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DUAL POLARIZED 3X3 MICROSTRIP ARRAY ANTENNA USING ORTHOGONAL FEEDS

I.Govardhani, M.Venkata Narayana, B.Anusha sumanthika

Department of ECE KLUniversity

E-mail of Corresponding Author: govardhanee_ec@kluniversity.in

ABSTRACT

A microstrip antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side. A 3X3 microstrip patch antenna which has width 'w' and length 'l' are placed over the surface of the substrate layer. The array of antennas exhibit dual polarization by using two feeds and hence called as orthogonal feeds. When the feed point lies on the diagonal then circular polarization occurs whereas if the feed point lies at any other place elliptical polarization occurs. In this paper we present the major parameters of the antenna as axial ratio, VSWR, radiation pattern, directivity and efficiency which are calculated practically.

Keywords— microstrip antenna, dual polarisation, orthogonal feeds

INTRODUCTION

Antenna is piece of conducting material which is form of a wire, rod or any other shape with excitation. In this paper a microstrip array antenna whose return losses and gain had been simulated. A micristrip antenna is also called as patch antenna. whose operating frequency is greater than 1GHZ. The term 'Microstrip' came because the thickness of this metallic strip is in micro-meter range.Microstrip patch antennas are popular, because they have some advantages to their conformal and simple planar structure. The features of a microstrip antenna are relatively ease of contruction, light weight, low cost and either confortability to the mounting surface or, at least,an extremely thin protrusion from the surface. These criterian make it popular in the field of satellite and radar communication system. Microstrip antennas are the first choice for the high frequency band such as X-band due to its light weight and low cost and robustness. In this paper we had designed microstrip with 3x3 array which is dual polarized and which has the operating frequency greater than 1GHZ. The following figure shows the geometry of rectangular microstrip patch antenna with dual polarization.

MICROSTIP ANTENNA DESIGN

Microstrip patch antenna consists of very thin metallic strip (patch) which is placed on ground plane where the thickness of the metallic strip is restricted by $t << \lambda_0$ and the height is restricted by $0.0003\lambda_0 \leq h \leq .05\ \lambda_0$ [2, 5]. The microstrip patch is designed so that its radiation pattern maximum is normal to the patch. For a rectangular patch, the length L of the element is usually $\lambda_0 /3 < L < \lambda_0 /2$. There are numerous substrates that can be used for the design of microstrip antennas and their dielectric constants are usually in the range of 2.2

$\leq \varepsilon_r \leq 12$. To implement the microstrip antennas usually Fr-4 (ε_r = 4.9), Rogers TMM 4(ε_r = 4.5), Taconic TLY-5 (ε_r= 2.2), Alumina (96%) (ε_r = 9.4), Teflon(PTFE) (ε_r = 2.08), Arlon AD 5 (ε_r = 5.1) dielectric materials are used as the substrate. The Performance of the microstrip antenna depends on its dimension. Depending on the dimension the operating frequency, radiation efficiency, directivity, return loss and other related parameters are also influenced. In order to create a model the design should be placed always in a air box for the radiations. The length of the patch along x-axis is 2.96 and the length of the patch along the y-axis is 2.44.

GEOMETRY OF ANTENNA

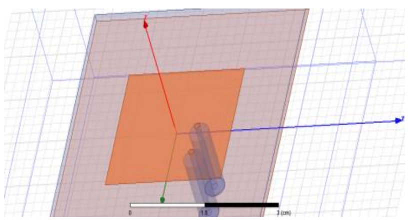

Fig 1 Geometry of Antenna

3x3 microstrip patch antenna

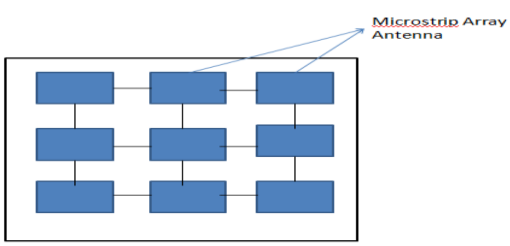

Fig 2 3x3 microstrip patch antenna

For an efficient radiation a practical width of the Rectangular patch element becomes

$$w = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}} \times \sqrt{\frac{2}{\varepsilon_r + 1}} \qquad [1]$$

And the length of the antenna becomes

$$L = \frac{1}{2f_r\sqrt{\varepsilon_{eff}}\sqrt{\varepsilon_0\mu_0}} - 2\Delta L \qquad [1]$$

$$\Delta L = 0.41h\frac{\varepsilon_{eff+0.3}}{\varepsilon_{eff-0.258}} * \frac{(\frac{W}{h} + 0.264)}{(\frac{W}{h} + 0.8)} \qquad [1]$$

And

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2\sqrt{1 + 12\frac{h}{w}}} \qquad [1]$$

Where, λ is the wave length, fr (in Hz) is the resonant frequency, L and W are the length and width of the patch element, in cm, respectively and ε_r is the relative dielectric constant.

MICROSTRIP ARRAY ANTENNA DESIGN

Microstrip antennas are used not only as single element but also very popular in arrays. Microstrip arrays radiate efficiently only over a narrow band of frequencies and they can't operate at the high power levels of waveguide, coaxial line, or even stripline. Antenna arrays are used to scan the beam of an antenna system, to increase the directivity and perform various other functions which would be difficult with any one single element. In the microstrip array, elements can be fed by a single line or by multiple lines in a feed network arrangement. Based on their feeding method the array is classified as

i. Series feed method

ii. orthogonal feed method

Series-feed microstrip array is formed by interconnecting all the elements with high impedance transmission line and feeding the power at the first element. Because the feed arrangement is compact the line losses associated with this type of array are lower than those of the corporate-feed type. The main limitation in series-feed arrays is the large variation of the impedance and beam-pointing direction over a band of frequencies.

In this paper we are using two feeds in order to perform dual polarization. When the feed lies on the diagonal, circular polarization takes place where as feed lies at any place on the patch elliptical polarization takes place. Hence the feed method is known as orthogonal feed.

RECTANGULAR PATCH MICROSTRIP ARRAY ANTENNA

In this paper we have designed the 3X3 microstrip array antenna, as shown in Fig. 1, to cover 1-5GHz operating frequency. Here the power is fed to the antenna by using the microstrip rectangular probe fed. The radiated field of the E-Plane for a single element rectangular patch can be expressed as following formula

$$E = j\frac{k_o w v_o e^{-jk_o r}}{r\pi}\left\{\frac{\sin\left(\frac{k_o h}{2}\cos\varphi\right)}{\frac{k_o h}{2}\cos\varphi}\right\}\cos\left(\frac{k_o L_e}{2}\sin\varphi\right) \quad (5)$$

The array factor is as follows

$$FA = \frac{\sin^2\left(N\pi\left(\frac{d_x}{\lambda}\right)\sin\theta\right)}{N^2\sin^2\left(\pi\left(\frac{d_x}{\lambda}\right)\sin\theta\right)}$$

Here, d_x is the element spacing and N is the number of elements. Combining array factor and element voltage radiation pattern we get the total element normalized power radiation pattern.

SIMULATION RESULT AND DISCUSSION

In this paper, it is considered that the substrate permittivity of the antenna is ε_r=2.2, operating frequency of the antenna is 4GHz. after the simulation, as in the below figure we found that, return loss is -17.337 dB at 4GHz and it is maximum.

Return loss:

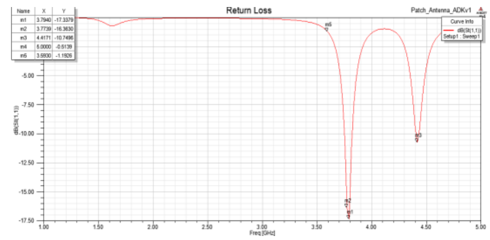

Fig. 3 Return loss of 3x3 array antenna

The simulated gain of the antenna, according to the following figure shows that around -14.02dB.

2D Gain:

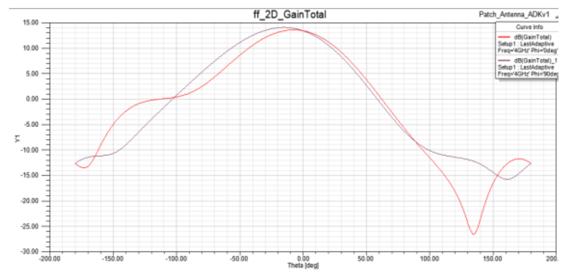

Fig. 4 2D gain of microstrip patch antenna

3D Gain

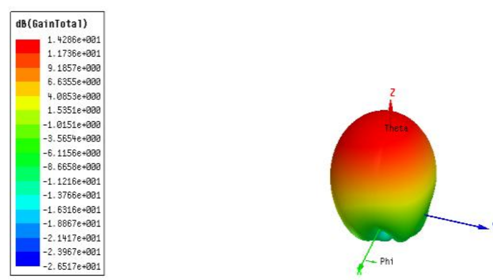

Fig. 5 3D plot of microstrip antenna

Radiation pattern for total gain in dB

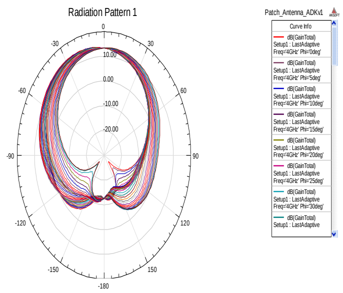

Fig. 6 Radiation pattern for total gain in dB

Radiation pattern for gain(phi) in dB

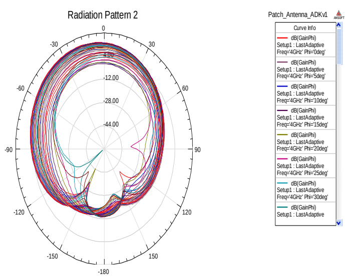

Fig. 7 Radiation pattern for gain(phi) in dB

Radiation pattern for gain(theta) in dB

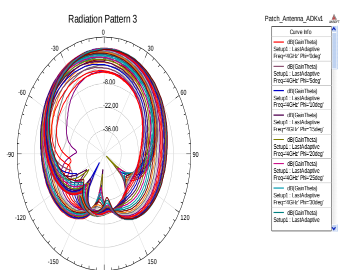

Fig. 8 Radiation pattern for gain(theta) in dB

H-Field Vector

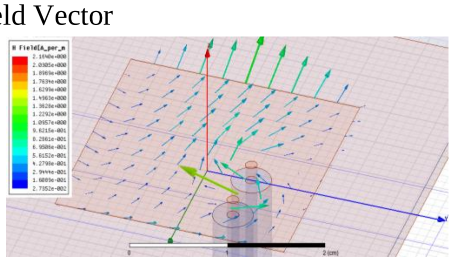

Fig. 9 H-Field vector

E-Field vector

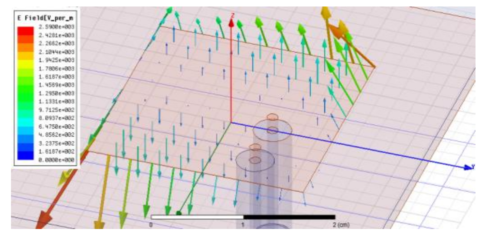

Fig. 9 E-Field vector

CONCLUSION

The unique feature of this microstrip antenna is its simplicity to get higher performance. In many applications basically in radar and satellite communication, it is necessary to design antennas with very high directive characteristics to meet the demand of long distance communication and the most common configuration to satisfy this demand is the array form of the microstrip antenna. Here designed array antennas covers 4 GHz operating frequency and it would also be possible to design the bands, operating any other system such as in WLAN, WiMax, WBAN or other wireless systems, by changing the dimension of the patch element. In future, we can investigate the spiral elements which seems to have more radiation efficiency for both the series feed and orthogonal feed and at the same time we can merge two different patch elements operating at two or more different frequencies by using quarter wavelength transformer method within an array network configuration to get multiband support. In this paper we had calculated return loss, gain and curreny distribution in E-Plane and H-Plane.

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