International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-9 Issue-1S5, December 2019

A 2×2 Antenna Array for L Band Phased Array RADAR Applications

K. Satish, M.Sekhar

Abstract— ***A Four element antenna array for the Phase array RADAR applications in the L Band with an operating frequency of 1.32GHz is presented. The four patches are been connected to four different transmitter circuit with which we can control the phase of the input signal. The antenna is having a size of 212mm×212mm×1.6mm with a gain of 8.78dB and directivity of 10.31dB at the operating frequency of 1.32GHz.. Low cost FR4 material is been used as the laminate base for the antenna which will act as the dielectric material.***

Keywords— ***Coax Feed, Phased Array, RADAR Applications.***

I. INTRODUCTION

To meet the requirement of long coverage area of the modern communication systems the need for antennas with high gain is increasing day by day and it has become a challenge for the designers to achieve high gain from microstrip antennas which are known for their disadvantages of low gain and low radiation efficiency. To achieve high gain we can make an antenna array from individual antenna elements such that the radiated power from each antenna is in phase with the remaining antennas and the power from all the antenna elements will be combined into single beam. Researchers around the world proposed different techniques to overcome these limitations and to enhance them. In [1] the authors proposed considering a air gap in between the ground plane and the substrate. In [2] a technique has been proposed to increase the gain of the antenna by taking a group of antennas and joining them as an array such that the power from all the individual elements will combine and form a single beam. In [3] Stacked patch techniques has been proposed which can be used for both gain enhancement and bandwidth enhancement depending upon the dimensions of the parasitic patch element. In [4] the authors proposed considering a air gap in between the ground plane and the substrate. In [5] a technique has been proposed to increase the gain of the antenna by taking a group of antennas and joining them as an array such that the power from all the individual elements will combine and form a single beam. In [6] Stacked patch techniques has been proposed which can be used for both gain enhancement and bandwidth enhancement depending upon the dimensions of the parasitic patch element. But all these techniques have complexity in designing either in terms of designing or in terms of cost.

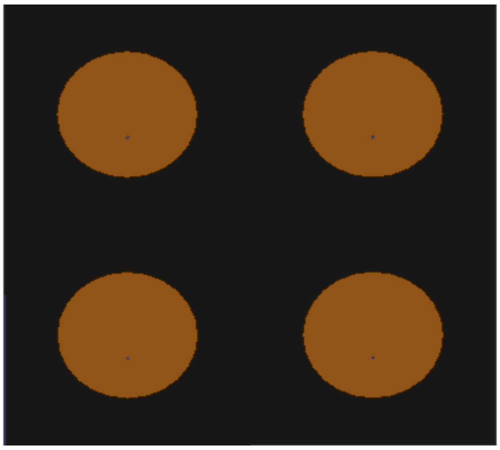
Manuscript published on 30 December 2019.
***** Correspondence Author (s)
K Science**. Satish,** Assistant Professor, Dept. of E.C.E, Vignan's Foundation For Technology and Research, Guntur, India.
M.Sekhar, Assistant Professor, Dept. of E.C.E, Vignan's Foundation For Science Technology and Research, Guntur, India.

So to overcome these limitations we proposed a technique of Dielectric Resonator Antenna(DRA) where we use Dielectric material as a radiator instead of conductor. In [7] an four element antenna array has been proposed where all the four elements are been excited with a single feed and because of this the control over the phase of the input signal is not possible which is very essential in the phased array antenna applications especially in RADRA's where we need to steer the beam in different directions. In [8] an four element antenna array has been proposed where a separate feeding structure has been used to excite the individual antenna elements. For this proximity feeding concepts are been used which will require two different substrates for the development of the antenna and is not encouraged as it will increase the cost of the antenna. In [9] an four element antenna array has been proposed to achieve high gain but to excite the antenna elements a complex directional coupler network has been used and this is bringing difficulty in antenna fabrication and also the feed network is generating some surface waves which will reduce the overall efficiency of the antenna.

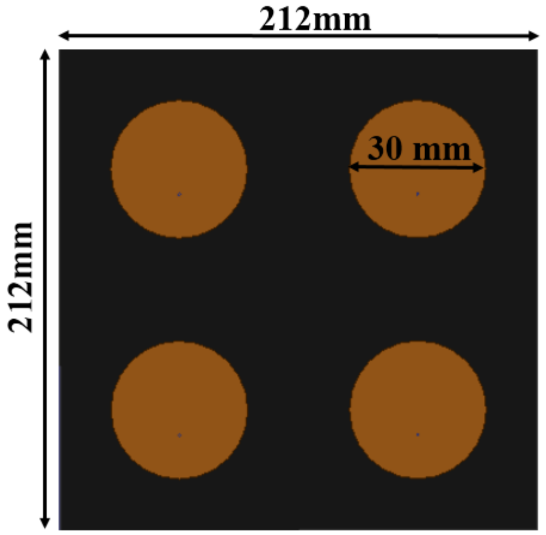
Here, we proposed a four element antenna array which can be used to control the phase of the input signal. By using individual feed elements there is no need of any additional feed network or substrate material or any chance of generation of unwanted surface waves because of the feed network.

II. PROPOSED ANTENNA DESIGN

Proposed design is a four element antenna array. It is having individual feed and excitation is provided to individual antenna element.The radiating elements were circular patches which are designed to operate at an operating frequency of 1.32GHz. Flame Retardent Glass epory material has been used as the substrate material with a size of 212mm×212mm.



(a) Top View of proposed antenna



(b) Schematic Model of Patch

Fig. 1. Proposed antenna

The radiating patch is a circle and is been fed with an probe feed. Proposed antenna elements were excited with four individual feed elements which can provide the input signal to the antenna elements with require phase and amplitude.

III. RESULTS

The performance of the antenna is measured by analyzing various parameters which includes impedance matching and radiation characteristics. Under impedance matching we will verify two parameters namely return loss also called as S_{11} and Voltage standing wave ratio which is simply called as VSWR. [6-7]. Figure 3 shows the S_{11} plot of the antenna from it we can know that the antenna is radiating in the frequency range of 1.29GHz to 1.34GHz with a operating centre frequency of 1.32GHz. It is observed that the return loss value is -32.49dB which indicates a perfect matching of impedance for the antenna with the input power source.

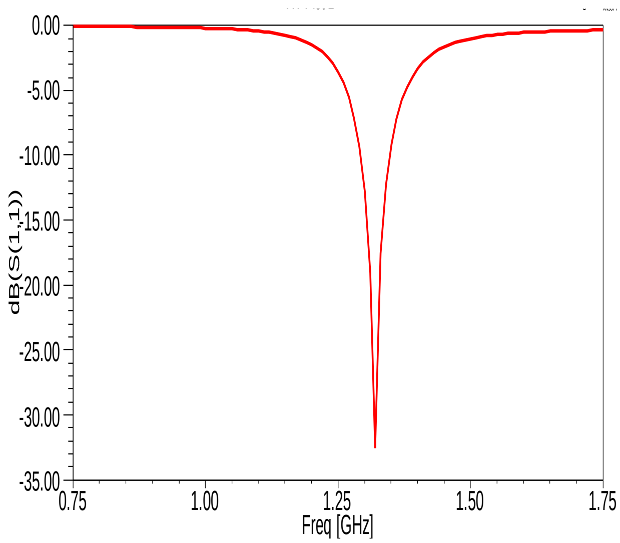


Fig. 3. Return loss

Figure 4 shows the VSWR, from it we can know that the antenna is radiating in the frequency range of 1.29GHz to 1.34GHz with a operating centre frequency of 1.32GHz. It is observed that the VSWR value is 1.04dB which indicates a perfect matching of impedance for the antenna with the input power source.

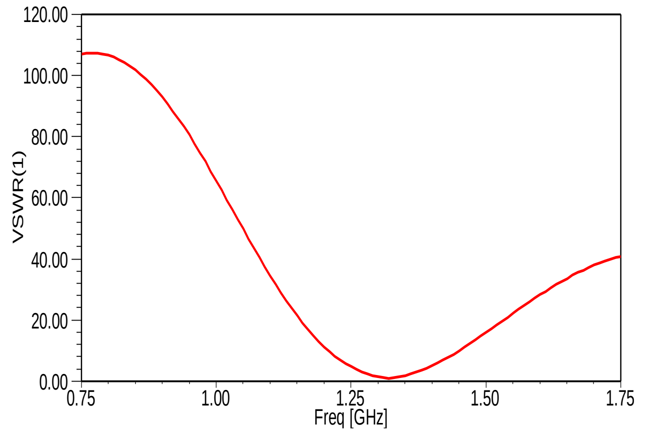


Fig. 4. VSWR

Figure 5, shows the 3D gain plot, figure 6 shows the 2D gain plot and the figure 7 shows the directivity at 1.32GHz, Gain is 8.78dB and the directivity of the antenna is 10.31dB. Figure 6 represents the two dimensional gain plot of the antenna it shows a uniform distribution of the power in different theta angles without any nulls which is very essential for the phased array RADAR applications [8,9]. It is also observed that the gain and directivity are nearly equal which represents that the losses in the proposed antenna are very low.

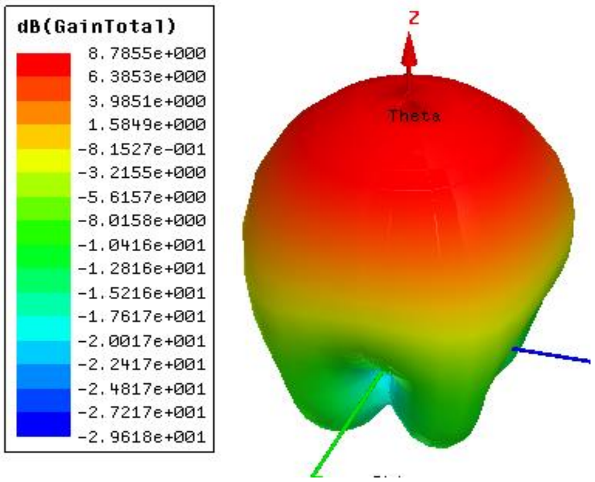


Fig.5. Gain at 1.32GHz

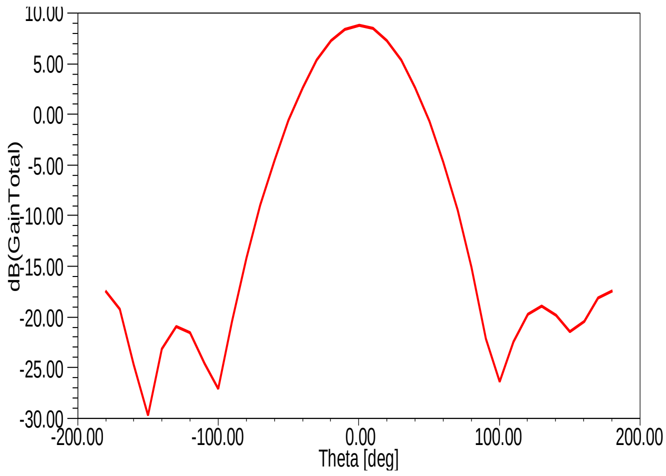


Fig. 6. Gain at 1.32GHz

Retrieval Number: A10171291S52019/2019©BEIESP
DOI:10.35940/ijeat.A1017.1291S519
Journal Website: www.ijeat.org

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

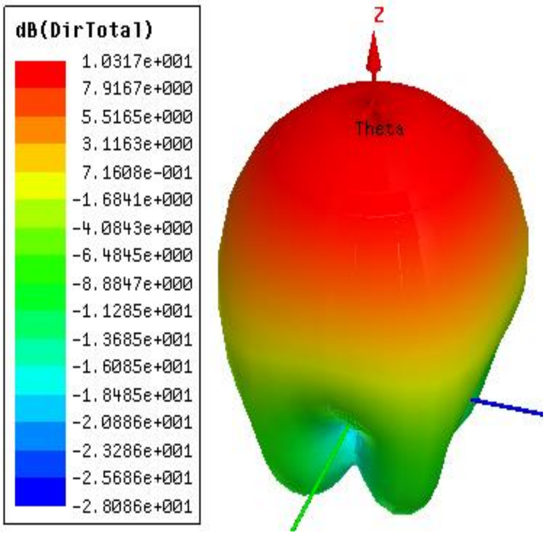


Fig.7. Directivity at 1.32GHz

The radiation characteristics of the antenna at the center frequency of 1.32GHz are shown below in Figure 8. To analyze the radiation characteristics of the antenna we need to check both the elevation plane and azimuthal planes.

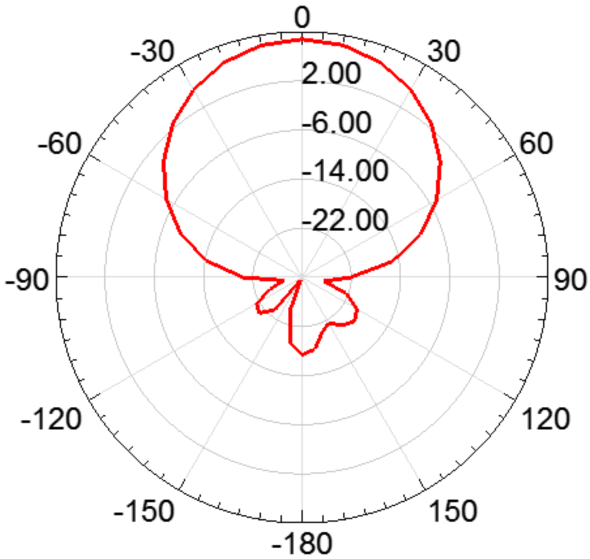


Fig. 8. Elevation Plane Patterns

Here we can observe that at both the patterns are having uniform distribution of the power in different theta angles without any nulls which is very essential for the phased array applications for proper planning of the antenna coverage area. In the Elevation plane and azimuthal plane there are no traces of any side lobes for the antenna array which is very essential for the RADRA applications.

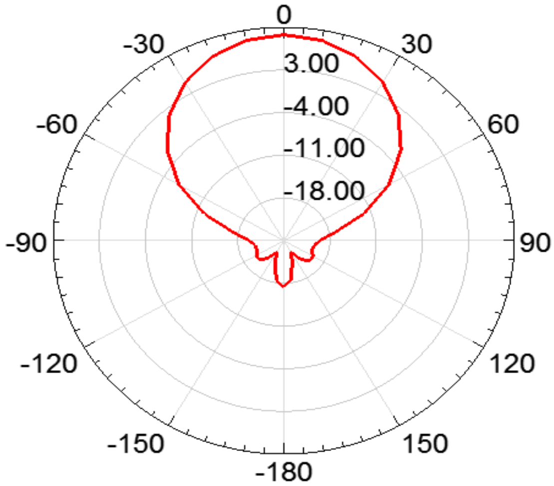


Fig. 9. Azimuthal Plane Patterns

The radiation of the antenna depends on the current fields as shown in figure 10. We can observe that the intensity of the current field is minimum at the center of the patch and maximum at the edges. Figure 11 below shows the smith chart plot of the antenna which represents the variation of the antenna impedance with the frequency.

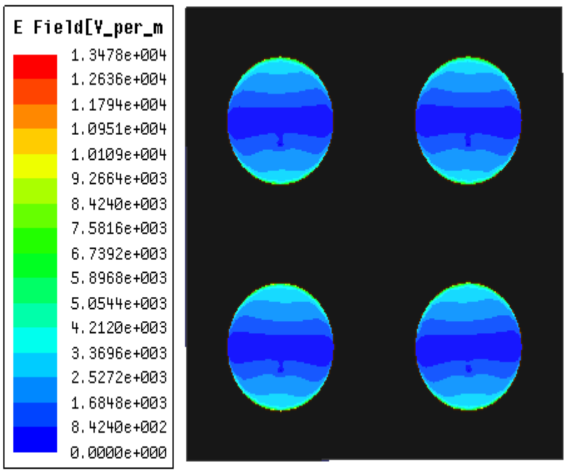


Fig. 10. Current distribution of the patch

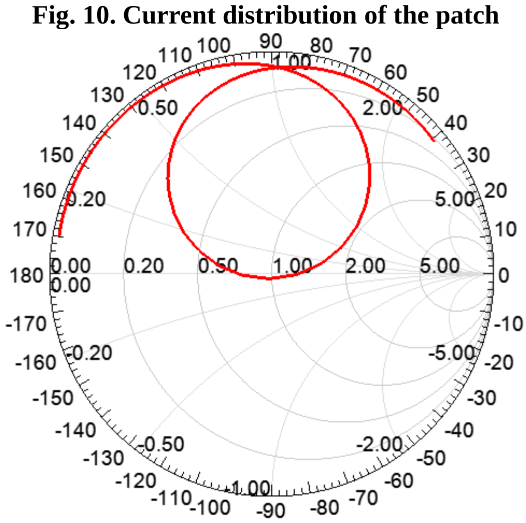


Fig. 11. Smith Chart

IV. CONCLUSION

A Four element antenna array for the Phase array RADAR applications in the L Band with an operating frequency of 1.32GHz is presented. The four patches are been connected to four different transmitter circuit with which we can control the phase of the input signal. The antenna is having a size of 212mm×212mm×1.6mm with a gain of 8.78dB and directivity of 10.31dB at the operating frequency of 1.32GHz.. Low cost FR4 material is been used as the laminate base for the antenna which will act as the dielectric material.

REFERENCES

1. E. Kusuma Kumari, A.N.V.Ravi Kumar. (2017). Wideband High-Gain Circularly Polarized Planar Antenna Array for L Band Radar. IEEE International Conference on Computational Intelligence And Computing Research, Tamilnadu College of Engineering. Tamil Nadu.
2. E. Kusuma Kumari, A.N.V.Ravi Kumar. (2017). Development of an L Band Beam Steering Cuboid Antenna Array. IEEE International Conference on Computational Intelligence And Computing Research, Tamilnadu College of Engineering. Tamil Nadu.
3. Sunkaraboina Sreenu, Vadde Seetharama Rao. (2017). Stacked Microstrip Antenna For Global Positioning System. IEEE International Conference on Computational Intelligence And Computing Research, Tamilnadu College of Engineering. Tamil Nadu.
4. Rao N.A, Kanapala S. (2018). Wideband Circular Polarized Binomial Antenna Array for L-Band Radar. Panda G., Satapathy S., Biswal B., Bansal R. (eds) Microelectronics, Electromagnetics and Telecommunications. Lecture Notes in Electrical Engineering, vol 521. Springer, Singapore
5. Kanapala S, Rao N.A. (2018). Beam Steering Cuboid Antenna Array for L Band RADAR. Panda G., Satapathy S., Biswal B., Bansal R. (eds) Microelectronics, Electromagnetics and Telecommunications. Lecture Notes in Electrical Engineering, vol 521. Springer, Singapore.
6. Sunkaraboina Sreenu, P. Gnanasivam, M. Sekhar (2018). Circular polarised Antenna Array for C Band Applications. Journal of Advanced Research in Dynamical & Control Systems, Vol. 10, 14-Special Issue.
7. K. Ashwini, M. Sekhar, Sunkaraboina Sreenu. (2018). Mutual Coupling Reduction Using Meander Square EBG Structures for C-Band Radars. Journal of Advanced Research in Dynamical & Control Systems, Vol. 10, 12-Special Issue.
8. Sekhar M, S Naga Kishore B, Siddaiah P. (2014). Triple Frequency Circular Patch Antenna. IEEE International Conference on Computational Intelligence And Computing Research, Park College Of Engineering And Tekhnology. Tamil Nadu.
9. J Lavanya, S Nagakishore Bhavanam, Vasujadevi Midasala “Design of Spiral Antenna for Multiband Applications” International Journal of Innovative Technology and Exploring Engineering, Volume-8 Issue-5 March, 2019.

Retrieval Number: A10171291S52019/2019©BEIESP
DOI:10.35940/ijeat.A1017.1291S519
Journal Website: www.ijeat.org

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)