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Multiple Notch Circularly and Linear Polarized antenna with Parasitic Array and Orthogonal Shorting-Pin Loading Techniques

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***Abstract*— A Multi-notch Circularly Polarized Antenna with Parasitic Array, U-Slot and Shorting-Pin Loading Technique is proposed in this paper. Design antenna-1 and antenna-2. The patch is designed with parasitic array technique; designing of parasitic array configuration yagi uda array concept is used. Top two layers as director and third layer used as driven elements, coaxial feeding used for excitation, forth layer ground plane used as reflector. Dimension of driven elements is design using transmission line model, and further design is carry out by parasitic array concepts. For achieving multiband and compactness of antenna geometry used three orthogonal shorting pins in parasitic array configuration. Circular polarization of antenna validated by axial-ratio (AR) curve. By loading a shorting pin to the patch in orthogonal pattern, the minimum point of lower frequency moves to higher frequency, and broad AR band is obtained consequently. The optimization parameter for the proposed antenna is to achieve multiple notches for validation of proposed geometry IE3D Simulator is used.**

***Index Terms*— Parasitic array, orthogonal shorting pin, circular polarization, multiple notches**

I. INTRODUCTION

CIRCULARLY polarized (CP) antennas are more demanded research in recent wireless communication systems due to their dual mode of operation in single antenna, independence of the transmitting and receiving configuration and eliminate in multipath reflections. Generally, CP

Operation can be achieved by dual feedings in orthogonal structure with equal amplitudes of but difference in phase [1] or using single feeding technique with perturbations such as truncated corners structure [2], author Sze, presented the feeding for Circular Polarization operation of antenna into two types: single-port–double-feed and single-port–single-feed [3]. In [4] describe technique to achieved circular polarization using simple feeding structures. many techniques used in recent scenario to obtained multiband with circular polarization using loading shorting pins, shorting posts placed near the edges of the fed patch, and multiple chip-resistors technique describes in [5], [6], [7] respectively. If one resonant mode is enhance by support of second generated mode then circular polarization is achieved. CP bandwidth is enhancing at the expense of antenna gain [8], in [9] a proximity-coupled L-shaped microstrip-line is used and obtained narrow 3-dB axial-ratio (AR) bandwidth of 1.9%. in this paper AR bandwidth of a patch antenna is enhanced by using thicker substrate. Thick air substrates in stacked geometry configuration are frequently used [10], [11] to achieve broad AR bandwidth. In [10], CP operation is achieved by a edge truncated patch, and a horizontally meandered strip (HMS) feeding structure. In [11], a stacked CP patch is in sequence fed by four feeding probes that are connected to suspended microstrip feed-line, and 3-dB AR bandwidth of 16.4% is obtained. In [12] meandering probe and meander structure used to enhance AR bandwidth and achieved up to 16.8%. All the above mentioned technique show broad CP band. In this paper, we proposed a Broadband Circularly Polarized Antenna with Parasitic Array and Shorting-Pin Loading Technique multiple resonant modes generates to obtain an AR bandwidth. Simulated AR Results show that the proposed antenna can obtain CP at multiple frequencies with a compact geometry.

II. ANTENNA DESIGN AND ANALYSIS

In fig1, shown proposed Multi-frequency circularly Polarized antenna. Mathematical analysis of theory micro-strip antenna and concept of parasitic array are used to for finding dimension of all layers of proposed antenna. Dimensions are

Antenna-1
Antenna-2
Design Description

Length and width of reflector is
L_R = 17.77mm, W_R=20.32mm
Length and width of driven element
L_D= 16mm, W_D= 18.288mm
Length and width of First director
L_{Dir1}=14.22mm, W_{Dir1}=16.256mm
Length and width of second director is
L_{Dir2}=12.44mm, W_{Dir2}= 14.22mm
The spacing between all elements is .1λ (.6mm)

Antenna-1

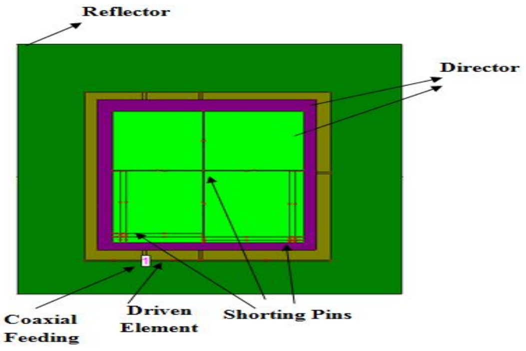

Figure 1 Proposed Antenna 1

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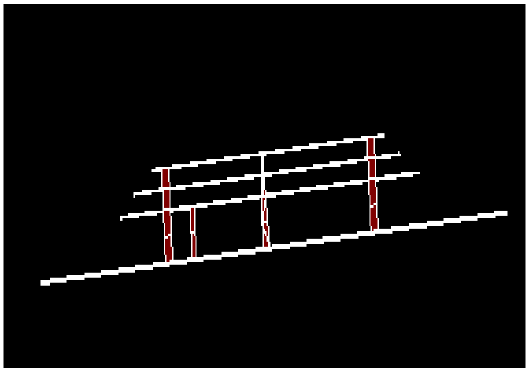

Figure 2 3D View of Proposed antenna

The Proposed antenna design in IE3D Simulator at 5.6 GHz centre frequency, the dimension of antenna calculated using transmission line model, design of reflector of dimension $L_R = Lg,+6h$ and $W_R=Wg+6h$ Where Wg and Lg are the width and length dimension of ground plane of theory antenna, h is height of theoretical antenna. The dimension of the Driven element has .1λ times small width and length compared to width to length of reflector, Directors design as per as theory of yagi-uda antenna. In design of each consequent elements have width to length ratio .1λ times small compared to width to length ratio of previous element. Spacing between all elements are 0.1λ, the design ratio 0.1λ is optimum for obtaining broad bandwidth, in paper analyses done with counting the effect of ground plane, this paper reported multiple notches at 3.2 GHz, 5.6GHz, 6.5GHz and 8GHz shown in return loss analysis.

Antenna-2

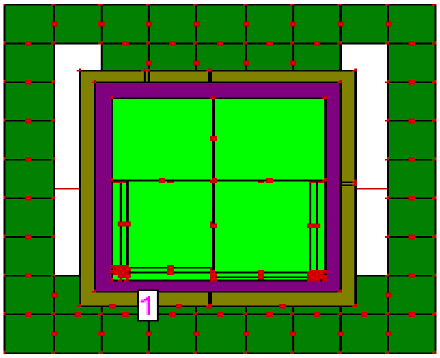

Figure 3 Proposed Antenna 2

To improving impedance matching of antenna 1 using U-Slot in antenna 1 has shown in geometry of antenna -2 in fig 2. U-Slot is designed in ground plane using stub matching technique.

III. RESULT AND DISCUSSION

Multiple Notch Circularly and Linear Polarized antenna With Parasitic Array and Orthogonal Shorting-Pin Loading Technique is discuss in this paper. For designing of this antenna firstly design theoretical antenna then loading parasitic and active layers as per as 0.1λ scale of integration, arrange in parasitic array configuration with combination of patches for reflector, driven element and directors . for improving in results of proposed antenna three orthogonal shorting pins are used. This pins generate multiple notches with less cross polarization. Orthogonal configuration of three pins reduce cross polarization and improve efficiency and directivity of proposed antenna, due to shorting pins improve surface current and shift higher edge of frequencies to lower edge of frequency and sustain compactness at 3GHz antenna is 40% compact compare to theoretical antenna. Proposed antenna design in IE3D Simulator and all results validated in IE3D Simulator. Return losses, VSWR, axial ratio, antenna and radiating efficiency, directivity and radiation pattern discuss in below section.

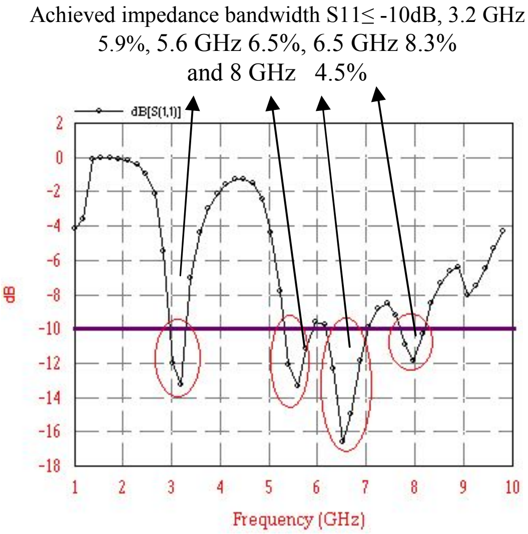

Figure 4 Return Loss Vs Frequency

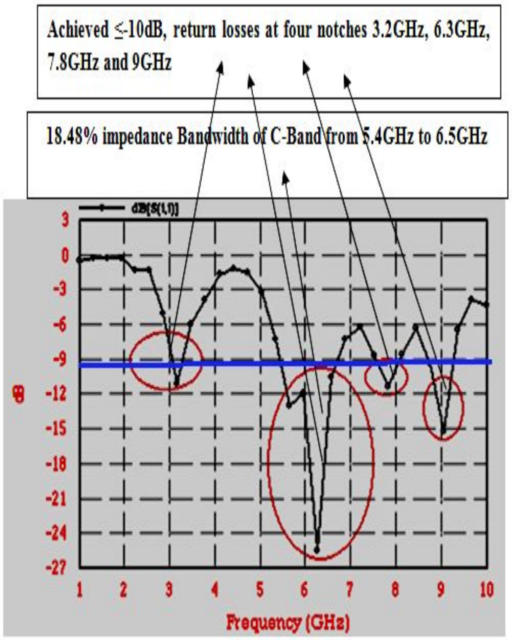

Figure 5 Return Loss Vs Frequency

Fig 4 and Fig 5 depicts return loss vs. Frequency of antenna 1 and antenna-2, this paper reported multiple notches at 3.2 GHz, 5.6GHz, 6.5GHz and 8GHz shown in return loss of an. Obtained -16.2dB, return loss at 6.5GHz. VSWR and Return Loss depicts in fig 3 and in fig 4. Achieved impedance bandwidth S11≤ -10dB, 3.2 GHz 5.9%, 5.6 GHz 6.5%, 6.5 GHz 8.3% and 8 GHz 4.5%. In antenna 2 obtain 18.48% impedance Bandwidth of C-Band from 5.4GHz to 6.5GHz, achieved ≤-10dB, return losses at four notches 3.2GHz, 6.3GHz, 7.8GHz and 9GHz.

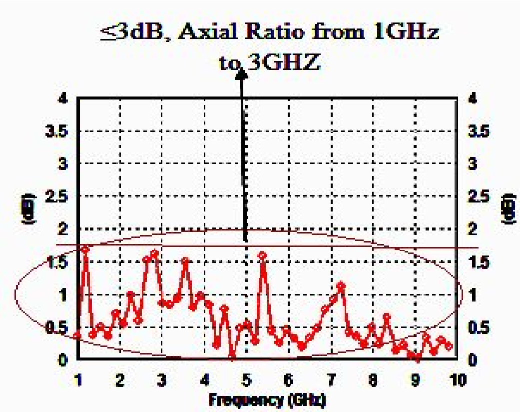

Fig 6 Axial Ratio Vs Frequency

Fig 6 depicts axial ratio result of proposed antenna From 1GHz to 10GHz achieved axial ratio less than equal to 3dB, Axial ratio represents polarization of antenna if axial ratio less than 1dB, then antenna is circular polarized and if axial greater than 1dB,then antenna is linear polarized. At 3GHz and 5.6GHz proposed antenna is linear polarized and at 6.5GHz and 8GHz antenna is circular polarized, all polarization verified from fig 5.

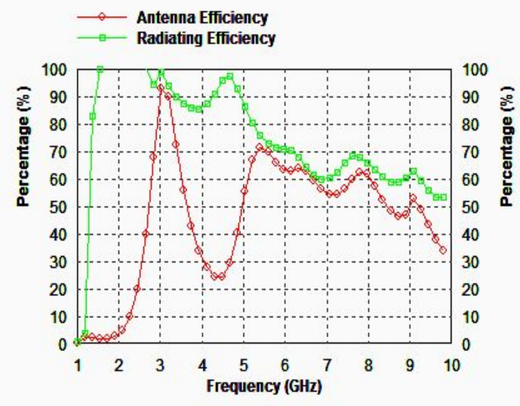

Figure 7 Efficiency Vs Frequency

Fig 7 shown antenna and radiating efficiency of proposed antenna, achived antenna from 60% to 92% and radiating efficiency obtained from 60% to 96%.

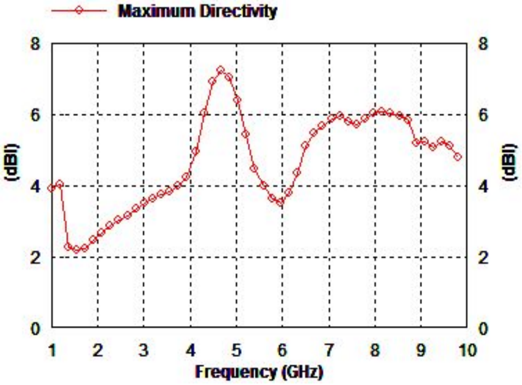

Figure 7 Directivity Vs Frequency

Fig 7 represents directivity vs. frequency of the proposed antenna. Directivity achieved up to 6dBi.

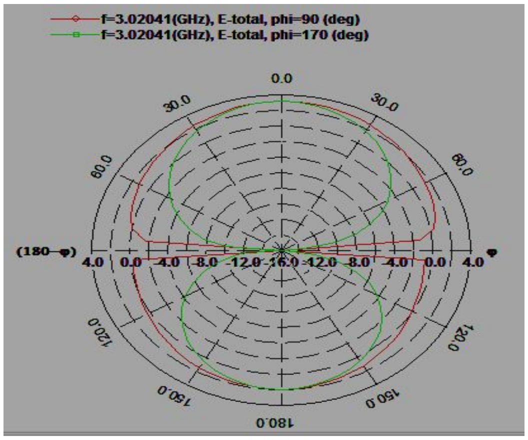

Figure 8 elevation pattern at 3GHz

Fig-8 and Fig 9 represents Elevation and azimuth pattern, from this results achieved Linear Gain: 3.15186 dBi Linear Directivity: 3.48633 dBi Linear Maximum: at (0, 0) deg. 3dB Beam Width: (88.7548, 161.578) deg. RH Circular Properties: Circular Gain: 0.911957 dBi Circular Directivity: 1.24643 dBi Circular Maximum: at (10, 0) deg. 3dB Beam Width: (0, 0) deg.

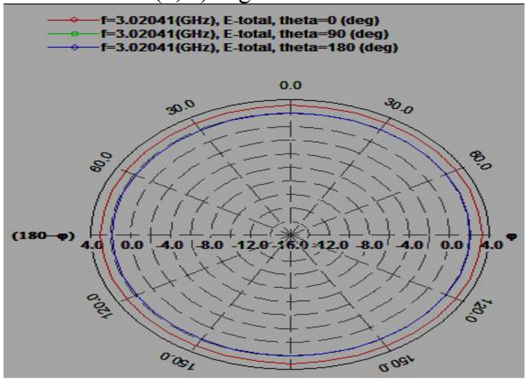

Figure 9 Azimuth pattern at 3GHz

Table-I Validation of Work with Previous Work

Ref	Configuration	≤ 3dB, Axial Ratio Bandwidth
10	HMS	13.5%
11	Sequential Feed	16.4%
12	M-Probe	16.8%
This work	Parasitic Array and Orthogonal shorting pins	18.48% impedance Bandwidth of C-Band from 5.4GHz to 6.5GHz, 3.2GHz is 2%, 7.8 GHz is 2% and at 9GHz is 5%, Achived ≤ 3dB, Axial Ratio from 1 to 6GHz

Table-II Results summary of proposed antenna at 3GHz

Parameters	**Proposed Design**
Input Power:	0.00937026 (W)

Radiated Power	0.00925876 (W)
Radiation Efficiency	98.8101%
Antenna Efficiency	92.5876%

Table-II Results summary of propo
sed antennas at four notches 3.2GHz, 6.3GHz,
7.8GHz and 9GHz.

	Antenna 1	**Antenna-2**
Return Losses	Achieved ≤-10dB, return losses at four notches 3.2GHz, 5.6GHz,6.5GHz, and 8GHz. Return loss is -16.2dB, at 6.5GHz	Achieved ≤-10dB, return losses at four notches 3.2GHz, 6.3GHz, 7.8GHz and 9GHz. Return loss -27dB, at 6.3GHz
≤ 10 Impedance Bandwidth	3.2 GHz 5.9%,5.6 GHz 6.5%,6.5 GHz 8.3% and 8 GHz 4.5%	18.48% impedance Bandwidth of C-Band from 5.4GHz to 6.5GHz, 3.2GHz is 2%, 7.8 GHz is 2% and at 9GHz is 5%

Validation and summary of work shown in Table-I, Table-II and Table-III. From this we concluded that proposed is multi notches with linear and circular polarization.

CONCLUSION

From the discussion of paper we concluded that proposed antennas work on the four notches with linear and circular polarization. Proposed antennas design successful used at multiple notches, parasitic array, U-Slot in ground plane and three orthogonal shorting pin successfully investigate proposed designs. Concluded that 0 .1λ scale of integration as per as parasitic array concept is appropriate method for generating multiple notches with optimum results, from validation of proposed work, concluded that this paper reported multiple notches at 3.2 GHz, 5.6GHz, 6.5GHz and 8GHz shown in return loss figure. Obtained -16.2dB, return loss at 6.5GHz. $S_{11,}$ -10dB, Impedance bandwidth at 3.2 GHz 5.9%,5.6 GHz 6.5%,6.5 GHz 8.3% and 8 GHz 4.5% from antenna-1.from antenna-2 Achieved ≤-10dB, return losses at four notches 3.2GHz, 6.3GHz, 7.8GHz and 9GHz. Return loss -27dB, at 6.3GHz . 18.48% impedance Bandwidth of C-Band from 5.4GHz to 6.5GHz, 3.2GHz is 2%, 7.8 GHz is 2% and at 9GHz is 5%. Axial ratio result of proposed antenna from 1GHz to 10GHz achieved axial ratio less than equal to 3dB, Axial ratio represents polarization of antenna At 3GHz and 5.6GHz proposed antenna is linear polarized and at 6.5GHz and 8GHz antenna is circular polarized, Due to orthogonal shorting pins generate 40% compactness at 3GHz. The applications of multi – notch antenna in for modern wireless communication, satellite communication at S-C-X Band application

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