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Design and Fabrication of High Gain Wearable and Flexible and For Wireless Applications

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Abstract:
In this paper, two wearable antennas are proposed. Modified DGS slot is loaded on top of antenna to achieve multi-functional capability for sub 2GHz-2.5 GHz wireless applications. The wearable antenna with modified DGS structure resonates at 2.035GHz & 2.36 GHz and consequent Return Loss (RL) bandwidths are 480 MHz (1.88-2.36 GHz) and 470 MHz (2.04-2.51 GHz) respectively. The proposed wearable antennas obtained circular polarization of -15.06dB at 3.2 GHz and -10.477dB at 3.49 GHz. The field analysis and parametric study of the proposed wearable antennas are presented using Mentor Graphics IE3D full-wave Electro-magnetic simulator, formerly Zeland Software. The gains obtained for the proposed antennas are more than 4dBi at all the resonances that have been occurred.

Keywords: CP Radiation, DGS structure, Wearable antenna, Bandwidth.

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I. INTRODUCTION

Wearable and flexible wireless systems are gaining exceptional popularity due to their profound potential in a variety of vital fields. Hence, development of flexible and wearable antennas is an important area that needs to be addressed since the processes involved are quite different from conventional antennas based on rigid substrates. Additional requirements are enforced when it comes to wearable and flexible applications[1]. For example, in body-centric applications[2], flexible materials must be biocompatible and compliant with health and safety requirements. On the other hand, textiles are adopted as conductive materials or substrate materials for applications that require clothing integration.

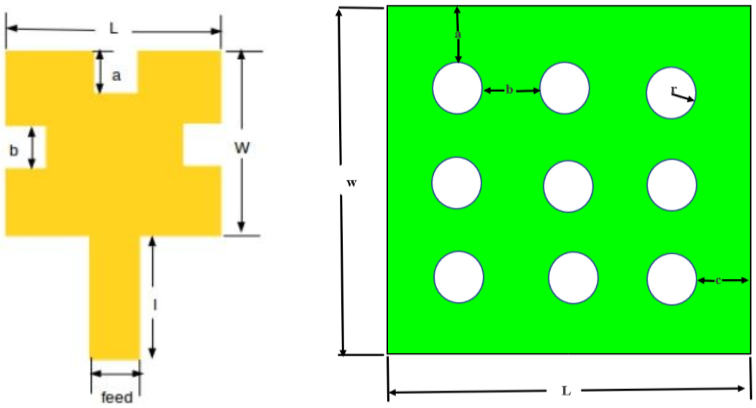
Rectangular patch of dimensions (50*50) mm^2 to which is deposited on a Jeans Substrate of relative permittivity (εr=4.4) with the given thickness. The thickness of the substrate is 1mm[3].With these dimensions simulation is done using a line feed in IE3D Zeland simulator. Simulation is performed to obtain the best results with impressed gain, bandwidth and VSWR and the required frequency is obtained when compared with the other iterative designs[4].

It is important to extract the best gain and impedance bandwidth or all the resonant bands produced by the final iterative design[5]. From the response of the return loss curve, it is observed that an impedance bandwidth of 470 MHz is obtained at 2.36 GHz with a high gain value of 4.249dB which is giving the best performance parameters when compared with the performance metrics of the other design iterations.

Microstrip line feed is one of the easier method to fabricate as it is a just a conducting strip connecting to the patch and therefore can be consider an extension of the patch. Line field also provides the best impedance matching. It is simple to model and easy to match by controlling the inset position. However the disadvantage of this method is that as the substrate thickness increases, surface waves and spurious feed radiation increases which limit the bandwidth to typically 2-5 %[6].

II. PROPOSED WEARABLE ANTENNAS

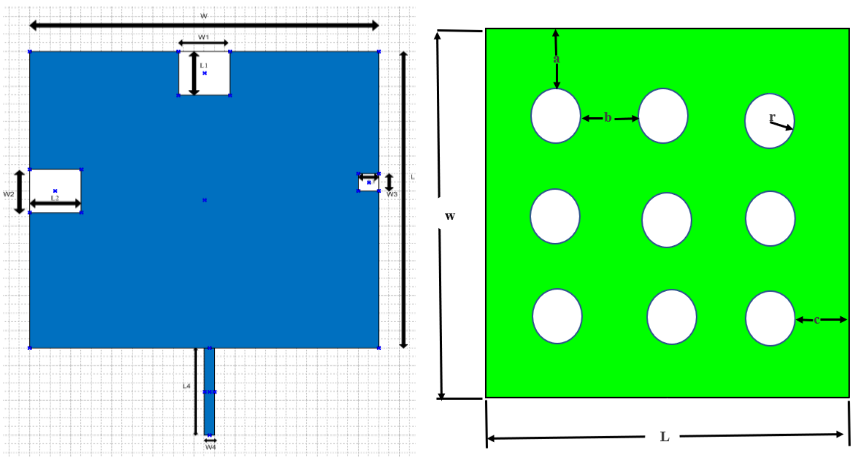
The proposed wearable antenna has a height of 40mm(w) and a length (L) of 40 mm is fed by line feed of 1mm and length(l) of 4mm, indentation depth of (a) of 0.5mm and (b) of 0.5mm is laid on DGS structure which is in bottom with a height of (w) of 50mm and length (L) of 50mm and spacing between each slot (a), (b), (c) of 11.5mm and radius of each slot (r) is 1mm and substrate thickness of 1mm with dielectric constant of 1.7 is shown in Fig. 1.



a)Front view b)Bottom view

Fig 1. Front and Bottom views of proposed wearable antenna1

The proposed wearable antenna has a height of 40mm(w) and a length (L) of 40 mm is fed by line feed of 1mm and length(l) of 4mm, indentation depth of (a) of 3mm and (b) of 3mm and (c) 1.5mm is laid on DGS structure which is in bottom with a height of (w) of 50mm and length (L) of 50mm and spacing between each slot (a), (b), (c) of 11.5mm and radius of each slot (r) is 1mm and substrate thickness of 1mm with dielectric constant of 4.4 is shown in Fig. 2.



a)Front view b)Bottom view

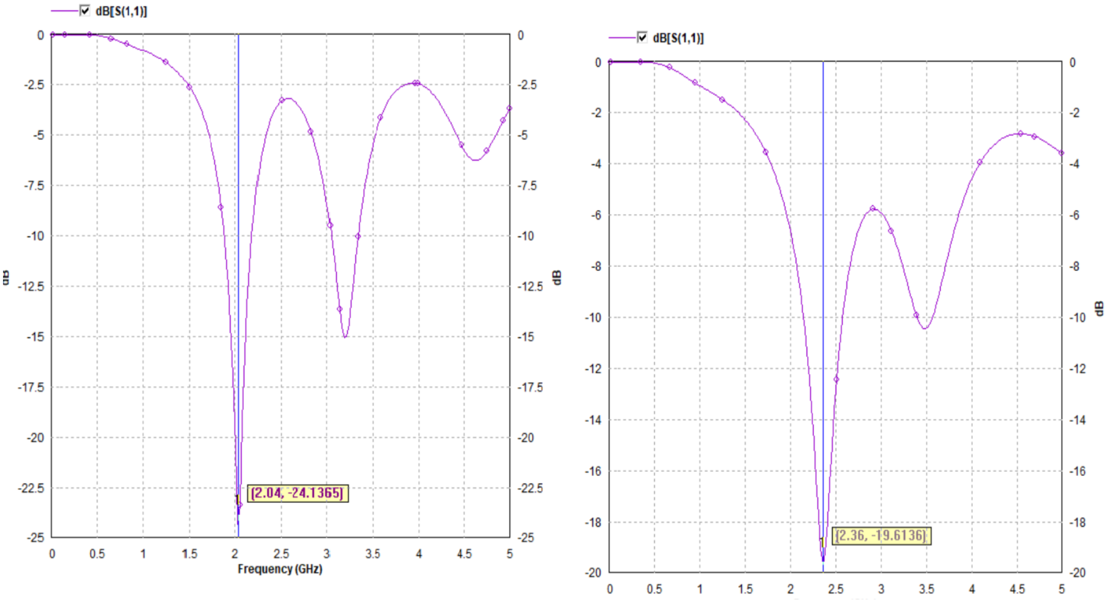
Fig 2. Front and Bottom views of proposed wearable antenna2

III. RADIATION PATTERNS AND SIMULATION RESULTS

The antenna design and simulation are done by using IE3D software. IE3D is a commercial electromagnetic simulator produced by Mentor Graphics company. The output graphs like RelativeLoss, VSWR, Radiation patterns and Gain patterns, Circular polarization and antenna Efficiency were plotted using this software.

A.Return loss :

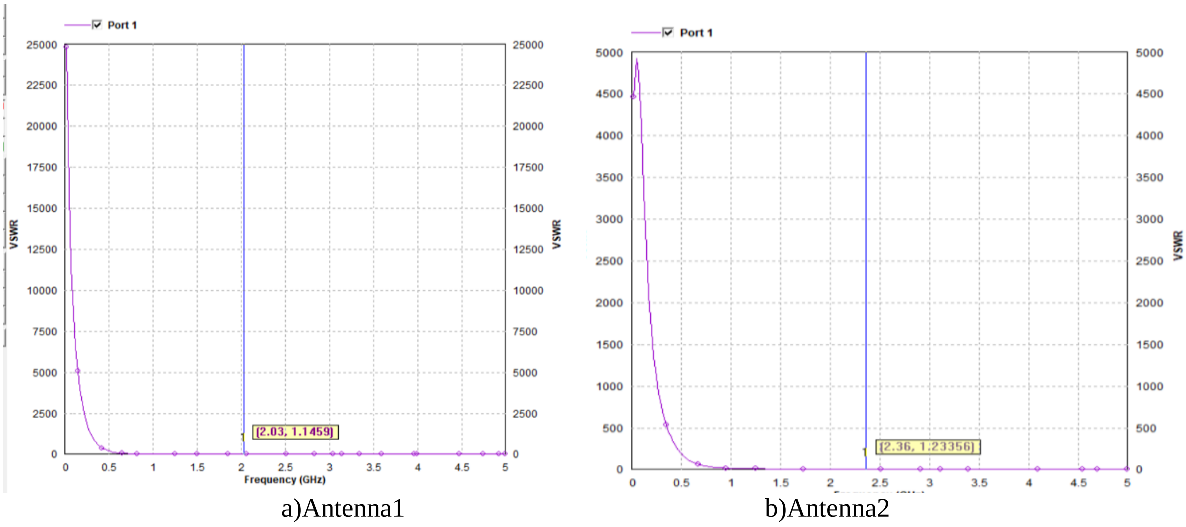
Return loss is the difference in dB between the incident power sent towards the Device Under Test (DUT) and the power reflected. Return loss for high gain wearable antenna(Antenna1) for (2.04 GHz) is -24.32 dB, (Antenna2) for (2.36 GHz) is -19.61 dB. The Return loss plot for proposed antennas is shown in Fig3.



a)Antenna1 b)Antenna2

Fig 3. Return loss of Antenna1 and Antenna2

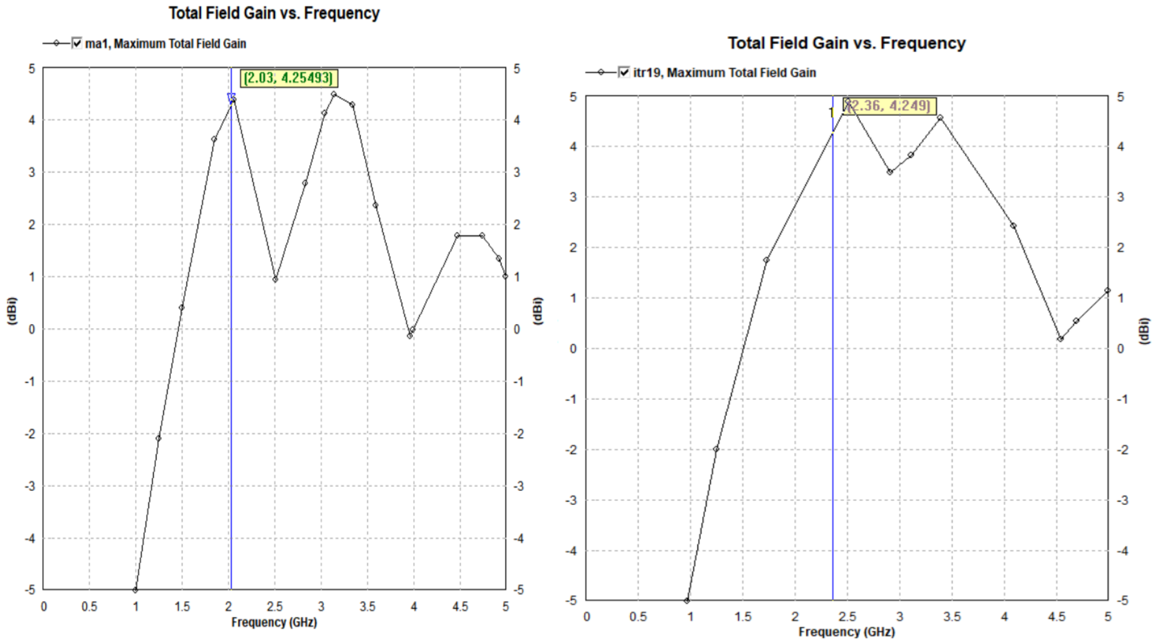
B. Voltage Standing Wave Ratio (VSWR) :
VSWR is a measure that numerically describes how the antenna impedance is matched with transmission line impedance. The VSWR values for high gain wearable antenna (Antenna1) for (2.04 GHz) is 1.14 , (Antenna 2) for (2.36 GHz) the VSWR value is 1.23. The VSWR plot for proposed antennas is shown in Fig 4.



a)Antenna1 b)Antenna2

Fig 4. Return loss of Antenna1 and Antenna2

C. Gain:
Antenna gain describes how much power is transmitted in the direction of peak radiation to that of an isotropic source. The gain values for high gain wearable antenna (Antenna1) for (2.03 GHz) is 4.25 dBi, (Antenna 2) for (2.36 GHz) the gain value is 4.249 dBi. The Gain plot for proposed antennas is shown in Fig. 5.

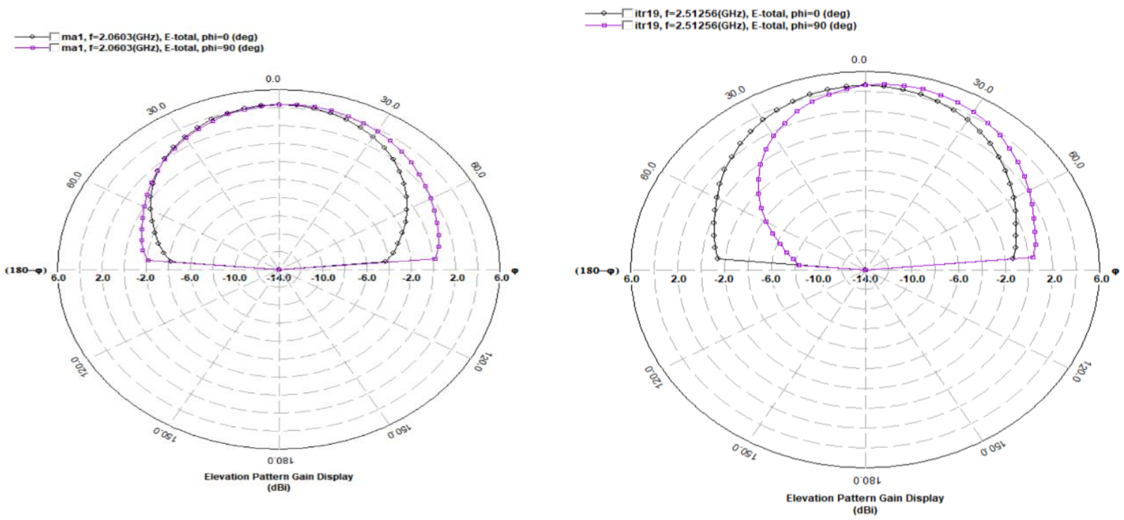


a)Antenna1 b)Antenna2

Fig 5. Gain of Antenna1 and Antenna2

D. Radiation Pattern :

Radiation pattern is a graphical representation of the radiation properties of antenna as a function of space coordinates. The radiation patterns of high gain wearable antenna (Antenna1) is (2.03 GHz). The radiation patterns of high gain wearable antenna (Antenna2) is (2.36 GHz) is shown in Fig. 6.

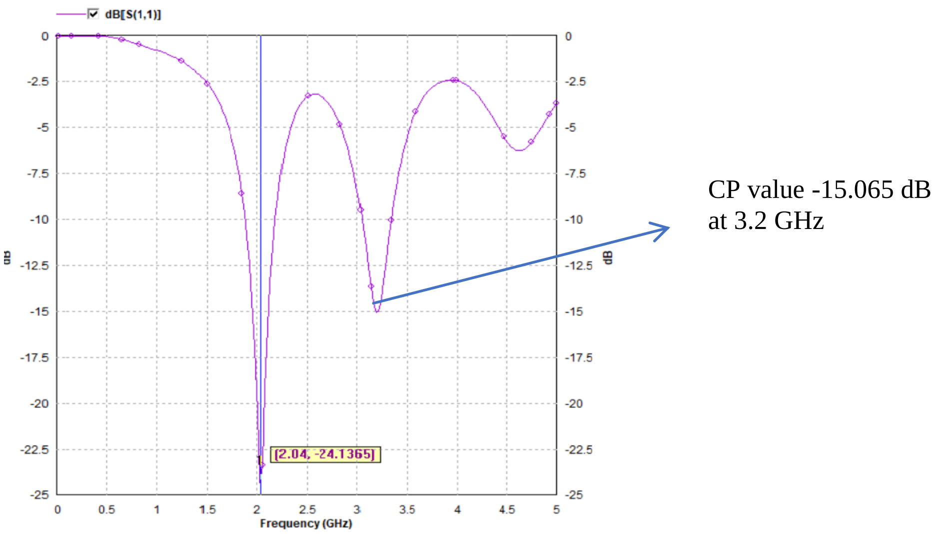


a)Antenna1 b)Antenna2

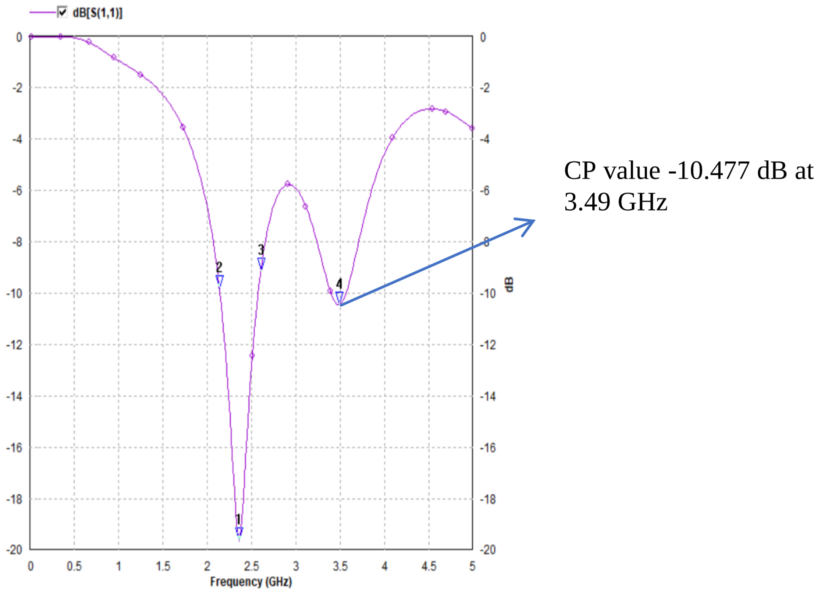
Fig 6. Radiation Pattern of Antenna1 and Antenna2

E. Circular Polarization(CP):

Circular polarization occurs when there are two components of the electric field, and they are equal in magnitude and one of the components leads the other by 90°. The CP values for high gain wearable antenna (Antenna1) for (2.03 GHz) is obtained at (3.2 GHz) with Return loss of -15.065 dB, (Antenna 2) for (2.36 GHz) is obtained at (3.49 GHz) with Return of -10.477 dBi. The Circular polarization for proposed antennas is shown in Fig 7.



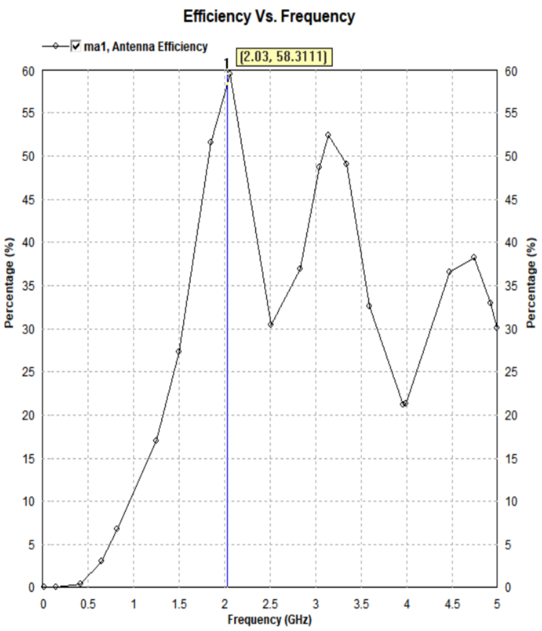
(a)Antenna1

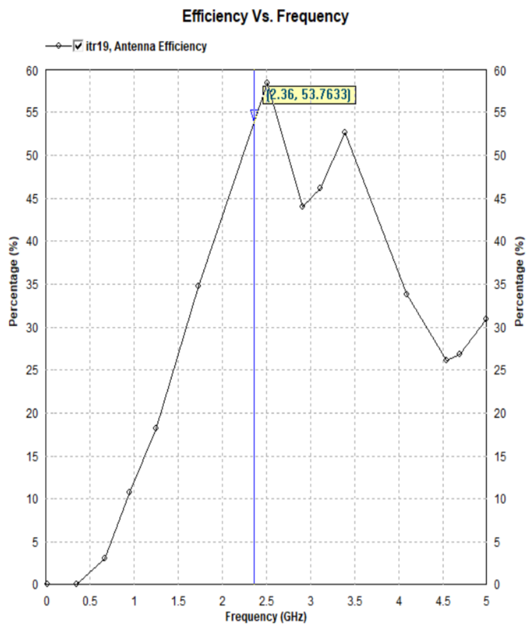


(b)Antenna2

Fig 7. Circular polarization of Antenna1 and Antenna2

F.Antenna Efficiency(%):
The efficiency of an antenna is a ratio of the power delivered to the antenna relative to the power radiated from the antenna. The efficiency for high gain wearable antenna (Antenna1) for (2.03 GHz) is 58.311%, (Antenna 2) for (2.36 GHz) is 53.763%. The antenna efficiency for proposed antennas is shown in Fig 8.





a)Antenna1 b)Antenna2

Fig 8. Antenna efficiency of Antenna1 and Antenna2

Table. 1. Results of proposed antenna

S.No	Parameters	Results of Antenna1	Results of Antenna2
1	Frequency(GHz)	2.035	2.36
2	Relative Loss(dBi)	-24.32	-19.61
3	VSWR	1.13	1.23
4	Circular Polarization (dB)	-10.477	-15.065
5	Gain(dBi)	4.25	4.249
6	Antenna efficiency(%)	58.311	53.76

IV. CONCLUSION

High gain wearable and flexible antenna for wireless applications are proposed in this paper. The proposed high gain wearable antenna resonates at 2.035 GHz and 2.36 GHz. The respective gains provided by the high gain werable antennas are 4.25 and 4.249. From the proposed antenna configurations, it can be concluded that, a circular polarization is obtained at 3.2 GHz and 3.49 GHz.

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