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DESIGN OF CIRCULAR MICROSTRIP ANTENNA ARRAY FOR X-BAND APPLICATION

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ABSTRACT

In this work the circular microstrip antenna arrays has been designed for X-band application by using the HFSS simulator. Arlon AD320A (tm) material with dielectric constant 3.2 and height of a substrate material is 1.7mm. The coaxial feed has been used for feeding the circular patch antenna. The design of microstrip antenna array configurations was 1x2 at 9.18 GHz was presented. The simulation results show improvements in average gain (7.6 dB) while in the single antenna (6.6 dB), band width of antenna array is not change about the band width of single antenna (18%) and show reduction of mutual coupling with increasing the separation between two elements (d) in antenna array.

Keyword: circular microstrip antenna array, HFSS, X-band, VSWR.

1. INTRODUCTION

Antennas transform electrical energy into electromagnetic energy and radiation it. Also are receiver to collect the electromagnetic energy from free space and converting into electrical energy [1]. Microstrip antenna consists of a patch on the top of dielectric substrate and conducting ground plane on the bottom of it [2].

According to the IEEE the different bands of frequencies has been defined with different ranges of frequencies such as L, S, C and X -bands and each frequency band has been used for different applications [3].

The microstrip antenna specify by small size, light weight, low fabrication cost and low profile planar, but the microstrip antenna is: narrow bandwidth. Low gain low efficiency; and the surface wave excitation due to thick substrate [4-5].

To increase the bandwidth, directivity and gain, the most common method is using multi-elements in a regular structure which are known as array [6].

There are different types of antennas array such as linear array planar array and circular array [7].

In linear array antenna the elements arranged as a straight line, but in the planar array the antenna elements arranged over planar surface such as rectangular array [8]. The feeding technique of array antenna is by using microstrip line feeding technique or coaxial probe feeding technique.

Surface waves can lead to mutual coupling between patch antennas. Near field coupling arises in the antenna is placed in zone of near-field from other antenna, the coupling lead to degradation in the antenna's radiation characteristics [9-10].

In this work, liner array of two antennas have been design by using circular microstrip patch antenna with cross- shaped slot [11].

2. DESIGN OF CIRCULAR MICROSTRIP ANTENNA ARRAY

The circular antenna array of 1x2 is simulated by arranging these two microstrip patch antennas in linear configuration. Each patch element is excited individually using separate port; the antenna array is simulated by using HFSS software.

The dimension of 1x2 array shown in Figure-1. The substrate material is Arlon AD320A (tm) with dielectric constant 3.2 and height is 1.7mm for. The distance separation between two patches (edge to edge) is d.

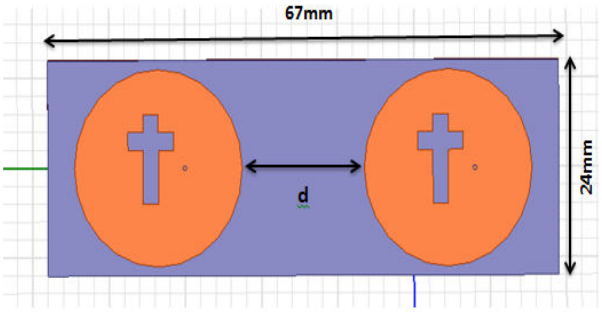


Figure-1. Dimension of 1x2 circular antenna array.

3. SIMULATION RESULTS

The simulation result of 1x2 antenna array of two elements was done as shown in figure-2 with aid of HFSS software.

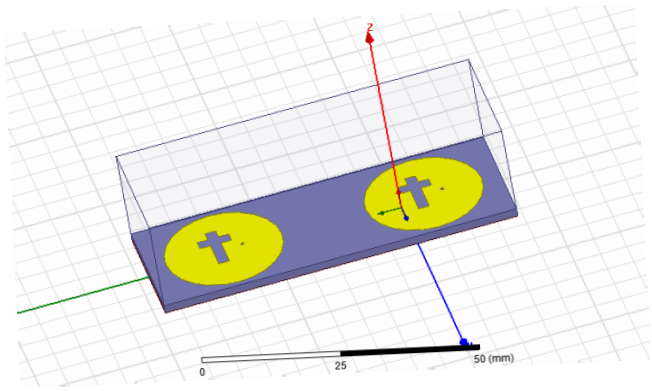


Figure-2. Linear antenna array of two elements.

Some of antenna parameters, such as the band width, VSWR, input impedance and radiation pattern, for 1×2 antenna array are demonstrated in the next figures. S parameter has been performed for microstrip 1×2 patch array antenna with coaxial feed shown in Figure-3.

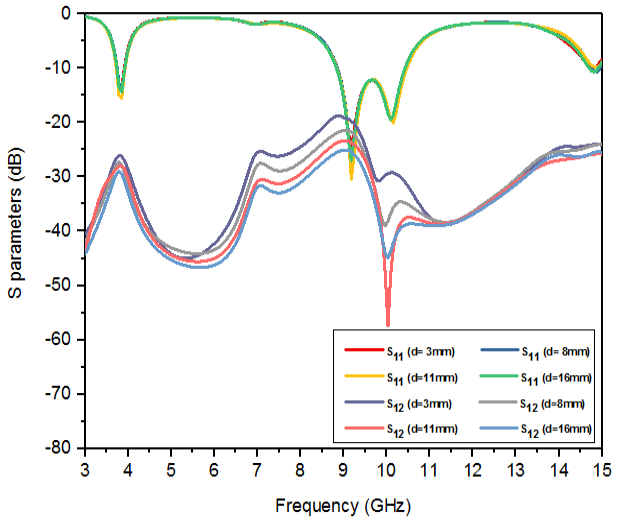


Figure-3. S parameters of antenna array with different d

The resonance frequency of the antenna is 9.18 GHz. In Figure-3 observe that, for different separation there is no differences in the resonance frequency and band width of antenna, while the value of mutual coupling (at resonance frequency) decreases with increasing the separation between two elements (d) in antenna array at listed in Table-1.

Table-1. The mutual coupling of antenna array for different separation.

d (mm)	S_{12} (dB)
3	-19.7
8	-21.7
11	- 23.6
16	-25.4

Figure-4 shows VSWR for different d, where at frequency 9.18 GHz the values of vswrare 1.12, 1.07, 1.06 and 1.09 for 3mm, 8mm, 11mm and 16mm respectively.

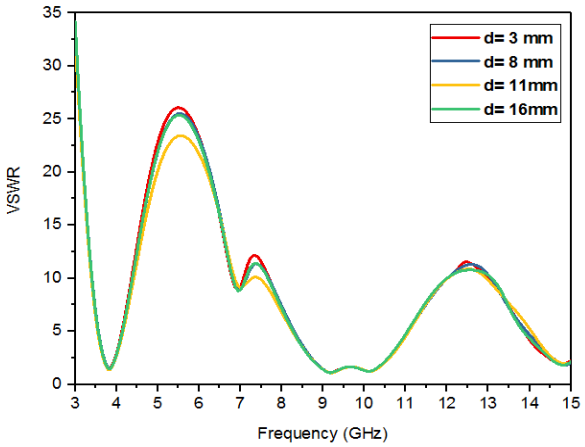
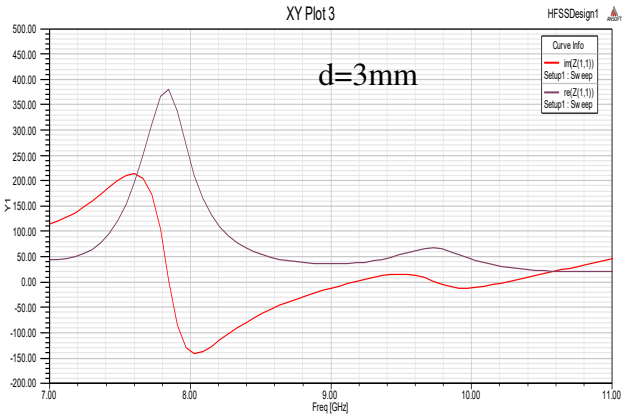
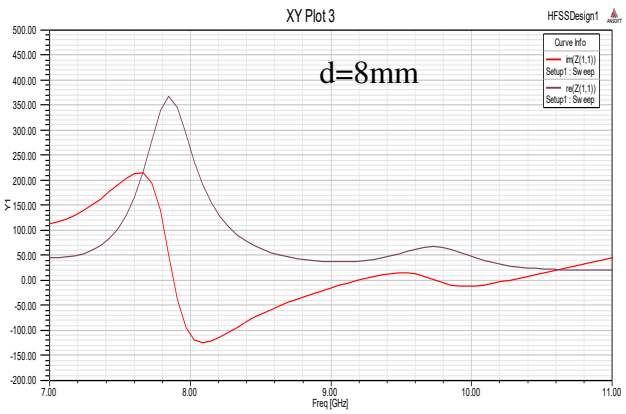


Figure-4. VSWR of antenna array for different d.

The input impedance for different d at 9.18 GHz as shown in Figure-5, where the real part of impedance is approximately 50 Ω and the imaginary part equal to zero.





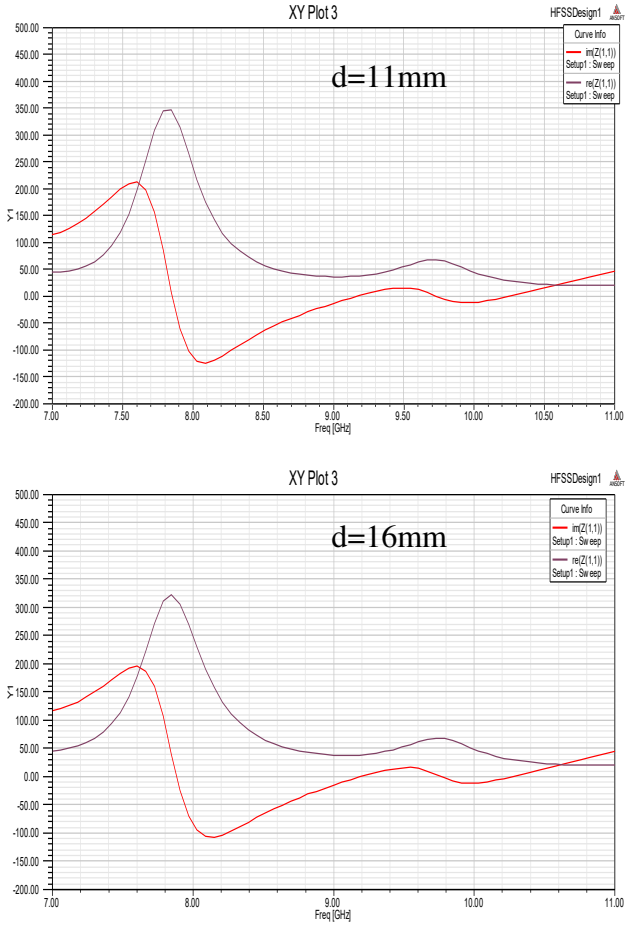
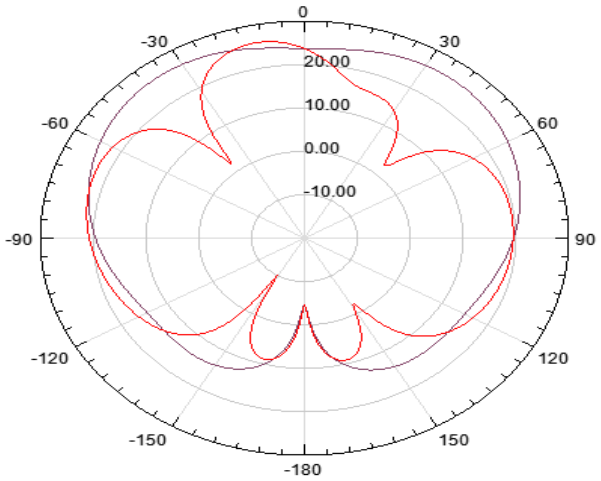
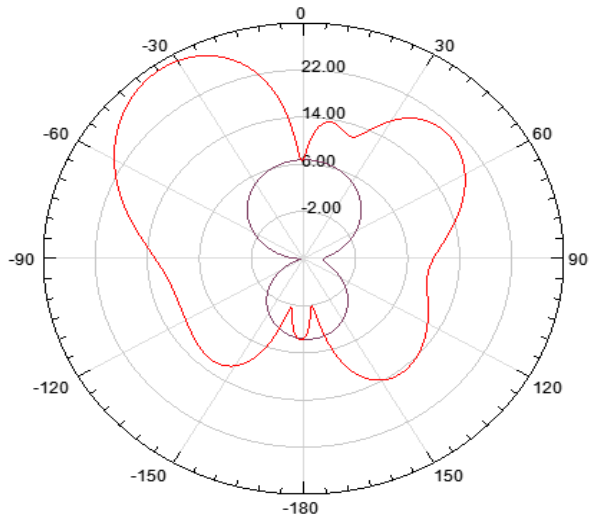


Figure-5. Real and imaginary part of the input impedance for different d.

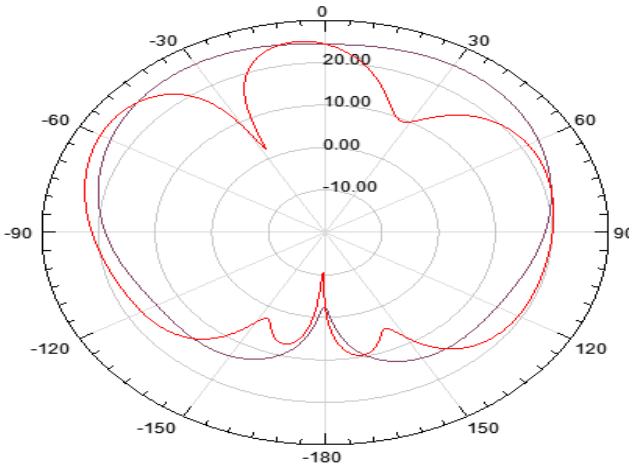
The 2-D radiation pattern of antenna array with different d is shown in Figure-6.



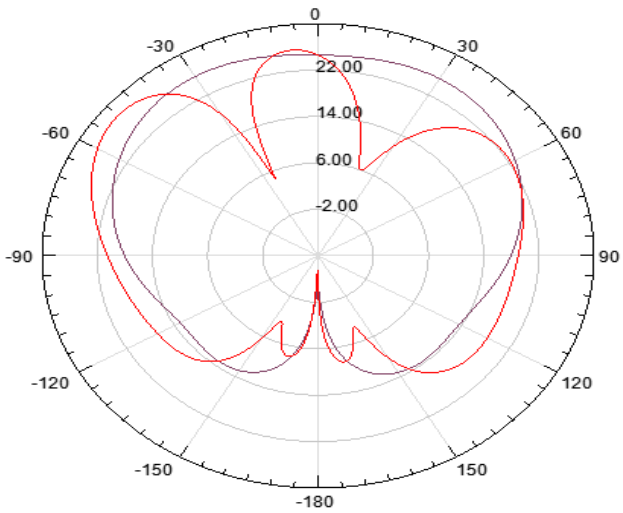
d=3mm



d=8mm



d=11mm



d=16mm

Figure-6. E-Plane and H -Plane of the antenna array for different d.

4. CONCLUSIONS

The circular microstrip patch antenna has been designed for X-band application by using the HFSS simulator. When the distance between elements in array has been increased then the mutual coupling is decreases and the performance parameters of antenna also increased efficiently. This work give band width equal to 18% and high average gain (7.6 dB) comparative with the single antenna (5.2 dB), this value of gain can be improving by using some of technique to reduction mutual coupling.

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