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A MULTIBAND MIMO ANTENNA FOR S AND C-BAND COMMUNICATION APPLICATIONS

B. T. P. Madhav, D. Lakshmi Kranthi, Ch. Kusumanjali Devi, N. Navyasanthi and B. Tarunteja Reddy
Department of Electronics and Communication Engineering, K L University, AP, India
E-Mail: btpmadhav@kluniversity.in

ABSTRACT

A compact multiband antenna that covers operating bands of C and S for communication applications is proposed in this paper. A multiple-input-multiple-output configuration is used in this design with two ports connected to the radiating element of the antenna. The MIMO antenna structure consisting of step shaped radiating element on four sides of the antenna model. Different iterations are constructed by introducing stepped slots on the basic antenna structure. The overall performance of the antenna in terns of s-parameters, radiation pattern, field distributions, directivity and efficiency are investigated and verified the basic parameters through measurements.

Keywords: multiband, multiple-input-multiple-output (MIMO), C-Band, S-Band, communication systems, directivity, field distributions.

INTRODUCTION

Wireless Communication systems should transmit high data rates in short duration. In recent years MIMO technology involves the usage of multiple antennas at both the transmitting and at receiving sections [1-4]. This MIMO technology with these antennas will enhance the data transmission performance and channel capacity without losing bandwidth and additional energy [5-6]. The MIMO systems are able to simultaneously transmit multiple signals through parallel channels between isolated multiple antennas. This provides reduction in multipath fading and data throughput is substantially increased with multiplexing technique.

The design of MIMO antenna for communication systems application is a challenging task to the researchers which involved many points to be taken into consideration. Another point related to the elements located close to each other may increase correlation coefficient related to the mutual coupling [7-9]. To enhance the isolation so many techniques like inserting additional parasitic structures, loading slots and radiating ground layers etc are used. In an antenna system with closely packed elements, the high mutual coupling can lead to large impedance mismatches. Also some techniques have been presented for communication applications recently, including steps, slots on the ground plane and orthogonal placement of radiating elements with respect to each other [10-14].

In this paper a two port MIMO antenna system with common elements applicable for C and S bands are presented. The proposed MIMO antenna system comprises two microstrip feed line monopole antennas with a common stepped radiating element on FR4 substrate. This model demonstrates satisfactory performance in terms of reflection coefficients, isolation and radiation characteristics.

Antenna geometry

The proposed MIMO antenna system consisting of stepped radiating element with two microstrip feeds on a finite ground plane structure. Figure-1 shows the basic configuration of the MIMO antenna without step structure on the radiating element. From Figure-2 to Figure-5 shows the incremental order step structures of different iterations. The prototype of MIMO antenna was built on FR-4 substrate with permittivity 4.4, thickness 1.6mm and loss tangent 0.025. The overall dimension of the antenna is around 120X110X1.6mm. To achieve a 50ohm input impedance matching, a micro strip transmission line is used to excite the suitable set of modes with width p6 equal to 1mm and length p5 equal to 22.5mm.

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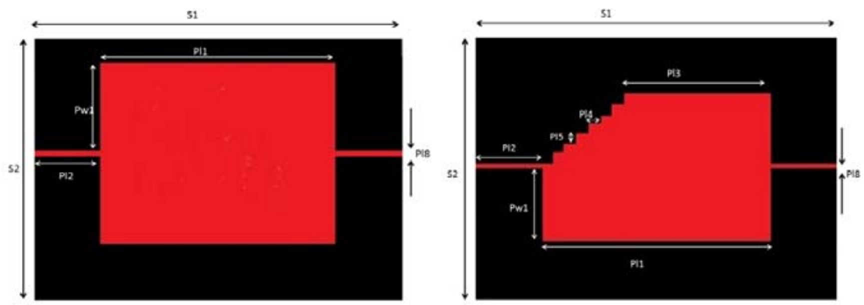

Figure-1(a). MIMO antenna basic model, **Figure-1(b).** MIMO antenna iteration 1.

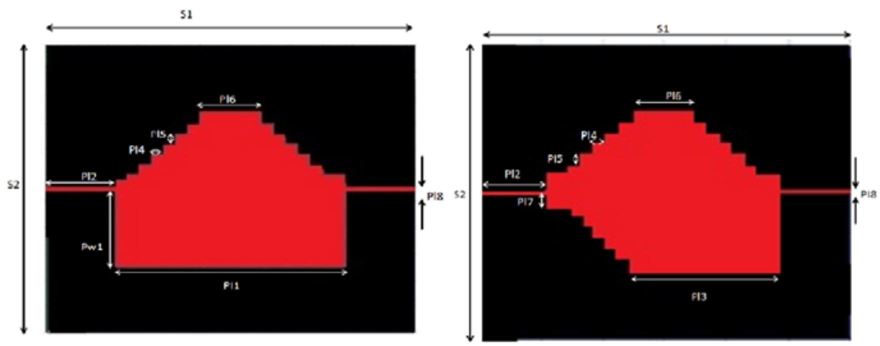

Figure-2(a). MIMO antenna iteration 2**, Figure-2(b).** MIMO antenna iteration 3.

Table-1. MIMO antenna dimensions.

DIMENSIONS

Parameter	S1	S2	Pl1	Pl2	Pl3	Pl4	Pl5	Pl6	Pl7	Pl8	Pw1
Value(mm)	120	110	75	22.5	47.5	4	4	20	4.5	1	29.525

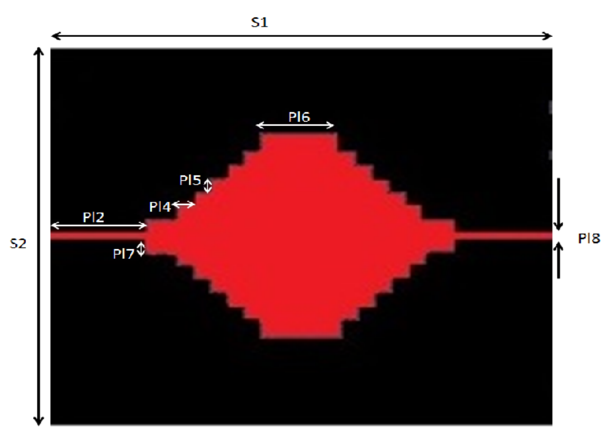

Figure-3. Proposed MIMO antenna.

RESULTS AND DISCUSSIONS

VOL. 10, NO. 14, AUGUST 2015 ISSN 1819-6608
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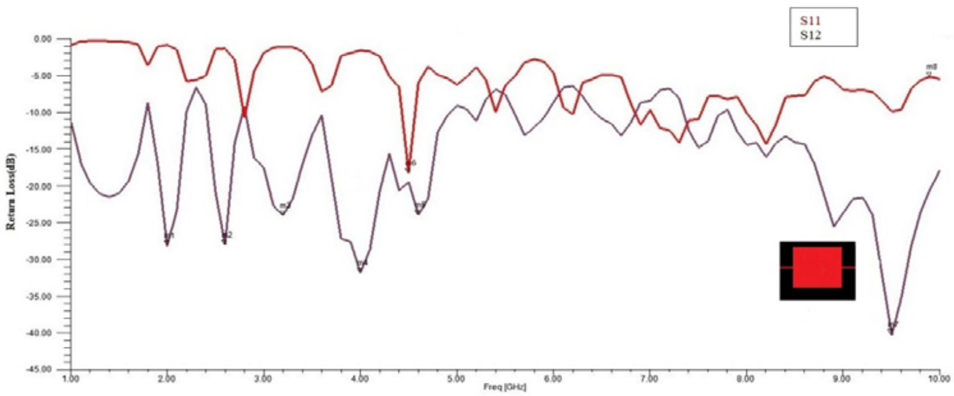

Figure-4. Returnloss of basic MIMO antenna.

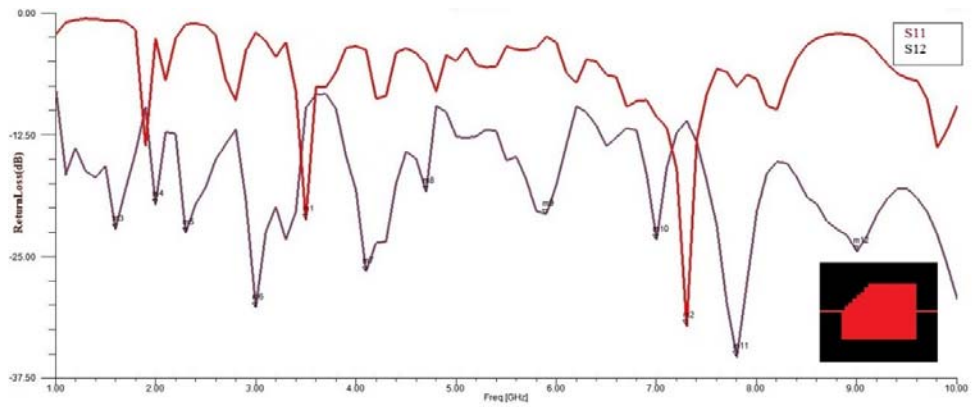

Figure-5. Returnloss of iteration 1 MIMO antenna.

Figure-4 shows the S11 and S12 results of the basic model with rectangular radiating element. The S11 parameter is showing the reflection coefficient of the antenna with respect to operating frequency. The antenna is resonating at 4.5 GHz with returnloss of -18dB. By giving input to the port-1 and output from the port-2 is taken for the base model and presented as S12 parameter in the Figure-4. Figure-5 shows the returnloss of iteration 1 by placing step serrated slots on the left side top most corner on the base model. For the iteration 1 model antenna is responding at triple band with returnloss of -13,-22 and -35dB at 1.9, 3.5 and 7.2GHz respectively.

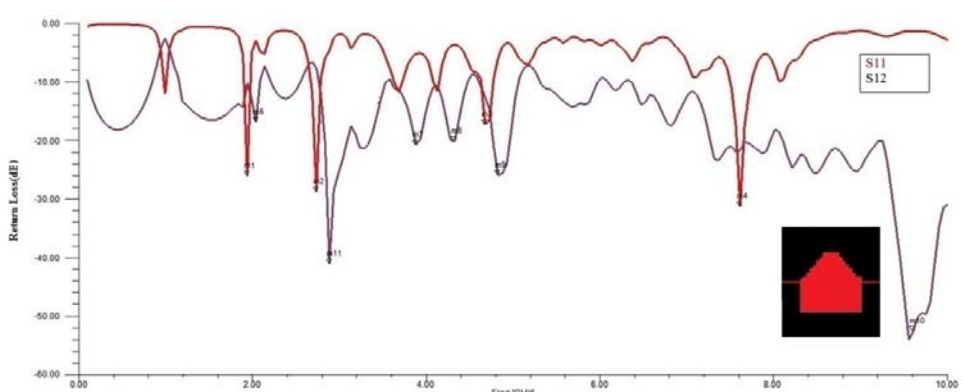

Figure-6. Returnloss of iteration 2 MIMO antenna.

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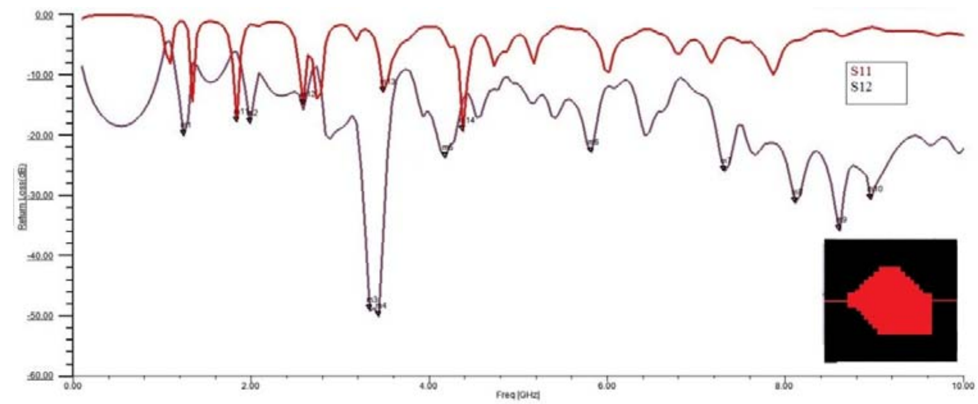

Figure-7. Returnloss of iteration 3 MIMO antenna.

The reflection coefficient of iteration 2 MIMO antenna is as shown in Figure-6. Iteration 2 consisting of step serrated slots on either sides of top corners with equal distribution. The iteration 2 is resonating at quad band with returnloss of -25,-30,-18 and -32dB respectively at 1.9, 2.5, 5.1 and 7.6 GHz. Figure-7 shows the iteration 3 of MIMO antenna with 3 sided step serrated slots. The iteration 3 is resonating at penta band with considerable reflection coefficient at resonant frequencies. Figure-8 shows the proposed MIMO antenna with step serrated slots in all directions with equal distributions of the elements. The proposed antenna is resonating with multiband characteristics which covers 1.56GHz (GPS), 1.9GHz (PCS), 2.4GHz (Bluetooth), 3.6GHz and 5.4GHz (WLAN communication band applications).

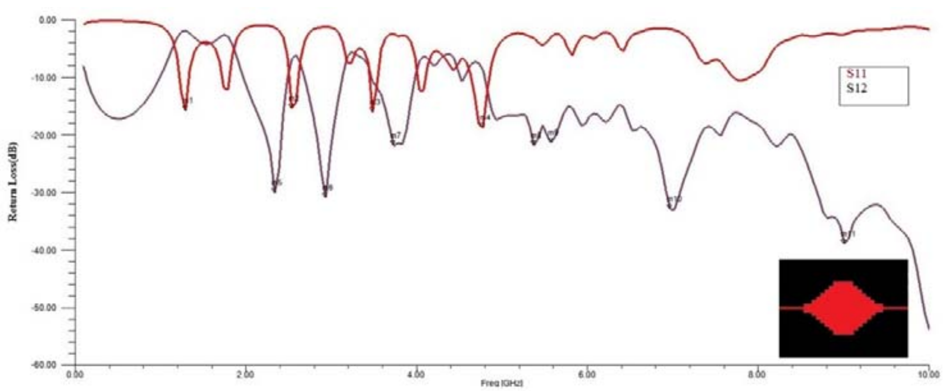

Figure-8. Returnloss of proposed MIMO antenna**.**

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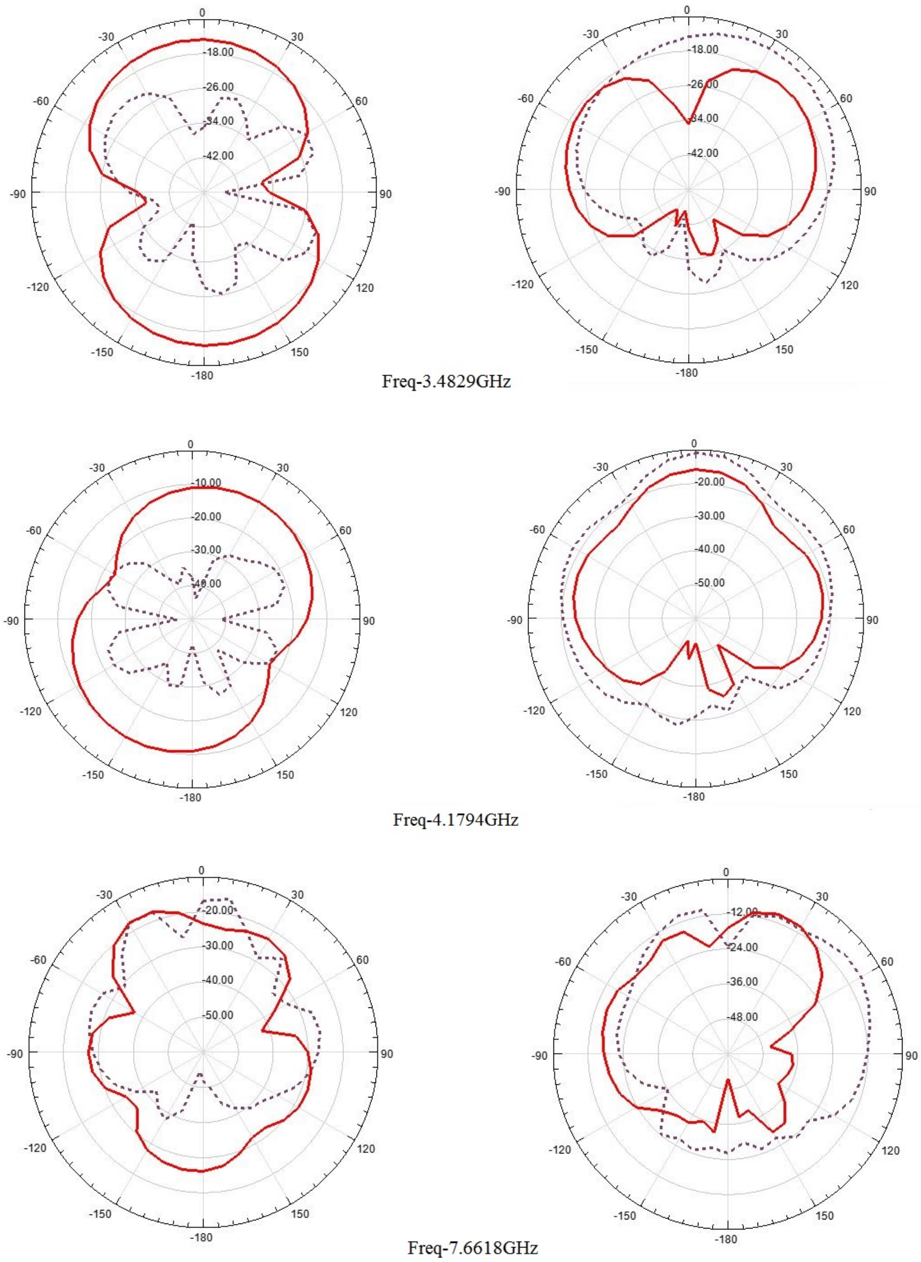

Figure-9. Radiation pattern of the proposed MIMO antenna at 3.4, 4.1 and 7.6 GHz.

Figure-9 shows the radiation pattern of the proposed MIMO antenna at different resonant frequencies. The radiation characteristics are seems to be directive rather than omni-directional radiation pattern. At 3.48GHz antenna is showing eight like radiation characteristics with low cross polarization of less than -28dB in the E-plane. At higher resonant frequencies antenna is showing quasi omni-directional radiation characteristics.

Figures 10-14 are showing current distribution plots for all the iterations at their respective resonant frequencies. Basic model is linearly polarized at lower resonant frequencies. Basic model is linearly polarized at lower resonant frequency but at higher resonant frequency the current element orientation is disturbed.

VOL. 10, NO. 14, AUGUST 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

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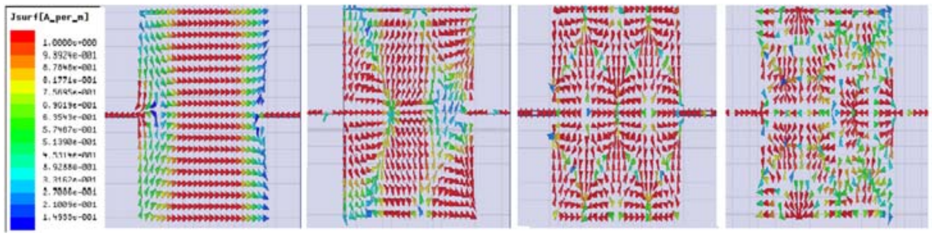

Figure-10. Current distribution of basic MIMO antenna.

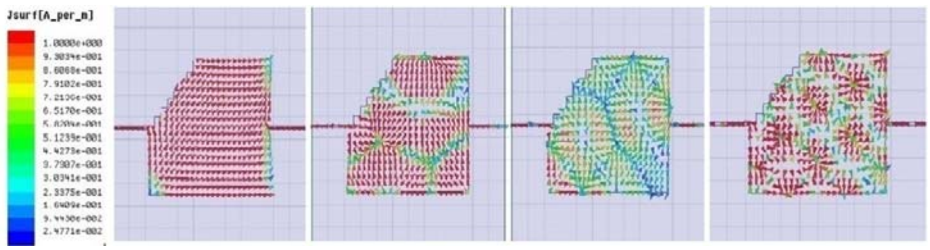

Figure-11. Current distribution of iteration 1 MIMO antenna.

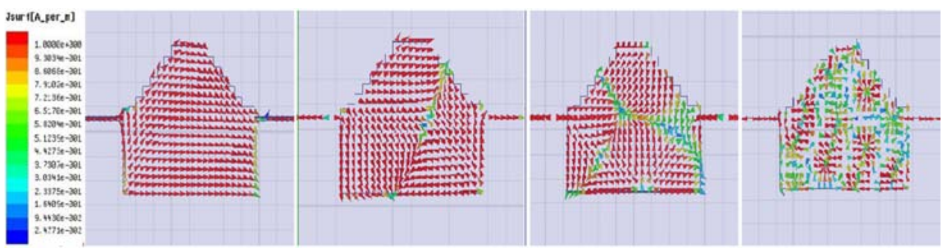

Figure-12. Current distribution of iteration 2 MIMO antenna.

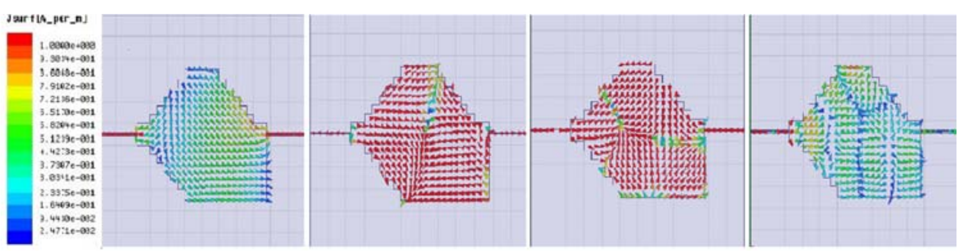

Figure-13. Current distribution of iteration 3 MIMO antenna.

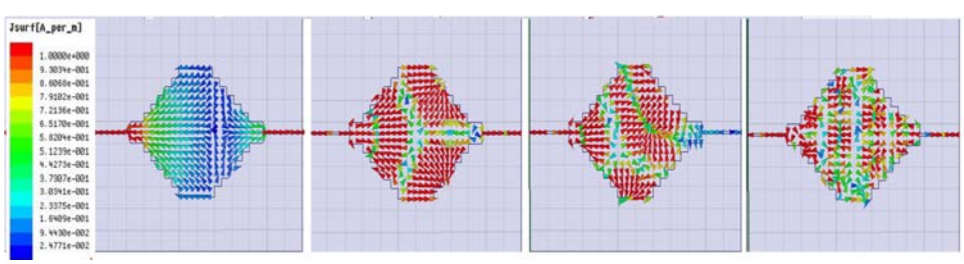

Fig.14. Current distribution of iteration 4 MIMO antenna.

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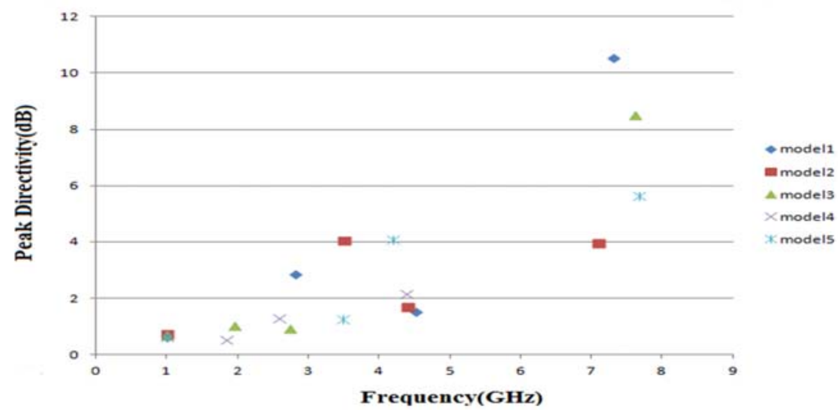

Figure-15. Frequency vs directivity of the proposed MIMO antenna.

Figure-15 is showing frequency Vs directivity of all the models. Basic model is showing maximum directivity of -11dB at higher resonant frequency. The proposed MIMO antenna model is showing directivity more than 5.5dB at highest resonant frequency of 7.6GHz. Figure-16 shows the MIMO antenna under testing connected to ZNB 20 vector network analyzer. Both S11 and S12 parameters can be observed on the screen of the VNA.

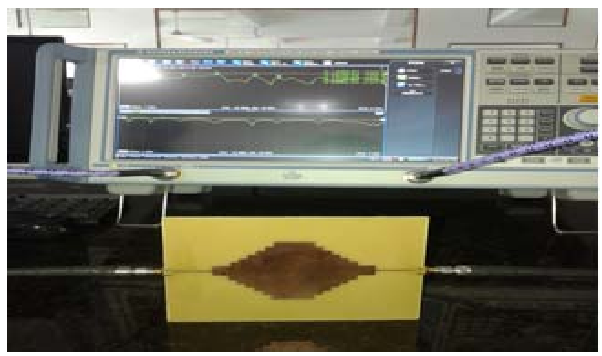

Figure-16. Fabricated MIMO antenna under testing.

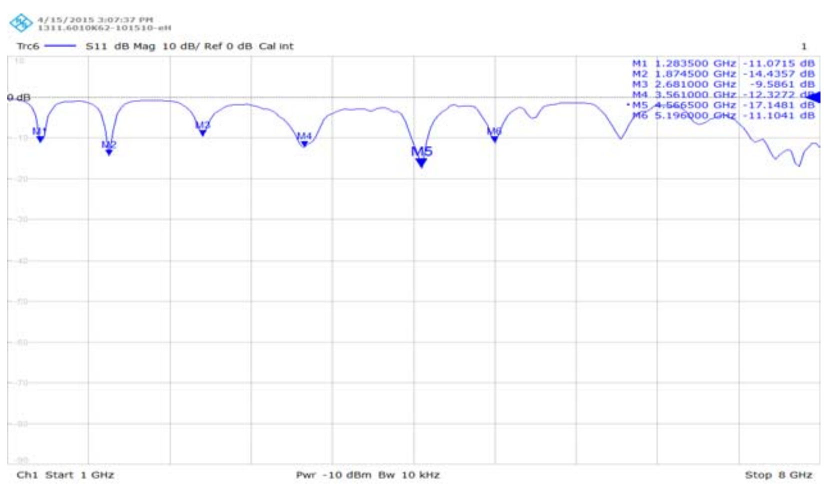

Figure-17. Measured result of S11 from ZNB 20 vector network analyzer.

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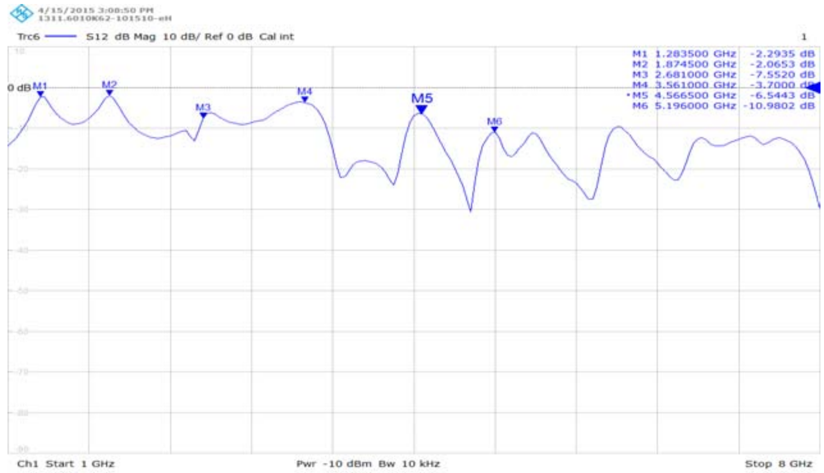

Figure-18. Measured result of S12 from ZNB 20 vector network analyzer.

Figure-17 shows the measured S11 value of the MIMO antenna and Figure-18 shows the measured S12 value of the MIMO antenna at its corresponding resonant frequencies. We observed that the measured and simulated values are exactly coincidence with each other.

CONCLUSIONS

A multiple input multiple output antennas for S and C-band applications are designed and prototyped in this work. The proposed model consisting of two ports with step serrated structure on the radiating element gives rise to multiple bands of resonant frequencies. The prototyped model on FR4 substrate is giving supporting results to the measured results from the vector network analyzer R and S ZNB 20. The proposed antenna is giving superior results compared to traditional antennas with respect to its reflection coefficient and radiation characteristics.

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REFERENCES

[1] D. W. Bliss, K. W. Forsythe, and A. M. Chan. 2005. MIMO wireless communication. Lincoln Lab. J. 15: 97-126.

[2] B.T.P. Madhav, VGKM Pisipati1, Habibulla Khan, V.G.N.S Prasad, K. Praveen Kumar, KVL Bhavani and M.Ravi Kumar. 2011. Liquid Crystal Bow-Tie Microstrip antenna for Wireless Communication Applications. Journal of Engineering Science and Technology Review ISSN: 1791-2377, 4(2): 131-134.

[3] M. S. Sharawi. 2013. Printed multi-band MIMO antenna systems and their performance metrics. IEEE Antennas Propag. Mag. 55(5): 218-232.

[4] B.T.P.Madhav, S.S.Mohan Reddy, Neha Sharma, J. Ravindranath Chowdary, Bala Rama Pavithra, K.N.V.S. Kishore, G. Sriram, B. Sachin Kumar. 2013. Performance Characterization of Radial Stub Microstrip Bow-Tie Antenna. International Journal of Engineering and Technology (IJET), ISSN: 0975-4024, 5(2): 760-764.

[5] B.T.P.Madhav, G. Vaishnavi, V. Manichandana, Ch Harinath Reddy, S. Ravi Teja, J. Sesi Kumar. 2013. Compact Sierpinski Carpet Antenna on Destructive Ground Plane. International Journal of Applied Engineering Research, ISSN 0973-4562, 8(4): 343-352.

[6] S. Shoaib, I. Shoaib, N. Shoaib, X. Chen, and C. G. Parini. 2014. Design and performance study of a dual-element multiband printed monopole antenna array for MIMO terminals. IEEE Antennas Wireless Propag. Lett. 13: 329-332.

[7] B T P Madhav, A Manikanta Prasanth, Sreeramineni Prasanth, Batchu Mohan Sai Krishna, Devani Manikantha, Usirika Sharmila NagaSai. 2015. Analysis of Defected Ground Structure Notched Monopole Antenna. ARPN Journal of Engineering

ARPN Journal of Engineering and Applied Sciences

and Applied Sciences, ISSN 1819-6608, 10(2): 747-752.

[8] M S S S Srinivas, T V Ramakrishna, B T P Madhav, N Bhagyalakshmi, S Madhavi, K Venkateswarulu. 2015. A Novel Compact CPW Fed Slot Antenna with EBG Structure. ARPN Journal of Engineering and Applied Sciences, ISSN 1819-6608, 10(2): 835-841.

[9] X. Zhou, X. L. Quan and R. L. Li. 2012. A dual-broadband MIMO antenna system for GSM/UMTS/LTE and WLAN handsets. IEEE Antennas Wireless Propag. Lett. 11: 551-554.

[10] B. T. P. Madhav, Sarat K. Kotamraju, P. Manikanta, K. Narendra, M. R. Kishore and G. Kiran. 2014. Tapered Step CPW-Fed Antenna for Wideband Applications. ARPN Journal of Engineering and Applied Sciences, ISSN 1819-6608, 9(10): 1967-1973.

[11] P. Syam Sundar, B.T.P. Madhav, D. Sri Harsha, P. Manasa, G. Manikanta and K. Brahmaiah. 2014. Fabric Substrate Material Based Multiband Spike Antenna for Wearable Applications. Research Journal of Applied Sciences, Engineering and Technology, ISSN: 2040-7459, 8(3): 429-434.

[12] B T P Madhav, VGKM Pisipati, Habibulla Khan, D Ujwala. 2014. Fractal shaped Sierpinski on EBG structured ground plane. Leonardo Electronic Journal of Practices and Technologies, ISSN 1583-1078, (25): 26-35.

[13] R. Karimian, H. Oraizi and M. Farahan. 2013. Novel F-shaped quad-band printed slot antenna for WLAN and WiMAX MIMO systems. IEEE Antennas Wireless Propag. Lett. 12: 405-409.

[14] B. Sadasivarao, B. T. P. Madhav. 2014. Analysis of Hybrid Slot Antenna based on Substrate Permittivity. ARPN Journal of Engineering and Applied Sciences, ISSN 1819-6608, 9(6): 885-890.