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Cross Polarization Reduction of Circularly Polarized Microstrip Antenna with SRR

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ABSTRACT

Application of SRR to suppress the cross polarization(pol) from array of microstrip antenna to get pure axial ratio is presented. A pair of SRR is placed adjacent to the patch antenna which is asymmetrical. The optimization for size and location of SRR has been examined using simulated results. The presence of SRR gives more than 28 dB cross pol isolation from its peak radiation when identical patch is compared with it. This has a pure axial ratio from 2.5 to 0.5. Cross pol suppression wave were found to be more than 10 dB over ± 15 degree at elevation angle. Measured results were well agreed with simulated results.

Keywords: SRR, Cross Pol reduction, pure axial ratio.

1. INTRODUCTION

The wireless components of microstrip patch antenna plays a major role. This microstrip patch antenna radiate in $TM_{m,,n}$ mode with some orthogonally polarized wave which is always associated with radiating fields and due to this polarization become less pure which is called as cross polarization. The cross polarization will reduce the efficiency of co polarization and at the same time it will affect the frequency reuse in polarization diversity.

Different techniques have been proposed to reduce the cross pol radiation from microstrip patch antenna. The radiating energy consists of orthogonal polarized field which leads to cross pol radiation. [1-3]. In H- plane it has cross pol level typically in the range of 15 – 20 dB which is below peak gain. Some experiment proved that cross pol can be reduced with dual feed with a 18deg difference in phase between them [4-5]. Also the cross pol is also reduced with modified feed geometry and the shaped ground plane has been discussed [6-7].

Orthogonal polarization create more cross pol which can be reduced with arc and dot defected ground structure. Metallic perturbation in a body of a dielectric antenna has been employed to reduce cross pol [8].

The simple resonant structure as a DGS suppresses the occurrences of orthogonal resonance. In our work single SRR geometry has been designed at the two side of circularly polarized patch antenna to reduce the cross pol significantly. The position of SRR was located by optimization. To validate the concept initially array of circular polarized antenna was designed for ISM band. Then the SRR is placed adjacent to the patch. The design was simulated was HFSS 16 which is a FEM based simulation.

Environment results were measured with the Agilent N9925A network analyzer and pattern was measured with anechoic chamber are presented. The geometry is shown in Fig.(1) with two SRR on a adjacent side of each patch and optimization of position of SRR and its results are shown in fig. (7). Suppress of cross pol level by 28dB and experimentally demonstrated for circularly polarized patch.

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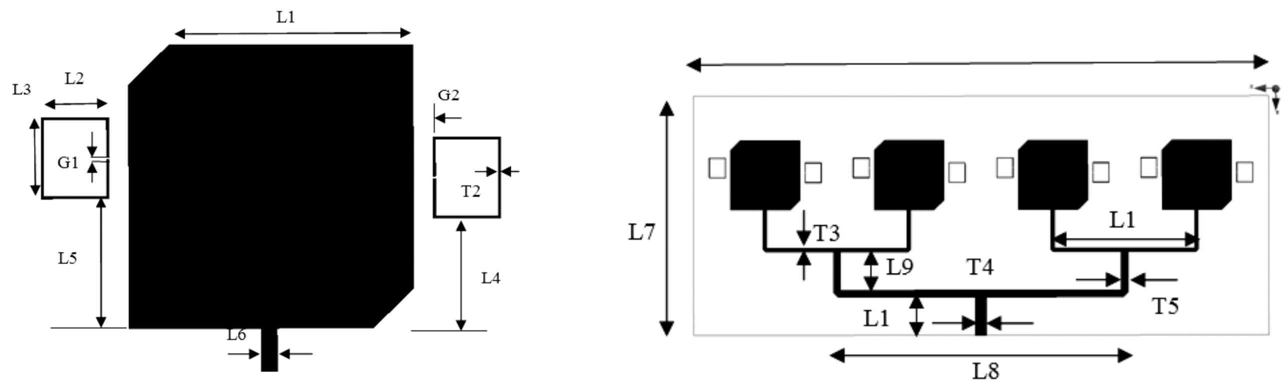
2. GEOMETRY OF MICROSTRIP PATCH ANTENNA WITH SRR

The configuration of circularly polarized array of microstrip patch antenna with pair of SRR in each element is presented in Fig. (1). The substrate chosen for the investigation is FR4 with dielectric constant of 4.4 and thickness of 62 mils.



(a) **(b)**

Figure 1: (a) and (b) shows circularly polarized array of microstrip patch antenna with SRR.

For getting circularly polarization the microstrip patch is chamfered at the two corners with dimensions found to be 5.71 mm. The size of ground plane has been chosen as $7.4\lambda_0$. Where λ_0 is the free space wavelength with the presence of four identical array antennas without SRR and another one with SRR have been studied to find the improvement of axial ratio in operating frequency.

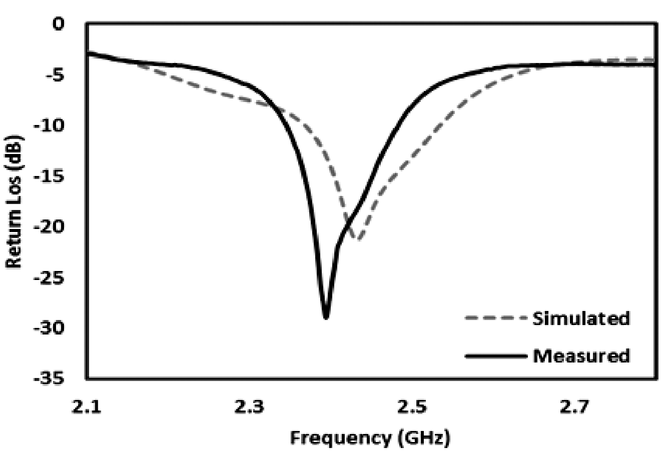


Figure 2: Presents the simulated and measured return loss of array antenna.

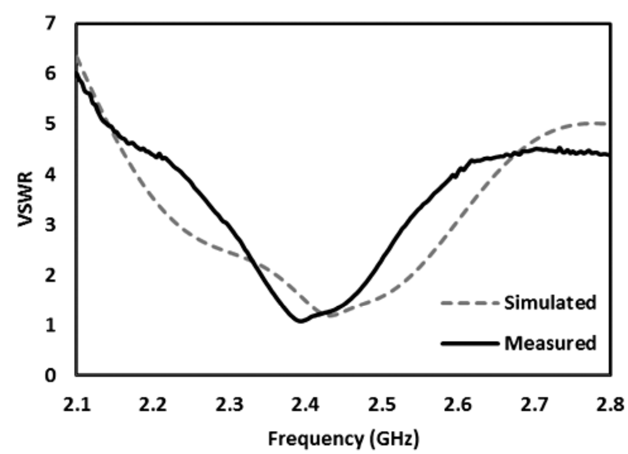
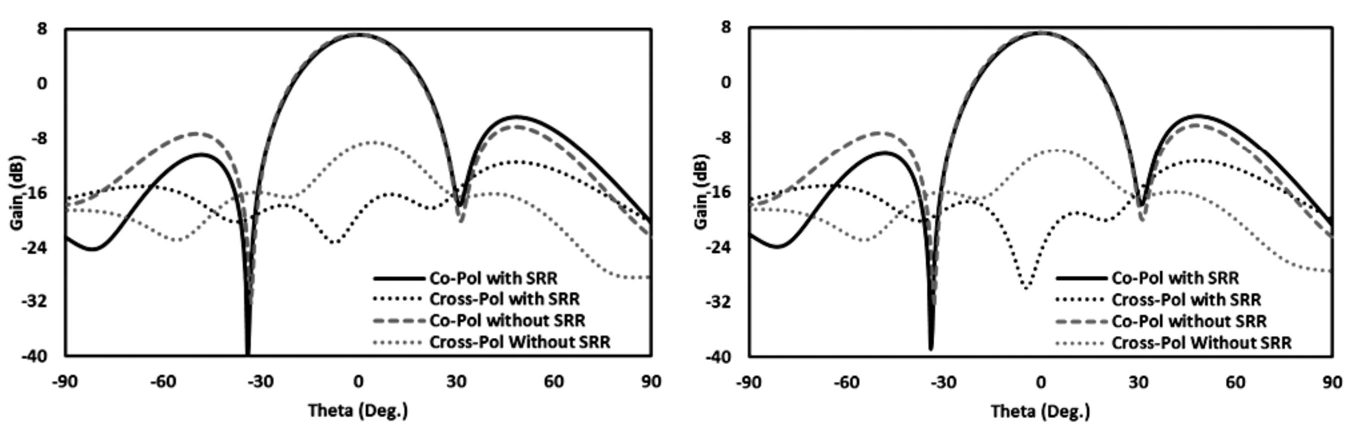
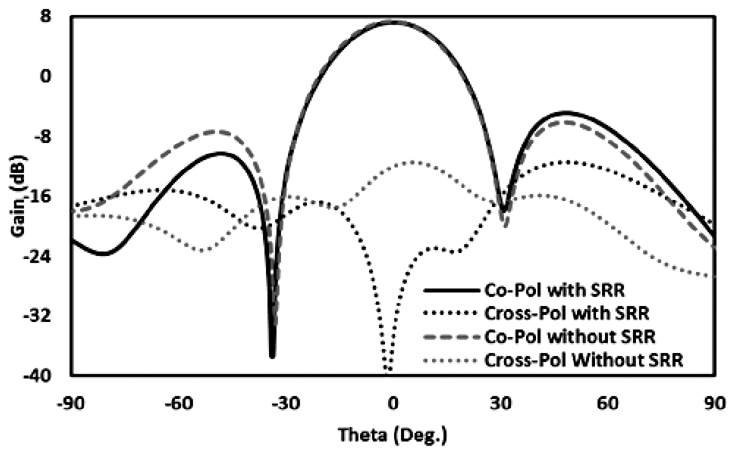


Figure 3: Presents the simulated and measured VSWR of array antenna.



(a) **(b)**



(c)

Figure 4: Presents the simulated radiation pattern at (a) 2.418 GHz, (b) 2.42Ghz and (c) 2.422GHz.

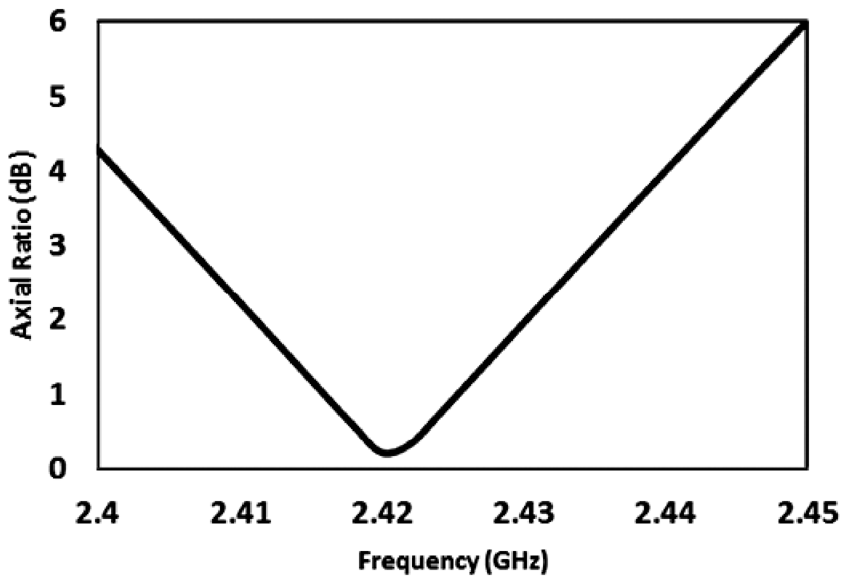
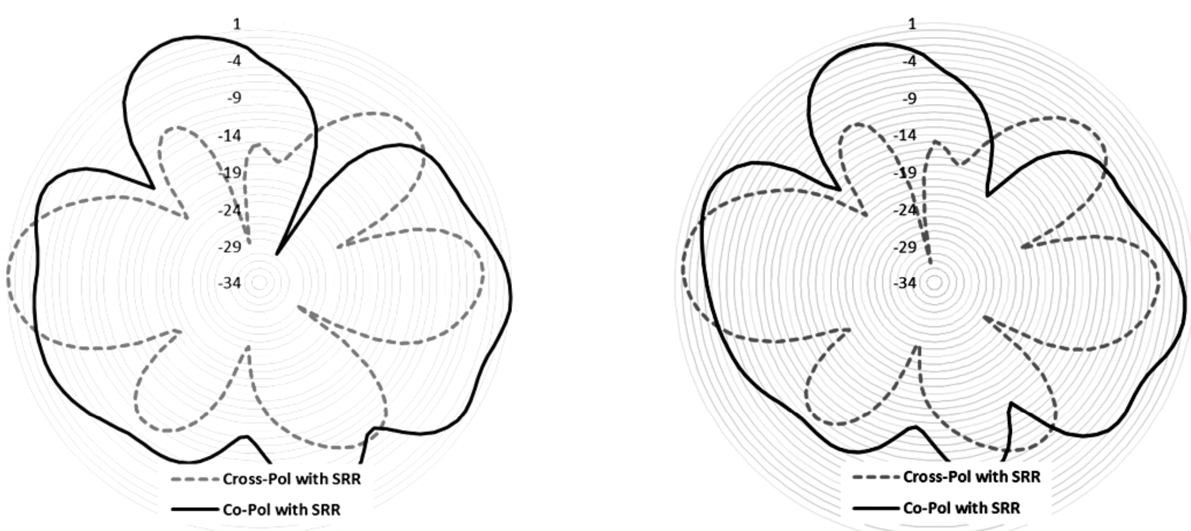


Figure 5: Presents the simulated axial ratio of prototype antenna .



(a) **(b)**

Figure 6: Presents the measured radiation pattern at (a) 2.4GHz, (b) 2.41Ghz.

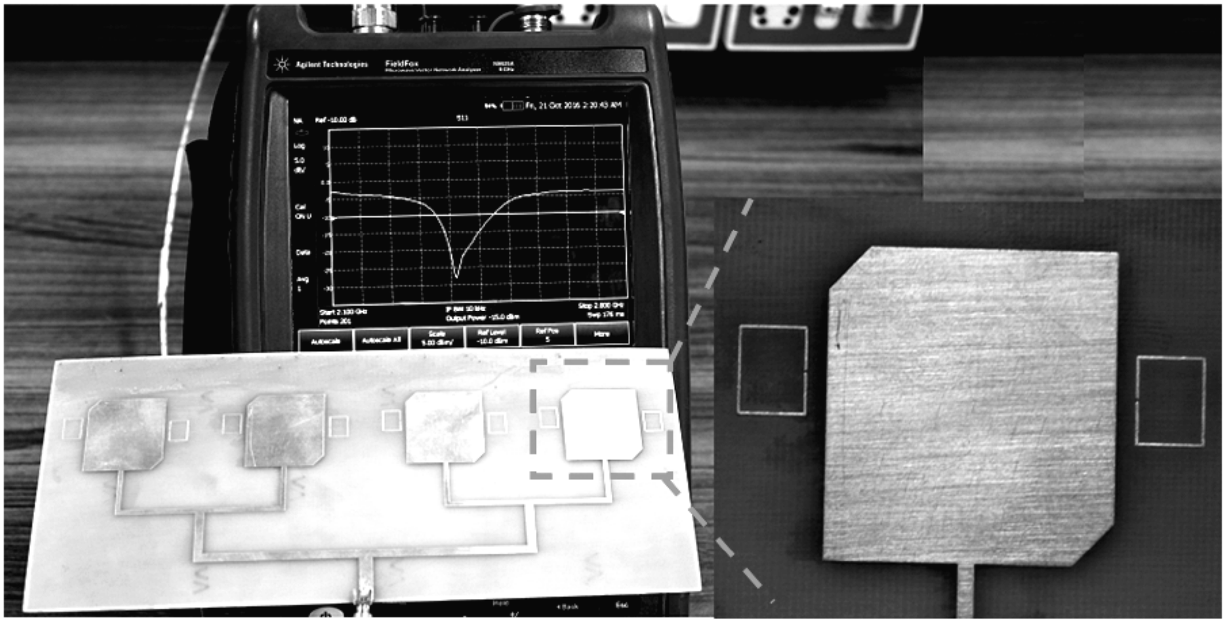


Figure 7: Return Loss measurement of proposed array of microstrip patch antenna. Each antenna element has two SRR on adjacent to the patch.

The array antenna is fed by a standard SMA connector with core thickness of 1.2 mm. The distance between each antenna element is fixed at 0.5 λ for better performance.

Two SRR is placed in an H-Plane where both side patch and its dimensions were optimized by unit cell analysis in HFSS.

The SRR of each element should be uneven with respect to center of the patch. The value of cross pol changes with respect to position of SRR were studied and presented in Fig.(7).

The optimum dimensions of SRR are given in the Table I (all dimensions are in mm).

Table 1
Parameters of antenna.

L1	L2	L3	L4	L5	L6	L7	L8	L9
28.83	6.25	8.25	11.15	13.15	238	98.3	57.9	18.6
L10	L11	T1	T2	T3	T4	T5	G1	G2
15.6	116	1.6	0.25	1.6	3	4.8	0.25	3.44

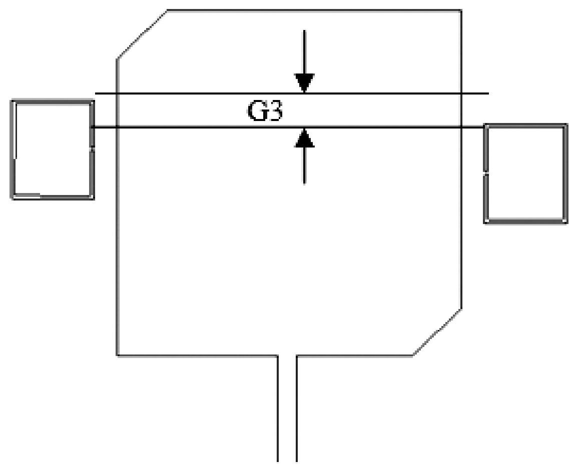
Using the single element with SRR an array of four identical elements have been studied. From designing feed network High-Low transmission line concept has been used to match the impedance of array antenna.

3. RESULTS AND DISCUSSION

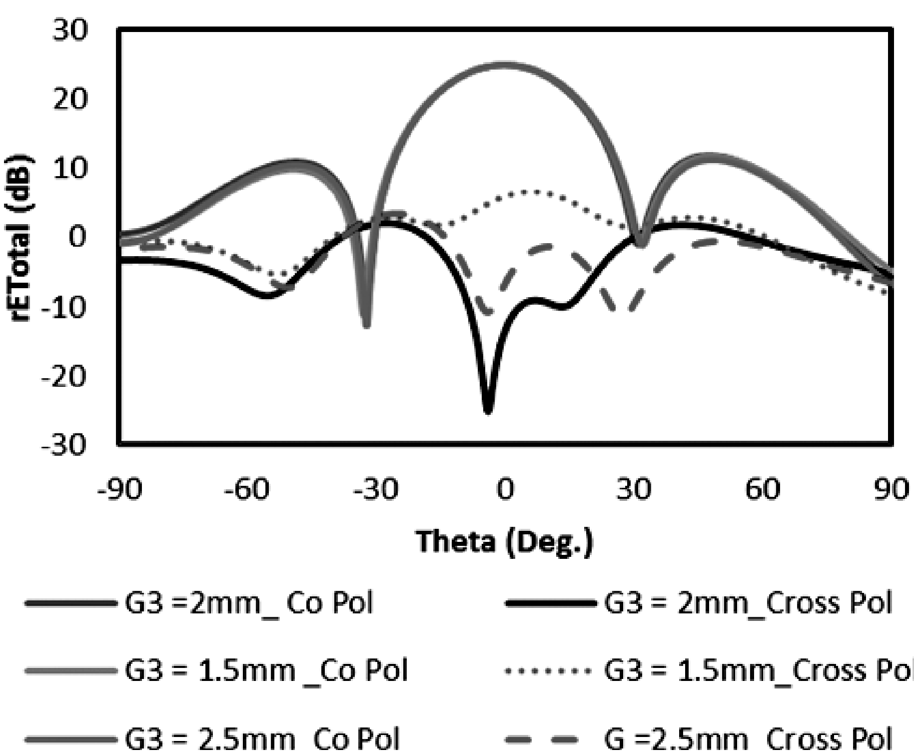
The prototype was measured using Agilent N9925A Network analyzer and an automatic anechoic chamber. Fig.(3) and (4) shows the simulated and measured s – parameter and VSWR characteristics of circularly polarized array patch with SRR.

The identical S11 shows that SRR which does not affect the input impedance but the maximum resonance frequency is shifted to 20 MHz to lower frequency. The radiation characteristics and cross pol reduction with SRR is compared in the Fig. (4). To compare the result of with and without SRR were simulated and the results were plotted in a single plot. In H-plane Fig. (6) it shows that the measured cross pol have been significantly reduced to ±15deg where the peak radiation is more. Suppression of 15 to 28 dB has been obtained in measurement and it is compare with simulated data. The presence of SRR provides more than 20dB isolation between co to cross pol radiation in H-plane. At the same time it improves the quality of axial ratio due less cross polarization and does not affect the co polarization. The suppression of cross pol characteristics are achieved in the bandwidth of 2.41GHz - 2.43GHz and its axial ratio improvement show in Fig. (5)

Reason for getting less cross polarization may be due to following reasons: In H-plane the fringing electric fields of left circularly polarized waves are in dominant mode and is responsible for cross pol radiation in H-plane. H-Plane wave can be suppressed by creating anti phase component in H-plane with SRR.



(a)



(b)

Figure 8: (a) and (b) Shows the parametric analysis of cross pol component with respect to position of SRR.

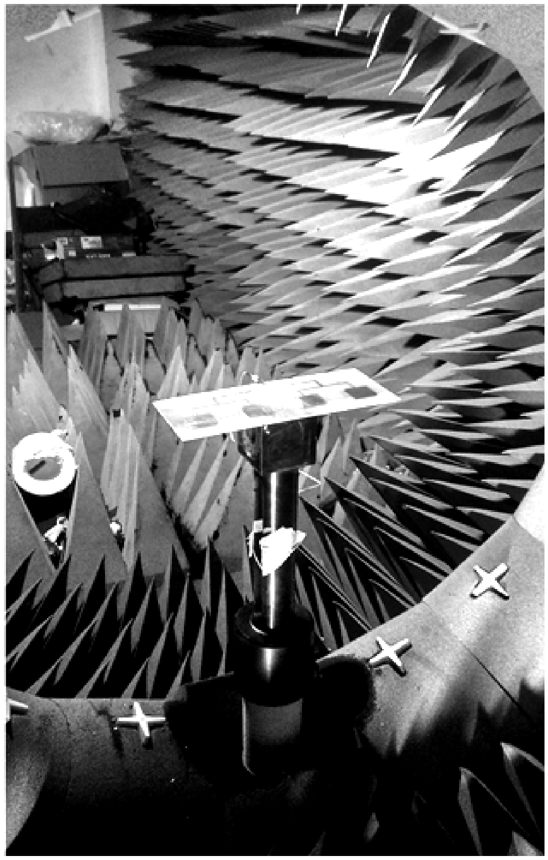


Figure 9: Radiation pattern measurement of prototype model in anechoic chamber.

4. CONCLUSION

A novel technique of suppression of cross pol with SRR at H-plane of circularly polarized microstrip planar array is designed and demonstrated successfully. In this investigation cross pol has been significantly reduced from 15 to 24 dB when it is compared to the peak radiation at bore sight with respect to structure. Hence it is clear that 15dB improvement in cross pol level it may be used for special applications like frequency reuse polarization diversity and sensor having polarization purity.

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