International Journal of Advanced Engineering and Innovative Technology (IJAEIT)
ISSN No 2348-7208 Special Issue on "Emerging Technology for Innovative India"

Adaptive Multiple Antenna Techniques Using HFSS Simulator

Prof. Devidas Chikhale, Shambhunath Sahani1, Shubham Singh2, Sitam Singh3, Bhagirathi Prajapati4

ssahani94@gmail.com,singhshubham1593@gmail.com,sitam61992@gmail.com,bagirathiprajapati3@gmail.com, devidas.chikhale@gmail.com

Department Of Electronics and Telecommunication, Lokmanya Tilak College Of Engineering, Navi Mumbai 400709.

Abstract—This paper presents design and simulation of multiple element of a rectangular microstrip patch array antenna at 2.4 GHz for wireless. In this paper a 1element,3x1,5x1 and 7x1 array of individual Microstrip patch antenna is designed to achieve higher gain, better bandwidth, and better directivity of the antenna.it poses a new challenge for the design of antenna in wireless communications. The rectangular microstrip patch antenna was analyzed using Ansoft HFSS Software and also made a comparison among the different number of element which shows different results based on same parameters.Multiple antenna techniques improve the communication system performance and providing high gain.

Keywords - Microstrip antenna array, Frequency, Gain, Bandwidth, Diversity, HFSS, Wireless communication.

I. INTRODUCTION

An Antenna is an electrical device which converts electric energy into radio waves and vice-versa. It is usually used with radio transmitter or radio receiver. In recent years there is a need for more compact antennas due to rapid decrease in size of personal communication devices. As communication devices become smaller due to greater integration of electronics, the antenna becomes a significantly larger part of the overall package volume. This results in a demand for similar reductions in antenna size. In addition to this, low profile antenna designs are also important for fixed wireless application. The microstrip antennas used in a wide range of applications from communication systems to satellite and biomedical applications.

II. Microstrip Antenna

Microstrip patch antenna has a ground plane on the one side of a dielectric substrate which other side has a radiating patch as shown in Fig1. A rectangular patch is used as the main radiator. The patch is generally made of conducting material such as copper or gold and can take any possible shape. Dielectric constant of the substrate (ϵ_r) is typically in the range 2.2< ϵ_r<12 .

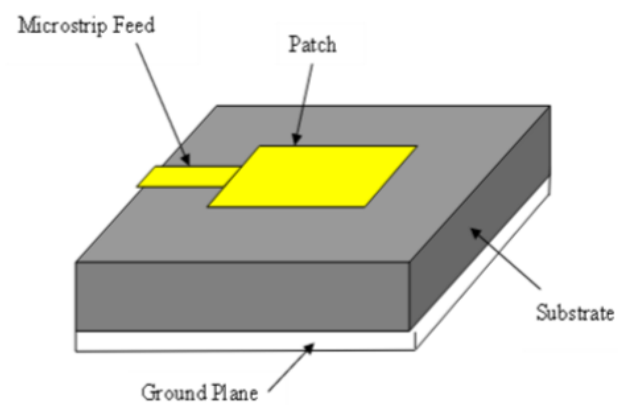


Fig1: Microstrip antenna

For good antenna performance, a low dielectric constant with thick dielectric substrate is desirable, as it provides better radiation, better efficiency and larger bandwidth.

III. DESIGN PROCEDURE

In this paper a 1element, 3x1, 5x1 and 7x1 array of individual Micro strip patch antenna is designed to achieve higher gain, better bandwidth, and better directivity of the antenna array. Because single antenna is not enough to achieve high bandwidth it has limited bandwidth. The rectangular patch is chosen because it simplifies and analysis and performance prediction. This antenna has been designed to operate at 2.4 GHz, using FR4 (ε_r=4.4) and height (h=1.6mm). The design starts with the simple rectangle patch of same dimensions for all the design and bus like feed is used to connect all the patch to the feed, then the feed and patch are united to assign Perfect E, port is designed in ZX plane to provide input signal to the antenna. Then, the Microstrip antenna is simulated using the Ansoft HFSS Software.

Figure2a.1 shows a patch with microstrip line feed from the side of the patch. This method of feeding is very widely used because it is very simple to design and analyze and very easy to manufacture.

Table1: Dimension of patch

Patch dimension in x direction	**20mm**
Patch dimension in y direction	**40mm**
Substrate height	**1.6mm**

Formula used for calculation of various parameters:

1) Width of patch

$$W = \frac{1}{2f_r\sqrt{\mu_0\epsilon_0}} \times \sqrt{\frac{2}{\varepsilon_r+1}}$$

2) Length of patch

$$L = \frac{1}{2f_r\sqrt{\varepsilon_{eff}}\sqrt{\mu_0\varepsilon_0}} - 2\Delta L$$

Where,

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2\sqrt{1+12\frac{h}{W}}}$$

$$\Delta L = \frac{\left(\epsilon_{reff}+0.3\right)\left(\frac{W}{h}+0.264\right) * 0.412h}{(\epsilon_{reff}+0.258)(\frac{W}{h}+0.8)}$$

IV. SOFTWARE TOOL

The software used to model and simulate the microstrip patch antenna is HFSS. HFSS is a high-performance full-wave electromagnetic (EM) field simulator for arbitrary 3D volumetric passive device modeling that takes advantage of the familiar Microsoft Windows graphical user interface. It integrates simulation, visualization, solid modeling, and automation in an easy-to-learn environment where solutions to your 3D EM problems are quickly and accurately obtained. Ansoft HFSS employs the Finite Element Method (FEM), adaptive meshing, and brilliant graphics to give you unparalleled performance and insight to all of your 3D EM problems. Ansoft HFSS can be used to calculate parameters such as S-Parameters, Resonant Frequency, and Fields .

V. SIMULATION RESULTS

The parameters which have been measured are Return loss, VSWR, Directivity, Gain and Radiation pattern. The first measurement that was performed is Return Loss. It ensures that these all designs covers ISM band for either 2.45 GHz or 5.45GHz

Table2: Observed Results

Parameter	1 element	3x1	5x1	7x1
Return loss(dB)	-11.123	-11.2051	-21.9772	-18.1429
VSWR	1.7691	1.7597	1.1793	1.2829
Lower Band	1.1GHz	2.3GHz	1.175GHz	1.125GHz
Bandwith	2.3GHz	2.1GHz	5.725GHz	3.225GHz
Gain	-8.0624	-1.0269	-6.3326	3.7131

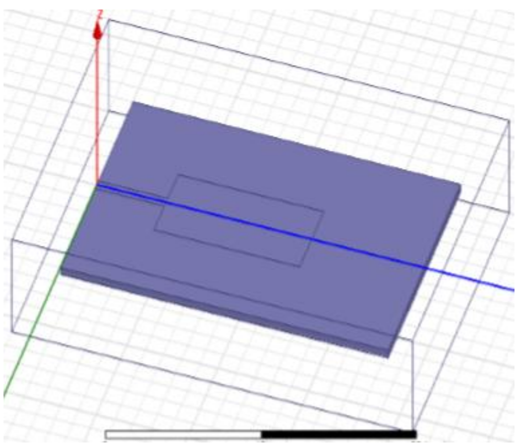


Fig2a. 1 element antenna

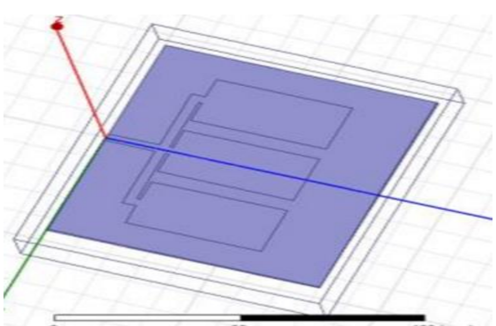


Fig3a. 3X1 array antenna

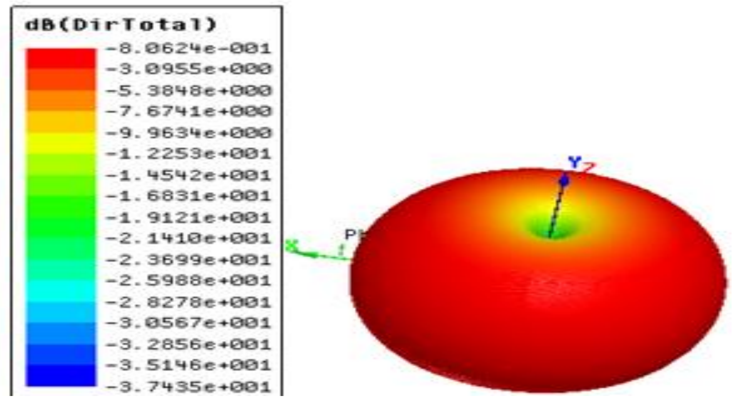


Fig2b. 3D-polar plot of 1 element

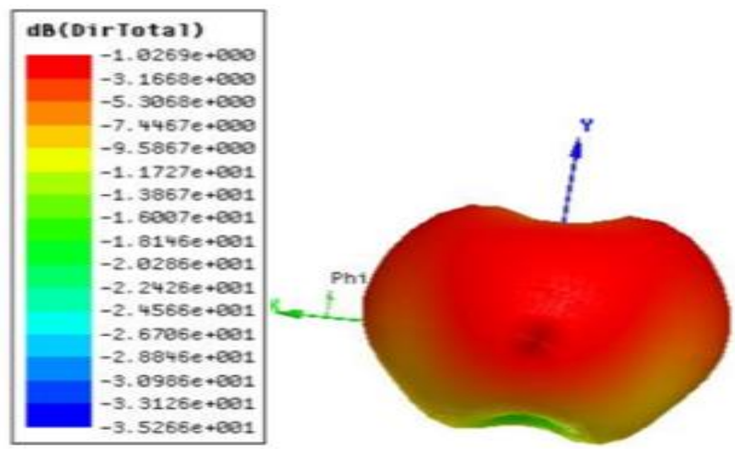


Fig3b.3D-polarplot of 3x1

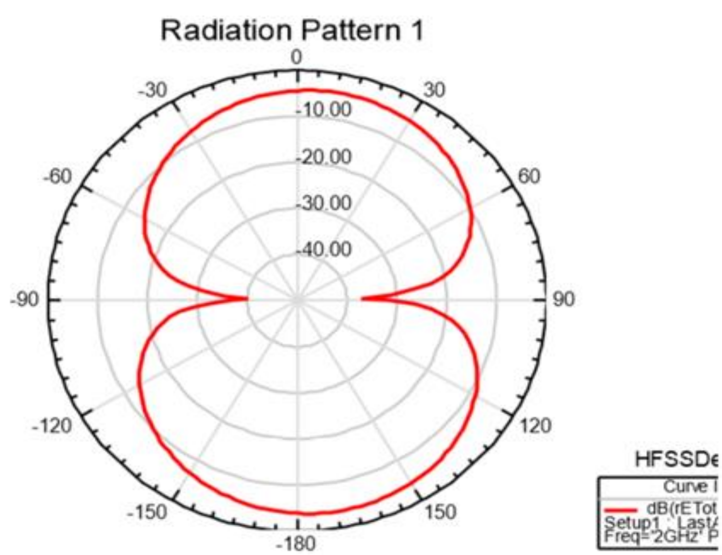


Fig2c. Radiation patter of 1 element

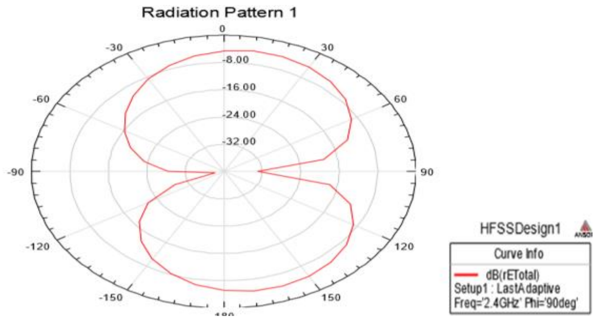


Fig3c. Radiation patter of 3x1 array

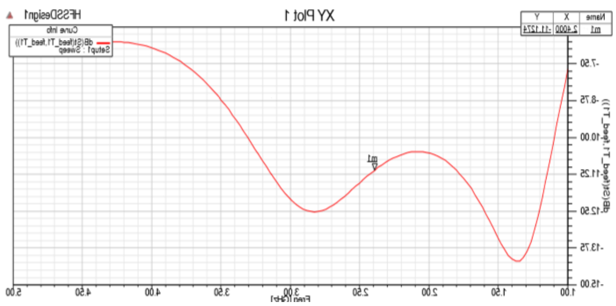


Fig2d. Return loss for 1 element antenna

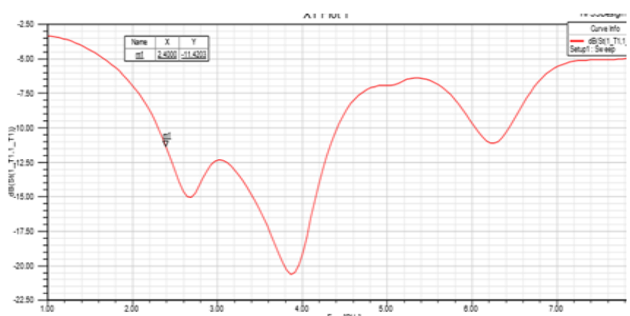
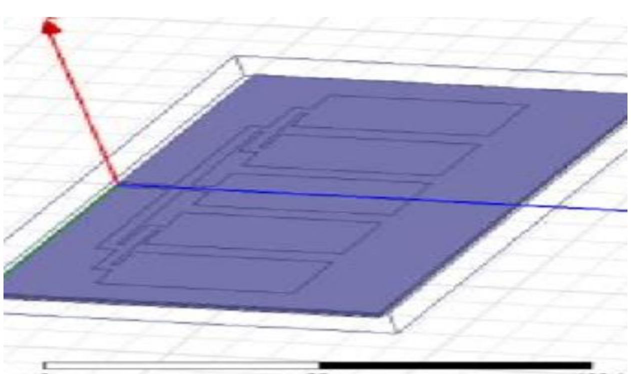


Fig3d. Return loss for 3x1 array

Fig4a. 5X1 array antenna



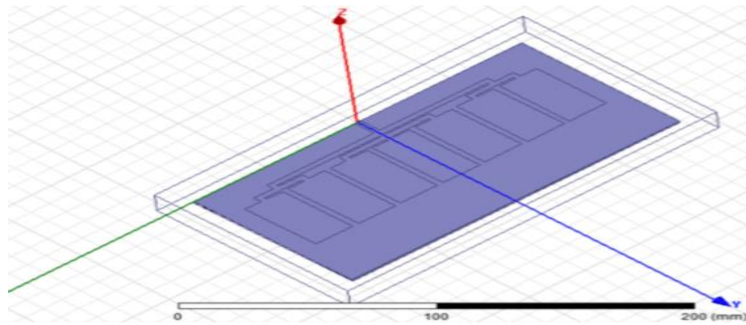


Fig5a. 7X1 array antenna

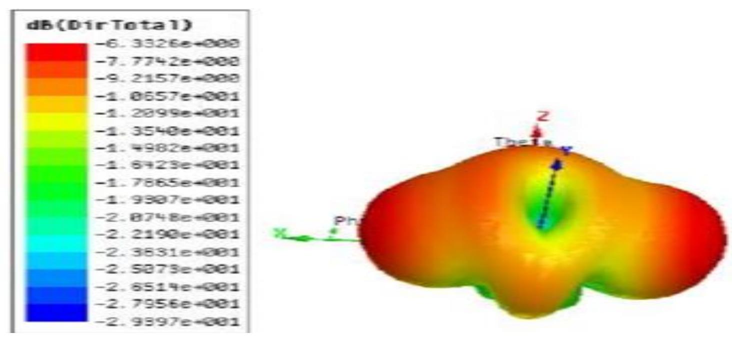


Fig4b. 3D-polar plot of 5x1 array

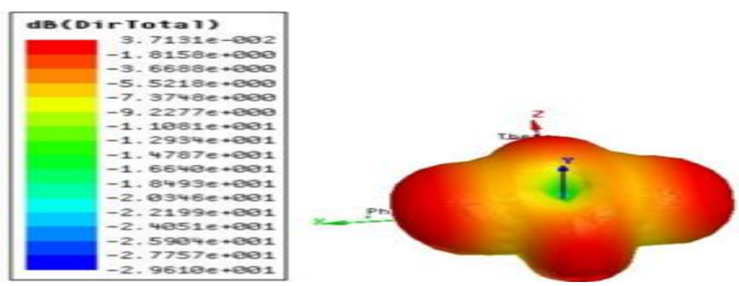


Fig5b. 3D-polar plot of 7x1 array

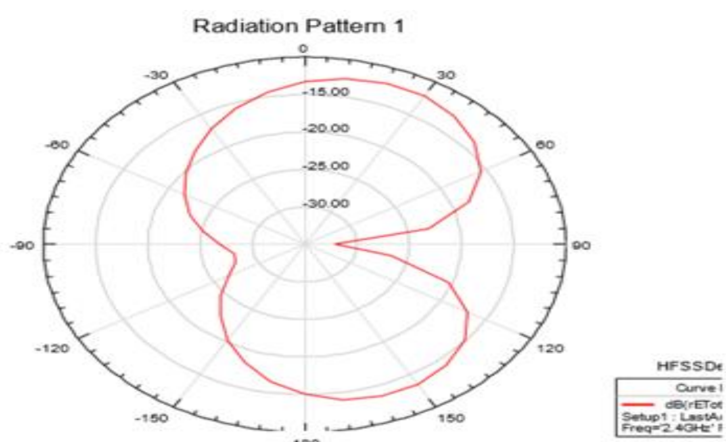


Fig4c. Radiation patter of 5x1 array

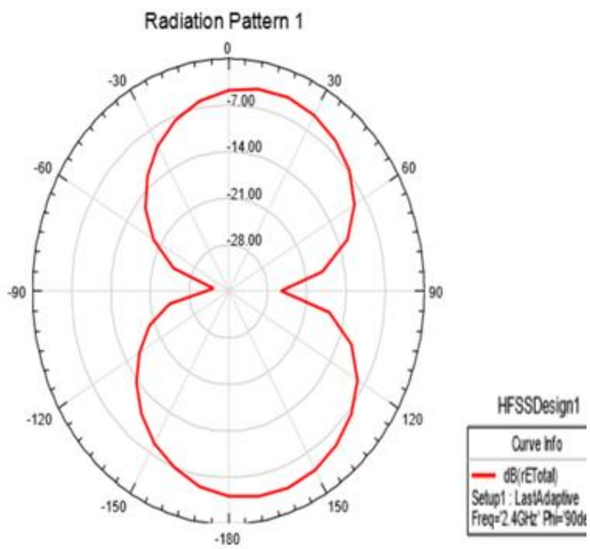


Fig5c. Radiation patter of 7x1 array

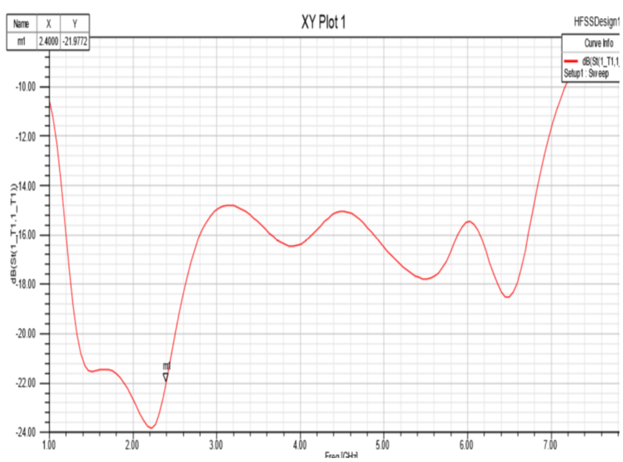


Fig4d.Return loss for 5x1 array

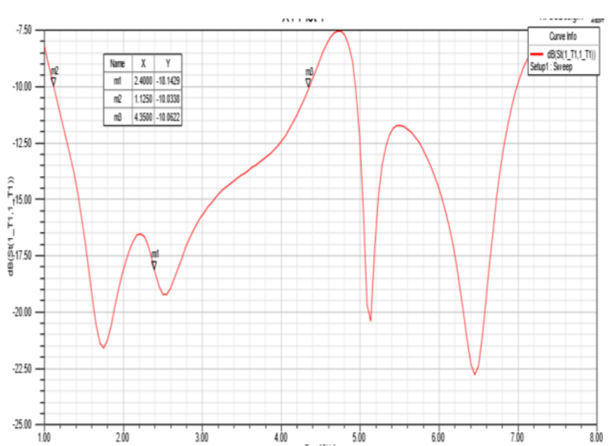


Fig5d. Return loss for 7x1 array

The figures above shows the variation in radiation pattern, directivity and s-parameter for different array having same dimension is shown.

VI. CONCLUSION

Thus the microstrip patch can be designed and analysed using ansoft hfss gives result approximate matching physical realization. From the result it was observed that the directivity goes on increasing with increase in number of patch.

REFERENCES

[1] C. A.Balanis, Antenna Theory: Analysis and Design, 2nd ed., John Wiley and Sons.

[2] Pozar D.M. "Micro strip antennas", Proc. IEEE, Vol. 80, 1992",.

[3] Amin Rida and Manos Tentzeris, " Design of Low Cost Micro strip Antenna Arrays for mm-Wave Applications", Antennas and Propagation 2011 IEEE International Symposium pp. 2071-2073.

[4] Int. J. on Recent Trends in Engineering and Technology, Vol. 8, No. 2, Jan 2013,"Design of Series Feed Microstrip Patch Antenna Array using HFSS Simulator".

[5] VSRD-IJEECE, Vol. 1 (9), 2011, 530-541 "Smart Antenna for Cellular Mobile Communication".