International Journal of Electronics Communication and Computer Engineering
Volume 8, Issue 5, ISSN (Online): 2249–071X

Circularly Polarized Antenna array based on Sequentially Rotated feed Technique for C-Band

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Date of publication (dd/mm/yyyy): 14/09/2017

Abstract **– This paper presents results on Broadband Antenna array designed to operate at a frequency of 5.3 GHz. Single Antenna used in this array is circularly polarized square slot antenna (CPSSA). Each single Antenna consist of inverted L shape grounded strips located at slots opposite corner to reduce cross polarization. The antenna is fed by symmetric coplanar waveguide. Here CPSSA performance has been enhanced in terms of return loss, impedance bandwidth, axial ratio bandwidth, Gain and directivity by using sequential rotated feed technique. Same time it is also compact in size. This sequential rotated feed technique is constructed by using 2×2 antenna array. This technique enhances the impedance bandwidth of 2.3 GHz in the range of 4.5 GHz to 6.8 GHz and it also enhance 3dB axial ratio bandwidth for VSWR <1.8 with the return loss of 50 dB.**

Keywords **– Micro-strip Array, Slot Antenna, Sequentially Rotated Feed Technique, Symmetrical Coplanar Waveguide (CPW) Feed, Circular polarization (CP), Axial ratio bandwidth.**

I. Introduction

With the advancement in modern technology, micro-strip antenna arrays have become a popular choice for applications. Modern wireless communication systems including GPS, Guided missile, radar tracking satellite link and mobile communication, prefers microstrip antenna due to its light weight, low profile and ease of fabrication[1][2][3]. In this paper circularly polarized (CP) Antenna is used in place of linearly polarized antenna. Because linear polarized antenna is not suitable for mobility, varying weather condition and for non line of sight applications. Meanwhile circular polarized antennas are flexible in terms of connectivity with both fixed and mobile devices. Since micro-strip Antenna suffers from its narrow bandwidth and relatively high feedline losses. So, in this paper sequentially rotated feed technique is used. This feed technique is helpful in improving arrays main beam, polarization purity and bandwidth. Another cause of using CP antenna are reduction in gain and increasing in cross polarization in linearly polarized Antenna. Recently many technique has been designed to improve narrow bandwidth and axial ratio bandwidth. Sequentially rotated feed technique is one of them. This technique include[4][5]-

1) Inverted L grounded strips in the slot.
2) Spiral slots in ground plane.

Arc shaped grounded metallic strip.

In this paper, Broadband circularly polarized antenna array is presented that is composed of four circularly polarized square slot antenna (CPSSA) elements [6]. The antenna unit cells are sequentially rotated to form the array. The individual antennas are constituted from a ground plane conductor with square aperture and excited with a rectangular patch. In order to overcome high cross polarization level that is normally occurs in sequential rotation technique, we use two L shape grounded strips located at to opposite corners of the slot [7][8][9].

II. Geometry of CPSSA Antenna

The geometry of the proposed CPSSA basically consist of a ground loop conductor with side length of G = 22mm and square aperture slot with a side length of L = 15mm, where the ground loop envelops a rectangular patch of length L_f = 7.5mm and width W_f = 2.2mm. A pair of inverted L shaped conductor strips of side length 0.3L is located at opposite diagonal corner of ground loop, one of which is adjacent to the patch. Circularly polarized operation is related to the width of two inverted L shaped conductor strips. Width of inverted L is 1mm.

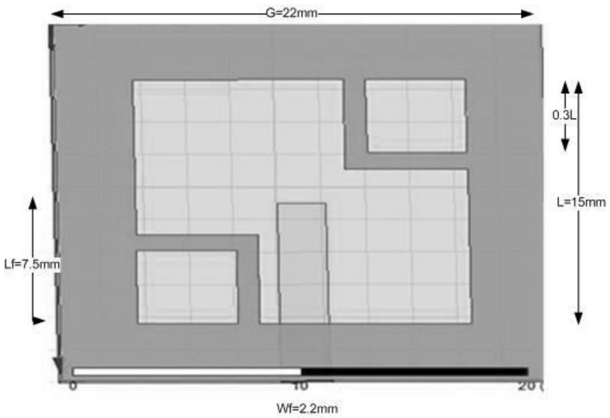

Fig. 1. Geometry of single element

G=22mm, L=15mm, W_f=2.2mm, L_f=7.5mm, h=0.8mm. The proposed Antenna was printed on an FR4 substrate with €r=4.4, tanδ=0.024 and height of h=0.8mm. The CPSSA was optimized at 5.5GHz.

III. Broadband Circularly Polarized Antenna Array

The feed network of proposed antenna consists of seven quarter wave transformers section that are curved and linked together in a consecutive sequence to form a four port network [10][11][12].

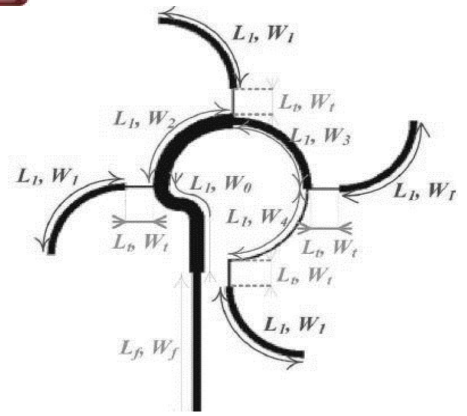

Fig. 2. Configuration of the feed network

This configuration is known as sequentially rotated feed technique. parameters are given as-L_1=18mm, L_f=25mm, L_t=4.8mm, W_0=2.6mm, W_1=1.3mm, W_2=2.8mm, W_3=1.5mm, W_4=0.3mm, W_f=1.5mm, and W_t=0.3mm.

The feeding system to CPSSA antennas uses a micro-strip line to CPW transition with cylindrical via pins in the ground plane having the gap of g=0.3mm. To minimize the discontinuity to array feed, all the feedline λ/4 transformers (λ is the wavelength of free space) were designed in a curved shape [13].

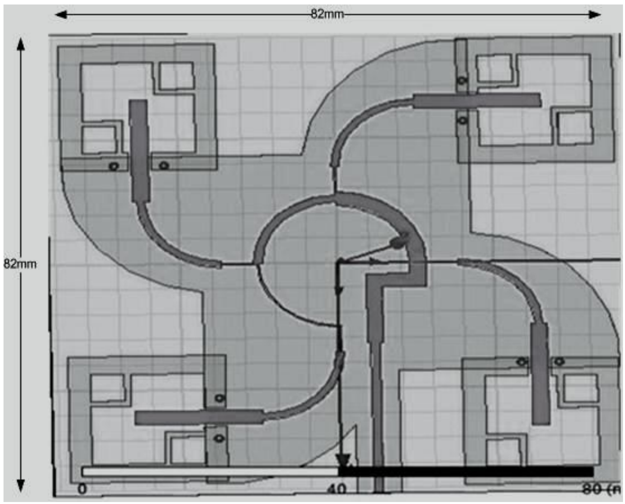

Fig. 3. 2×2 Broadband CPSSA array structure

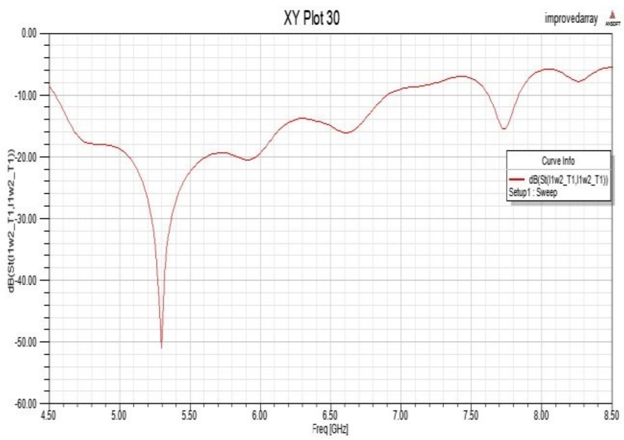

Fig. 4. Measured and simulated results

For proposed antenna, S11= -50dB at 5.3 GHz. having impedance bandwidth of 2.3 GHz in the range of frequency 4.5 Ghz to 6.8 GHz.

IV. Results and Discussion

The measured impedance bandwidth for S11<-10 dB is 2.3 GHz in the range of frequency 4.5 GHz to 6.8 GHz. Axial ratio is within 3dB for VSWR<1.8. The proposed CPSSA array has a peak gain of 6.6dB at 5.3 GHz and peak directivity of 9.3 dB at 5.3 GHz. The antenna array size is 82×82 mm^2. The design when compared to CPSSA IEEE base paper, proposed work shows saving of 1740 mm^2 area with improved gain and directivity along with improved impedance bandwidth, axial ratio bandwidth and polarization ratio.

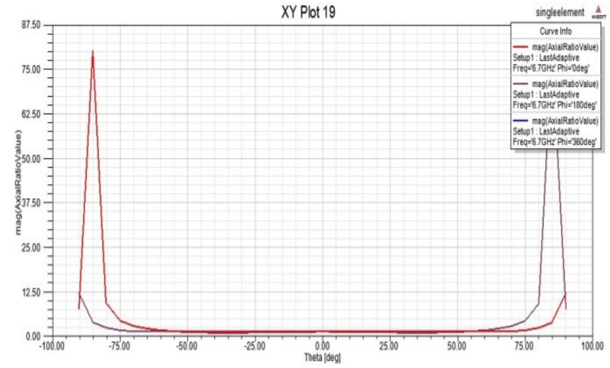

Fig. 5. Axial ratio of proposed antenna having value less than 3 dB

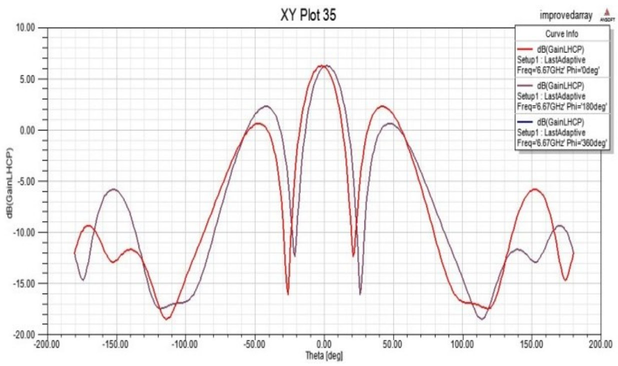

Fig. 6. Peak gain of 6.6 dB for LHCP at φ = 0

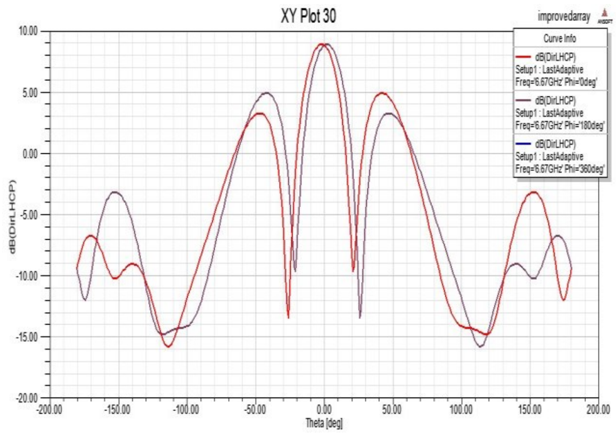

Fig. 7. Peak directivity of 9.3 dB for LHCP at ϕ = 0

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V. Comparison of Present Work with Respect to Simulated IEEE Standard Work

Parameters	Simulated IEEE standard work	present work
Resonance frequency	5.6 GHz	5.3GHz
S_{11}	-29dB	-50dB
Impedance bandwidth	1.8GHz	2.3GHz
Maximum gain	5.3dB	7dB
Maximum directivity	7.7dB	9.4dB
Area of CPSSA array	92×92 mm^2	82×82 mm^2

VI. Conclusion

A Broadband Antenna array having four CPSSA antenna fed by sequentially rotated feed technique has been presented. This Antenna array shows relatively simple structure, low fabrication cost and less area as compared to before antenna structure. This Antenna array shows Broadband operation of 2.3 GHz having acceptable axial ratio within 3dB for VSWR<1.8. Presented antenna also shows better separation between LHCP and RHCP Polarization Ratio for better circular polarization. The measured maximum antenna gain was 6.6dB and maximum directivity is 9.3dB.

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Tilakdhari Singh is an M.Tech student lives in Itwa, Sakaldiha district Chandauli born at 22 Sept 1989 in UP INDIA. He received his B.Tech degree in Electronics & Communication Engineering from FGIET Raebareli, (UP) India in Aug 2012. Recently He has completed his M.Tech in Digital Communication from BBDNIIT, Lucknow (UP) India in Jan 2017. Till now He has published 2 research paper in international journals, first of which is published in IEEE digital xplore and attended one IEEE international conference organized by Medi-Caps University, Indore (MP) India.

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