



## Hexagonal Antenna Array for Broadcasting Applications

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**Abstract:** In this paper, we have proposed a antenna arrays of 8 elements hexagonal patch for radar applications designed at 15.1 GHz frequency. The antenna array simulations are carried out by using HFSS software. FR4 epoxy with dielectric constant 4.4 and thickness 0.8 mm is used as substrate. Details of the antenna array design are presented and simulation results are discussed. Antenna arrays are useful for many types of applications such as traffic control and collision avoidance radars, smart base station antennas for WLAN and cellular communication.

**Keywords:** Antenna Array, HFSS, Radar.

### I. INTRODUCTION

Recently, the development of communication technology is highly increased and indicating still continues to grow, not least with a wireless communication system. Not only making advanced technology increases, the wireless communication systems with their services applications are very popular in everyday life with a variety of advantages, such as to provide communication services at anytime and anywhere for the users. Those phenomenon's can be seen by the increasing demand for cellular phone service, wireless internet access, teleconference. These days, there is a very large demand by the end user for integrated wireless digital applications. Antennas which are used in these applications should be low profile, light weight, low volume and broad bandwidth [1]. To meet these requirements, microstrip antenna is preferred. An antenna should be low-profile, comfortable to planar and non planar surfaces, simple and inexpensive to manufacture, mechanically robust when mounted on rigid surfaces[2]. When the particular patch shape and mode are selected they are very versatile in terms of resonant frequency, polarization, pattern and impedance. Microstrip single antenna has several advantages, it also has several disadvantages such as low gain, narrow bandwidth with low efficiency. These disadvantages can be overcome by constructing many patch antennas in array configuration. In this paper, the design of single and one by four (1x4) and one by eight (1x8) patch array microstrip hexagonal antennas with microstrip line as feeding method is presented. Quarter-wave transformer is used to match the feeding line to the antennas. The center frequency is determined to operate at 15.1 GHz. The 1x8 patch array antenna designed on the substrate type FR4 epoxy with dielectric constant of 4.4 and thickness of 0.8 mm. This antenna offers a return loss of 23.70 dB. More significantly, as per the rigorous simulation study using HFSS microwave studio, the 1x8 patch array antenna perform the single patch antenna in terms of radiation gain, directivity and bandwidth

### II. ANTENNA GEOMETRY AND SIMULATION

The patch in the antenna is made of a conducting material Copper (Cu) and this can be in any shape like rectangular, circular, triangular, elliptical or some other common shape. The hexagonal patch antenna is designed so as it can operate at the resonant frequency.

Side of a hexagonal patch is given by

$$S = \frac{C}{23.1033 \text{ fr } \sqrt{\epsilon_r}}$$

Radius of hexagonal patch antenna is given by

$$r = S \times \sqrt{\frac{2.598}{\Pi}}$$

Fig.1 shown below is the basic element of the Hexagon patch Array with microstrip feed.

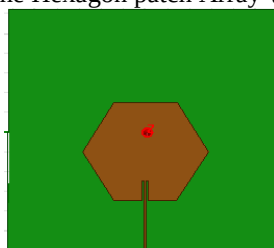


Fig. 1: Basic Hexagon patch antenna

Fig.2 shown below is a four element Hexagon patch array with microstrip feed and equal power divider.

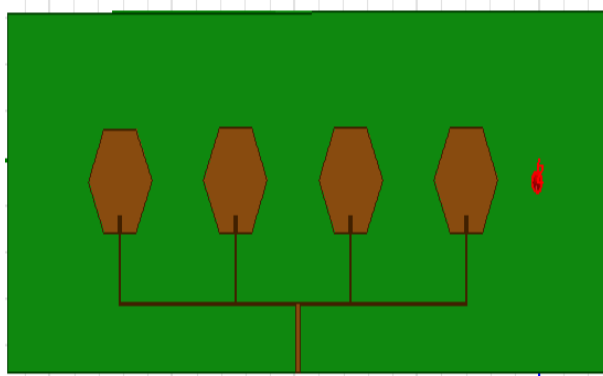


Fig. 2: 4 element Hexagon patch array

Fig.3 shown below is a eight element Hexagon patch array with microstrip feed and equal power divider with two input ports.

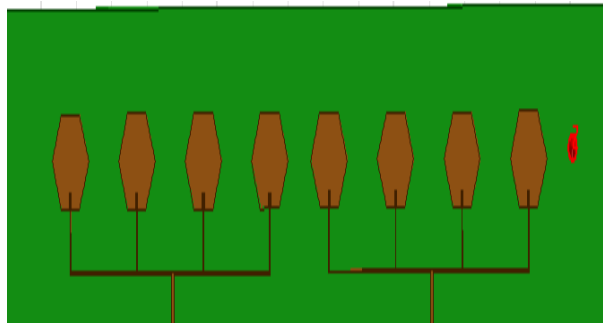


Fig. 3: 8 element Hexagon patch array

### III. RESULTS AND DISCUSSIONS

Basic Microstrip feed Hexagon patch antenna has been designed for  $k_u$  – Band and the various antenna parameters are shown below.

Return Loss:

S11 versus frequency plot has a return loss of -23.607 dB at 15.1GHz

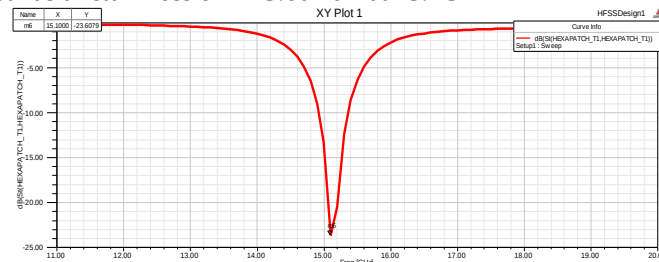


Fig. 4. Return Loss

VSWR:

Proposed antenna has a VSWR of 1.148dB at 15.1GHz

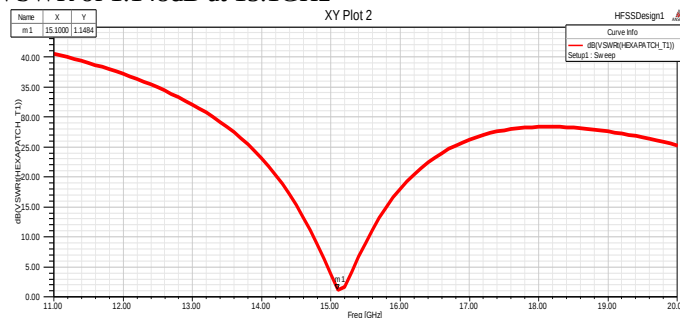


Fig. 5. VSWR

### Radiation Pattern:

E-plane and H-plane radiation patterns are as shown below:

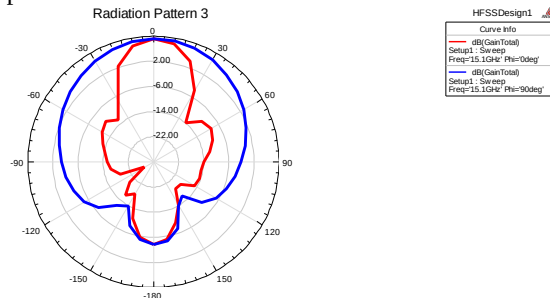


Fig. 6. Radiation Pattern

### 3D Polar Plot:

A total Gain of 4.6135 dB is observed in the 3D-Polar plot at 15.1GHz.

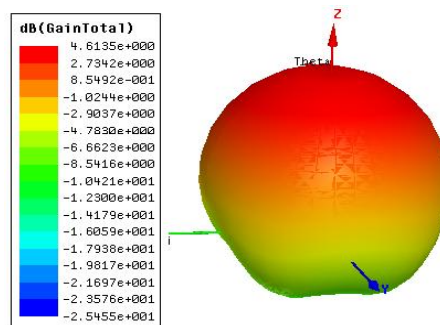


Fig. 7. 3D Polar Plot

Microstrip feed Hexagon patch antenna array with 4 elements with equal power divider has been designed for enhanced Gain and the various antenna parameters are shown below.

### Return Loss:

S11 versus frequency plot has a return loss of -26.339 dB at 15.1GHz.

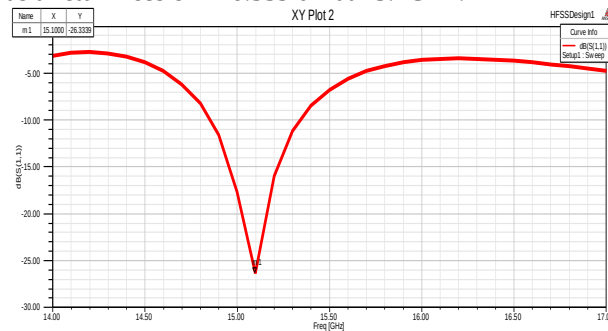


Fig. 8. Return Loss

### VSWR:

Antenna has a VSWR of 0.8385dB at 15.1GHz.

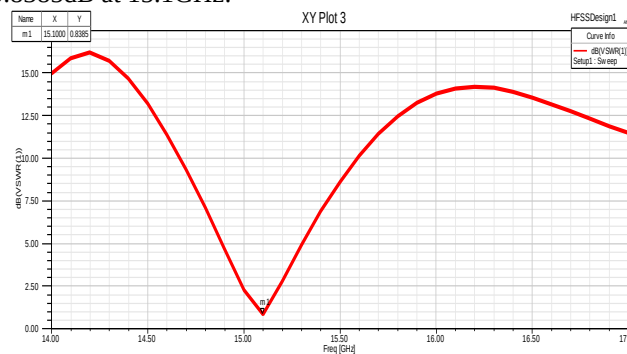


Fig. 9. VSWR

### 3D Polar Plot:

A total Gain of 9.112 dB is observed in the 3D-Polar plot at 15.1GHz.

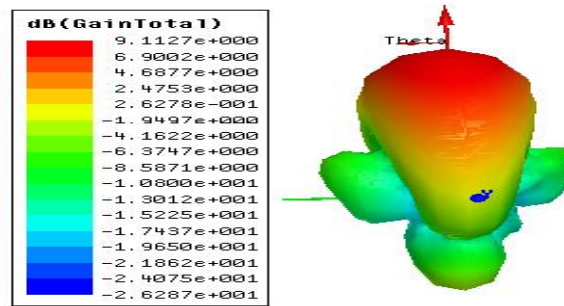


Fig. 10. 3D Polar Plot

### Radiation Pattern:

The Radiation Pattern of the 4-Array antenna at 15.1 GHz is as shown below.

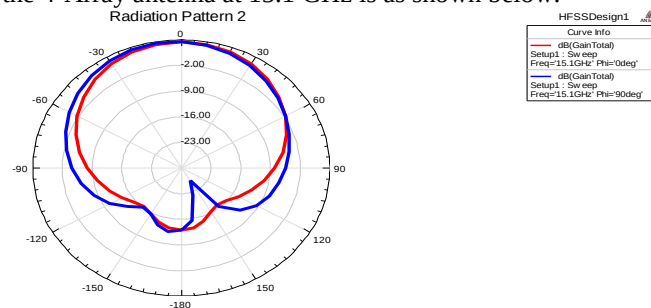


Fig. 11. Radiation Pattern

Microstrip feed Hexagon patch antenna array with 8 elements having equal power divider and two input ports has been designed for enhanced Gain and the various antenna parameters are shown below.

### Return Loss:

S11 versus frequency plot has a return loss of -23.706 dB at 15.1GHz.

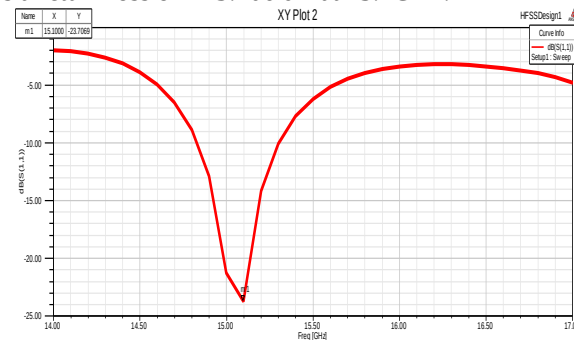


Fig. 12. Return Loss

### VSWR:

Antenna has a VSWR of 1.135dB at 15.1GHz.

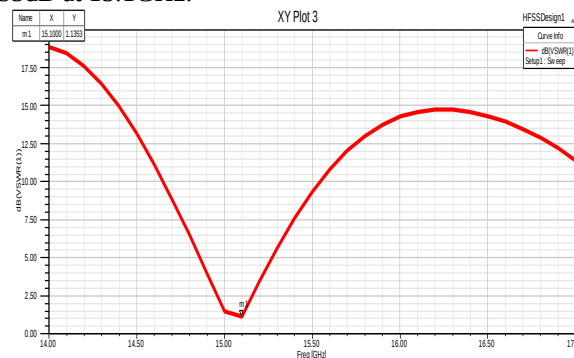


Fig.13. VSWR

### Radiation Pattern:

The Radiation Pattern of the 8-Array antenna at 15.1 GHz is as shown below

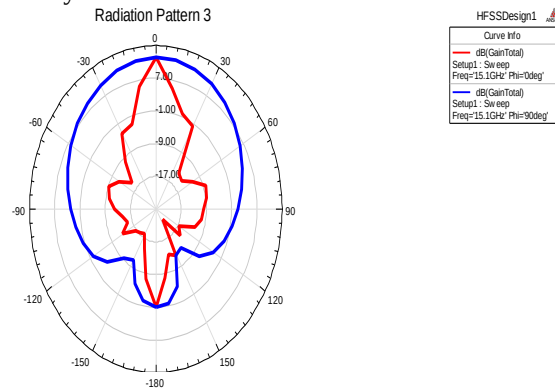


Fig. 14. Radiation Pattern

### 3D Polar Plot:

A total Gain of 11.94dB is observed in the 3D-Polar plot at 15.1GHz

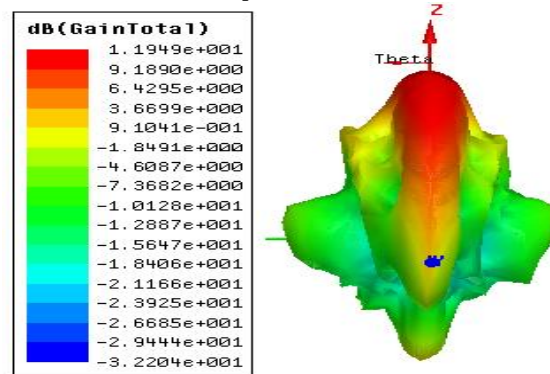


Fig. 15. 3D Polar Plot

Figure 16 shows the comparison of the E-Plane pattern of the single element, four element and eight element Hexagon patch antenna array.

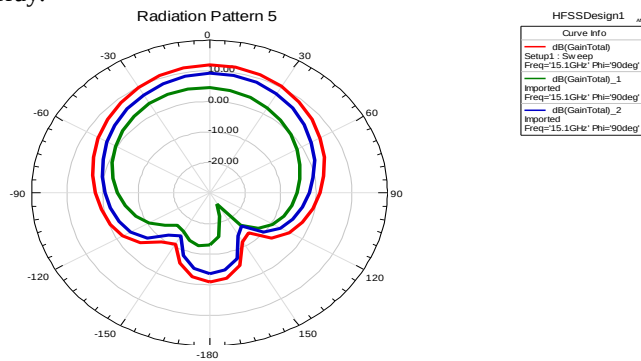


Fig. 16. E-Plane Pattern

Figure 17 shows the comparison of the H-Plane pattern of the single element, four element and eight element Hexagon patch antenna array.

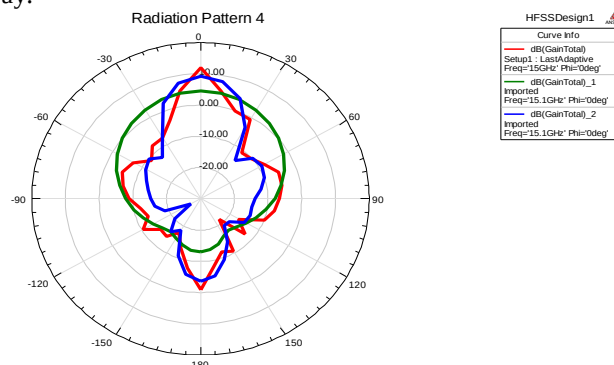


Fig. 17. H- Plane Pattern

#### IV. CONCLUSION

Design of Hexagon Patch antenna array is done using the simulation software HFSS, achieved a good response in terms of the various antenna parameters like Return loss, VSWR, Gain and Radiation Pattern. E-Plane and H-Plane patterns of the Single patch antenna 4- element array and 8 element array are compared and it is observed that the gain and directivity increases with increase in the number of elements.

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