

Array of circular microstrip patch antenna

Urwashi Vithal Miringkar¹, Asst.Prof.Palhavi Kerkar²

¹Electronics And Telecommunication-Industrial Automation And Radio Frequency, Goa College of Engineering

²Electronics and Telecommunication, Goa College of Engineering

Abstract - This paper presents the array of circular microstrip patch antenna. The element of the antenna is 1x4 arrays. The antenna operates at 3.5GHz. Circular antennas give good return loss, and better gain and directivity. The main aim of using the array is to improve the gain of the antenna. Inset feed technique is used to design the antenna. The size and feed technique is determined by design formulas. Ie3d software is used for simulation.

Key Words: Antenna array; directivity; Microstrip patch;

1.INTRODUCTION

Several antennas are arranged and connected in regular structure to form single antenna. There are various types of antenna array i.e, Log periodic dipole array, planar array, collinear array, and phased array. Phased array antenna consists of multiple antenna system, in which, that the radiation pattern can be reinforced in a desired direction & suppressed in undesired directions. The phased array antennas are now widely used, and are spreading to civilian applications. Phased arrays are used by many AM broadcast radio stations to enhance signal strength and therefore, minimizes interference to other areas.

Antenna arrays are widely used because it increases the radiated power and provide high directional beam which avoids power loss in other directions. Basically the arrays are used to improve the radiation pattern. Arrays increase the directivity of the antenna and provides electronic steering which eliminates the use of mechanical steering using servo motor. And hence beam can be moved in less than millisecond. Arrays are also used for tracking in radar and surveillance. Configuration of array is simple arrangement of elements.

There are various types of structures available for microstrip patch, such as rectangular, circular, triangle, square, out of which circular has more advantages improved gain, return loss, easy design and improved bandwidth. Circular antennas also provides the flexibility of designing the the arrays. Circular Patch antennas can be designed to have horizontal, vertical left hand circular or right hand circular polarization, with multiple feeding points, or a single feed point. Such antennas are common in airplanes and military applications because of its ability to give high gain in low profile antennas.

The basic information about the circular antenna and the arrays has been described in the introduction. The first part consists of the design parameters and the antenna design. The later section describes the result and conclusion.

1. ANTENNA DESIGN

We have designed a patch antenna array consisting of FR4 substrate. 3.5GHz is the resonant frequency of the antenna array. FR4 substrate has 4.4 relative permittivity. The loss tangent for FR4 is 0.02 and thickness is 1.6mm. A circular patch is designed of radius 12mm, and 1x4 array is designed using one circular element. Following are the formulas to find the radius of the circular patch.

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

$$F = \frac{8.791 \times 10^9}{f_r \sqrt{\epsilon_r}} \quad (2)$$

$$a_e = \frac{1.8412 v_0}{2\pi f_r \sqrt{\epsilon_r}} \quad (3)$$

Inset feed technique is used while designing this antenna. The dimensions of the line feed are 25.8mm width and 3mm is the length which is calculated using the required formulas.

$$W_1 = \frac{c_0}{2f_r} \sqrt{\frac{2}{\epsilon_r + 1}} \quad (4)$$

$$\epsilon_{r_{eff}} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left(1 + \frac{12h}{W}\right)^{-\frac{1}{2}} \quad (5)$$

$$\frac{\Delta L}{h} = 0.412 \frac{(\epsilon_{r_{eff}} + 0.3) \left(\frac{W}{h} + 0.264\right)}{(\epsilon_{r_{eff}} - 0.258) \left(\frac{W}{h} + 0.8\right)} \quad (6)$$

$$L = \frac{c_0}{2f_r \sqrt{\epsilon_{reff}}} - 2\Delta L \tag{7}$$

I. 1x4 ANTENNA ARRAY

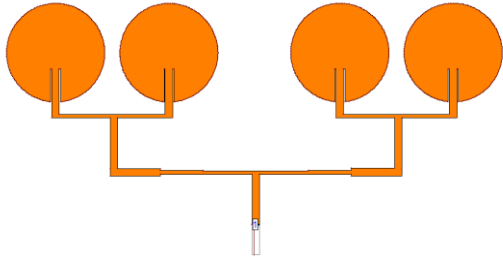


Fig 1:1x4 antenna array

Fig 1 is the antenna array design of 1x4 arrays. It consists of 4 circular patch antennas with inset feed technique designed on FR4 substrate.

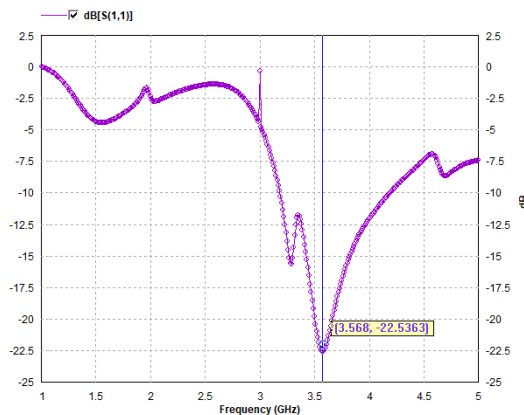


Fig 2: Return loss

The above figure shows the return loss of 1x4 antenna array. The return loss of -22.5dB is obtained at 3.5 GHz. The desired return loss for the antenna must be less than -10dB.

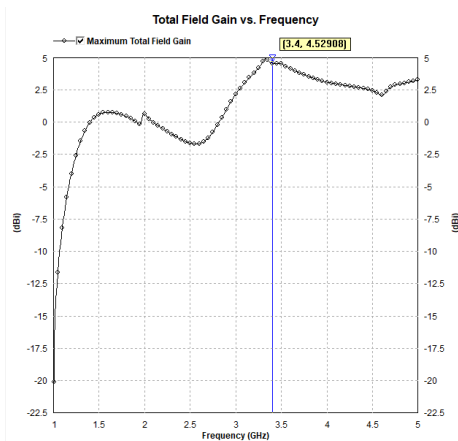


Fig 3: Gain

Fig 3 shows the graph of gain v/s frequency. Gain is an important parameter of an antenna that defines the total power which is radiated in a particular direction. The unit of gain is dBi. The gain of 4.52dBi is obtained.

3. CONCLUSIONS

Accordingly we have designed 1x4 microstrip patch array antenna at 3.5GHz frequency. Several antenna parameters like gain and return loss are obtained. The obtained gain is 4.52dBi, which we can see is comparatively greater than the single patch. The single patch antennas give gain of 2-3dBi. The return loss obtained is -22.5dB. The results give satisfactory performance. Hence we can conclude that 1x4 antenna improves the gain and the performance of the antenna.

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