Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 12, Issue 7, July 2021:9842 – 9849

Design of DGS Printed Antenna for Surface Ship Radar Applications

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Abstract- In this paper proposed dual layer single coaxial feeding DGS printed antenna by cutting some slots from the patch and adding some slits with the patch. It is the very easiest design to achieve our desired application for which it is designed. We compare the proposed antenna with the conventional design and the proposed structure gives a 49.82% size reduction with compare to the conventional antenna. In this paper we analyze the gain, bandwidth, return loss for the desired proposed structure. The proposed structure designed with the help of IE3D electromagnetic solver which uses the Method of Moment (MoM) based analysis. The proposed structure simulated results are verified by a measurement which is carried out by VNA network analyzer. In this paper, proposed design achieved multiple resonant frequencies and they are applicable for different microwave band applications. As per the concern of 1st resonant frequencies, the proposed structure applicable for surface ship radar applications.

Index Terms- Layer, Edge, DGS, Patch, Slot, Return Loss.

I. INTRODUCTION

To increase the demand on printed antenna with Defective Ground Structure (DGS) among microwaves engineers [1], we choose size reduced antennas. The reason behind choose the antennas, it consume less space, more effective, movable and robust free to any surface. But there will be certain disadvantages like- low gain and low power handling capacity [2-5]. But we use the printed antenna so there will be some disadvantages but due to miniature size it is very helpful for any application. The microwave engineer demand is to use one antenna for different application and the printed antenna satisfies their demand. Rather than printed antenna there are some other antennas are also there like: DRA and fractal antennas [14-19]. Due to the size reduction property, the proposed antenna will give lower resonant frequency than conventional antenna structure [6-8].

Printed MSA requires high interest during research because the antenna having small dimension with low cost and it is easily connected with any microwave monolithic integrated circuit [9-10]. The antenna size reduced by cutting slots and adding slits with the patch at proper place from top as well as bottom layer. We use high dielectric constant for getting high size reduction in proposed structure than conventional structure [11-13]. The simulation done by IE3D [20] software and verified by measurements. The proposed structure is a good candidate for the application of S-Band microwave communication for the frequency band of 2 GHz to 4 GHz. Designed structure also applicable for weather radar, surface ship radar, and some communications satellites like microwave ovens, microwave devices/communications, radio astronomy, mobile phones, wireless LAN, Bluetooth, GPS, amateur radio.

II. ANTENNA DESIGN

The conventional DGS printed antenna configuration is shown in Figure 1 with all dimensions with substrate view.

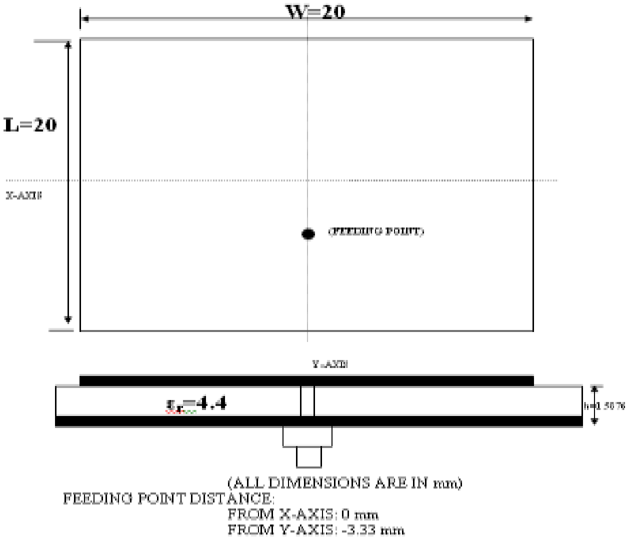

Figure 1: Conventional Antenna configuration

Figure 2 and figure 3 displays proposed antenna configuration of proposed antenna with same PTFE substrate which used for design of conventional antenna. The figures shows the structure of proposed antenna for top layer as well as ground layer.

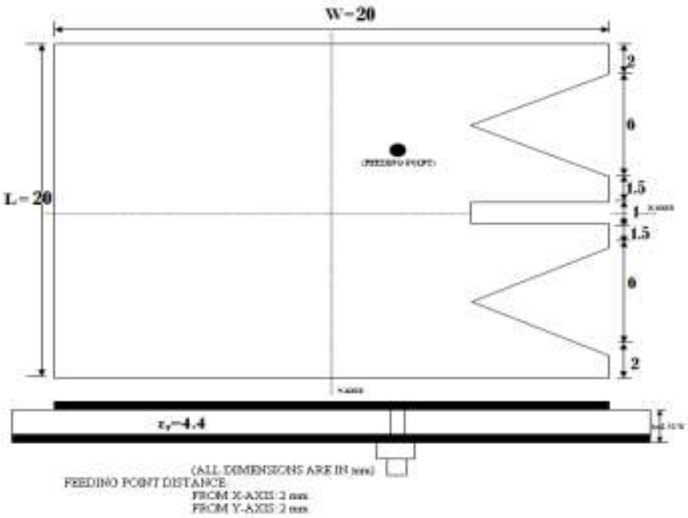

Figure 2: Proposed Antenna (Top View)

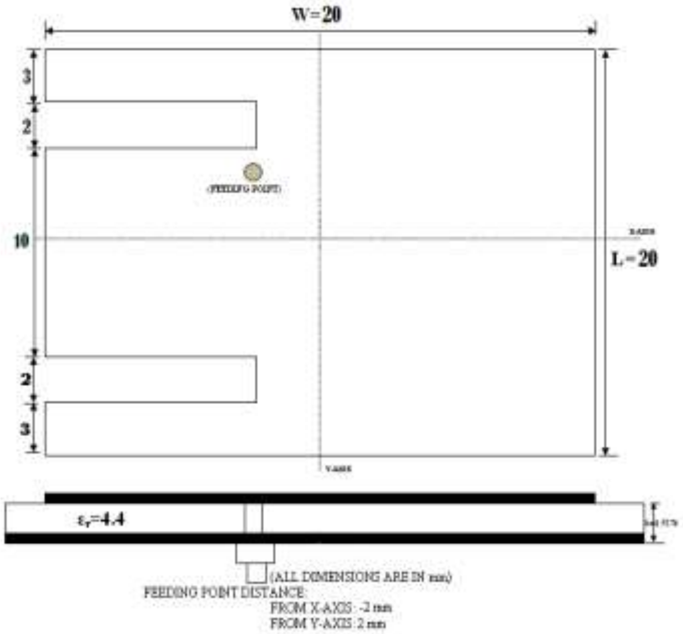

Figure 3: Proposed Antenna (Ground View)

III. RESULTS AND DISCUSSIONS

Simulated reflection coefficient plot in decibel for conventional as well as proposed antenna structures are shown in Figure 4 and figure 5. From the return loss pattern, it is observed that proposed structure has a significant improvement in resonant frequency than conventional structure.

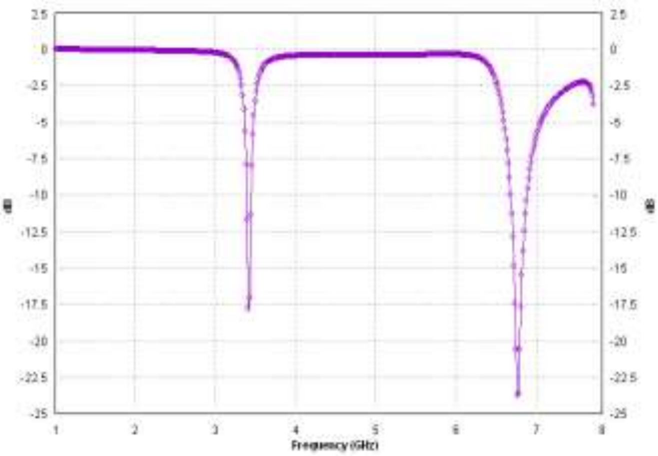

Figure 4: Conventional Antenna reflection coefficient plot in decibel

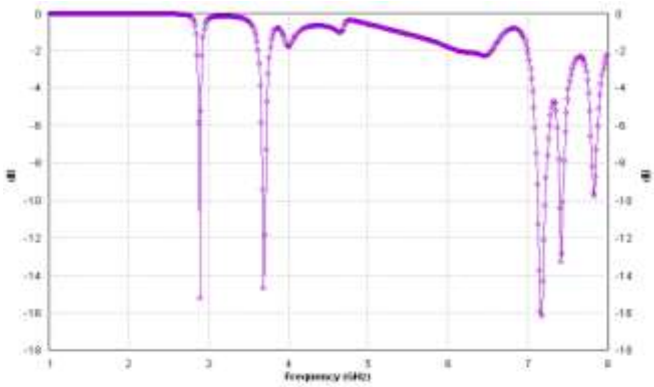

Figure 5: Proposed Antenna reflection coefficient pattern in decibel

The detailed analysis from return loss pattern are summarized and explained in Table-1.

A. SIMULATED RADIATION PATTERN

Figure 6 describes simulated Electric field and magnetic field patterns of conventional antenna only for 1st resonant frequency. As the same way simulated Electric and magnetic field patterns for proposed antenna shown in Fig.7 only for 1st resonant frequency.

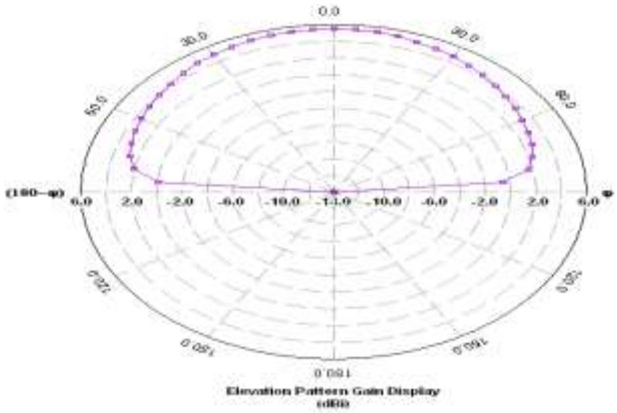

Fig 6(a): Simulated Electric field pattern for conventional antenna

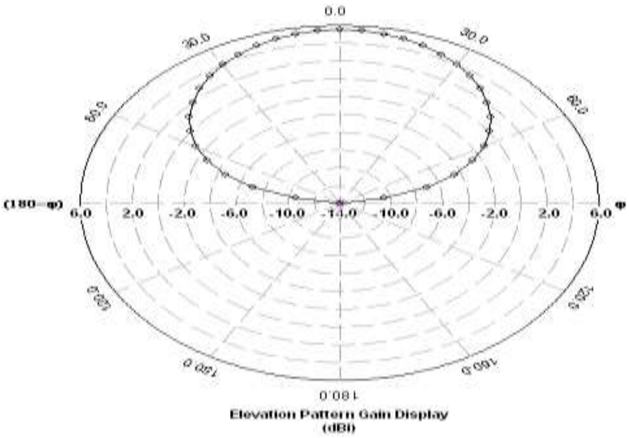

Fig 6(b): Simulated magnetic field pattern for conventional antenna

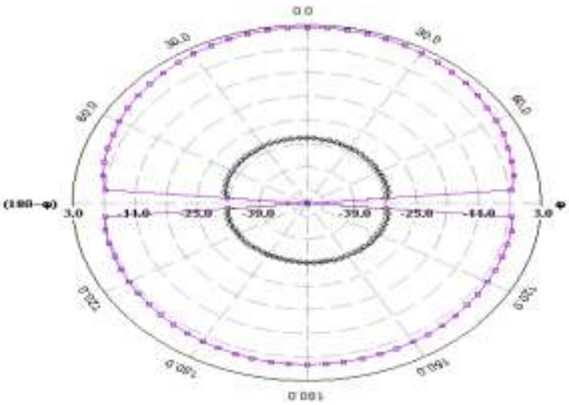

Fig 7 (a): Simulated Electric field pattern for proposed antenna

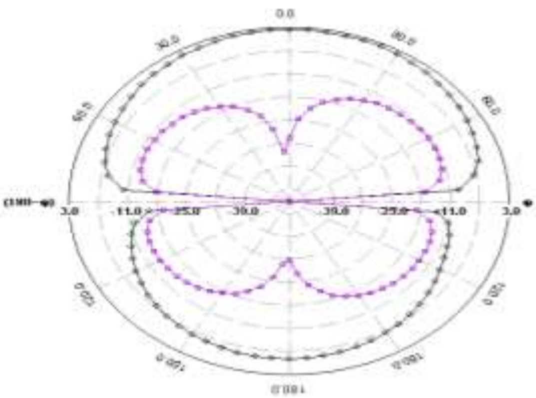

Fig 7(b): Simulated magnetic field pattern for proposed antenna.

The proposed antenna VSWR illustrated in Figure 8 for the designed proposed structure. For all the resonant frequencies we achieved VSWR within 2:1 range.

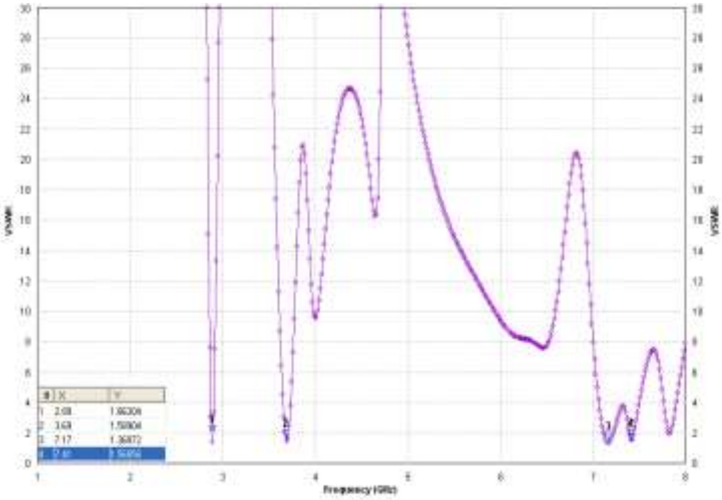

Figure 8: Proposed structure VSWR

All the radiation pattern results are summarized in Table-II.

TABLE I:

SUMMARIZE ALL PARAMETERS FOR BOTH ANTENNAS BASED ON REFLECTION CO-EFFICIENT

ANTENNA STRUCTURE	FREQUENCY (GHZ)	RETURN LOSS (DB)	BANDWIDTH (MHZ)
1	f_1= 3.41	-17.7	53.7
	f_2= 6.77	-23.7	202.1
2	f_1= 2.89	-15.25	15.22
	f_2= 3.69	-14.68	32.30
	f_3= 7.17	-16.18	95.27
	f_4= 7.41	-13.32	44.98

TABLE II:

SUMMARIZE ALL PARAMETERS FOR BOTH ANTENNAS BASED ON RESONANT FREQUENCIES

ANTENNA STRUCTURE	FREQUENCY (GHZ)	FREQ. RATIO	BEAM WIDTH (^{0})	GAIN (DBI)
1	f_1= 3.41		171.06^0	5.43
	f_2= 6.77	f_2/ f_1=1.985	170.40^0	3.23
2	f_1= 2.89		158.60^0	2.33
	f_2= 3.69	f_2/ f_1=1.277	170.66^0	3.46
	f_3= 7.17	f_3/ f_1=2.481	170.67^0	2.81
	f_4= 7.41	f_4/ f_1=2.564	149.81^0	-6.51

IV. EXPERIMENTAL RESULTS AND DISCUSSION

The prototype of the proposed structure was design and tested by using Vector Network Analyzer (VNA) Agilent N5 230A. The designed prototype for conventional as well as proposed structure illustrated in figure 9 and figure 10. Figure 11 displays the variation of return loss for conventional antenna and figure 12 displays the variation of return loss for proposed antenna.

Fig 9(a): Top Layer of Conventional Antenna

Fig 9(b): Bottom Layer of Conventional Antenna

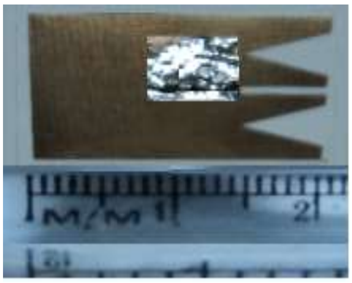

Fig 10(a): Top Layer of Proposed Antenna

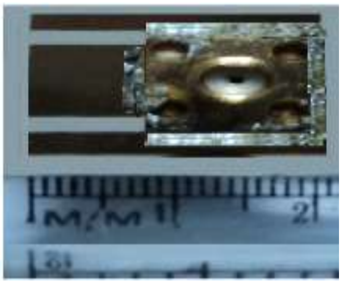

Fig 10(b): Bottom Layer of Proposed Antenna

The differences between the measured and simulated results are observed due to the fabrication tolerance or improper soldering of SMA connector.

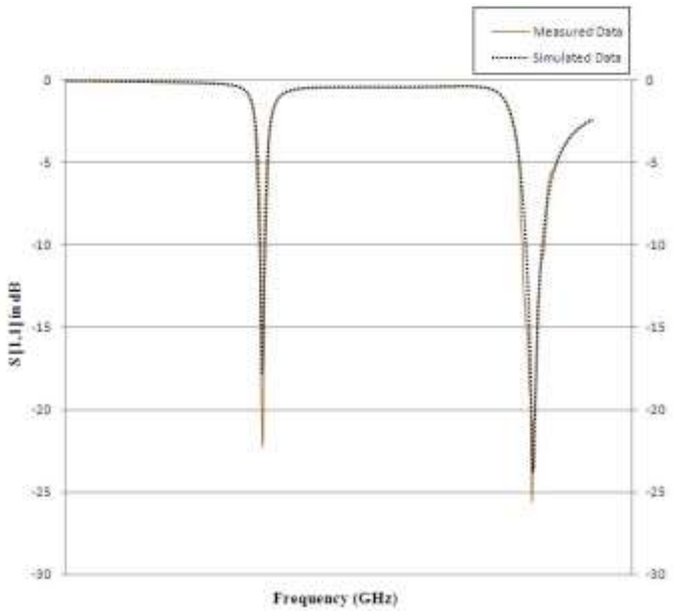

Fig 11: Comparison between simulated & measured data for conventional antenna

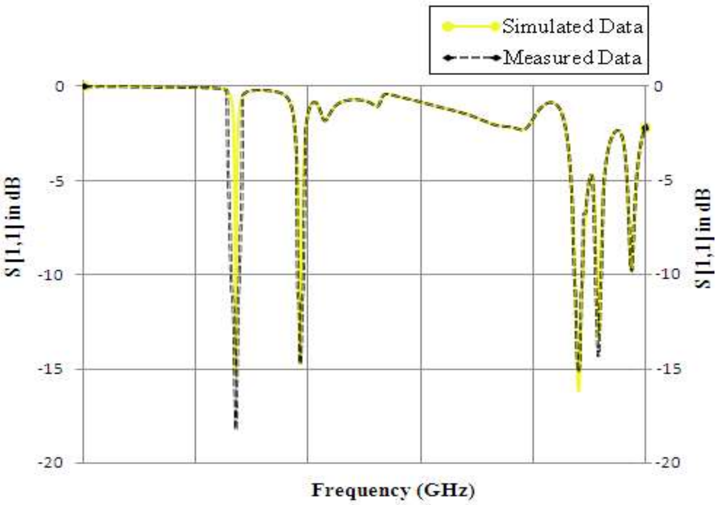

Fig 12: Comparison between simulated & measured data for proposed antenna

V. CONCLUSION

Dual layer single feed compact DGS printed antennas have been simulated by using IE3D software which uses Method of Moment based techniques. By introduce slots and slits at both layers of the patch, proposed structure size is reduced 49.82% than conventional structure. The result also verified by Vector Network Analyzer (VNA) Agilent N5 230A. Beam-width achieved for proposed structure is 158.60° which is becomes a broad beam for the application intended i.e. Surface Ship Radar applications especially.

ACKNOWELEDGEMENT

We acknowledge gratefully the financial support for this work provided by AICTE (India). We are also thankful to Prof. Bhaskar Gupta of JU, Jadavpur, Kolkata for providing the measurement facility.

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