

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 ($\epsilon_r=4.4$) and height ($h=1.6\text{mm}$). 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

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

2) Length of patch

$$L = \frac{1}{2f_r \sqrt{\epsilon_{eff}} \sqrt{\mu_0 \epsilon_0}} - 2\Delta L$$

Where,

$$\epsilon_{eff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2\sqrt{1 + 12\frac{h}{W}}}$$

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

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

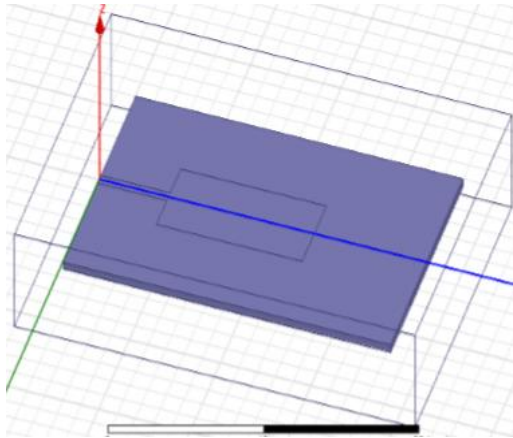


Fig2a. 1 element antenna

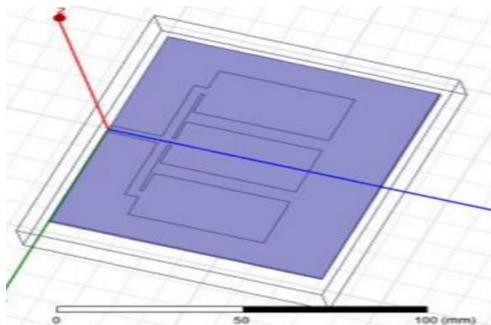


Fig3a. 3X1 array antenna

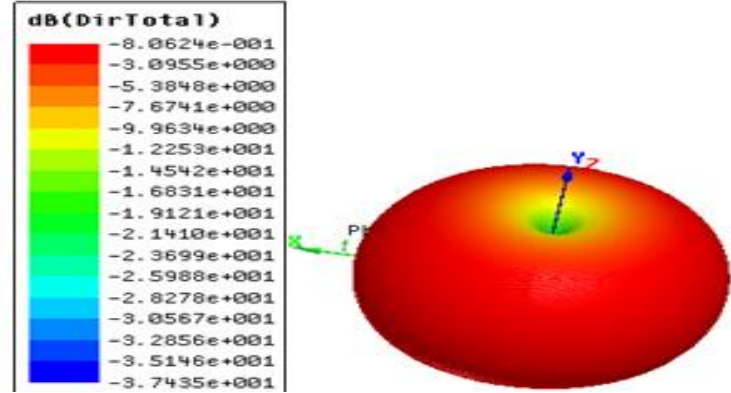


Fig2b. 3D-polar plot of 1 element

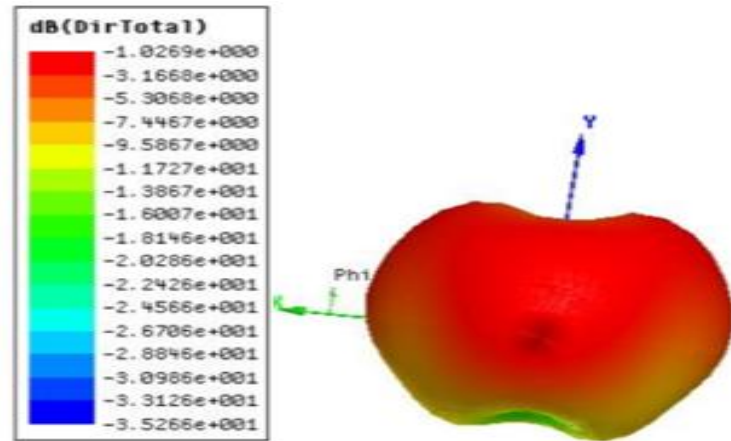


Fig3b.3D-polarplot of 3x1

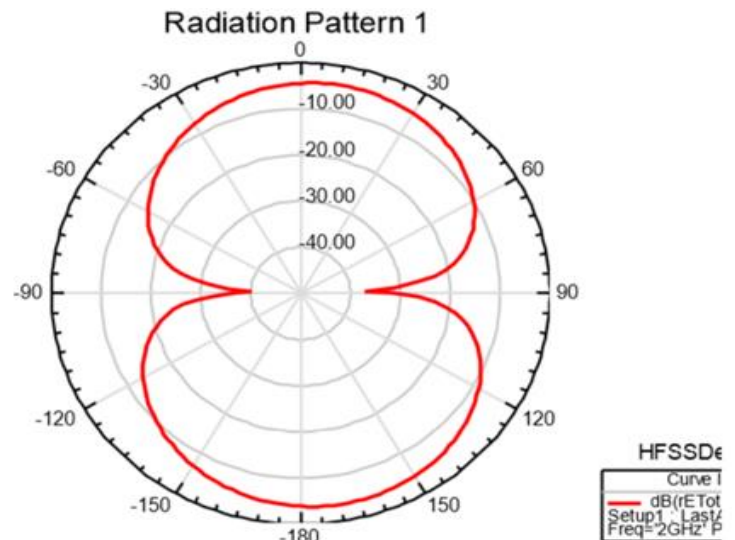


Fig2c. Radiation patter of 1 element

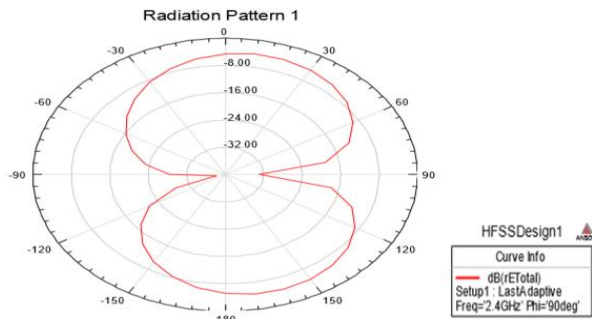


Fig3c. Radiation patter of 3x1 array

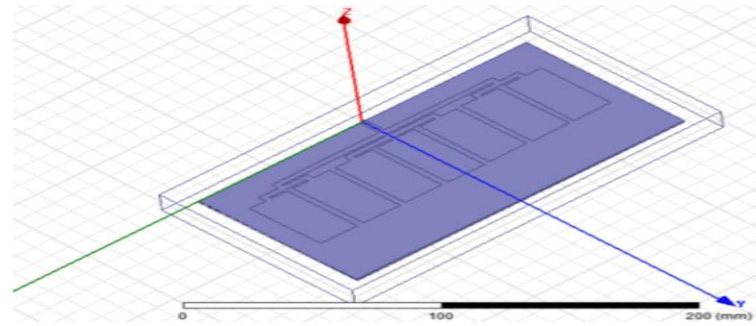


Fig5a. 7X1 array antenna

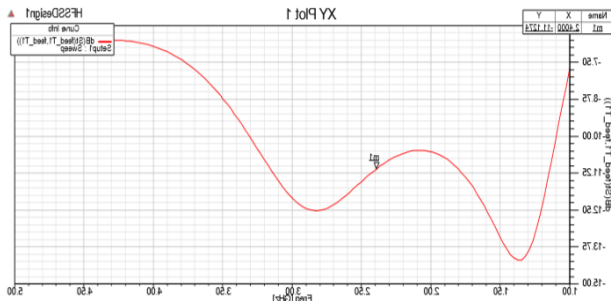


Fig2d. Return loss for 1 element antenna

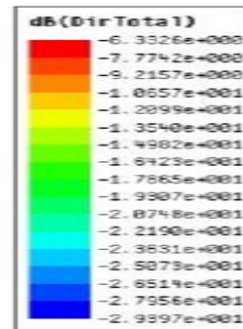


Fig4b. 3D-polar plot of 5x1 array

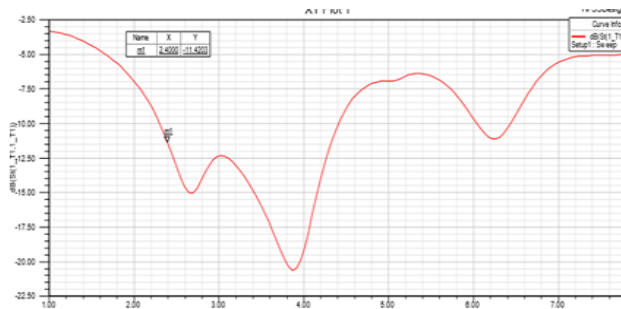


Fig3d. Return loss for 3x1 array

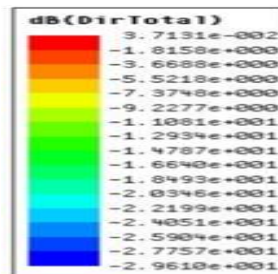


Fig5b. 3D-polar plot of 7x1 array

Fig4a. 5X1 array antenna

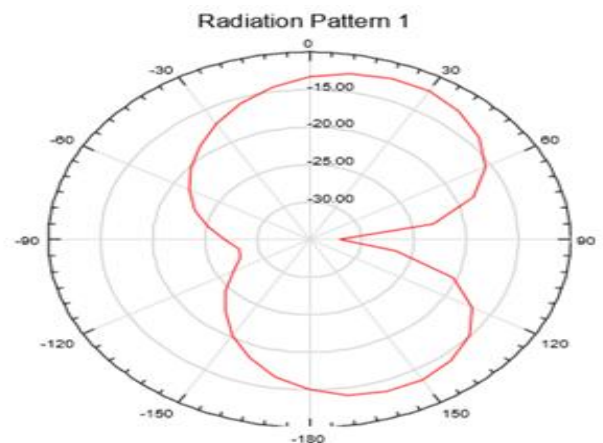
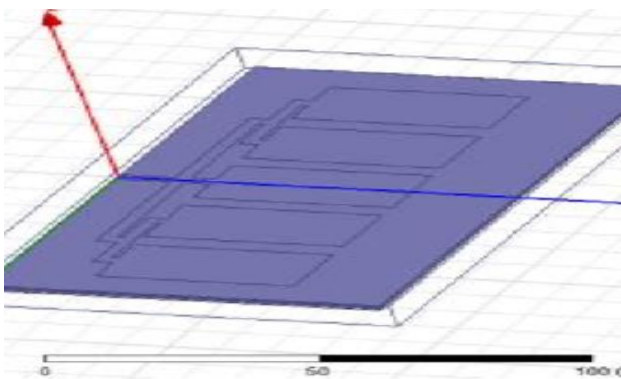


Fig4c. Radiation patter of 5x1 array

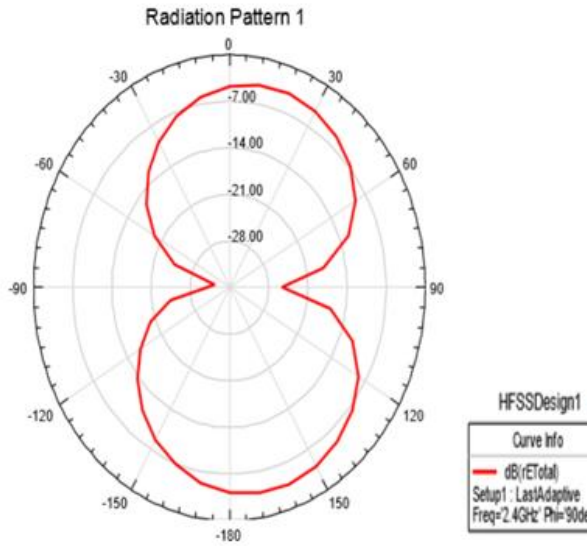


Fig5c. Radiation patter of 7x1 array

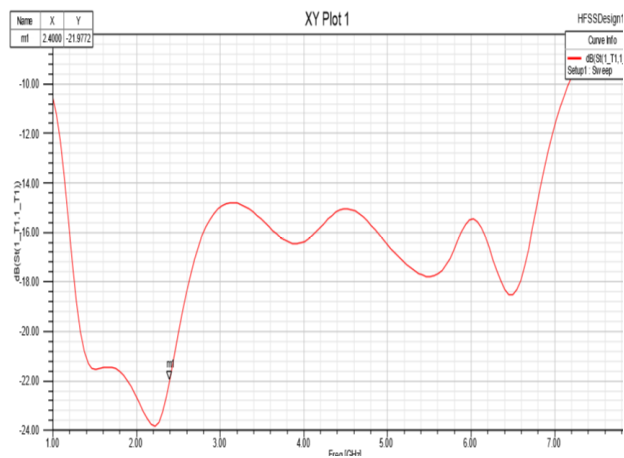


Fig4d.Return loss for 5x1 array

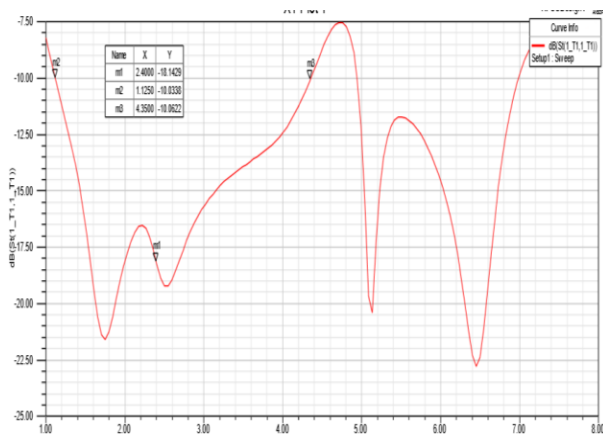


Fig5d. Return loss for 7x1 array

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".