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Comparison of Performance Characterization in 2X2, 3X3 and 4X4 Array Antennas

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Abstract:
The best way of gain enhancement can be obtained is from the array models, but there are some problems associated with array antennas. Mutual coupling losses, element spacing and design complexity are major concerns in the array antennas. The present paper deals with the performance characterization among the 2X2, 3X3, 4X4 array antennas. Rectangular patch array models are constructed and simulated using Ansoft HFSS. Antenna output parameters and antenna performance characteristics are presented in this current work.

Keywords: Performance Characterization, Array Antenna, Gain Enhancement.

I. Introduction:

The microstrip patch antennas are using in number of applications like in mobile communications, satellite communication, GPS applications, wireless communication etc. The main problem associated with the micro strip patch antenna includes Low efficiency, High quality factor, Low power handling capacity, Poor polarization purity. But advantages include Low profile, Compact size, Planer configuration, Low weight, Easy to fabricate [1-4].

The performance of micro strip antenna mainly depends on the substrate material, dimension of antenna, feeding technique. The array of patch elements is used instead of single patch to enhance the gain and the band width. By controlling the dimension of the antenna by using slot models and by choosing proper dielectric constant with suitable substrate will provide some improvement in band width. This paper mainly focuses on different types of array antennas and the performance characterization of these antennas with respect to antenna output parameters [5-8].

The electromagnetic band gap materials are using by different people in their work for designing the antennas to enhance the gain band with product. EBG structures are generally known as photonic band gap structures which associated with the area of optics. Generally EBG is a periodic structure that forbids the propagation of electromagnetic surface waves with in a particular frequency band called band gap. EBG also permits additional control of the behavior of electromagnetic waves in a different way from conventional guiding or filtering structures. EBG having a capability to provide a simple and efficient solution for problems of surface and leaky waves. The performance of antennas and input impedance matching characteristics can be improved by EBG structures [9-10].

A comparative study is done on different types of arrays like 2*2, 3*3, 4*4 antenna arrays and their performance characteristics presented and an analytical study is done by considering performance of all the structures. Figure (1) shows the different antenna array models designed and generated by Ansoft HFSS. The systematic evaluation is done by considering the planar array models and all the output characteristics are presented based on the simulation results.

A typical 2X2, 3X3 and 4X4 patch antenna arrays with finite ground planes are shown in figure (1), (2) and (3). The antenna dimension of 70X70mm is used for all the models except the patch dimension and spacing between them.

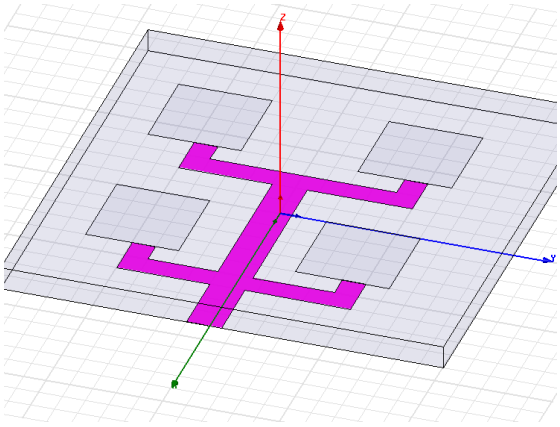


Fig (1) 2X2 Rectangular Array Patch

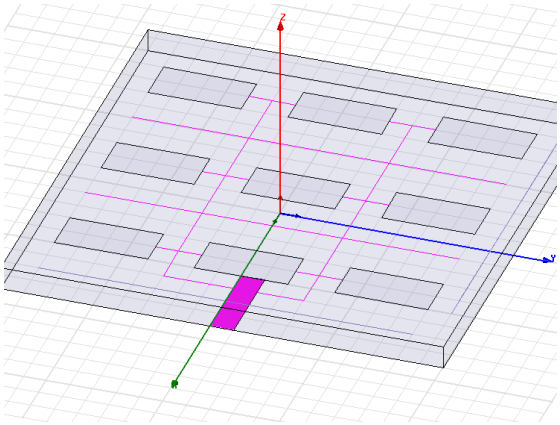


Fig (2) 3X3 Rectangular Array Patch

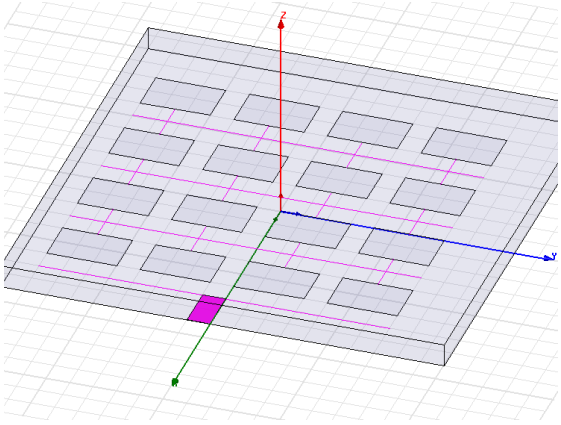


Fig (3) 4X4 Rectangular Array Patch

II. Results and Discussion:

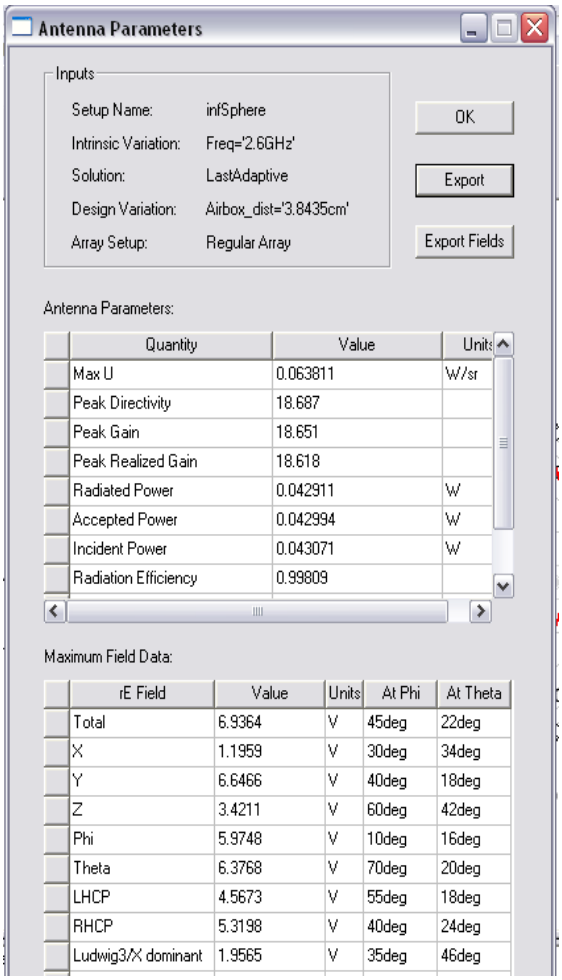
The performance characteristics of all the three models are presented here and the analysis is done depending on the comparative study. Table (1) shows all the three types of antennas output parameters. Table (1) shows the parameters return loss, bandwidth and gain of the three antennas.

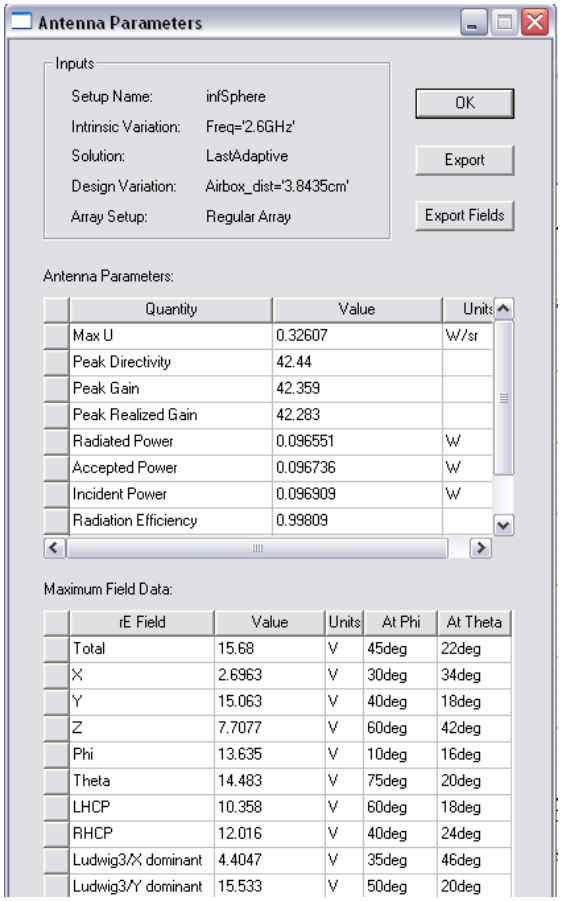
S.No	Array Type	Return Loss	Bandwidth	Gain
1	2X2	-30.11	0.88%	11.54
2	3X3	-30.11	0.89%	15.22
3	4X4	-30.11	0.90%	17.92

Table (1) Antenna Parameters

The return loss is same for 2x2, 3x3 and 4x4 array patch antennas working at 2.6 GHz. The bandwidth and gain are showing some incremented values when array size is increasing. The bandwidth enhancement of 0.01% is observed when we go from 2x2 to 4x4. The main theme of going for array models is for getting better gain. The simulation results showing the gain is increasing if array elements are increasing.

Table (2) shows the Antenna parameters and maximum field data for 2x2, 3x3 and 4x4 patch array models.





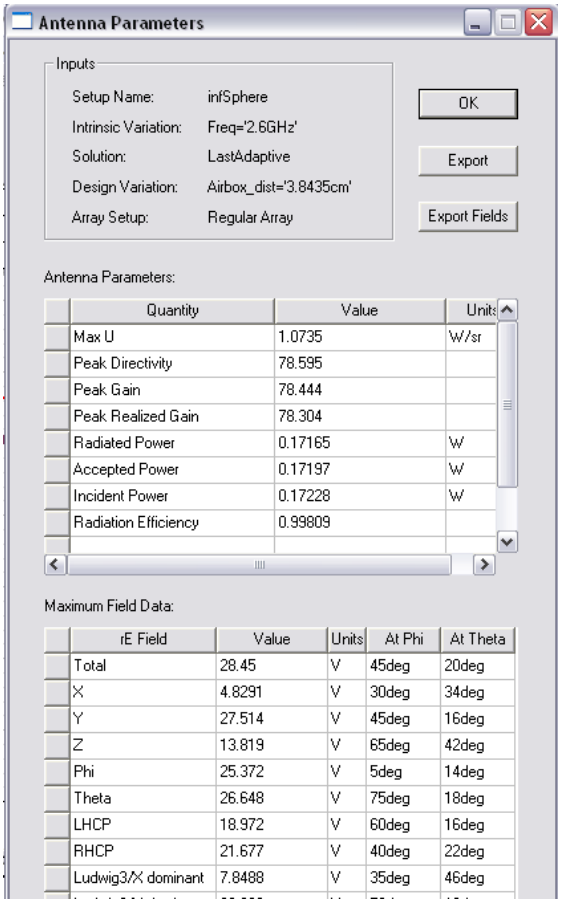


Table (2a), (2b), (2c) Antenna additional parameters and field data for three models

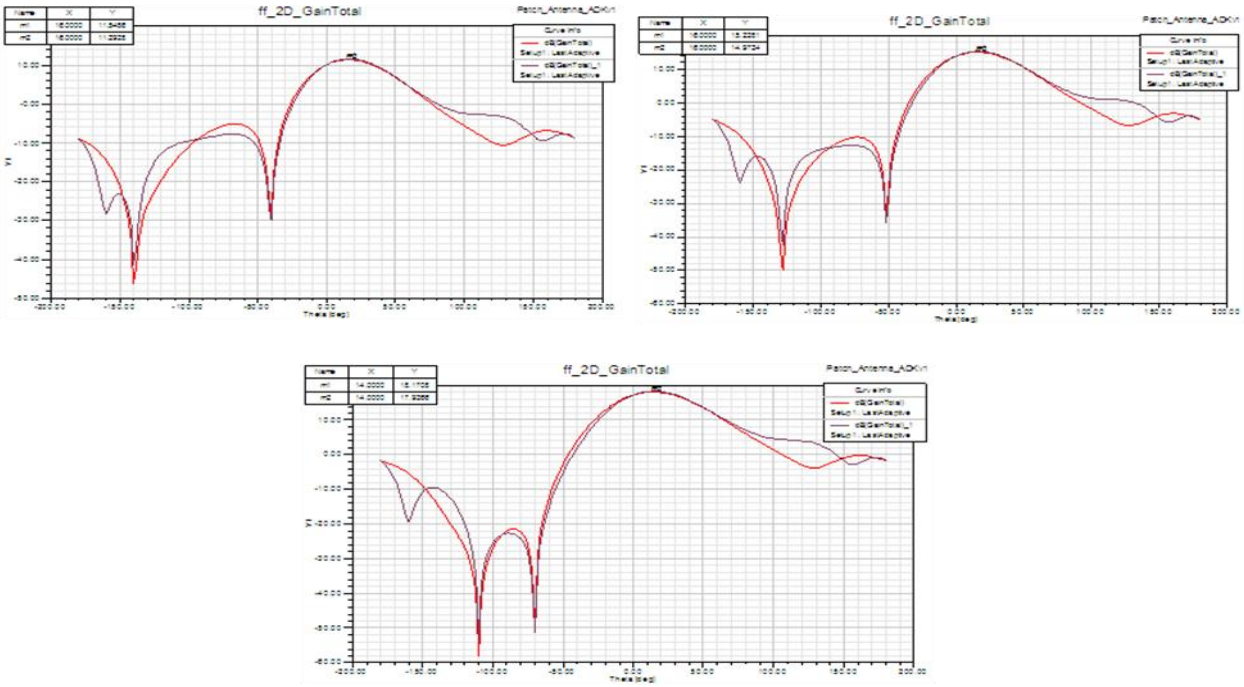


Fig (4) Gain Curves for 2x2,3x3 and 4x4 array patch antennas

Figure (4) shows the gain curve for all the three models. From the simulation results it is clear that the gain enhancement can be done by increasing number of patch elements. The peak directivity and peak gain is almost doubled when patch elements increases from 4 to 16 with 2x2, 3x3 and 4x4 array. The radiation efficiency is showing the same value for all three cases but the incident and accepted powers are different for each case. Left hand circular polarization and right hand circular polarization values can be collected from the maximum field data results.

As per the power consumption is concerned the 2x2 array model consumes less power compared to other models and 4x4 consumes more power. The element spacing is very nearer in the case of 4x4 array patch which leads to mutual coupling losses and in the case of 2x2 array the mutual coupling is less.

III. Conclusion:

2x2, 3x3 and 4x4 array patch antennas are designed and simulated using Ansoft HFSS and their performance characteristics are presented in this work. As we observed that the gain and bandwidth are enhanced by increasing the number of patch elements in the models from 2x2 to 4x4. The radiation efficiency, return loss remain same even with change in the patch elements but Radiated power also increased accordingly. All these models are used line feeding instead of coaxial feeding and the performance characteristics of these antennas should be studied using coaxial feeding and edge feeding also in the future. The surface and leaky waves can be reduced by using EBG structures may improve the efficiency of the array patch antennas in our future work.

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References:

[1] Yong Huang, Ke-Li Wu, Da-Gang Fang and Ehlert, M., "An integrated LTCC millimeter-wave planar array antenna with lowloss feeding network," *IEEE Trans. Antennas and Propagation* vol. 53, issue 3, pp. 1232 – 1234, March 2005.

[2] Balh IJ and Bhartia P (1980) Microstrip antennas. Artech house, Norwood, MA.

[3]. Balanis CA (1997) Antenna theory, John Wiley & Sons, Inc.

[4] K.F.Lee and W.Chen, ―Advances in microstrip and Printed antennas, Wiley, Newyork,1997, pp.144-147.

[5] Arun K Bhattacharayya, ―Phased Array Antennas‖, Wiley series in Microwave and Optical Engineering, Chapter 5.

[6]. K.L.Wong, ―Compact and Broadband Microstrip Antennas, John Wiley & sons, Text Book

[7].R.B.Waterhouse, et.al, Broadband printed millimeterwave Antenna, IEEE Trans. AP – 51, No.9, Sep 2003,pp 2492- 2495.

[8] R. Gonzalo Garcia, P. de Maagt, and M. Sorolla, "Enhanced patchantenna performance by suppressing surface waves using photonicband- gap substrate," *IEEE Trans. Microwave Theory Tech.*, vol. 47, no. 11, pp. 213 1–2138, Nov. 1999.

[9] B.T.P.Madhav, Prof. VGKM Pisipati, Prof. Habibulla Khan, VGNS Prasad, Prof. P.V.Datta Prasad, P.Sreekanth, "Microstrip Circular Patch Array Antenna For Wlan Applications On Liquid Crystal Polymer Substrate", Journal of Emerging Trends in Computing and Information Sciences. , Vol. 2, No. 1, February 2011.

[10] B.T.P.Madhav, Dr. K. Sarat Kumar, Pranob K Charless, P.Sreyash, V.Satyasainadh, P.L.Madhuri, A.Snehitha, Saroj Gautam," Rectangular Microstrip 6X6 Patch Array Antenna Performance Evaluation based on Permittivity of the Substrate Materials", GJCAT, Vol 1 (1), 2011, 83-91, ISSN: 2249-1945.

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