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Design Of Circular microstrip Array Antenna For Wireless Applications

Authors Name N.M.Mary Sindhuja,AP(ECE)

K.Lavanya

G.Karpagavalli

***Abstract*—The circular micro strip array antenna is designed to operate in s-band at 3.3GHz frequency for wireless applications. In order to increase the gain and bandwidth the array antenna is used. The circular patch antenna is designed on a FR4-substrate with dielectric constant is 4.4 and height of the substrate is 1.6mm. In order to increase the gain, directivity, signal strength and maximize the signal to noise ratio. The array antenna is used in various mobile communication systems, land mobile, satellite based systems. In this paper the design of circular patch array antenna at 3.3GHz for wireless applications is designed & performance parameters such as return loss, VSWR, gain and directivity is simulated using HFSS software.**

***Keywords*— s-band;wireless applications; gain; directivity; satellite based systems; return loss.**

I. INTRODUCTION

Micro strip antenna are popularly investigated due to their properties such as low profile, low cost, conformability and ease of integration with active devices [5]. They allow all the advantage of printed circuit technology. Micro strip patch antenna consists of two parallel conductors separated by a thin layer of dielectric substrate [2]. The lower conductor functions as a ground plane and upper conductor acts as a patch antenna. Micro strip antenna is also known as printed antenna. An antenna fabricated using micro strip techniques on a printed circuit board. The arrays are widely used since for many applications, antennas with high gain are necessary [2]. The patch are generally linear, planer and circular. The circular array has applications in radar, land mobile, and satellite based systems. Usually the radiation pattern of a single element is relatively wide and each element provides low values of directivity. The advantage of circular patch antenna to increase the gain and reduce the return loss. Micro strip line feed is one of the easier methods to fabricate as it is a conducting strip connecting to the patch and therefore can be consider as extension of patch. The advantage of the feed can be etched on the same substrate

to provide a planer structure. An inset cut can be incorporated into the patch in order to obtain good impedance matching without the need for any additional matching element. This is achieved by properly controlling the inset position.

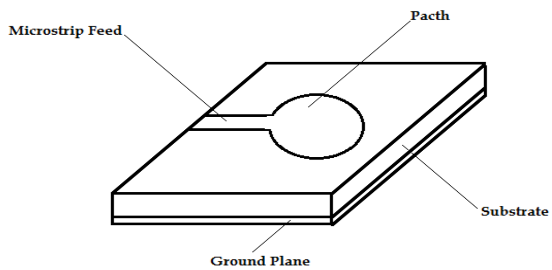

Figure 1.Microstrip Circular patch antenna.

II. DESIGN OF ANTENNA

In the typical design procedure of micro strip antenna, the desired resonant frequency, thickness and dielectric constant of the substrate are known or selected initially. In this design of circular micro strip antenna, FR4 dielectric material is 4.4mm and the substrate height is 1.6mm.

Formulas used for calculating radius (a)

$$a = \frac{F}{\left\{1 + \frac{2h}{\pi \epsilon_r F}\left[ln\left(\frac{\pi F}{2h}\right) + 1.7726\right]\right\}^{1/2}} \quad \text{……… (1)}$$

Where,

$$F = \frac{8.791\times10^9}{f_r\sqrt{\epsilon_r}}$$

The radius calculated by using above formula would not consider the fringing effects. By considering this effect the effective radius of the circular patch is

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$$a_e = a\left\{1 + \frac{2h}{\pi \epsilon_r a}\left[ln\left(\frac{\pi a}{2h}\right) + 1.7726\right]\right\}^{1/2} \quad \ldots\ldots (2)$$

The resonant frequency of the circular patch is

$$(f_r)_{110} = \frac{1.8412 V_0}{2\pi a_e \sqrt{\epsilon_r}} \quad \ldots\ldots (3)$$

Table 1:

Antenna design specification

Parameters	Dimensions
Operating frequency (f_r)	3.3GHz
Radius of circular patch (a)	12.96mm
Dielectric substrate (ϵ_r)	FR-4epoxy
Dielectric constant	4.4
Substrate thickness	1.6mm
Feed line	Micro strip line
Ground plane	L=50.3mm,w=75mm

III. Results and discussion

A. Results of circular microstrip antenna for 2×1 array

1. Return loss

The desired return loss for an antenna Fig 1 should be below -10dB. Return loss of 2×1 circular array antenna at 3.3GHz is -10.59dB which shows acceptable value with good response.

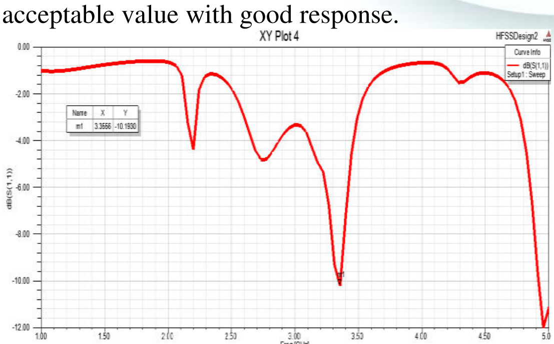

Fig 1. return loss of 2×1 array

2. Gain

The desired return loss for an antenna Fig 2 should be above 3.8dB. Gain of 2×1 circular array antenna at 3.3GHz is 5.51dB which shows acceptable value with good response.

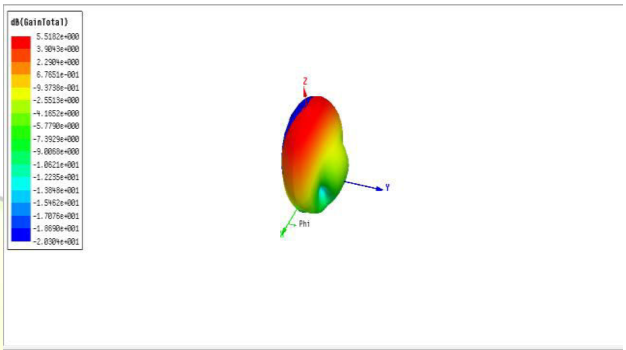

Fig 2. gain of 2×1 array

3. Directivity

The desired return loss for an antenna Fig 3 should be 0 or 1dB. Directivity of 2×1 circular array antenna at 3.3GHz is 8.71dB.

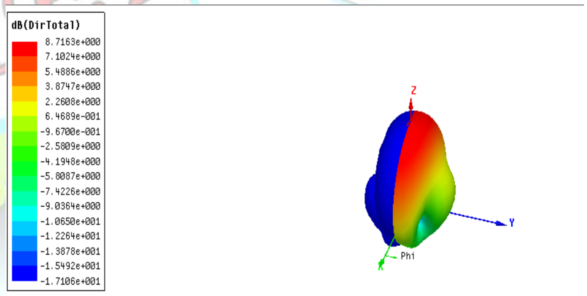

Figure 3. directivity of 2×1 array

B. Results of circular microstrip antenna for 4×1 array

1. Return loss

The desired return loss for an antenna Fig 4 should be below -10dB. The simulated return loss for the array is to be -12.58dB at the operating frequency. To get the best impedance matching at operating frequency parameters are optimized.

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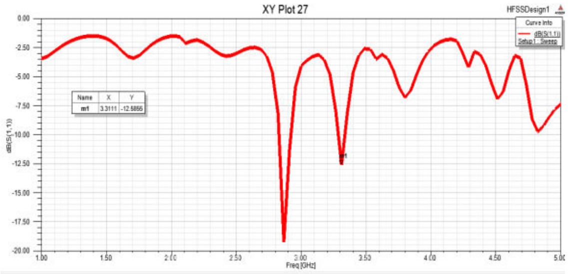
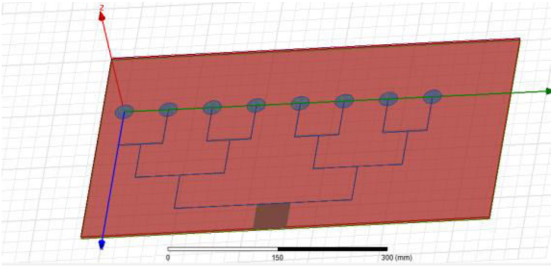


Fig 4. return loss of 4×1 array

D. LAYOUT STRUCTURE OF CIRCULAR PATCH ANTENNA USING HFSS



2.Gain

Fig 5 shows the gain for an antenna array. The simulated value for the array antenna gain is to be 7.18dB which is also higher than 4×1 antenna array.

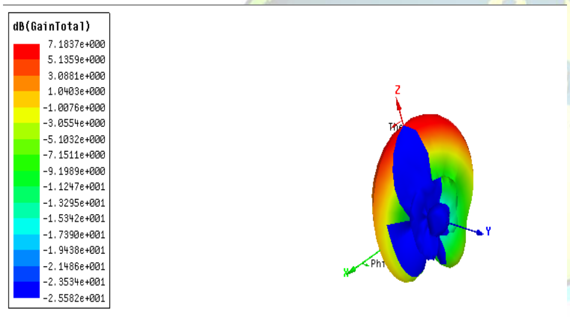


Fig 5. gain of 4×1 array

3. Directivity

The desired return loss for an antenna Fig 6.shows should be 0 or 1dB. Directivity of 2×1 circular array antenna at 3.3GHz is -1.22dB which shows acceptable value with good response.

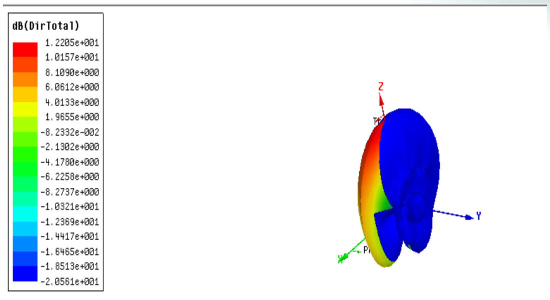


Fig 6. directivity of 4×1 array

E. RESULTS OF CIRCULAR MICROSTRIP ANTENNA FOR 8×1 ARRAY

1. Return loss

The desired return loss for an antenna Fig 7.shows should be below -10dB. Return loss of 8×1 circular array antenna at 3.3GHz is -13.84dB which shows acceptable value with good response.

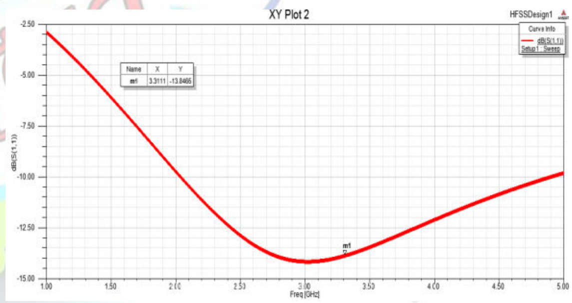


Fig 7. return loss of 8×1 array

2. Gain

Fig8. Shows the gain is obtained around 9.27dB which is acceptable value with good response.

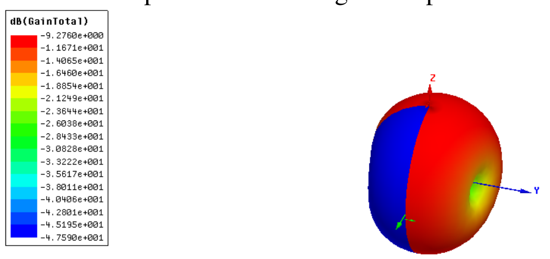


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Fig 8. return loss of 8×1 array

3. Directivity

The desired directivity for an antenna Fig 9.shows should be 0 or 1dB. Directivity of 8×1 circular array antenna at 3.3GHz is -1.63dB which shows acceptable value with good response

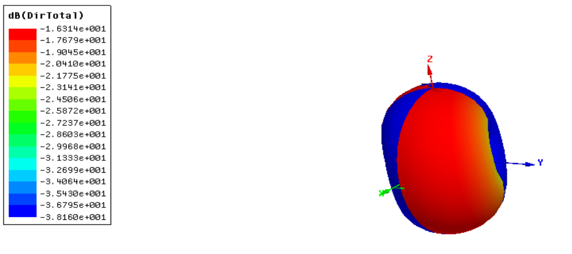

Fig 1. directivity of 8×1 array

Table 2: Performance parameters of array antenna

Parameters	***Two element array***	***Four element array***	***Eight element array***
Return Loss	-10.59	-12.58	-13.84
VSWR	2.04	1.61	1.78
Gain	5.51	7.18	9.27

III.CONCLUSION

In this paper the circular micro strip array antenna are simulated using HFSS. The antenna has been designed to be used in wireless applications in s-band. The proposed antenna have the advantage of high gain, better performance, and increased signal strength. The proposed antenna array shows better gain performance and radiation characteristics at 3.3GHz.

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