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A SINGLE LAYER AND DUAL-BAND FED CIRCULARLY POLARIZED PLANAR APERTURE ANTENNA ARRAY

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ABSTRACT: The circular polarization with L1 frequency will be utilized in the recent global position system (GPS) receivers. To manage the different frequencies in circular polarization using dual band feeding an antenna with better gain is essential. For dual-CP (circular polarization) radiation applications an efficient antenna array called mm Wave (millimeter wave) method will be used. This millimeter Wave method have four-beam end-fire antenna pattern. A differential antenna will be used to get precise information. The antenna with a wide band width and high thickness, called microstrip gives a dual band and circular polarization specifications. This antenna have only single layer but it provides large frequency ratio of two bands, for many applications. Microstrip is a type of electrical transmission line which can be fabricated using printed circuit board technology, and is used to convey microwave-frequency signals. A popular antenna called planar aperture antenna based on circularly polarization (CP) will be suitable in millimeter-wave technique. This planar aperture antenna has increased gain and bandwidth. The antenna will be uses a differential feeding approach. The technology called printed circuit board (PCB) will be used to design an aperture antenna over a single layer. With all these features we will expect an antenna with a more economical and flexible to fabricate over differential circuits. The size of the planar aperture antenna will be enhanced to a higher gain by considering dual strips design. So in this paper, an efficient planar aperture antenna will be designed with help a single layer circular polarization with dual feed.

KEYWORD: GPS, circular polarization (CP), differential feeding, millimeter-wave and PCB

I. INTRODUCTION

The dual band fed circular polarized pattern is used to get a planar aperture antenna using single layer. This technique can produces an antenna with better gain and good directivity. The larger arrays with better efficiency and gain will be achieved using a feed networks. The circular polarization can produce optimum frequency response. The CP radiation with dual band can be proposed by using single-layer antenna elements [1]. Unequal arm lengths with cross slots will be implemented on patch antenna to get dual band circular polarization based on single layer design. The right hand circular polarization has a L1 frequency of 1.575 GHz and this can be used in GPS receivers. For these applications a stacked microstrip antenna will be used. The bandwidth of this antenna is wide and thickness is high. To get dual feeding circular polarization, the microstrip antenna will be highly preferable. Present days for dual band CP operation a square wave antenna with changeable slots will be proposed. This operation will give various specifications like single layer, a single feed, less frequency ratio. So this type of antenna will be implemented for GPS applications.

Reflectarray antenna can gives the benefits of both traditional parabolic antenna and array antenna. It is a most suitable antenna for various applications because of low cost, low size and high gain [2]. The multipath effects and polarization mismatches are reduced in CP array antenna. So these antennas are also much preferable in modern wireless communication systems. So it is essential to design a wideband CP reflectarray antenna. There are several methods to design a CP reflectarrays, among two are very popular approaches. In the first method, reflectarrays will get circular polarization with help of CP feed and it has different elements [3]. Second reflectarrays can get circular polarization with help of a LP (linear polarization) feed. These two are preferable methods to achieve a circular polarization. For dual-CP radiation application, a most efficient millimeter Wave based antenna array will be designed and verified. This antenna array is developed by considering some parameters such as feeding network, dielectric load and air gaps between coupling suppression. By developing the prototype antenna array there is a scope to achieve optimum performance. In this paper, a single-layer dual band circularly polarized technique will be proposed to design an efficient antenna with better features.

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The horn and parabolic reflector antennas are the examples aperture antennas. Because of better gain, larger band width and flexible structure these antennas will be effectively used in various -Wave applications. The conventional aperture antennas are not preferable in user-level applications since they have high profile, bulky in size, high cost. Present days an innovative planar antenna will be implemented, which is almost similar to the conventional aperture antennas. So these antennas can able provide a similar aperture field in physical aperture for radiation. Hence it is called planar aperture antenna. The planar aperture antenna offers several benefits such as large gain, more bandwidth, low cost, less in size and low profile [4]. There exists a polarized loss because it is a linearly polarized. All these problems can be easily resolved by using circularly polarized (CP) antenna. The Circularly polarized (CP) antenna will have several advantages reduce the fading problem. Fading is the result of alters in the course of polarization in at least one of the proliferation ways of waves showing up at an accepting point. This is mainly occurred due polarization mismatch because of wrong feeding between transmitter and receiver. At mm-Wave frequencies there is lot of scope for free-space loss. This loss can be rectified by with help of high gain antennas such as circularly polarized (CP) antennas.

II. LITERATURE SURVEY

Dual band antennas are generally used in satellite communication systems different frequencies. Orthogonal polarization will be more preferable to enhance the isolation for antennas. A single layer antenna with dual-band characteristics is known as microstrip antenna. The pattern of this antenna is stacked rectangular shape. It can able to get dual resonance with better resonance frequency by changing the dimensions of a patch antenna. This can also achieved constant upper resonance frequency with increased length and width of the antenna. The patch antenna is also called as microstrip antenna and printed circuit antenna [8]. The microstrip antenna is a better option when it is required to get conformal and low profile antennas. This antenna has several advantages such as portable, cheap, reproducibility, installation and better design. The feed lines with radiating elements will together easily placed on a thin dielectric sheet. They element may be rectangular, round and square. These elements can travel through several feed points at a ground plane. Though it has several advantages, it has one major drawback such as narrow bandwidth. These problems will be solved by using circular polarization antenna to meet better wide band characteristics for practical purposes. The literature purely based on how the polarization will be developed in polarization antennas.

In the past, both in rectangular and spherical coordinate systems the polarization and its related functions can implement. Generally rectangular coordinates are much useful in circular polarization. So the antenna far-field radiation will be used to implement spherical coordinates. The fundamental expressions for electric- type radiated field can developed by using elementary electric dipoles. These are very useful to determine the required conditions for a CP radiation. The efficiency of the CP pattern can be implemented by using different elementary source and it is compared with polarized vector. The microstrip antenna can be selected as better radiation source. By using circular polarization design of antenna can be designed perfectly. The speeder produces a linear polarization (LP) spherical wave is forwarded through a reflect plane and the concern plane is converted into CP plane radiation into free space. Dual-polarized unit cell belongs to circular polarization reflectarray elements and these are having dual-layer T-shaped element [5]. They are designed with very low gain and bandwidth. Therefore it is very important to design a single-layer wideband CP reflectarray with LP feed. Here the pattern of the array is perpendicular to the beam-steering antenna arrays. This type of arrays will be mainly useful in the portable devices. The better end-fire arrays based on multi-beam will be constructed for applications of linear polarization (LP) [6]. The microstrip antenna efficiency can be decreased because of its drawbacks such as narrow bandwidth, small gain; bulky in size are the significant drawbacks of microstrip antennas. Among all these drawbacks, the narrow bandwidth will have more impact on antenna performance. The bandwidth of an antenna can improve by increasing the thickness of substrate. Due to this operation, the power dissipated more in the resistor and in turn it decreases the efficiency. In the past several unidirectional circular polarizations (CP) antennas and arrays for mm-Wave band were developed [7]. They are cross dipole antenna, dielectric resonator antenna, open-loop antenna, slot antenna. All these antenna designs are suffer from various limitations poor performance and complex structure. All these antennas are limited to some practical applications. The performance of an aperture antenna can be enhanced by using CP radiation. The concept of dual band also used in getting the better gain of an antenna. So by using dual-band fed circularly polarized planar aperture antenna (DFCPPAA) array, the gain and directivity of the antenna will be improved.

III. DFCPPAA ARRAY

The electric field can differ in two orthogonal planes such as x and y direction, with 90 degrees phase shift and no change in the amplitude. This is happened in circular polarization. It can produces the operation in two modes such as, in the x direction one mode i.e. TM10 mode and in y direction another mode i.e. TM01 mode. In portable devices, multi-beam end-fire radiation arrays will be suitable technique. This was happened because of

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performance of CP and the way how the mutual coupling will be takes place. So it is required to design an antenna array with dual-CP radiation to increase the directivity of an antenna. For dual-CP radiation application, a most efficient millimeter Wave four-beam end-fire antenna array will be designed and verified. This antenna array is developed by considering some parameters such as feeding network, dielectric load and air gaps between coupling suppression. By developing the prototype antenna array there is a scope to achieve optimum performance.

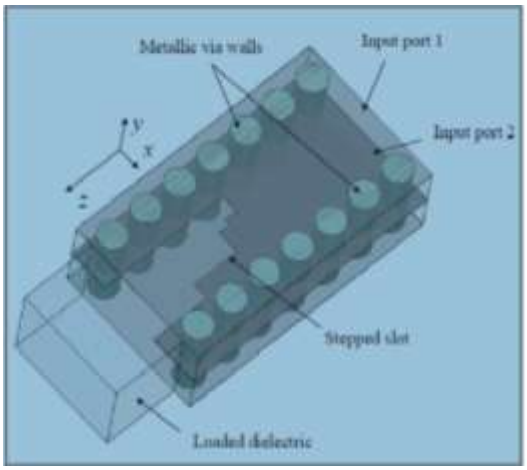

Fig. 1: The design structure of the DFCPPAA array.

The design structure of the dual-fed circular polarized planar aperture antenna (DFCPPAA) array can be shown in Fig. 1. The two printed circuit board (PCB is used for complete design). The metallic's wire two rows are used as a side wall of the SIW. This is utilized to energize the dual CP planar aperture antenna. This structure will comprise of two layers and each layer ought to be consolidated with the two inputs feeding of ports. The middle metallic layer between the two dielectric layers will be isolated by a ventured slot. In this condition, the enhanced dielectric is stacked at the open finish of the SIW. This enlarged dielectric can assume fundamental job, for example, radiator, the moving from the open end of the SIW to the free space. If this antenna element fed by the input port then it gives radiation in left handed circular polarization (LHZP) wave and if it is fed by the input port 2 then it will provides radiation in right handed circular polarization (RHZP) wave.

It is essential to design a planar topology based aperture antenna which can used to generate a circular polarization (CP) radiation and initially it's very important to design an antenna. The major aim or requirement is to achieve better CP performance and large gain at any direction. The travelling wave is much useful in wideband operations. The differentially feeding technique can have several benefits such as stability, symmetric, large power and better polarization. The basic single layer antenna component is shown in Fig. 2(a). This antenna has two sections. They are - two arms of strips that create a loop-like shape and an opening cavity. After cutting the surface copper layer at the middle of the top face of the opening cavity, the stripes are formed. The metalized vias and ground planes are used as a side walls and bottom respectively to create the opening cavity design. The upper surface of the boundary is traced by a copper. The physical aperture for an antenna can be designed from the peripherals and opening of the cavity.

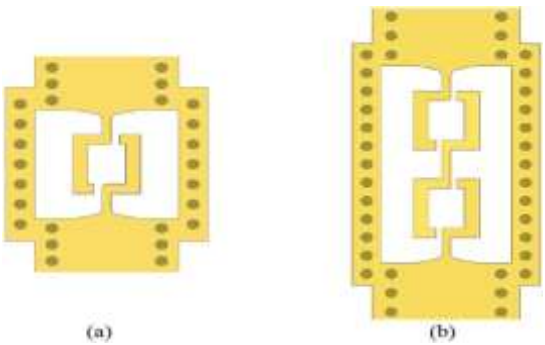

Fig. 2: Preliminary models DFCPPAA array (a) Single layer based antenna. (b) Dual layer based antenna.

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All these design considerations will give an aperture antenna since the antenna does not resonate and it provides large gain. Here the energy completely radiates by the circularly polarized radiated antenna. An antenna is connected differentially to the counterpart edges and this can be implemented by SIW. These edges have narrow extensions the SIW's top wall fed to the outer ends of the strips. This type of antenna feeding technology can able to avoid the demand for the multilayer configuration. Generally in conventional spiral antennas and dual-rhombic loop antennas should need multilayer configuration.

The same methodology is used to enhance physical aperture size of the antenna with better aperture efficiency. The derived structure had four loops-like strips formations with the size of the opening cavity should not exceed 7.9mm × 7.9 mm. The geometric representation of the dual band fed circular polarized planar aperture antenna (DFCPPAA) design can be shown in fig. 3.The formation of the stripes should have two similar sets of dual loop-like designs

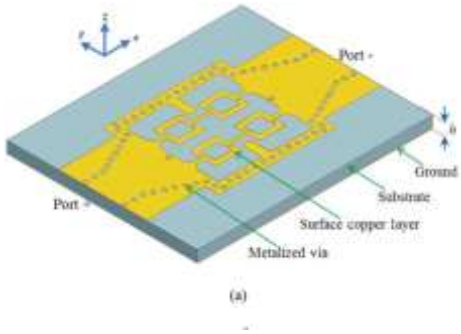

Fig. 3: The geometric representation of DFCPPAA array

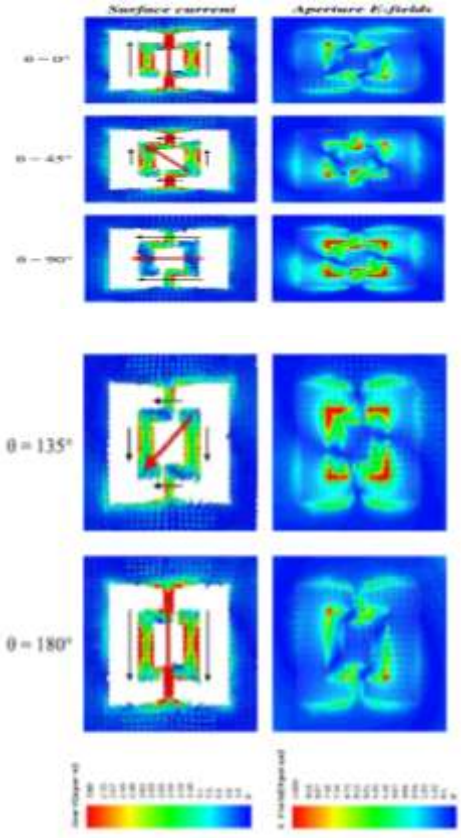

Fig. 4: E-field distributions and simulated current of DFCPPAA array

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These are located at the exactly middle of the top face of the opening cavity. The physical aperture of the dual band circularly polarized antenna will be defined from the opening of the cavity and it's peripheral. The diameter of the opening cavity should be $2\lambda_0$. Here λ_0 can represents the wavelength of the antenna in free space. It has height of one fourth of a guided wavelength, $\lambda g/4$. The height of the aperture antenna will gives concern thickness of mm-Wave bands. The dual band fed circularly polarized aperture antenna is much compatible with standard planar antennas at mm-Wave bands. This planar aperture antenna will be operated at a very high frequency i.e. 60 GHz. The simulated surface current distribution is shown in fig. 4. This is much useful in verifying the operating principle for the design of an aperture antenna. It also gives the aperture E-field distribution for various phases. The phase difference can be taken for every 45 degrees for surface current and aperture e-field distribution. So by using single layer double fed circularly polarized design, the antenna will give high gain and better directivity. This can be achieved by either increasing the size of antenna or by increasing the dimensions of antenna.

IV. RESULTS

Point of comparison	Microstrip feed	Proximity feed	DFCPAA Antenna
Radius (mm)	23.96	23.3	21.6
50Ω feed line width (W_f)	4.88	4.62	3.91
Impedance bandwidth (%)	2.92	5.36	1.89
Directive antenna gain (dB)	8.11	8	7.1
Axial ratio bandwidth (%)	0.833	1.45	.729
Design frequency (GHz)	2.4	2.4	2.35
Difference between co and cross polarization in E-plane (dB)	31.08	28.14	27.4
Difference between co and cross polarization in H-plane (dB)	31.08	28.14	26.8
Half power beam width in the E-plane	70	70	74.3
Half power beam width in the H-plane	73	77.5	75.9

Table 1: Comparison between various antennas

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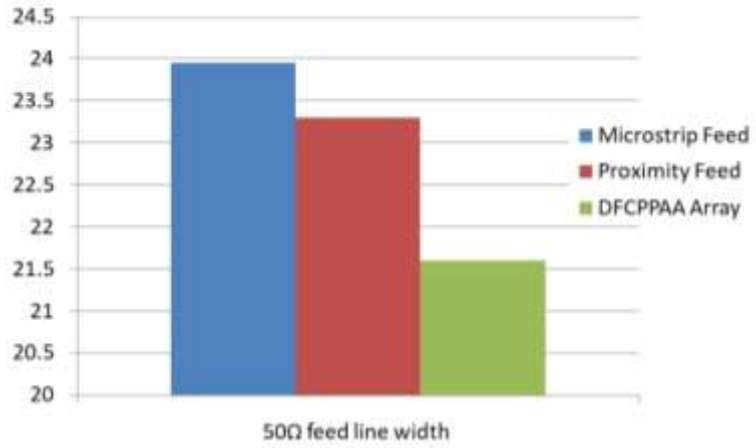

Fig.5: 50Ω feed line width (W_f) for three antennas

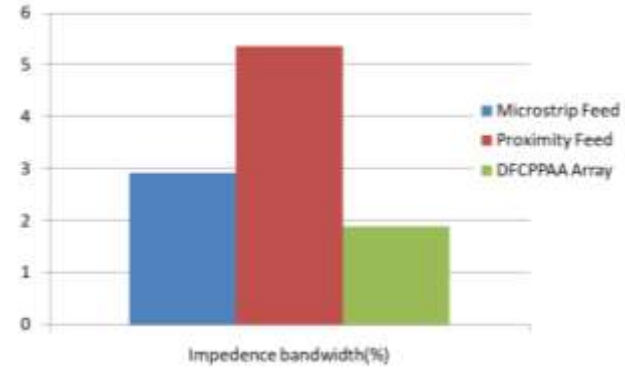

Fig.6: Impedance bandwidth for three antennas

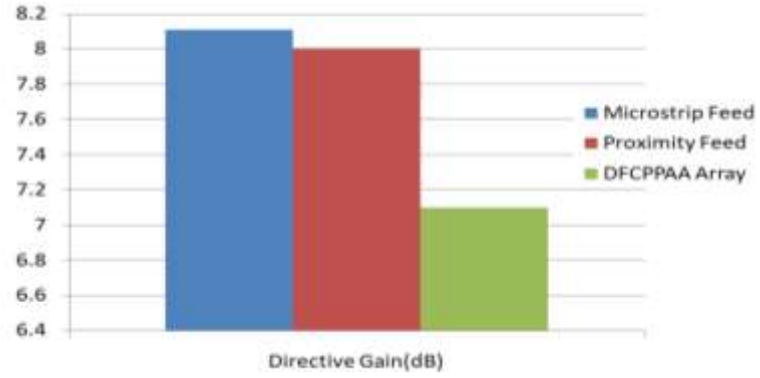

Fig.7: Fig.7 Directive antenna gain for three antennas

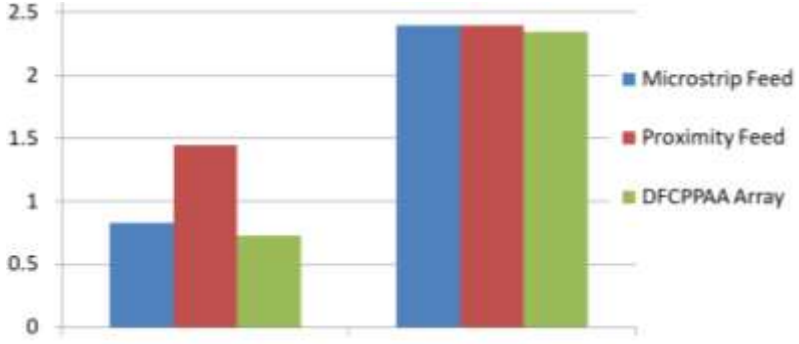

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Fig. 8: Axial ratio bandwidth and design frequency for three antennas.

In this paper the planar aperture antenna can be designed by using single layer and dual fed circular polarization method. This method is effective in the design of antenna with higher gain and better bandwidth. It has two ports to feed so it's called as dual fed. To meet all these benefits, this technique should consider so many parameters. These parameters can influence or impact the performance of any antenna. The major parameters are radius, Impedance bandwidth (%), directive antenna gain (dB), axial ratio bandwidth (%), Design frequency (GHz) and half power beam width. All these parameters for two existed systems and DFCPPAA (Dual-band fed circularly polarized planar aperture antenna) will be depicted in table1. The DFCPPAA array have small radius i.e. size of the antenna when compared to remaining antennas.

The graphical representation of some major parameters will be explained in this section. The comparison for various antennas in terms of 50Ω feed line width (W_f) can be shown in fig. 5. This shows that the DFCPPAA decreases the required feed line width over a remaining two. The impedance bandwidth decreased in the present antenna compared remaining two antennas and it will be shown in fig. 6. This can made possible because of dual feeding. The directive antenna gain and axial ratio beam width for three antennas can be shown in fig. 7. The two parameters are decreased in DFCPPAA array. Finally the design frequency and is generally required in GHz will be reduced in DFCPPAA array technique. All these are possible in planar aperture antenna by using dual fed circular polarization method.

V. CONCLUSION

The antenna with a wide band width and high thickness, called microstrip gives a dual band and circular polarization specifications. The antenna used a differential feeding approach. This can be designed on a single layer overlay with help of better technology printed circuit board (PCB). For dual-CP radiation applications an efficient antenna array called mm Wave method was used. This method have four-beam end-fire antenna pattern. A differential antenna has used to get precise information. This antenna have only single layer but it provides large frequency ratio of two bands, for GPS applications. A popular antenna called planar aperture antenna based on circularly polarization (CP) was opted in millimeter-wave technique. This planar aperture antenna has increased gain and bandwidth. With all these features it was given a more economical and flexible to fabricate over differential circuits. The size of the planar aperture antenna has used to a higher gain by considering dual strips design. An efficient planar aperture antenna designed with help a single layer circular polarization with dual feed.

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