ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 5, Issue 5, May 2016

Design of 4 Elements Rectangular Microstrip Patch Antenna with High Directive Gain

R. A. Pandhare, P. L. Zade, M. P. Abegaonkar

***Abstract*—The objective of this paper is to obtained high directive gain by implementing array method to microstrip antenna for S band (5.2 GHz) application. Initially we set our antenna as a single element microstrip patch antenna and after evaluating the outcomes of antenna features; operation frequency, radiation patterns, reflected loss, efficiency and antenna gain, we transformed it to a 2x1 linear array. Finally, we analyzed the 4x1 linear antenna arrays to increase directivity, gain, and efficiency and have better radiation patterns. The design and results of a single element, 2x1 elements and 4x1 element patch antenna are detailed. A prototype of the antenna was fabricated with the RT-DUROID substrate. Experimental validation of technique is carried out and measured results were found to be comparable with simulated results.**

Keywords — Antenna gain ,Microstrip patch antenna, 2x1 linear array antenna, 4x1 linear array antenna

I. INTRODUCTION

Microstrip antennas are quite and an obvious choice for wireless devices because of its properties like low fabrication cost, light weight & volume, and a low profile configuration as compared to the other bulky type of antennas. It can be easily mounted on rockets, missiles and any conformal shaped satellites without major modification and arrays of these antennas can simply be produced [1]. Microstrip antennas are very versatile and are used, among other things, to synthesize a required pattern that cannot be achieved with a single element. In addition, they are used to scan the beam of an antenna system, increase the directivity, and perform various other functions which would be difficult with any one single element. The elements can be fed by a single line or by multiple lines in a feed network arrangement, so in this paper we used an array to develop the performance of this antenna [2]

II. SINGLE ELEMENT MICROSTRIP PATCH ANTENNA

A reference single element microstrip patch antenna is shown in Figure1.In this design, the substrate RT DUROID was used. The substrate with height 0.762 mm, dielectric constant 2.2 and the loss tangent 0.0004 was used. The CST Microwave studio tool was used to optimize the dimensions of newly designed antenna.

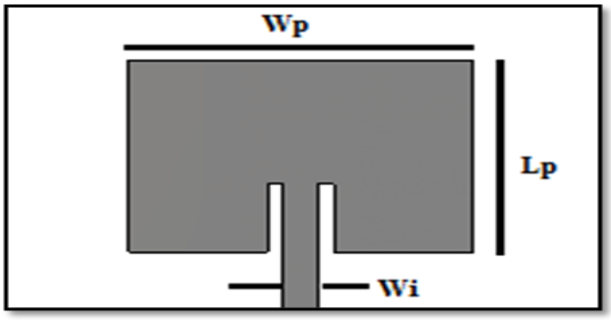

Figure 1: Reference Single Element antenna

A metal patch (Lp=18.6 mm and Wp=22.80 mm) was connected to 50 ohm feed line with an inset on the top of the substrate. The dimensions of inset feed were Li=11 mm and Wi=2.3 mm. Figure 2 shows the simulated result of reference antenna, S_{11} versus frequency indicating fundamental resonance frequency .The polar plot at Phi=90 as shown in Figure3

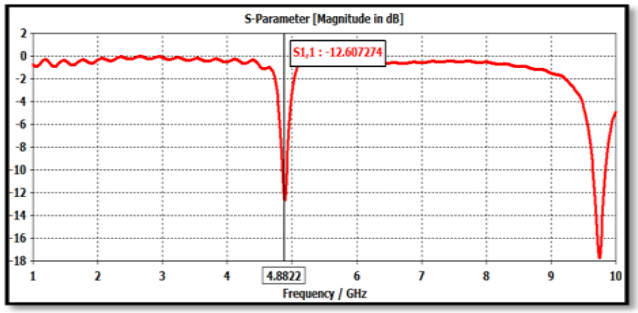

Figure 2. Simulated S11 of the patch antenna resonating at 5.2 GHz

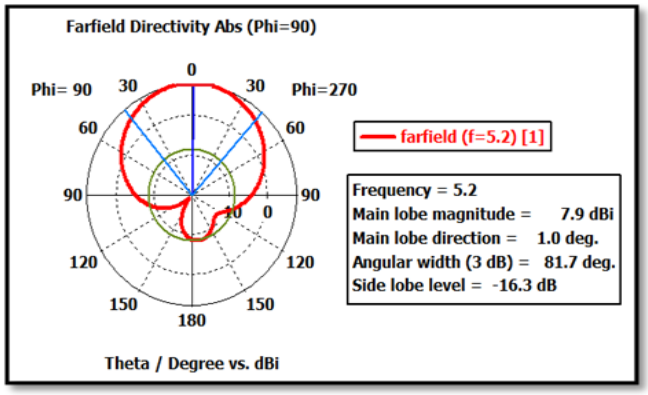

Figure 3. Reference Antenna radiation pattern at Phi=90

The design and simulation of the single element antenna has been carried out. Fig. 2 shows [S_{11}] dB of the antenna resonates at frequency 5.2 GHz with the gain 7.9 dBi. The main objective of this work is to increase the gain of the antenna using an array method. Initially single element antenna transformed to a 2x1 linear array. Finally, we analyzed the 4x1 linear antenna arrays to increase directivity, gain, and efficiency and have better radiation patterns.

III. MICROSTRIP 2X1 ELEMENT PATCH ANTENNA ARRAY

A modified 2x1 element array microstrip patch antenna is shown in Figure 4.The design of 2x1 element microstrip antenna in order to enhance performance of the antenna like increasing gain, directivity scanning the beam of an antenna system, and other functions which are difficult to do with the single element [3].

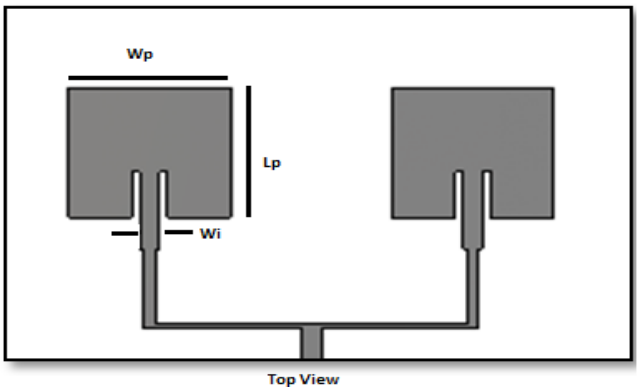

Figure4: Reference 2x1 Element array antenna

A metal patch (Lp=18.6 mm and Wp=22.80 mm) was connected to 50 ohm feed line with an inset on the top of the substrate. The dimensions of inset feed were Li=11 mm and Wi=2.3 mm. The microstrip line 1:2 power divider is used to feed the two antennas and hence the line widths are adjusted according to the power division. Fig.5 shows the simulated result of the modified 2x1 linear array antenna, S_{11} versus frequency indicating fundamental resonance frequency[4]. The polar radiation plots simulated at ϕ=90° are also shown in Fig.6.

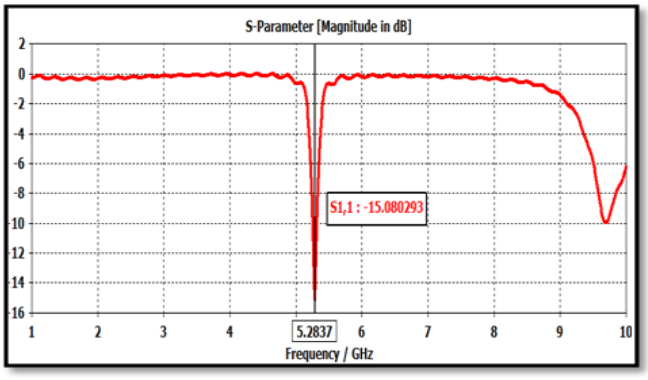

Figure 5. Simulated S11 of the patch antenna array resonating at 5.2 GHz

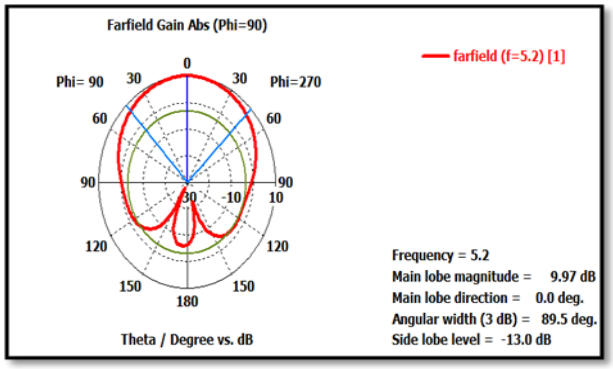

Figure 6: Antenna radiation pattern at Phi=90

From the simulation result it has been observed that 2x1 linear array antenna increases the gain by 2dBi. As the single element reference antenna resonates at 5.2 GHz with the gain 7.9 dBi whereas with the modified 2x1 linear array antenna increases the gain of antenna at 9.97dBi with the same resonates frequency i.e. 5.2 GHz.

IV. MICROSTRIP 4X1 ELEMENT PATCH ANTENNA ARRAY

The proposed antenna is shown in Fig.7. In order to increase the directive gain,4x1 patch antenna array is introduced in this design.Fig.7 shows geometry of proposed 4x1 element array microstrip patch antenna

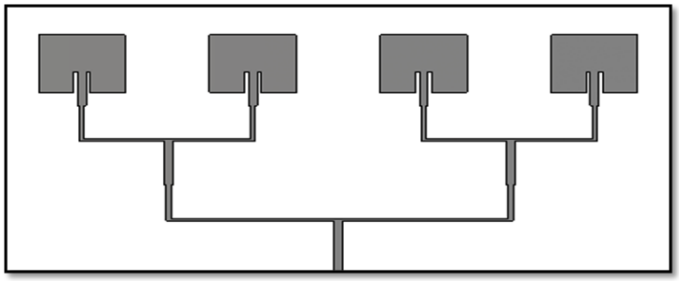

Figure7: Proposed 4x1 Element array antenna

Fig.8 shows the simulated result of the modified 4x1 array antenna, S_{11} versus frequency indicating fundamental resonance frequency .The polar plot at Phi=90 as shown in Fig.9.

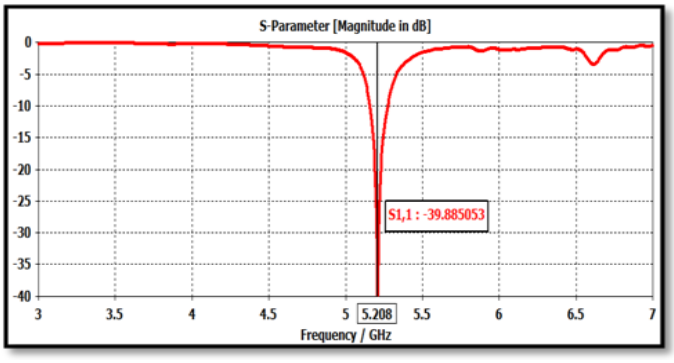

Figure 8. Simulated S11 of the patch antenna antenna array resonating at 5.2 GHz

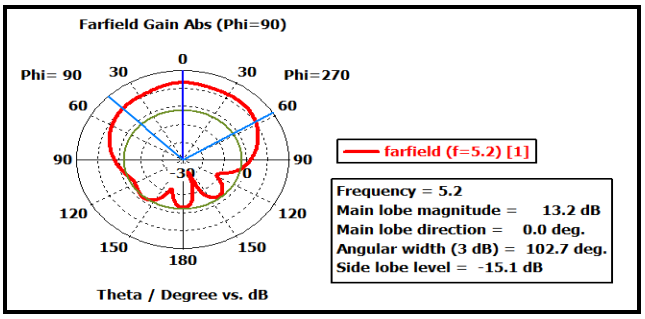

Figure 9: Antenna radiation pattern at Phi=90

From the simulation result it has been observed that 4x1 linear array antenna increases the gain by 6 dBi as compared to single element reference antenna as shown in table1. As the single element reference antenna resonates at 5.2 GHz with the gain 7.9 dBi whereas with the modified 4x1 linear array antenna increases the gain of antenna at 13.2 dBi with the same resonates frequency i.e. 5.2 GHz.

Parameter	Single Element Antenna	2 by 1 Antenna Array	4 by 1 Antenna Array
S11	-12.89dB	-15.09dB	-39.65dB
Gain	7.99dBi	9.9dBi	13.22dBi

Table1. Parameter comparison of different proposed antenna

V. Fabrication and Measurement

A prototype of single element microstrip patch antenna was fabricated as reference antenna as shown in Fig 10.Whereas 2x1 and 4x1 linear array antenna fabricated as proposed antenna as shown in Fig.11 and Fig.12 respectively. Performance of antenna measured experimentally shows an excellent agreement with the simulated result.

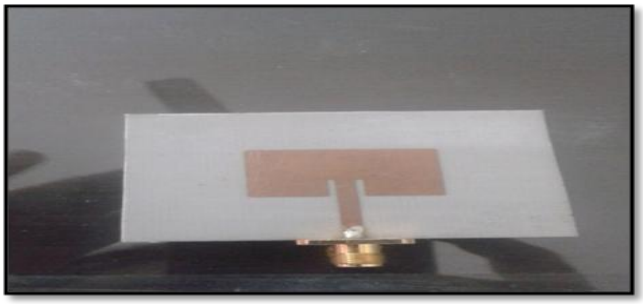

Figure 10. Prototype of the fabricated single element microstrip patch antenna

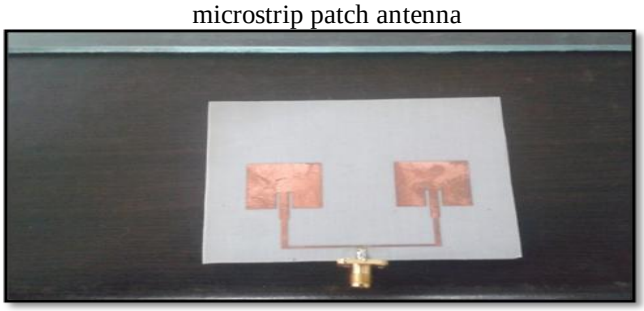

Figure 11. Prototype of the fabricated 2x1 element microstrip patch antenna array

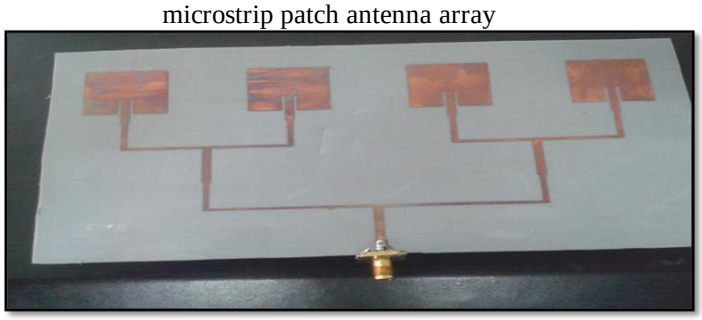

Figure 12. Prototype of the fabricated 4x1 element regular rectangular microstrip patch antenna array

VI. Conclusion

In this work, array of antenna was presented to enhance the gain of antenna. This proposed 4x1 array antenna has high gain about 13.22dBi with good impedance matching. The gain obtained by array method is much higher than single element antenna. This feature makes the proposed antenna
appropriate for many applications such as radar and wireless networks.

Acknowledgment

The authors expresses deep sense of gratitude to the Centre of Applied Research, IIT, New Delhi for the support in carrying out design, experimentation and fabrication of Antenna.

REFERENCES

[1] *Balanis, C.A.*, Antenna Theory: Analysis and Design, John Wiley & Sons, Inc New Jersey, 1997.

[2] *Garg R , Bhartia P, Bahl I, Ittipiboon A,* Microstrip Antenna Design Handbook, Artech House, Norwood 2000.

[3] *M. Bemani and S. Nikmehr* A Novel Wide-Band Microstrip Yagi-Uda Array Antenna For Wlan Applications, *Progress In Electromagnetics Research B, Vol. 16, 389–406, 2009*

[4] Pandhare R A, Zade P L, M. P. Abegaonkar , Harmonic Control by Defected Ground Structure on Microstrip Antenna array, International Journal of Electronics and Communication Engineering,Vol.10,Issue 6

[5] *Arya A K, Patnaik A, kartikeyan M. V.*, Gain Enhancement of Micro-strip patch antenna using Dumbbell shaped Defected Ground Structure, International Journal of Scientific Research Engineering & Technology, Volume 2 Issue 4, pp 184-188, July 2013

[6] *M. Ghiyasvand, A. Bakhtiari, R. A. Sadeghzadeh,* Novel Microstrip Patch Antenna to Use in 2×2 Sub Arrays for DBS Reception, Indian journal of science and technology, Volume 5, Issue 7, July 2012 .

[7] *Pandhare R A, Zade P L* ,Dual Band Compact Microstrip Patch Antenna with Defected Ground Structure" International Journal of Electronics and Communication Engineering & Technology (IJECET), Volume 06, Issue 09, (September 2015)

[8] B. P. Kumar and G. R. Branner, "Design of unequally spaced arrays for performance improvement," IEEE Trans. Antennas Propag., vol. 47, pp. 511-523, Mar.1999.

Ms. Rashmi Pandhare received her BE in Instrumentation and Control systems from Pune university, Maharashtra & M.Tech in Electronics from Nagpur University, Maharashtra, India. She is presently working as a Head of Electronics Engineering Department, DMIETR, Wardha. Currently she is pursuing her PhD under the guidance of Prof. P.L.Zade, University of Nagpur, Maharashtra, India. Her areas of interest are Microstip Antenna, Defected Ground Structure (DGS) in Antenna. She contributed more than 15 research papers in national and international journals and conference.

Dr. Prasanna L. Zade is currently Professor & Head of Electronics & Telecommunication Engineering, at Yeshwantarao Chavan College of Engineering, Nagpur (India). He is postgraduate in Electronics Engineering and completed his doctoral degree from RTMNU, Nagpur. He has research and teaching experience of 23 years in the field of Antenna and Wireless Technology. He contributed more than 50 research papers in National & International journals &conferences. He is best paper award winner at CCCCI-2011 at Bangkok, Thailand.

Dr.Mahesh Abegaonkar completed his M.Sc. in Physics from BAM University, Aurangabad, Maharashtra in 1995 and Ph.D. in Physics from Department of Physics, University of Pune, Pune, Maharashtra in 2002. He has worked with Kyungpook National University, Daegu, South Korea as a Post-Doctoral Researcher and Assistant Professor during2002-2004. He joined CARE, IIT Delhi as an Assistant Professor in Feb. 2005. He contributed more than 100 research papers in National & International journals &conferences..