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

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Abstract- *In this paper results on Triple-bandAntenna array designed to operate at a Resonance frequency of 4.7 GHz, 6.7 GHz and 8.1 GHz has shown.Circularly polarized square slot antenna(CPSSA) has been used as single Antenna.Each single Antennaconsists of inverted L shape grounded strips located at slots opposite corner to reduce cross polarization. The antenna is fed by symmetric coplanar waveguide. In this paper CPSSA performance has been increased in terms of impedance bandwidth and axial ratio bandwidth by using sequential rotated feed. Here sequential rotated feed technique is constructed by using 2×2 antenna array. This technique provide extra large enhance impedance bandwidth of 4.5 GHz in the range of 4.5 GHz to 9 GHz and it also enhance 3dB axial ratio bandwidth for VSWR <1.23.*

Index Terms- *Micro-stripAntenna, CP Slot Antenna, Sequentially Rotated Feed Technique, Symmetrical Coplanar Waveguide Feed.*

1. INTRODUCTION

In modern age, with the rapid and advance technology, micro-strip antenna array has been preferfor manyapplications in high performance wireless communication systems like GPS, Guided missile, radar tracking, satellite communication and mobile communication.Microstrip antenna gets preference because of its light weight, compact size and ease of fabrication[1][2][3]. In this paper circularly polarized(CP) Antenna is used instead of linearly polarized antenna. Since linearly polarized antenna is not suitable for mobility, fluctuating weather condition and for non line of sight (LOS) applications. Since circularly polarized antennas are flexible in terms of connectivity with both fixed and mobile devices. As micro-strip Antenna creates problem from its narrow bandwidth and relatively high feedline losses. This is the reason for using sequentially rotated feed technique in this paper. Sequential rotating feed technique is helpful in improving arrays main beam, polarization purity and bandwidth. Another reason for using CP antenna are reduction in gain and increasing in cross polarization in linearly polarized Antenna. At present time many techniques have been designed to improve narrow bandwidth and axial ratio bandwidth. Sequentially rotated feed technique is lies in one of them. Sequentially rotated feed techniqueinclude[4][5]-

[1] Inverted L grounded strips in the slot.
[2] Spiral slots in ground plane.
[3] Arc shaped grounded metallic strip.

In this paper, Triple-band 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 that create the array. The individual antennas are combined from a ground plane conductor with square aperture
and it is excited with a rectangular patch. In order to overcome high cross polarization level that is normally occurs in sequential rotation technique[7][8][9], we use two L shape grounded strips located at to opposite corners of the slot.

2. Structure of CPSSA Antenna-

The structure 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, here 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 thewidth of two inverted L shaped conductor strips. Width of inverted L is 1mm.

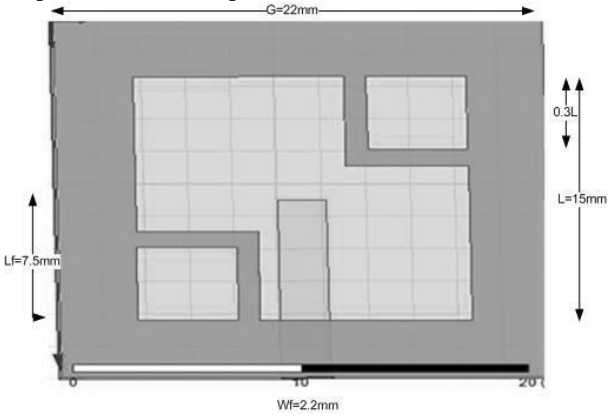

Fig1. Geometry of single element
G=22mm, L=15mm, W_f=2.2mm, L_f=7.5mm, h=0.8mm.

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 6.8Ghz.

3.Sequentially rotated feed technique for 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].

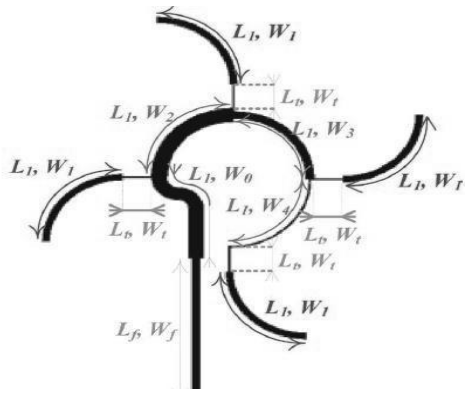

Fig2. Configuration of the feed network.

This configuration is known as sequentially rotated feed technique. parameters are given as-L_1=18mm, L_f=28mm, 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.

In this work, feed length of Antenna array has changed to 28mm instead of 25mm of IEEE standard work and also used some parametric analysis.

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[9].

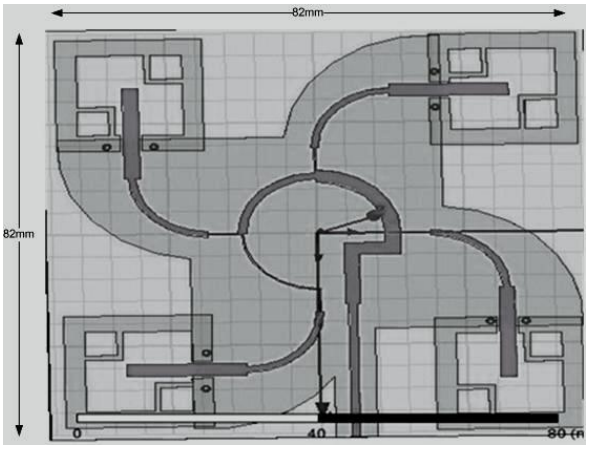

Fig3. 2×2 Broadband CPSSA array structure.

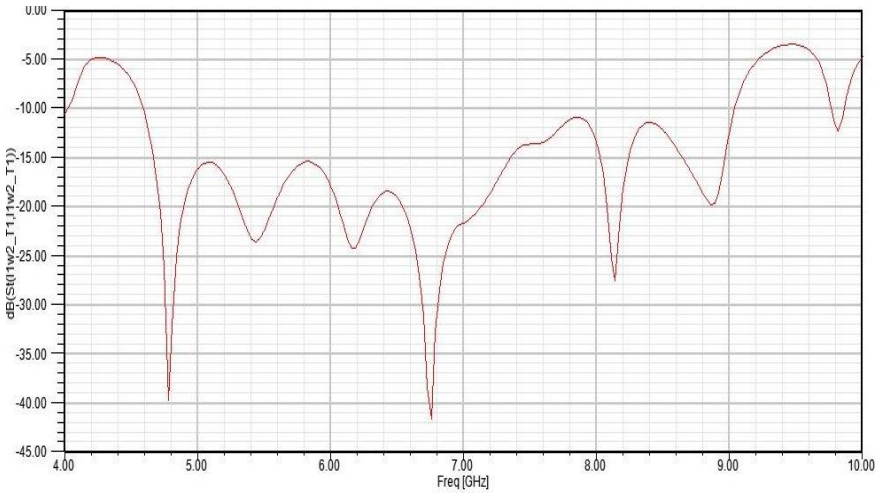

Fig4. Figure shows a triple band Extra large Bandwidth for CPSSA array with respect to reference level of -15 dB.

In fig 4-

1st Band consist of- S_{11}= -39 dB at 4.7 GHz
2nd Band consist of- S_{11}= -41 dB at 6.7 GHz
3rd Band consist of - S_{11}= -27 dB at 8.1 GHz
Here impedance Bandwidth for the system is 4.5 GHz lies between 4.5 GHz to 9GHz.

4. Results and Discussion

The S11 and axial ratio of the proposed antenna array were measured using simulation software. The measured impedance bandwidth covers 4.5GHz Bandwidth in the range of 4.5 GHz to 9GHz having triple band at 4.7 GHz, 6.7 GHz and 8.1 GHz. Axial ratio is within 3dB for VSWR<1.28. The proposed CPSSA array has a peak gain of 2.5dB at 6.8 GHz and peak directivity of 4.6 dB at 6.8 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.

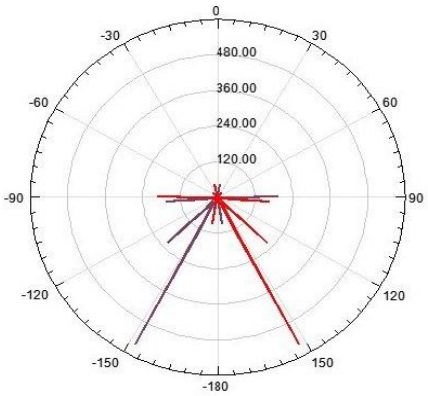

Fig5. Radiation pattern of Axial ratio of proposed antenna havingvalue less than 3dB.

5. Conclusion

A Triple-band Antenna array having four CPSSA antenna fed by sequentially rotated feed technique has been presented. This Antenna array showsrelatively simple structure, low fabrication cost and less area as compared to before antenna The measured maximum antenna gain was 2.5dBand maximum directivity is 4.6dB.

6. Comparison with IEEE Standard work [13].

S.No.	Parameters	IEEE Standard Work [13]	Present work
1.	Resonance frequency	5.6 GHz	4.7GHZ, 6.7GHz and 8.1 GHz
2.	S_{11}	-29dB	-39dB, -41dB and -27dB
3.	Impedance Bandwidth	1.8GHz	4.5GHz
4.	Maximum Gain	7.7dB	2.5dB
5.	Maximum	7.7dB	4.6dB

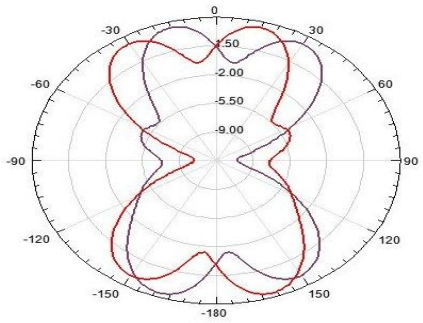

Fig6. Radiation pattern for Peak directivity of 4.6dB for LHCPat ϕ=0

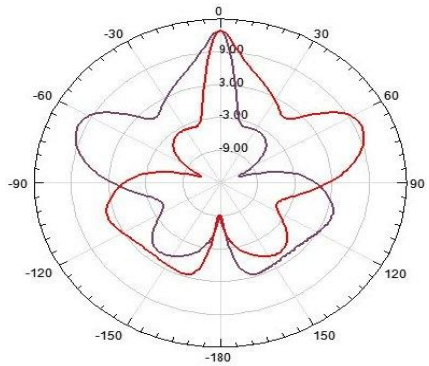

Fig7. LHCPPolarization at ϕ=$0^0$and at ϕ=180^0

structure. This Antenna array shows Triple-band operation having impedance bandwidth of 4.5GHz at resonance frequency of 4.7GHz, 6.7GHz and 8.1GHz.acceptable axial ratio within 3dB for VSWR<1.28. Presented antenna also shows better separation between LHCPAnd RHCP.

	Directivity		
6.	Area of Array	92×92 mm^2	82×82 mm^2

Table.1

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