Design & Simulation of Array DGS using HFSS

Vasujadevi Midasala, P. Siddaiah

Abstract**:** ***Array antennas are useful in military applications due to high gain and more directivity. But the individual elements of array radiation may interfere each other and resulting in Mutual coupling. In this research paper, Defected Ground Structure (DGS) is used to reduce the mutual coupling and further array of DGS is used for the optimization of output parameters. The proposed antenna of 1x2 array and 4x4 array of DGS is designed and simulated using HFSS software. It operates at 15GHz (Ku band) with minimum mutual coupling of -25dB. The gain is 8dB and VSWR and Return loss are in optimal Range. The output parameters are plotted and compared using MATLAB software.***

Index Terms**:** ***DGS, Ku-band, Mutual Coupling, HFSS, Return loss, VSWR.***

I. INTRODUCTION

Micro strip Patch antenna arrays (MPAA) are highly popular in wireless applications. But they usually suffer from low gain and excitation of surface waves. Excitation of Surface waves leads to high mutual coupling between the elements, which in turn results in low performance of the MPAA. EBG structures are the existing solution to overcome the coupling of radiation problem.

II. LITERATURE REVIEW

Ankit Arora et.al[1] talked about that the issue of shared coupling, contingent upon entomb component partition and their relative introduction, turns into a test. To conquer this, we proposed an EBG organized reception apparatus. The most utilized qualities of Electromagnetic Band Gap (EBG) structure are the surface wave concealment impact inside its band hole. Henceforth, they can decrease the common coupling because of surface wave propagation.EBG gives better minimization, simple coordinated element and 2-D band hole properties.

Mohamed Ezzat and Choon Sae Lee [2] suggested that a straightforward advancement system to decrease common coupling between two firmly coupled reception apparatuses. By presenting an association line between the two ports, it is demonstrated that the coupling can be considerably decreased.

Prakash Kuravatti, T. S. Rukmini [3] introduced Jerusalem cross occasional structure is proposed as a powerful answer for lessening shared coupling in a small scale strip cluster recieving wire with more than one component.

Qian Li, Chong Ding et.al[4] introduced Meander lines (MLs) in two setups to diminish the shared coupling (MC) between two miniaturized scale strip fix recieving wire components. Embeddings an opening in the ground plane between the radio wire components is a straightforward strategy to diminish the MC, while including the MLs in the space of the ground can additionally lessen the MC.

Meander lines (MLs), EBG methods, periodic structures are the different solutions proposed by the researchers in the literature. In this research work, Defected Ground structure (DGS) is proposed to reduce the radiation coupling between the MPAA elements. The further optimization of the antenna output parameters is achieved by incorporating 4x4 array DGS.

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III. DESIGN METHODOLOGY

The proposed research work carried in 2 steps.
1. Design of MPAA (Microstrip Patch Array Antenna)
2. Design and incorporation of array DGS to proposed MPAA

A. Design of MPAA

The proposed design of MPAA has 1x2 order of array elements. Each element has a rectangular Patch, made-up of RT Duroid 5880. The design parameters are 50x25x1.6 mm3 substrate and 23.5x15mm patch.

Fig 1: MPAA of 1x2 Elements

A1. HFSS Simulation Results:

Return Loss:

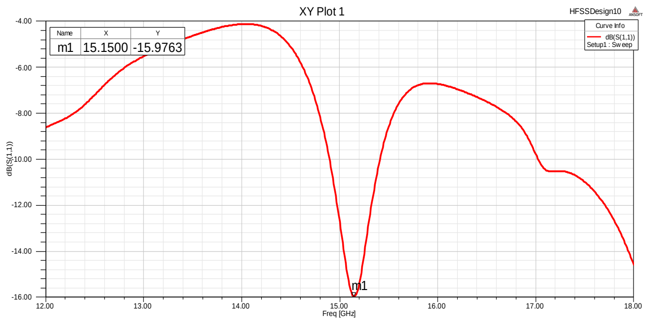

Fig 2: Return loss of 1x2 array MPA

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The frequency Vs S11 plot of 1x2 array antenna is shown in fig.8. The S11 parameters of the proposed antenna is obtained as -15.9dB at 15.17GHz of frequency.

VSWR:

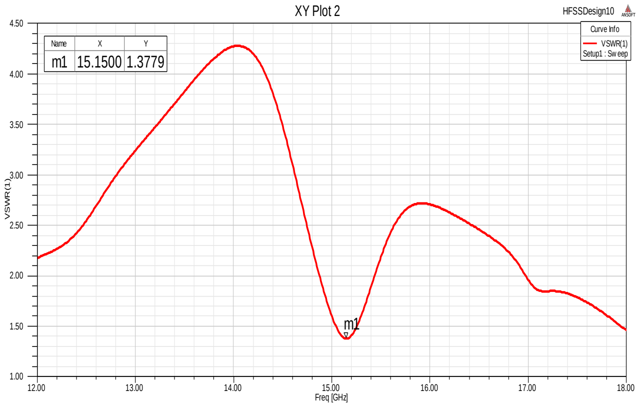

Fig 3: VSWR of 1X2 array MPAA

The frequency Vs VSWR plot of 1x2 array is shown in fig.3. The VSWR of the proposed antenna is obtained as 1.375 at 15.17GHz of frequency.

Mutual Coupling:

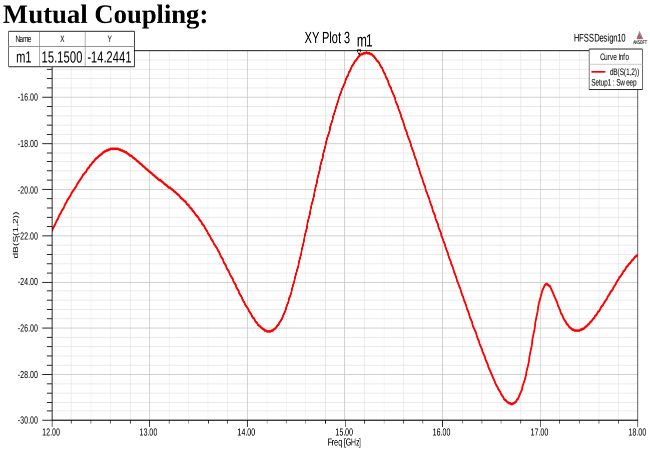

Fig 4: S21 parameters of 1x2 array MPAA

The mutual coupling between the antenna array elements is measured by S21 parameters. The frequency vs S21 plot is obtained and observed as -14.24dB which should be <-15dB.

Gain:

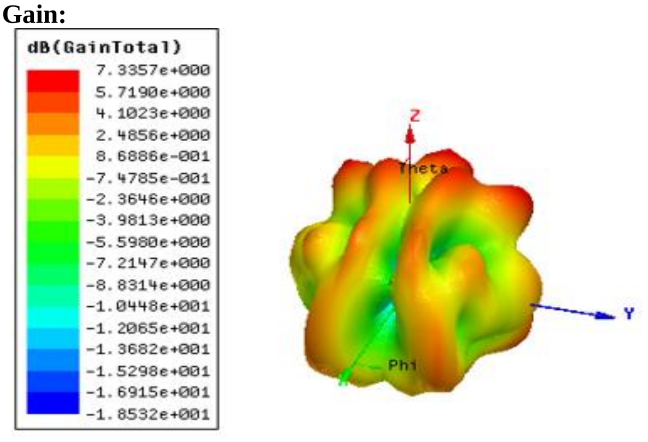

Fig 5: Gain

The 3D gain plot of 1x2 array is obtained and shown in fig.5. It is observed that the peak gain is 7.33 dB at 15.15GHz.

B. Design of array DGS

The array DGS has 4x4 order of unit cells, where each cell consists of the structure and it is incorporated to MPAA as shown in the fig.6.

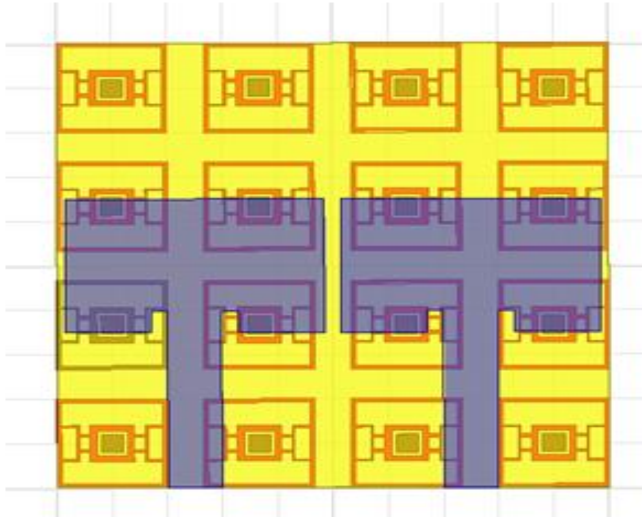

Fig 6. 4x4 DGS array is incorporated in MPAA

B1 HFSS Simulation Results:

Return Loss:

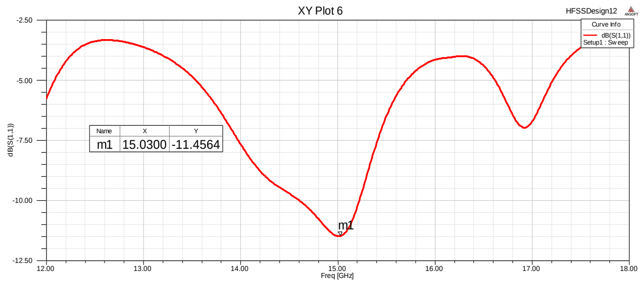

Fig 7: return loss for proposed antenna

The frequency Vs S11 plot of 1x2 array antenna with Unit 4x4 array DGS is shown in fig7. The S11 parameters of the proposed antenna is obtained as -11.45 dB.

VSWR:

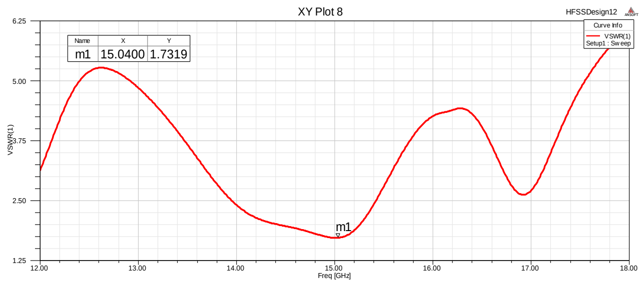

Fig 8: VSWR plot of 1x2 array with 4x4 array DGS

The frequency Vs VSWR plot of 1x2 array with 4x4 array DGS is shown in fig 8. The VSWR of the proposed antenna is obtained as 1.73.

Mutual coupling:

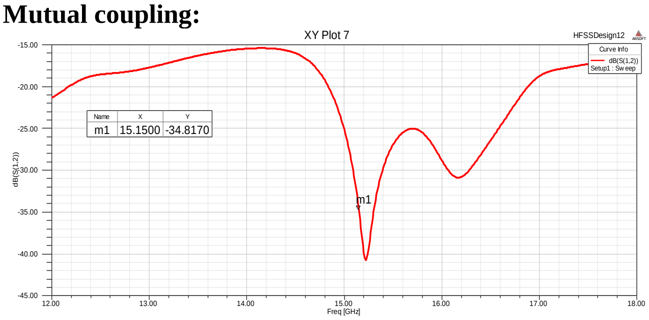

Fig 9: Mutual coupling of proposed antenna design

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The frequency vs S21 plot is obtained and observed as -34.81 dB which should be <-15dB.It represents that proposed 1x2 array antenna is achieved low mutual coupling by incorporating 4x4 array DGS.

Gain:

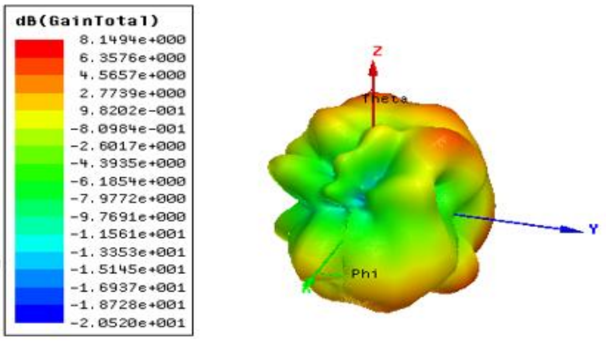

Fig 10: Gain for the proposed antenna

The 3D gain plot of 1x2 array antenna with 4x4 array DGS is obtained and shown in fig. It is observed that the peak gain is 8.14 dB.

IV. RESULTS & DISCUSSION

The different modules of the design carried as design of 1x2 array antenna, implementation of unit cell DGS, and 4x4 array DGS implementation. The Mutual coupling of each module is compared and plotted using MATLAB Software as shown in fig.11.

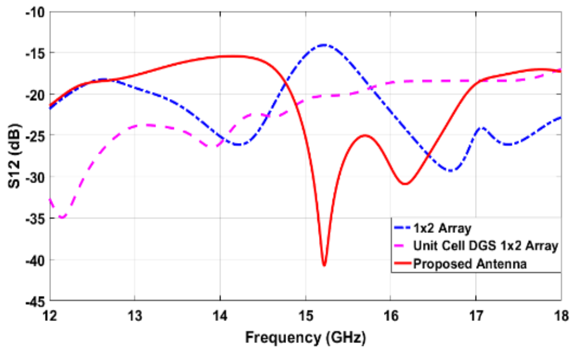

Fig.11: Mutual coupling comparison plot for different modules of the proposed design.

V. CONCLUSION

MPA array elements may suffer from Mutual coupling problem due to interference of radiation of individual elements. DGS array is proposed to overcome the stated problem. In this research work, the 1x2 array MPAA is designed and 4x4 array DGS is incorporated to reduce the mutual coupling and further optimization. The proposed antenna is operating efficiently at 15.1 GHz frequency with returnloss -11.45dB, VSWR 1.74, gain 8dB and Mutual Coupling is -34.81dB. The designed antenna is more suitable for millitary applications.

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