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Effect of DGS on 1x2 Linear Array Antenna

Vasujadevi Midasala, P Siddaiah

Abstract*: *Main objective of the proposed research is to investigate the effect of Defected Ground Structure (DGS) on linear array antenna. The proposed linear array is aimed to operate at 15GHz frequency. It is dimensioned at 50x50x1.6mm3, with two rectangular patches on Rogers RT/DUROID 5880 Substrate (Ɛr =2.2). The proposed model is designed and simulated using HFSS software using finite element method. The output parameters are obtained as |S11|= -15.9dB, |S21|=-14.24dB, VSWR is at 1.3 with Peak gain as 7.3 dB. Due to strong Mutual coupling observed, it is necessary to investigate the effect of DGS on 1x2 array antenna in terms of mutual coupling and other output parameters. It is evident that mutual Coupling is reduced by 42.95% and gain improved by 8.1% by integrating DGS to the proposed antenna.

Index Terms*: *Linear array antenna, DGS, Mutual Coupling

I. INTRODUCTION

Array antennas can be more accurate, directive and more suitable for military applications due to presence of multiple elements. Mutual Coupling is the problem due to interference between the neighboring elements. In the literature EBG structures, AMC, meander lines were used to reduce the mutual coupling. In the proposed research, Defected Ground Structure (DGS) is used as decoupling method [1]. It can be realized by cutting the existing ground plane in periodic lattice structure to achieve band gap. As the band gap increases, Mutual coupling can be reduced by suppression of surface waves.

In the proposed research, the linear array is subjected to etch it's ground plane to achieve reduction in mutual coupling, cross polarization and improved performance.

The objectives of the proposed research as follows

1. Design of proposed 1x2 linear array
2. Design of Defected Ground Structure, and integration with proposed antenna model
3. Investigation of effect of DGS on linear array, by comparing the output parameters of both the models.

II. DESIGN METHODOLOGY WITH SIMULATED RESULTS

A) Design of proposed 1x2 linear array:

The proposed linear array consists of two rectangular patches placed in E-plane with a separation of 25mm between them. The dimensions of the antenna are 50x50x1.6mm3 and ground thickness is 0.035mm. The substrate being used is Rogers RT/Duroid 5880 (Ɛr =2.2). The antenna fed by inset feed to get good impedance matching, the depth of inset is 4.4mm and width is 1.55mm. The proposed antenna design is shown in figure 1.

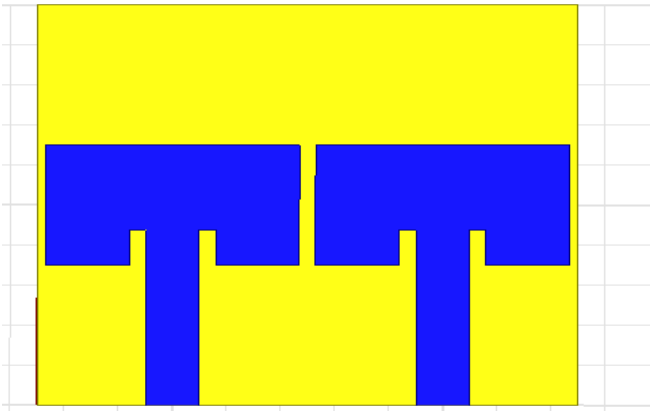

Fig 1: Design of proposed 1x2 linear array antenna

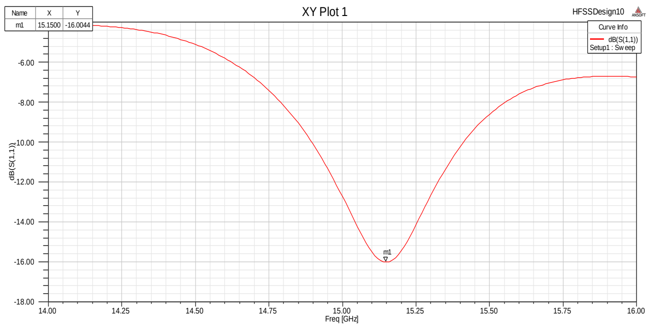

Fig 2: Return loss of proposed 1x2 linear array antenna

The proposed linear array antenna resonates at 15GHz frequency with good impedance matching at |S11|=-16 dB.

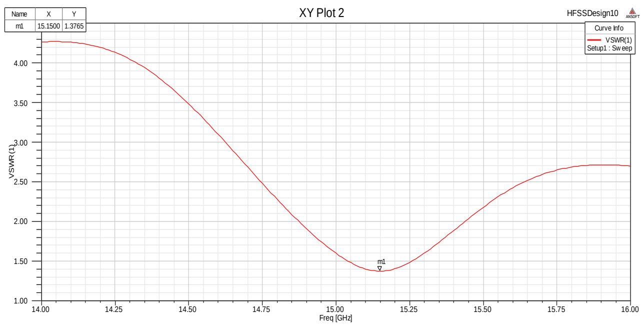

Fig 3: VSWR of proposed linear array antenna

The proposed model Frequency Vs VSWR plot represents that VSWR =1.3 dB which is in the range of 1<VSWR<2.

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***Correspondence Author(s)**
Vasujadevi Midasala, Research Scholar, JNTUA, Asst. Prof., Dept. of ECE, Koneru Lakshmaiah Education Foudation, Vaddeswaram, Gunntur, A.P. India
Prof. P. Siddaiah, Principal, University College of Engineering & Technology, Acharya Nagarjuna University, Guntur.

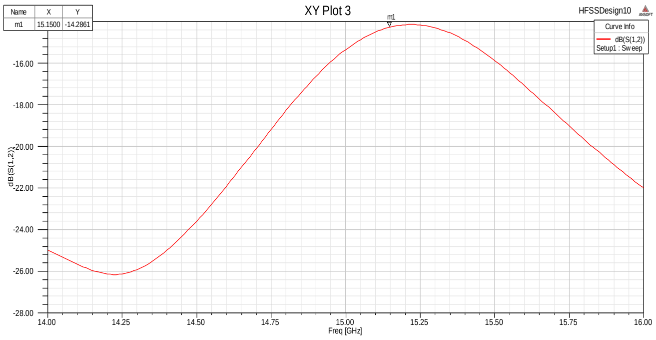

Fig 4: Transmission coefficient (S21) of proposed 1x2 linear array antenna

Transmission coefficient (S21) measures the mutual coupling between the elements and obtained value is |S21|=-14.2 db. It is observed that strong mutual coupling is present in between the antenna elements.

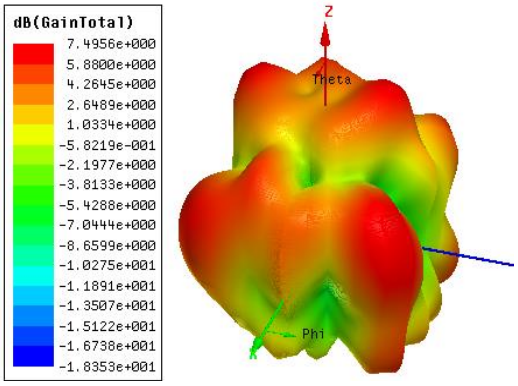

Fig 5: Gain of the proposed 1x2 linear array antenna

The peak gain of the proposed linear array model is 7.49dB.

B) Design of Defected Ground Structure & integration with proposed antenna model:

A lattice structure is etched on the ground plane of the proposed antenna as shown in the figure 6. The structure has been chosen in such a way that it can trap the electric field to provide the band gap. The design parameters are as follows:

{a,b,c,d,e,f,g,h,i,j} = {50,50,20,10,14,18,5,5,6,3} (in mm).

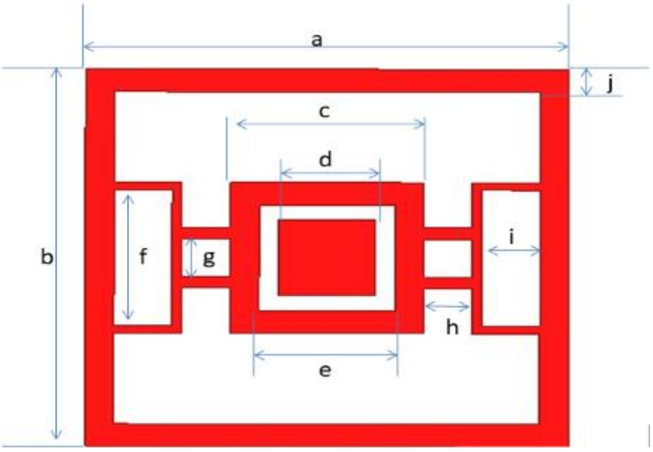

Fig 6: Proposed model of Defected Ground Structure

The proposed DGS structure is integrated with 1x2 array antenna and the obtained view is shown in the figure 7.

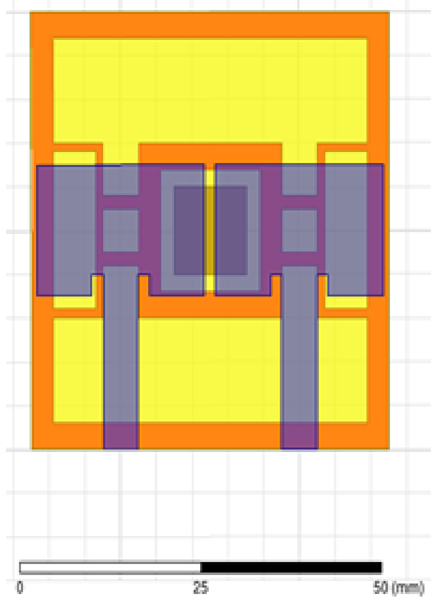

Fig 7: Design of 1x2 Array Antenna integrated with Defected Ground Structure

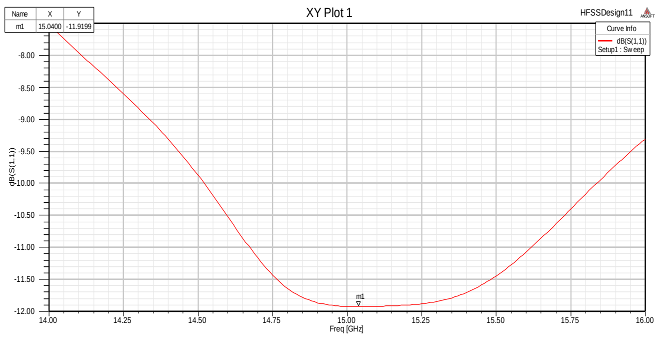

Fig 9: S11 parameters of the proposed 1x2 linear array with DGS

The return loss of the proposed model represented in figure 9. The return loss is obtained as |s11| = -11.9 dB , which is lesser than -10dB .

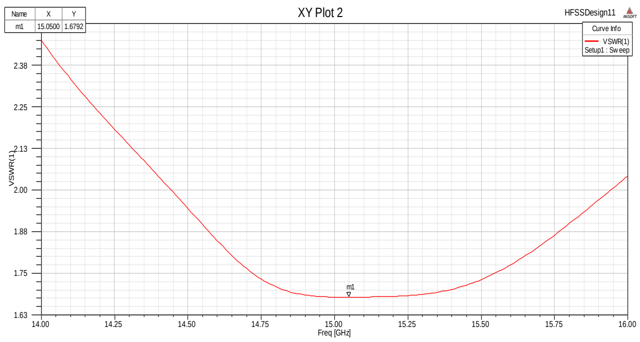

Fig 10: VSWR of the proposed 1x2 linear array with DGS

The VSWR plot of the proposed design is shown in figure 10. The VSWR is obtained as 1.68db which is in the acceptable range.

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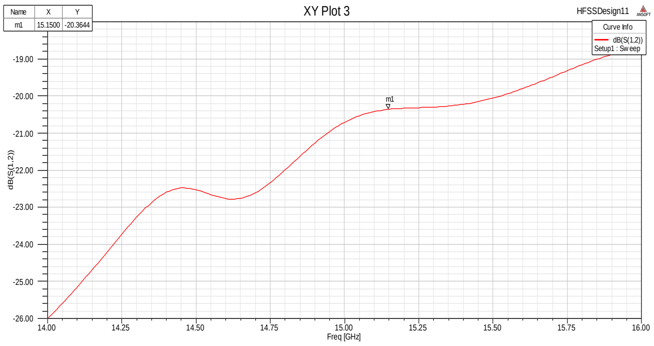

Fig 11: Mutual coupling of the proposed 1x2 linear array with DGS

Mutual Coupling is measured using the plot frequency Vs S21 as shown in the figure 11. It is obtained as -20.3dB, which is much lesser than the -15dB.

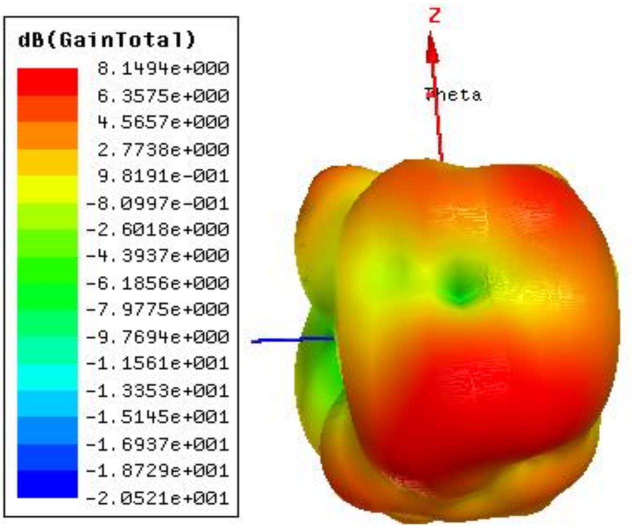

Fig 12: Gain of the proposed 1x2 linear array with DGS

The Peak Gain of the proposed antenna obtained as 8.14dB, as shown in the figure 12.

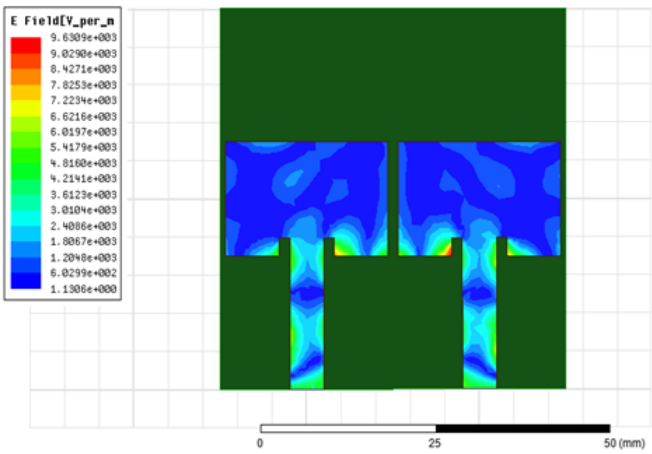

Fig 13: Current distribution of the proposed 1x2 linear array with DGS

The surface waves distribution is represented in fig 13 for the proposed antenna.

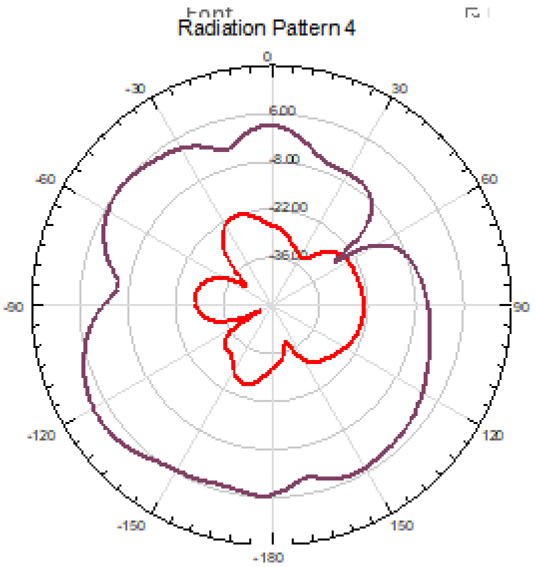

Fig 14: The co-polarization and cross-polarization of proposed 1x2 array antenna with DGS

The co-polarization and cross-polarization of proposed 1x2 array antenna with Unit cell DGS at (ɸ =0o) is shown in fig.14. Good Isolation is observed between the horizontal and vertical polarizations. The obtained cross polarization is less than -27dB.

III. RESULTS DISCUSSION

The proposed model design and simulation is done using HFSS software. Investigation of the effect of DGS on linear array is carried by comparing the output parameters of both the models is shown in the table 1.

Design method	Return Loss in dB(S_{11})	VSWR	Gain (dB)	Transmission coefficient in dB (S_{21})
1x2 Linear Array *Without DGS*	-16.0	1.3	7.4	-14.28
1x2 Linear Array *With DGS*	-11.9	1.6	8	-20.36

It is evident from the table 1, the mutual coupling is diminished by 6.08dB which is 42.55% reduction possible by applying DGS to the proposed 1x2 linear array. Gain is improved by o.6dB which reflects 8.1% of enhancement.

IV. CONCLUSION AND FUTURE SCOPE

Investigation on the effect of Defected Ground Structure integration with the 1x2 linear array is carried out in the proposed research.

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It is observed that 42.55% of reduction in mutual coupling and 8.1% of gain enhancement is possible by integrating DGS in the proposed 1x2 linear array antenna. Good Isolation is observed between the horizontal and vertical polarizations. The obtained cross polarization is less than -27dB. The proposed atenna is resonating at 15GHz frequency with good impedance matching |S11| < -10dB. The proposed antenna is resonating in Ku band range which is applicable in military applications.

Scaling of DGS structures can improve the Band gap and the proposed antenna can be optimized further.

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REFERENCES

1. Vasujadevi M, Dr. P. Siddaiah, " Design & simulation of array DGS using HFSS" International Journal of Innovative Technology and Exploring Engineering ,Volume 8, Issue 3, 2019, Pages 47-49.
2. S Nagakishore Bhavanam, Rokkam Satya Kalyan "Design of a Novel Coaxial Feed Triple Frequency Patch Antenna with Slots and Shorting Pin", ELSEVIER Journal-Procedia Computer Science, ISSN: 1877-0509, Vol 85, 2016, Pages 345–351.
3. S Nagakishore Bhavanam, and B. Lakshmi Narayana "Design & Simulation of Tripple Frequency Triangular Patch Antenna by Using HFSS 14.0" International Journal of Applied Engineering Research, vol. 10, No. 20 April 2015, ISSN : 0973-4562(print), ISSN : 1087-1090 (Online), pp. 18585-18588.
4. Sharmila, Bhavanam, S.N.B "Design, simulation & Fabrication of multiband octagonal patch antenna" International Journal of Innovative Technology and Exploring Engineering, Volume 8, Issue 2, 2018, Pages 51-55.
5. S Nagakishore Bhavanam, M. Sekhar and Dr. P. Siddaiah "Triple Frequency Circular Patch Antenna" IEEE International Conference on Computational Intelligence and Computing Research (IEEE ICCIC-2014) Coimbatore, Tamilnadu, 18-20 December, 2014, pp.1231-1233.
6. Vasujadevi, M., Naga Kishore "Performance optimization of multiband microstrip patch antenna by incorporating EBG structures", JARDCS, Issue 2017, pp. 2066-2075.
7. Midasala, V., Siddaiah, P "Rectangular patch antenna array design at 13GHz frequency using HFSS", IEEE ICCIC14, pp.1-4.

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