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Bandwidth Enhancement of Rectangular Dielectric Resonator Antenna with and Without a Parasitic Patch

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Abstract: This literature investigates the model of wideband Circularly Polarized (CP) Rectangular Dielectric Resonator Antenna (RDRA) which has been energized through a novel shaped feed (Roman Three) and results have been enhanced by introducing the parasitic patch. The novel feed has been comprised of five metallic strips, which have been optimized to generate two orthogonal modes to produce a CP. The suggested RDRA produced CP over a bandwidth of ~ 8.50% in conjunction with impedance Bandwidths ($|S_{11}|$ < -10 dB) of ~ 8.95% after introducing the parasitic patch the impedance bandwidth-enhanced to ~11.25% and axial ratio jumps to ~11% All other parameters i.e. Gain and beam width are compared with and without a parasitic patch, it has been found that through parasitic patch mostly all parameters enhanced significantly. The proposed design has been simulated in computer simulation technology (CST) software by using the transient solver which is based on the finite integration technique (FIT).

Keywords: Roman three feed, rectangular dielectric resonator antennas, parasitic patch, and circular polarization.

1.0 INTRODUCTION

Since 1st time presented by Long et al. [1] in 1983 The DRA has gotten intensifying consideration over the most recent two decades. The scientists give priority to DRA over the other conventional antennas specially Microstrip antenna as microstrip antenna produce narrow bandwidth. The DRA has numerous advantages for example, compact in size, economical, fewer losses, light in weight and easy to excite. Especially Rectangular Dielectric Resonator Antenna (RDRA) has a few advantages over the cylindrical and hemispherical DRA's i.e. by selecting proper dimension of RDRA feed along with changing the permittivity, the mode degeneracy issue can be avoided and, in addition, the bandwidth can be improved. [2]-[3].

Initially, researchers pay concentration on DRA's those producing linear polarization (LP) [4] but with the passage of time DRA's producing circular polarization (CP) attract tremendous research attention as they are insensitive to transmitter and receiver alignments, such as mobile & Satellite communications. In order to produce CP different feeding techniques i.e., single feed [5]-[6],

Dual feed [7], quadrature [8]-[9] or a tailor-made feeds [10]-[11] has been used along with different DRA's arrangements [12] but dual and quadrature make the DRA more complex and big in size while on the other hand special shaped DRA's may not be easily available commercially.

In this research article, the parasitic patch is Positioned beside the novel roman three feed. It is investigated that, same to the hemispherical and cylindrical DRA's [13], [14], the parameters of CP are not very much affected by the Patch location and, therefore, designing the CPDRA is not challenging.

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2.0 MATERIALS AND METHODS

The Geometry of the RDRA with and without parasitic patch is demonstrated in Fig. 1 where the dimension of the both RDRA is kept same as in [15] i.e. H_1=25.4 mm, L_1=26.1mm and W_1=14.3mm and dielectric constant εr (8.0).

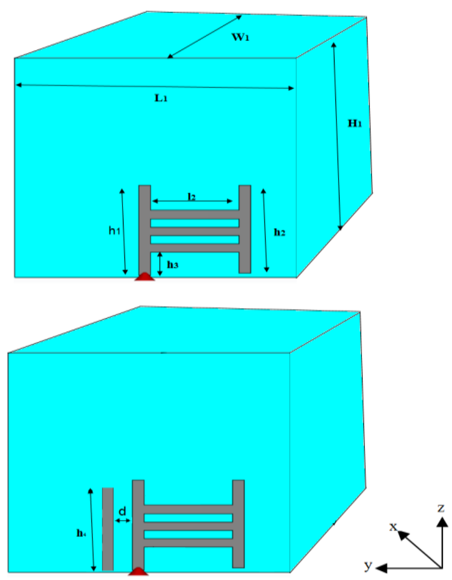

Fig. 1. Configuration of the conformal-strip excited DRA without/With parasitic.

The boundary condition of Zmin is set to be Et=0 in order to simulate the effect of an infinite ground plane. The Proposed feed has been exited through discrete edge port. Mashed parameters like, lines per wavelength, lower mesh limit and Mesh line ratio limit is 60, 35, and 50 respectively and finally, for the proposed Antenna, mesh cells for the RDRA without parasitic is 5, 09,437.Furthermore , same mashed parameters are kept for RDRA with parasitic patch. The optimized design has been simulated by using hexahedrons meshing. The feed position has been moved on the surface of the RDRA (with/without a parasitic patch) beside the y-axis by parameter swipe, and the best position of the feed has been at the center of the RDRA surface. The novel design has been simulated in CST by using transient solver, which is based on the finite integration technique (FIT).

3.0 RESULTS

The RDRA is fed by the conformal strip which is made up of five (5) metallic strip, the optimized parameters of the conformal strip is illustrated in fig 1. The optimal length of the conformal feed is h2=10.50mm, h3=2.5mm, l2=8mm, and h1=10.75mm. The width of all the strip has been kept 1 mm. On the other hand, the parasitic patch of height h4=10.50mm is located at a distance d=1.5mm from the conformal strip. As demonstrated in Fig. 2 acceptable enhancement in return loss ($|S_{11}| < -10$ dB) has been observed in the simulated results of RDRA without/with parasitic patch. Furthermore, it can be perceived that an S_{11} ≤-10 dB bandwidth of 8.95% (4.04-4.42GHz) has been achieved in RDRA conformal strip without parasitic patch to 11.25% (4.04-4.53GHz) with parasitic patch. The lowest S_{11} has been computed for the RDRA without/with parasitic patch at 4.208 GHz and 4.248 GHz respectively.

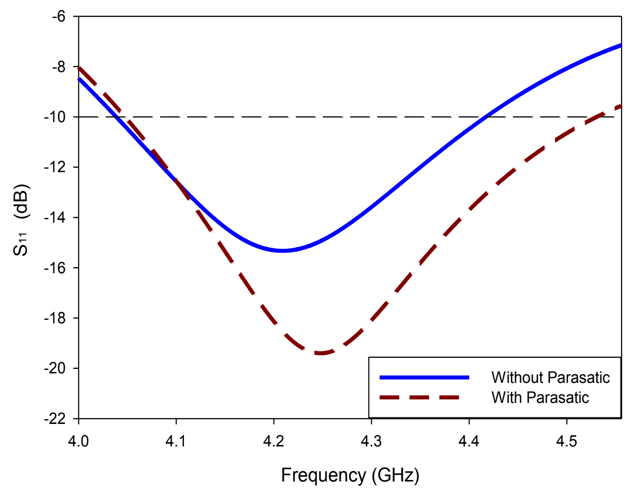

Fig. 2: Return losses of the RDRA Without/with parasitic

3- dB Axial ratio bandwidth has been calculated and demonstrated in Fig. 3, it is clearly seen that significant enhancement is observed in axial ratio bandwidth by introducing parasitic patch i.e. ~ 11% which is in conjunction with an impedance-matching bandwidth while on the other side 3- dB Axial ratio bandwidth of RDRA without parasitic patch is ~8.50% which is also in conjunction with an impedance-matching bandwidth.

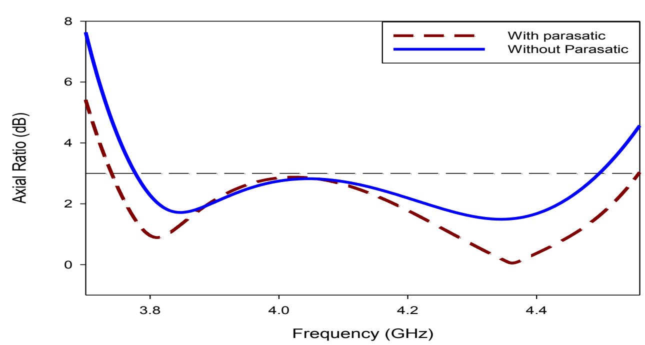

Fig. 3: Axial ratio of the RDRA Without/with parasitic

By introducing Parasitic patch not only enhance S11 and Axial ratio bandwidth but also Gain and beam width which is evident in Fig. 4 and 5, it can be observed that the RDRA without parasitic patch offers circular polarization above measured beam-widths of ~ 32° in both planes which further jumps to 42° by putting parasitic patch.

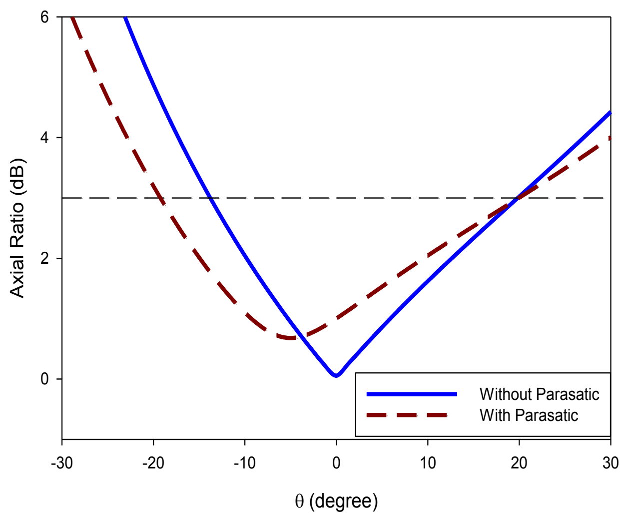

Fig. 4: AR beam-width of the RDRA Without/with parasitic.

As shown in Fig. 5, RDRA with parasitic patch demonstrate expectable boresight gain i.e. 5.2 dBi as compared to RDRA without Parasitic patch which is 5.0 dBi.

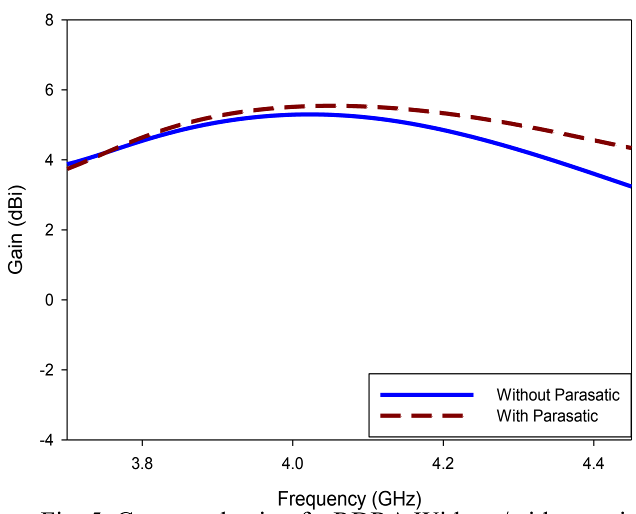

Fig. 5. Computed gain of a RDRA Without/with parasitic patch

5.0 CONCLUSION

All basic parameter of antenna-like Return loss, axial Ratio Bandwidth, Gain and beam width of RDRA have been improving significantly through optimized dimensions and placement of the parasitic element near the conformal strip. The parasitic patch is very desirable, since by including this in the structure without increasing the antenna dimension and complication, additionally, the novel design has been simulated in commercially available simulator i.e. computer simulation technology (CST).The Computational technique using CST is based on the finite integration technique (FIT).

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