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Research Paper

A novel planar dual polarized millimetre wave antenna for KU band applications.

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Abstract

A dual polarized antenna array to operate in Ku band is analysed and designed. Cross polarization is the major factor considered. The second requirement is the uni-layer fabrication used for any vertical interconnection accesses. Circular microstrip patches are chosen as the radiating elements. The antenna is fed through the two orthogonal linear edges and shown in microstrip line pattern. Reduction of sidelobes is done by using dolphchebychev distribution. scattering parameters procedure is done to get efficient stimulation. The properties of antenna array simulation are fixed over a bandwidth having center frequency 500MHz. Hence proven, showing that a cross polarised antenna is used for ku band frequencies or millimeter wave applications. The design procedure and parameters are explained clearly to utilize the fact that the antenna array could be reduced.

***Keywords**: Millimeter Wave Antennas, Antenna Arrays, Dual Polarization, Planar Arrays and Radar Antennas*

1. Introduction

By the diversity technique the standard communication channels are improved[1].By using two cross polarizations the decoupling of the communication channels can be done. Two cross polarizations are provided with two dual polarised antennas[2].This information of polarization can be improved with different classification[3].To analyse that antennas that exhibit less crosstalk between various polarizations are necessary to design highly complex antenna structures, microstrip technology is the best choice because of its low cost and less weight. A sophisticated compactness and feasibility and reliable control of the parameters are the major challenges in designing and developing the planar dual polarized arrays. Several designs require more area for their feeding or they used to propose another signal layer. Two expensive materials with high natural frequencies are added together by this crosstalk can be created. The crosstalk suppression is improved because of second layer by using series microstrip antennas are fed single polarized arrays. The dual polarization can be obtained by second order technique, but it is more difficult to fabricate. Accurate dimension should be maintained among the feeding layer and antenna. Substrate integrated wave guide is another feeding technique for single radiators[4].Single polarization is done by using first technique and second technique gives the information about the spacing between the surfaces. Grid antennas are the printed with substrate on one side and ground plane on other side[5].The sidelobes of antenna array should be less than -13.5db.Feeding system consists microstrip feed lines, carefully adjusted for each and every element with a goal of analysing dolphchebychev distribution[6].The proposed antenna is dual polarized antenna in section II. The design steps and explanation of radiating components are fed and shown in section III. The measurement of scattering components are explained in section IV, which describes the measurement of radiation properties of an antenna.

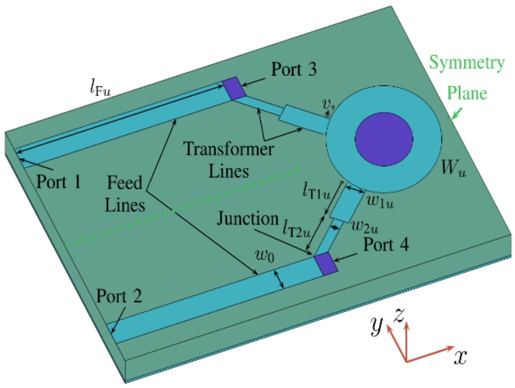

FIG 1: Diagram representation of single element in circular patch.

2. Design of array column:

Some preliminary measures of antenna array are proposed. The antenna is having ten elements with phase and amplitude. Each and every element is excited in the antenna[7]and [8].The figure gives us the detail about the antenna array. Theses antennas are labeled with index numbers from 1,2…..N are represented in X direction. The selected design consists of ten single elements having certain amplitude and decrease in sidelobes takes place in each separation. The series arrangement of these ten elements having fanebeam and narrow halfpower beamwidth ϕ=0 and broad for ϕ=90.

3. Design of single element array

Every patch design is considered to be a circle to get resonance frequencies are having equal polarizations, within the coordinate system axis X, Y and Z.
The frequency is given by

$$(f_r)'_{100} = (f_r)'_{010} = \frac{1}{2L_u\sqrt{\mu\varepsilon}}$$

Feeding is done at the two cross polarized edges to excide the modes. The patch consists of electric field are radiated with sinusoidal feature among the patch and ground plane. There is a small hole in the middle of the patch with sharp edges. Initial feed is taken between points. To obtain the symmetric shape in the antenna array with each and every element maintaining angle at 45degrees.Thus a planar single layer with microstrip line feeding technique is possible. And also it is possible to acquire coupling effect among the two cross polarizations. The second polarization exhibit the radiation pattern with help of microstrip feed. Based on shape and size of patch the substrate properties can be changed. The input impedance of the patch is determined by determining patch and feed techniques. Rogers 4350 used to obtain crosstalk and every part of the feed. The patch modes are excited due to change in transformation lines.

The axial ratio is given by:

$$AR = \frac{(E_X{}^2+E_Y{}^2+(E_X{}^4+E_Y{}^4+2E_X{}^2E_Y{}^2cos(2\Delta\emptyset))^{1/2})^{1/2}}{(E_X{}^2+E_Y{}^2+(E_X{}^4+E_Y{}^4-2E_X{}^2E_Y{}^2cos(2\Delta\emptyset))^{1/2})^{1/2}}$$

Ex and Ey are the magnitudes of electric field of linear polarizations.φ indicates the time phase among the polarisation of linear waves. Polarization ellipse across the y-axis is given by

$$\tau = \frac{\pi}{2} - \frac{1}{2}\tan^{-1}\left[\frac{2E_XE_Y}{E_X{}^2 - E_Y{}^2}cos(\Delta\emptyset)\right]$$

Elements having magnitudes Ex and Ey must be similar. By Ludwig transformation separates the cross and co components in far field representation[10].

Table 1: Parameters of the proposed antenna.

S NO	R1(mm)	R2(mm)	Lfu(mm)
1	1	0.5	Arb
2	1	0.5	7.30
3	1	0.5	7.38
4	1	0.5	7.41
5	1	0.5	7.47
6	1	0.5	7.49
7	1	0.5	7.42
8	1	0.5	7.42
9	1	0.5	7.37
10	1	0.5	7.32

A.Geometry parameters:

Here the components are chosen independently. By this group of elements in discrete form tend to form a building like structure. High frequencies with microstrip lines are used here as wave guides. Table 1gives us the clear detail about the proposed antenna array. At each and every patch consists of three ports which are connected to feedline. Here the circuit is connected in positive manner.
Line impedance of an transmission line is given by:

$$Z_U = \left\{\frac{\frac{60}{\sqrt{\varepsilon_e}}ln\left(\frac{8d}{W_u}+\frac{W_u}{d}\right)}{\sqrt{\varepsilon_e}\left[\frac{W_u}{d}+1.393+0.667ln\left(\frac{W_u}{d}+1.444\right)\right]}\right\}$$

Here the width of an microstrip line canbe calculated by measuring thickness, and by knowing the dielectric constant of the substrate. The first element to the last elements are interconnected by maintaining length and width and outer edges cut with fixed width with microstrip lines having 6λ0 and 1λ0 respectively.

B. Feed Network:

Two microstrip impedance line transformers are connected directly to feed point of the radiating elements. Impedance of the line changes in accordance to the width of microstrip line. We use transformers to obtain broadband behaviour. By using 50 ohms feed lines the characteristic transformer and microstrip patches are connected. Transition of first element feed line is connected from microstrip to coaxial line. The length of the entire microstrip transformer lines is constant for all the elements, if the size of the patches are equal. If not they result in impedance discontinuities. In order of weak excitation’s the first element dimensions are reduced to achieve desired amplitude distribution .At every junction point, power traveling through feed line is decreased by the amount of power that is accepted by a particular element.Coupling of strong feed line and patch corner occurs in first radiating element.The fixed transformer lengths are lT1u = 1.81mm and T2u = 1.72mm, except for the first element which is geometrically small, where its lT21 = 1.90mm. Widths of impedance transformers are carefully adjusted so that each and every element has its amplitude distribution along the array.This variation result in a variable input phase, where feed line lengths (lFu) between the elements are adjusted to obtain desired in-phase excitation of all elements.
In HFSS we designed a square patch antenna array having ten elements with dimensions are mentioned in table 1 and inside a circle of radius 1mm.

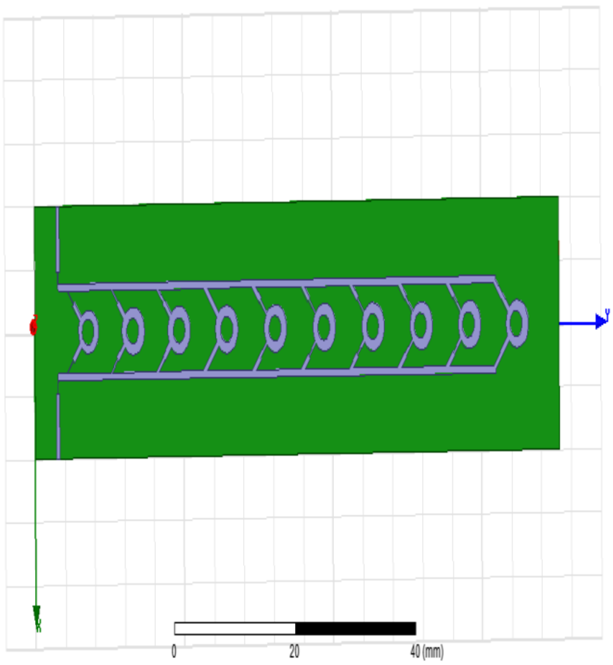

FIG2 : Diagram representation of circular patch array in Hfss.

3. Analysis of Scattering parameters:

Every element in the array have their own individual scattering parameters are analysed in hfss software. Every element is optimized to get the desired pattern.

AF=$\sum_{n=1}^{N} a_n \, e^{j(n-1)\varphi_n}$
Where $\varphi_n = kd_n sin\theta + \beta_n$

Where Ko denoted the wave number, An is the excitation coefficient, Dn Distance among the radiators, and(β) is the progressive phase shift.

4. Measurement of radiation properties:

By observing the different parameters of the antenna we can analyze the application where it is going to use. In this paper we calculated the s parameters with two lumped ports, gain, directivity, radiation pattern and axial ratio.

1.Results for the linear polarization i.e for squared patch.
2.Results for the circular polarization i.e for circular patch.

S1,1 PARAMETER (RETURN LOSS):

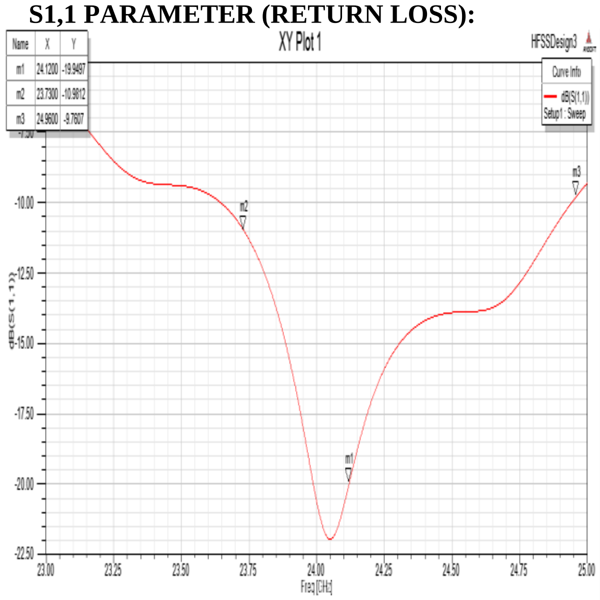

FIG 3: Representation of S11

Scattering parameters mostly used in network operations and microwave frequencies. Electrical components like inductors, capacitors and resistors are measured using s-parameters.

Radiation Pattern:

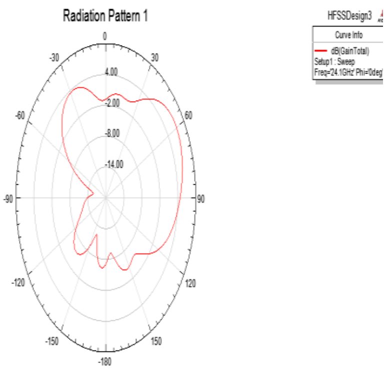

FIG 4: Radiation pattern representation.

Radiation power is defined as the power radiated by the antenna. It radiates the given signal in directions. It tells about the power radiated or received.

Directivity:

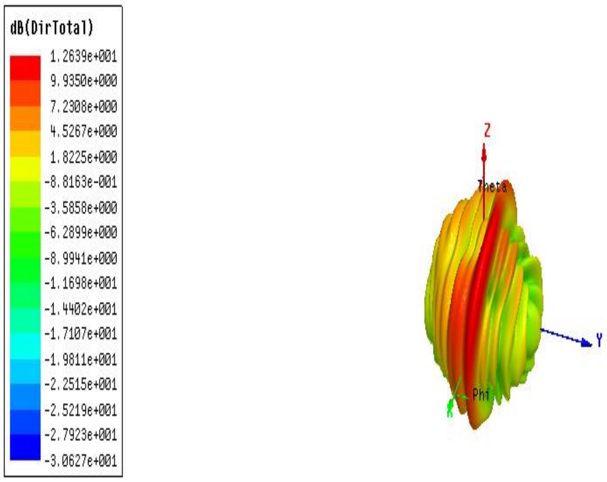

FIG 5: Directivity Representation

The direction in which the radiated signal is emitted and degree of signal concentrated in single direction.

VSWR:

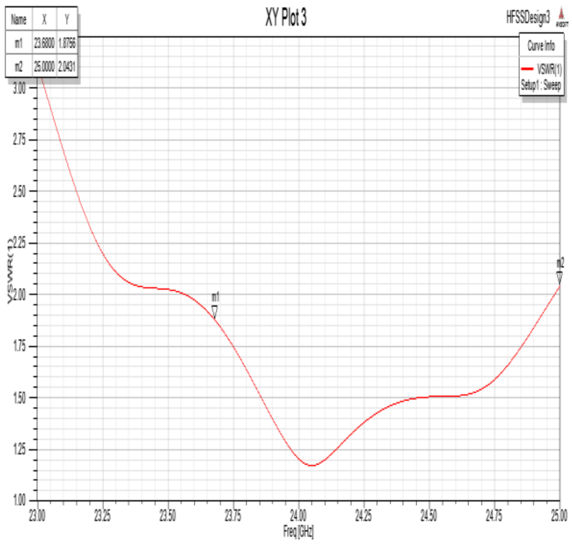

FIG6: VSWRepresentation

It shows the measure of frequency power transmitted from a power source efficiently. Here main purpose is to measure the voltage across the transmission line.

Axial Ratio:

It tells about whether, the electromagnetic radiation is elliptical or circularly polarized. It explains us the ratios of major and minor axis.Here the axial ratio is75Db AT ϴ=100 degrees.It indicates that it is a perfectly circular polarized antenna**.**

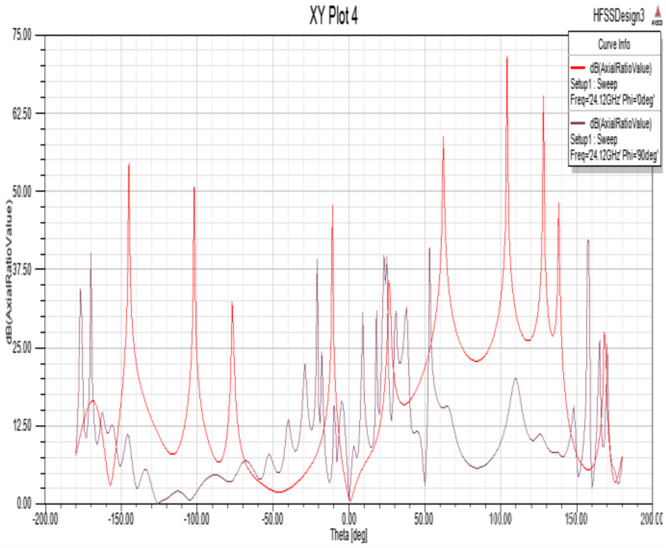

FIG 7: Axial Ratio

5. Conclusion

A Novel Dual polarized millimetric wave antenna array for Ku Band frequency have been presented. series feeding in the microstrip technology for different ports is very difficult and single layer structure is easily manufacturable and extended upto higher millimetric frequencies. If several antenna elements are arranged as an array in columns then one dimensional dual polarized beam forming exists and side lobe level is very low from 23GHz to 25 GHz frequency. Two orthogonal polarizations which means linear and circular polarizations which are obtained at Ku band frequency. This antenna array can be useful in Radar and Satellite applications. Further The antenna elements can be increased and different types of feeding techniques are applied to get high frequency applications.

References

[1] G. L. Grisdale, J. G. Morris, and D. S. Palmer, “Fading of long-distance radio signals and a comparison of space- and polarization-diversity reception in the 6–18 Mc/s range,” Proc. IEE-B, Radio Electron. Eng., vol. 104, no. 13, pp. 39–51, Jan. 1957.

[2] S. Alamouti, “A simple transmit diversitytechnique for wireless communications,” IEEE J. Sel. Areas Commun., vol. 16, no. 8, pp. 1451–1458, Oct. 1998.

[3] D. Giuli, “Polarization diversity in radars,” Proc. IEEE, vol. 74, no. 2, pp. 245–269, Feb. 1986.

[4] T. Li and W. B. Dou, “Millimetre-wave slotted array antenna based on double-layer substrate integrated waveguide,” IET Microw., Antennas Propag., vol. 9, no. 9, pp. 882–888, Jun. 2015.

[5] F. Bauer and W. Menzel, “A 79 GHz microstrip grid array antenna using a laminated waveguide feed in LTCC,” in Proc. IEEE Int. Symp. Antennas Propag., Spokane, WA, USA, Jul. 2011, pp. 2067–2070.

[6] C. L.Dolph, “A current distribution for broadside arrays which optimizes the relationship between beam width and side-lobe level,” Proc. IRE, vol. 34, no. 6, pp. 335–348, Jun. 1946.

[7] G. F. Hamberger, S. Trummer, U. Siart, and T. F. Eibert, “A planar dualpolarized microstrip antenna array in series-parallel feed configuration,” in Proc. Loughborough Antennas Propag. Conf., Nov. 2015, pp. 1–4.

[8] G. F. Hamberger, S. Trummer, A. Drexler, U. Siart, and T. F. Eibert, “A planar dual-polarized microstrip 1D-beamforming antenna array for the 24 GHz ISM-band,” in Proc. Eur. Conf. Antennas Propag., Davos, Switzerland, Apr. 2016, pp. 1–5.

[9] C. A. Balanis, Antenna Theory: Analysis and Design. Hoboken, NJ, USA: Wiley, 2012.

[10] A. Ludwig, “The definition of cross polarization,” IEEE Trans. Antennas Propag., vol. 21, no. 1, pp. 116–119, Jan. 1973.

[11] Vanitha Rani Rentapalli, Sowjanya B. and B. T. P.Madhav,” An Efficient Power Control Detection Scheme For Mimo Transmission In Lte” ARPN Journal of Engineering and Applied Sciences VOL. 11, NO. 13, JULY 2016ISSN 1819-6608.

[12] Vanitha rani Rentapalli, 2 Sowjanya B,et “A Novel Transmission Technique For Interference Management And Mitigation In 3gpp Lte-Advanced” Journal of Theoretical and Applied Information Technology, ISSN: 1992-8645 .,E-ISSN: 1817-3195.