.05 dB.

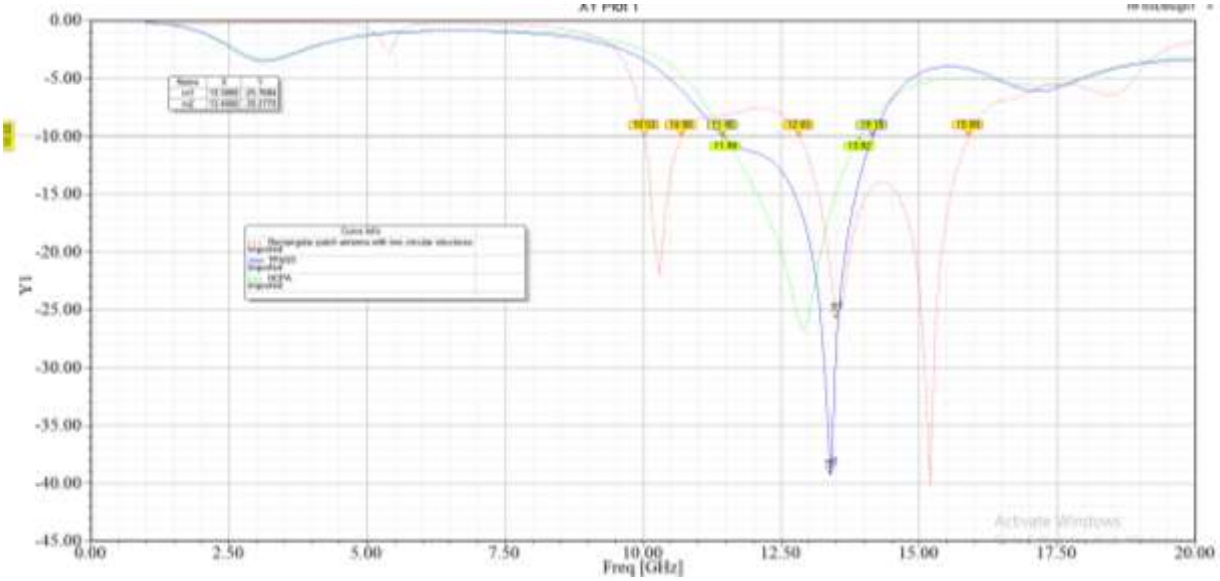


Fig 8:Return losses for the proposed antenna.

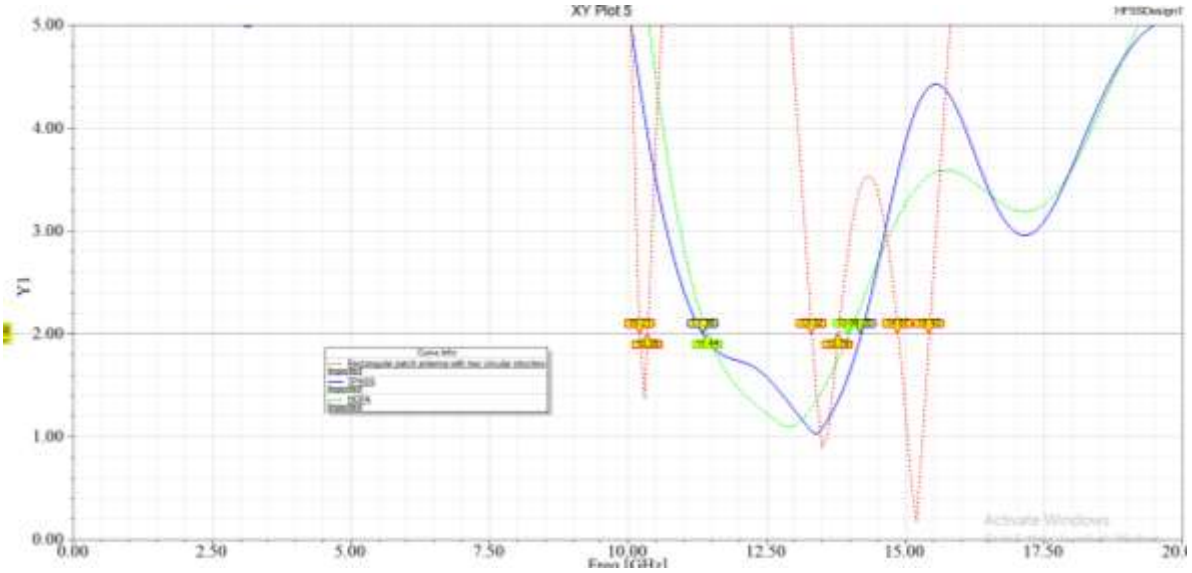


Fig9: VSWR for the proposed antenna.

4. Conclusion

In this paper MIMO antenna of Two Patch Antennas of Same Structure(TPASS) is designed .The propsed antenna operates in Ku band. The return loss and bandwidth of the proposed antenna is -39dB and 2.71GHz.The substrate used here is FR4 epoxy. Here two half cut antennas are implemented on the single substrate which gives better results.

References

[1] “MIMO Broadcasting for Simultaneous Wireless Information and Power Transfer” by Rui Zhang and Chin Keong Ho.

[2] "Bandwidth enhancement and miniaturization of circular-shaped microstrip antenna based on beleved half-cut structure for MIMO 2x2 application" by Teguh Firmansyah1, Supriyanto Praptodiyono2, Herudin3, Didik Aribowo4, Syah Alam5, Dian Widi Astuti5, Muchamad Yunus7

[3] "Slot and Corner Truncation for Enhancing Bandwidth of Circularly Polarized Patch Antenna"By Nurul Fadilah and Achmad Munir† Radio Telecommunication and Microwave Laboratory School of Electrical Engineering and Informatics, Institut Teknologi Bandung Bandung, Indonesia †munir@ieee.org

[4] "Design of a four-element WLAN/LTE/UWB MIMO antenna using half-slot structure"

By Bing Yang∗, Minzhe Chen, Lingyun Li

[5] "CPW-fed Compact Polarization Diversity UWB MIMO Cup-Antenna" by M. I. Ahmed Microstrip Department Electronics Research Institute Giza, Egypt. M. F. Ahmed Department of Electronics and Comm. Engineering Faculty of Engineering, Zagazig University Zagazig, Egypt.

[6] H. Huang, Y. Liu, S. S. Zhang, and S. X. Gong, "Compact polarization diversity ultrawideband MIMO antenna with triple band-notched characteristics," Microwave Opt. Technol. Letter, vol. 57, pp. 946–953, April 2015.

[7] MIMO Wireless Networks: Channels, Techniques and Standards for Multi-Antenna