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Performance Analysis of 4*4 Circular Patch Phased Array Antenna Using HFSS

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Abstract: In this paper, we have proposed a phased antenna arrays of 4x4 square grid with circular patch for radar applications designed at 1.35 GHz frequency. The antenna array simulations are carried out by using HFSS software. FR4 epoxy with dielectric constant 4.4 and thickness 5.6 mm is used as substrate. Details of the antenna array design are presented and simulation results are discussed. Phased antenna arrays are useful for many types of applications such as Satellite navigation, Telecommunications, Aircraft surveillance, Amateur radio, Digital Audio Broadcasting and Astronomy.

Keywords: Phased arrays, beam steering, phase shifter.

I. INTRODUCTION

A multiple-antenna system in which the radiation pattern can be reinforced in a particular direction and suppressed in undesired directions is known as a Phased array antenna. This can be achieved by varying the phase of the radiating elements electronically, thereby producing a pattern electronically with high effectiveness managing to get narrow beam widths and minimum side lobe levels. Instead of having mechanical rotation system for entire antenna, The direction of phased array radiation can be electronically steered. These unique capabilities have found phased arrays a broad range of applications since the advent of this technology. Phased arrays have been traditionally used in military applications for several decades. Recent growth in civilian radar-based sensors and communication systems has drawn increasing interest in utilizing phased array technology for commercial applications. Phased array antennas are common in communications and radar and offer the benefit of agile operational conditions, far-field beam shaping and steering for specific. They are especially useful in advanced space time adaptive signal processing and modern adaptive radar systems where there is a trend toward active phased arrays. In phased arrays by applying a progressive phase shift across the array aperture all the antenna elements are excited simultaneously and the main beam of the array is steered.

II. DESIGN OF MICROSTRIP ARRAY ANTENNA

Microstrip patch antennas are important as single radiating elements but their major advantages are realized in application requiring moderate size arrays. The primary radiator microstrip antenna is designed with frequency f = 1.35 GHz which gives single element microstrip antenna as shown in Figure 1. and the feed is shown in the Figure 2. The dimensions of the patch are calculated using formulae found in [4]. Single patch is extended to sixteen element microstrip array shown in Figure 3. And the sixteen element feed is shown in Figure 4.

Further, to achieve beam steering the input phase angel of the individual element is changed so as to achieve the required output. The above antennas are simulated and optimized using commercially available HFSS software, various antenna parameters are shown in Table 1.

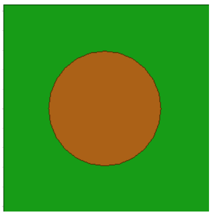

Fig. 1.Single Circular patch antenna

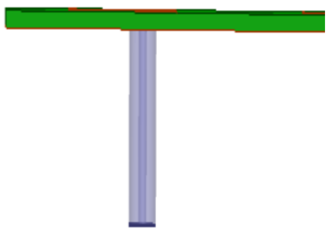

Fig. 2.Single Element Feed

The array is developed without any spacing in between the individual antenna elements.

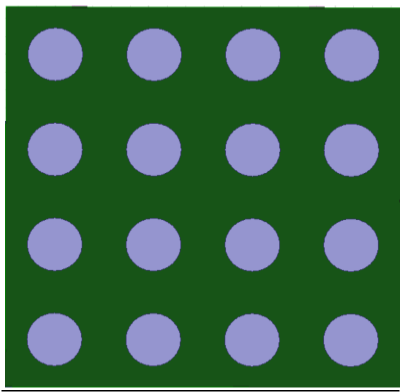

Fig. 3. 4x4 Circular patch array

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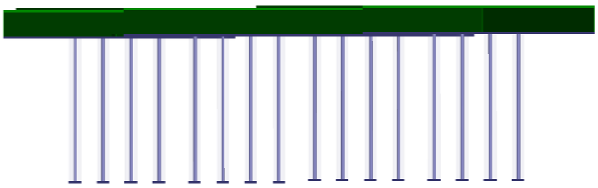

Fig. 4.16 element Feed

Table. 1. Individual Antenna Parameters

Individual Antenna Parameters	Value (mm)
Length of Substrate	24
Width of Substrate	24
Circular patch radius	6.74

III. RESULTS and DISCUSSIONS

The S-parameter (return loss) of the proposed Circular patch antenna and Circular patch antenna array are shown in the Fig. 5. and Fig. 6. Achieved a return loss of -37.96 dB and -27.10 dB at 1.35 GHz respectively.

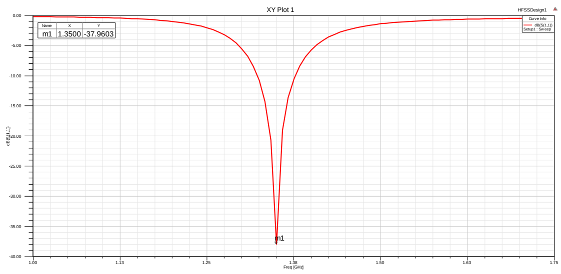

Fig. 5. Return Loss plot for Circular Patch Antenna

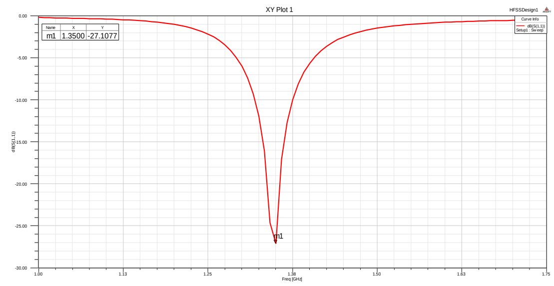

Fig. 6. Return Loss plot for Circular Patch Antenna Array

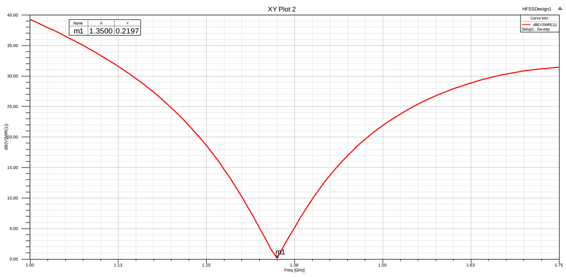

Fig. 7. VSWR plot for Circular Patch Antenna

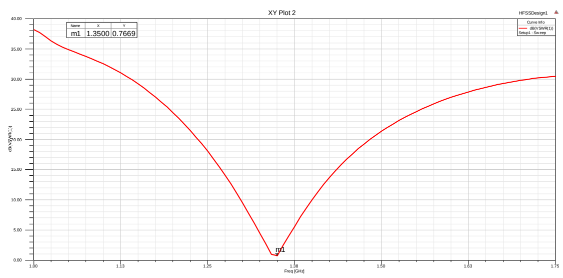

Fig. 8.VSWR plot for Circular Patch Antenna Array

The VSWR of the proposed Circular patch antenna and Circular patch antenna array are shown in the Fig. 7. and Fig. 8. Achieved a VSWR value of 0.21 dB and 0.76 dB at 1.35 GHz respectively.

The radiation pattern (E-Plane) of the Circular patch antenna and Circular patch antenna array at different input phase angles are shown in the Fig. 9 to Fig. 12 from the results it is observed that the proposed antenna is having Omni Directional radiation pattern which is well suited for the radar applications.

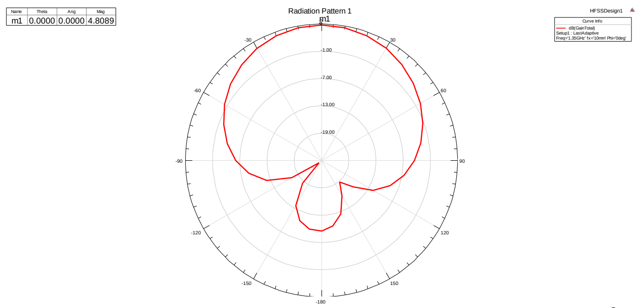

Fig. 9. E - Plane plot for Circular Patch Antenna with 0^0 phase shift

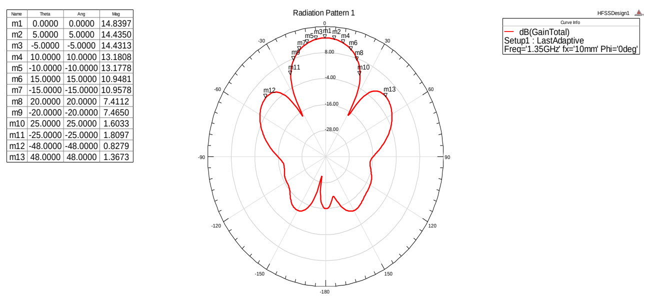

Fig. 10. E - Plane plot for Circular Patch Antenna Array with 0^0 phase shift for individual element

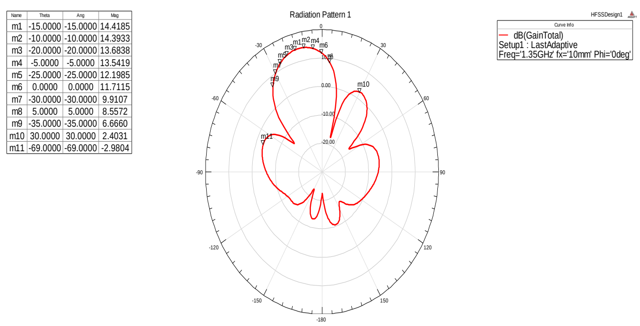

Fig. 11. E - Plane plot for Circular Patch Antenna Array with 10^0 phase shift for individual element

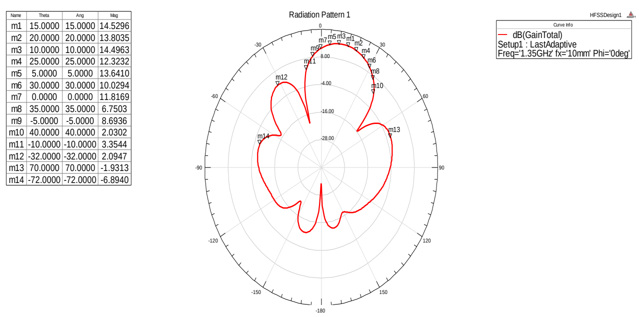

Fig. 12. E - Plane plot for Circular Patch Antenna Array with -10^0 phase shift for individual element

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The 3D Polar plot of the antenna at different input phase angles are shown in the Fig. 13 to Fig. 16 from the results it is observed that the proposed antenna is having a stable gain for all the input phase angles.

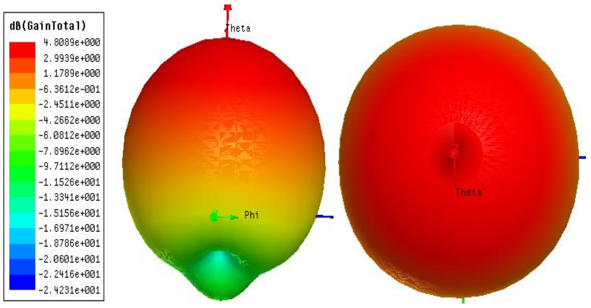

Fig. 13. 3D-Polar Plot for circular patch antenna

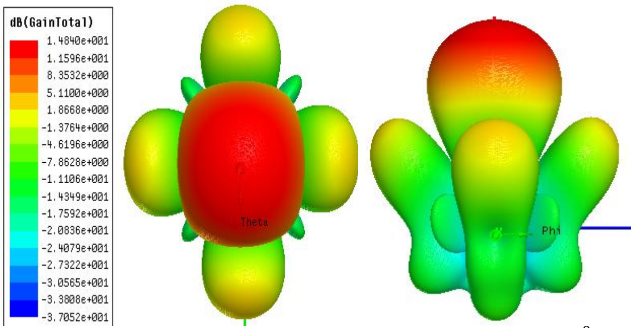

Fig. 14. 3D-Polar Plot for circular patch array with0^0 phase shift for for individual element

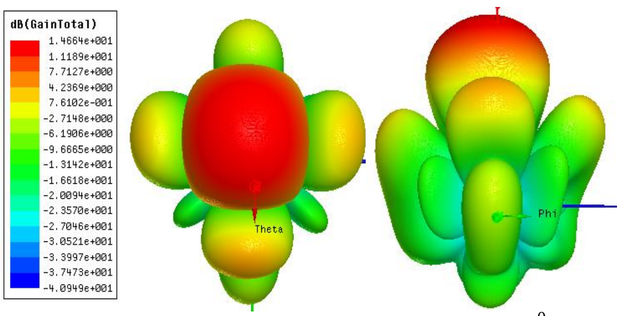

Fig. 15.3D-Polar Plot for circular patch array at 10^0 phase shift for individual element

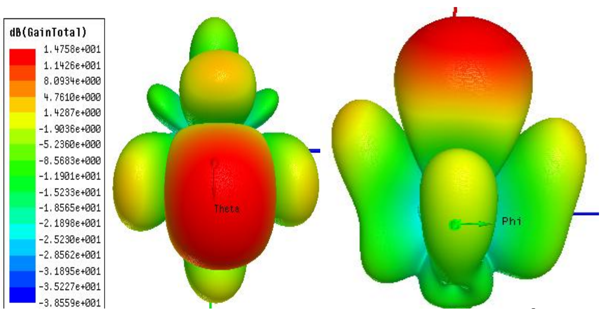

Fig. 16.3D-Polar Plot for circular patch array at -10^0 phase shift for individual element

IV. CONCLUSION

Phased array antennas are capable of providing a directional beam that can be electronically steered and can significantly enhance the performance of sensors and communications systems. The directional beam of a phased array also allows for a more efficient power management. In addition, by suppressing signals emanating from undesirable directions the spatial filtering nature of the phased array systems alleviate the problem of multipath fading and co-channel interference.

REFERENCES

[1] P. Ioannides, and C.A. Balanis, “Uniform circular and rectangular arrays for adaptive beamforming applications”, IEEE Antennas and Wireless Propagation Megazine, 2005, pp. 192-206.

[2] D. Ehyaie and A. Mortazawi, "A 24-GHz Modular Transmit Phased Array,"Microwave Theory and Techniques, IEEE Transactions on, vol. 59, pp. 1665-1672, 2011.

[3] A. Dalli, L. Zenkouar and S. Bri, “Study of Circular Sec-tor Patch Array Antenna with Two and Four Elements for C and X Band,” European Journal of Scientific Research, Vol. 81, No. 2, 2012, pp. 150-159.

[4] A. Natarajan, S. K. Reynolds, T. Ming-Da, S. T. Nicolson, J. H. C. Zhan, K. DongGun, L. Duixian, Y. L. O. Huang, A. Valdes-Garcia, and B. A. Floyd, "A Fully- Integrated 16-Element Phased-Array Receiver in SiGeBiCMOS for 60-GHz Communications," Solid-State Circuits, IEEE Journal of, vol. 46, pp. 1059-1075, 2011.

[5] K. Meena and A. P. Kabilan, “Modeling and Simulation of Microstrip Patch Array for Smart Antennas,” International Journal of Engineering, Vol. 3, No. 6, 2010, pp. 662-670.

[6] V. R. Anitha and N. Reddy, “Design of an 8 × 1 Square Microstrip Patch Antenna Array,” International Journal of Electronic Engineering Research, Vol. 1, No. 1, 2009, pp. 71-77

[7] R. J. Mailloux, J. F. McIlvenna and N. P. Kernweis, “Microstrip Array Technology,” IEEE Transactions on Antennas and Propagation, Vol. 29, No. 1, 1981, pp. 25-37. doi:10.1109/TAP.1981.1142525

[8] Sekhar M, P Siddaiah “Performance of Feed on Dual Frequency Antenna in Ka-Band,” IJIREEICE, Vol. 2, Issue 5, May 2014.

[9] R.L. Haupt, Antenna Arrays: A Computational Approach, Wiley-IEEEPress, 2010.

[10] R. Vescovo, “Array factor synthesis for circular antenna arrays”, Antennas and Propagation Society International Symposium, AP-S. Digest. 1993.

BIOGRAPHIES

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