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Low Profile Wideband Antenna for Telematics Applications using DGS

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ABSTRACT: In this paper, a wide band linearly-polarized microstrip patch antenna is designed and simulated with Defect Ground Structure using HFSS simulation software. Antenna parameters are examined in this paper which includes resonating frequency, terminal impedances, VSWR and bandwidth of the proposed slotted patch antenna with DGS having inset probe feed. The designed antenna is proposed for wireless communication applications of Telematics ranging from 500 MHz to 3100 MHz having the wideband of almost 2.5 GHz. This paper focuses on the designing of microstrip patch antenna with ground slot introduction on a ground plane to improve wideband results as compared to conventional ground plane antenna and analysing the results like return loss S11, VSWR, bandwidth, impedance and radiation pattern (including 2D pattern) E- field at resonating frequencies..

KEYWORDS: Wideband patch antenna, Microstrip Antenna, DGS, Low-profile antenna, **,** telematics, etc.

I. Introduction

The expansion of W-CDMA, Wi-Max and Wi-Fi/WLAN in Telematics applications represent one of the major techniques in the information technology and communication system field. As per the current trends in information systems has been to develop minimum in cost, profile, weight commonly used dielectric substance of FR4_EPOXY (εr =4.4) that are able of providing tall performance over a broad range of frequencies [1].

With a simple and easy design, microstrip patch antennas offer many advantages not commonly exhibit in other antenna designs. Return of these microstrip patch structures are low outline, less pricey, lightweight and easier to fabricate using present day technology of PCB, compatible with monolithic microwave circuits and millimetre-wave and centimetre waves integrated circuits, and covers the ability to match to antenna designs [1-2].

In addition, once the design, operating mode and shape of the patch are selected, model become very specific in terms of operating frequency; return loss, radiation pattern, gain, VSWR and impedance [2]. Using the slotted multi band and wideband microstrip patch antenna thought, in this paper a wideband slotted microstrip antenna with DGS is designed and simulated for proposed work. Few antenna simulation software available which gives the optimization and modification of the antenna. HFSS is one of the most superior electromagnetic software which allows designing, optimization and solving for radio messages and microwave application. The HFSS tool computes all of the useful parameters that are required such as radiation pattern, gain, input impedance, return loss, VSWR, etc.

II. ANTENNA DESIGN

In particular, the conventional microstrip antenna structure is designed after that slots are added for multiband operations and finally with modified Defect Ground Structure has achieved with miniaturization and good performance. The design methods of this antenna using the slots and DGS resonating structures are common [3]. The design of the proposed antenna is shown in Figure 1, which is designed on a FR4_EPOXY (ε_r = 4.4, tan loss=0.02) substrate with a height of 1.575 mm.

The antenna is comprised of a inset probe feed and a rectangular shape of 34 X 38 mm structure. The antenna consist the microstrip metal line of 6X 2 mm and plain ground plane. After to this patch has two rectangular slot cuts of 1.5mm×12mm placed 8mm and another of 1.5mm×17mm placed 12.5mm distance from the edges of the patch as shown in Figure 2. Centre of feed point of radius 1 mm and outer radius of 1.6 mm of 5 mm height. The amount of the

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return loss parameter S_{11} for the antenna is designed by the commonly used. The obtained results shows that slotted patch will provide multiband as result achieved with two slots is dual band patch antenna[6-10]

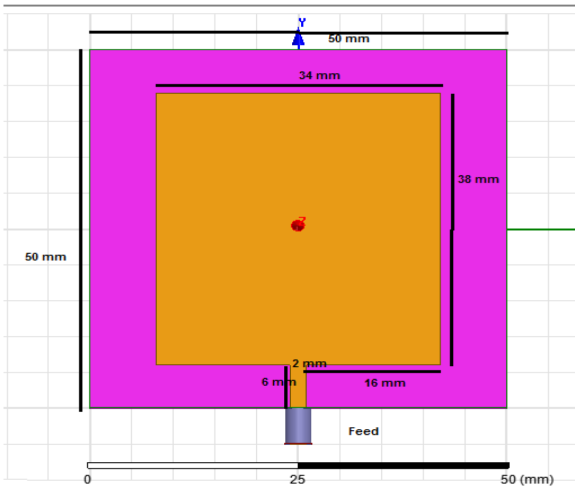

Figure 1: The configuration of patch of the proposed for 1.85 GHz

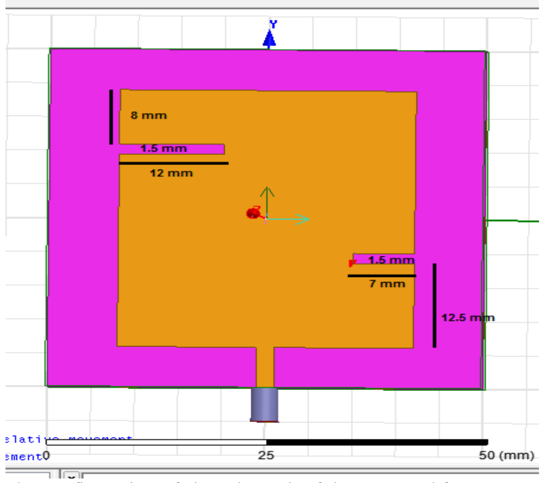

Figure 2: The configuration of slotted patch of the proposed for 1.85 and 3.2 GHz

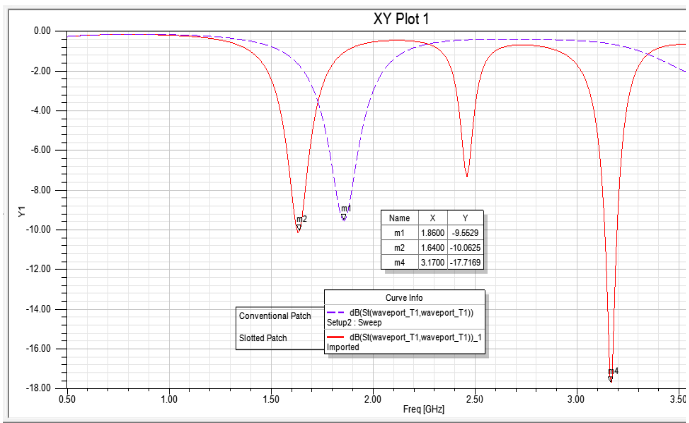

Figure 3 Return loss S_{11} vs. frequency plot of Conventional and slotted patch antenna.

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III. DESIGN METHODOLOGY

There have been numerous new concepts applied to microwave circuits. One such method is defected ground structure or DGS, in which ground plane metal of a microstrip (stripline, or coplanar waveguide) is intentionally modified to improve performance. The name for this technique merely means that a "defect" have been placed in the ground plane, which is normally considered to be an estimate of an infinite, perfectly conducting current sink. A ground plane at microwave frequencies is distant removed from the performance of perfect ground. Although the extra perturbations of DGS modify the uniformity of the ground plane, they do not cause to be it defective[5-7].

In the first proposed design of conventional patch was introduced and added slot which resulted in the following characteristics of S_{11} (reflection coefficient or return loss in dBs) vs. frequency in Gigahertz yielding 2 resonating bands at 1.85GHz and 3.32 GHz.

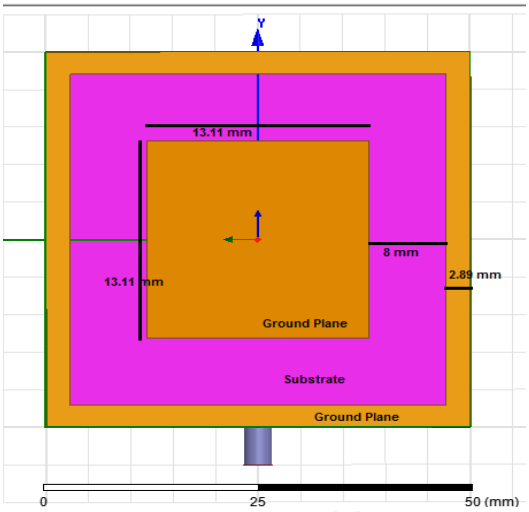

Figure 4. DGS1 Ground Plane

Then DGS1 was designed and simulated for wideband outcomes for this centre ground plane is made of 13.11 mmX 13.11 mm with the outer boundaries of 2.89 mm in combination .Ground Plane area is in general taken two times the patch area to understand the effect of infinite ground which is practically not possible to implement considering smallness [6] . Ground plane act as a signal return path and therefore a ground slot, as discontinuity in return path, produce wave result introducing slot impedance which shift the resonant frequency [9-10].

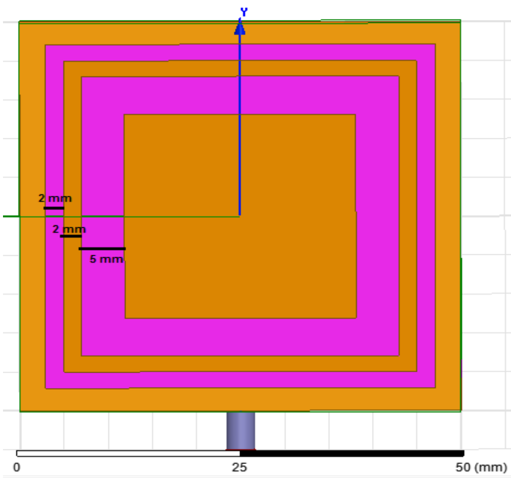

Figure 5. DGS2 Ground Plane

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Then the existing DGS1 slot on above design was replaced by another DGS2 as shown in Figure 5. at 5mm from the center of Ground plane point having dimension 2 mm around it. Finally the proposed design as DGS was also simulated two achieve multiwideband antenna as shown in Figure 6. DGS3 ground plane. By adding one more structure of 2 mm width around the centre ground plane at 1 mm apart and 2 mm from DGS2 structure.

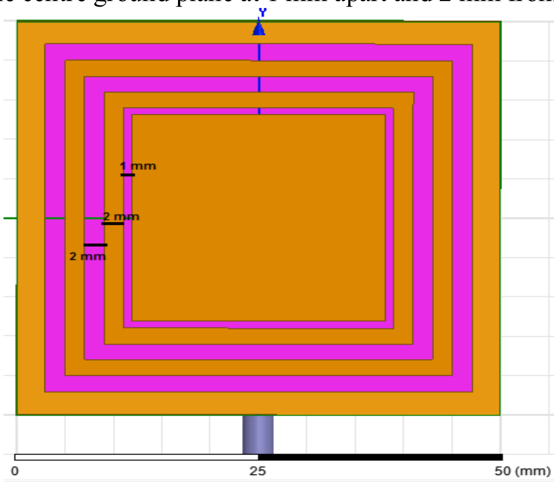

Figure 6 DGS3 Ground plane

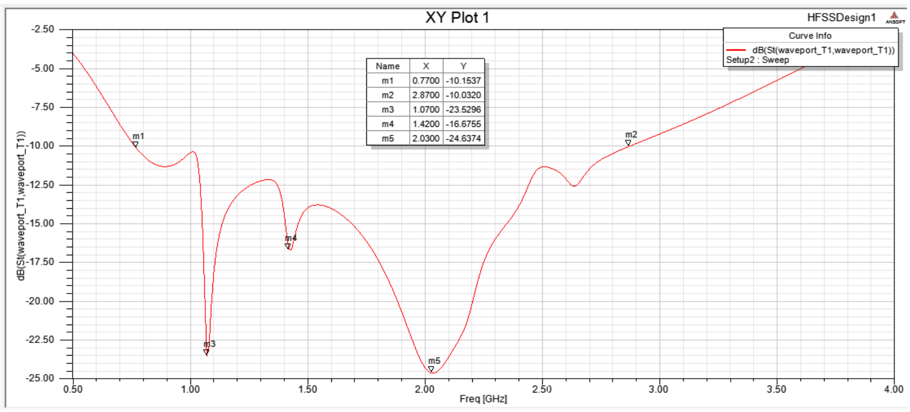

Figure. 7 Return loss S_{11} vs. frequency plot of DGS3 ground plane

IV. SIMULATION/EXPERIMENTAL RESULTS

The antenna simulation HFSS software, simulated results of S_{11} is shown in Figure.7 from DGS3 with respect to frequency in Gigahertz for the range 0.5GHz to 4GHz, where three frequency bands are obtained for the designed antenna. The antenna exhibits the characteristics of the wide and tri-band operation, i.e., a measured below -10 dB S_{11} and bandwidth of 2.5 GHz for the first resonating frequency at 1.1 GHz,-23 dB S_{11} and for the second resonating frequency at 1.42 GHz and -15dB S_{11}, for the third resonating frequency at 2 GHz with -24 dB covering the applications of Telematics for microwave communication, comparative characteristics of S_{11} is shown in Figure 8. The results of return loss, VSWR and impedance are given in Table 1.

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TABLE 1 RESULTS OF SIMULATED ANTENNA

S. No.	**Antenna parameters**	**Simulation**		
		f_1	**f_2**	**f_3**
1	Resonant frequency (GHz)	1.1	1.42	2
2.	Return loss S_{11}(dB)	-23	-15	--24
3.	VSWR	1.0114	1.1543	1.0899
4.	Impedance (Ω)	48	52	46
5.	Bandwidth(MHz)	0.7 to 3.1 GHz results **2.4 GHz**		

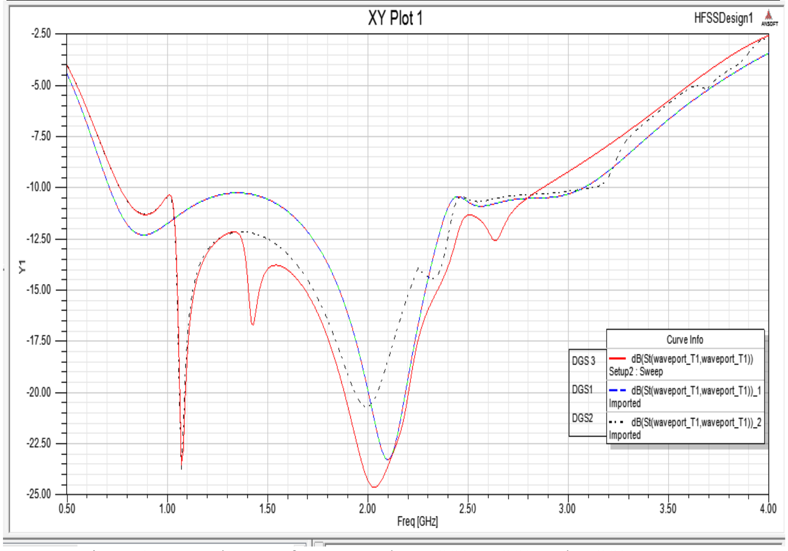

Figure 8 Return loss vs. frequency plot DGS1, DGS2 and DGS3 antenna.

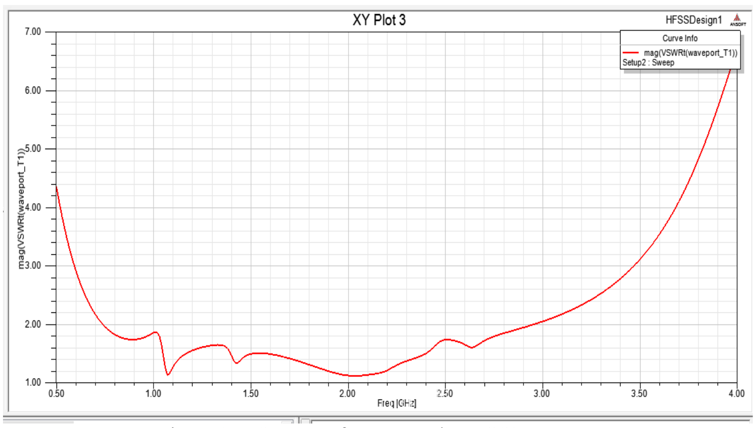

Figure 9: VSWR vs. frequency plot DGS3 antenna.

It can easily observed that the VSWR values at the resonance frequencies are lowest from 1-2. The simulated radiation pattern of all the resonating frequencies for the proposed DGS3 structure microstrip antenna are plotted in Figures 10.

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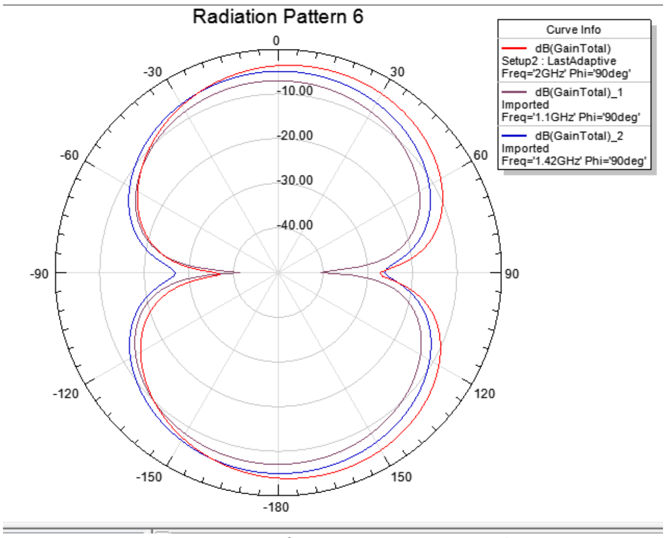

Figure 10 Gain pattern for DGS 3 at 1.1, 1.42 and 2 GHz.

V. CONCLUSION

We have designed and simulated Wideband defect ground structure microstrip antenna with modified ground structure which has a resonating frequency of 1.1 GHz, 3.42 GHz and 2 GHz with return loss of -23 dB, -15 dB and -24 dB respectively. This wideband antenna has wide application in of wireless communication in Telematics bands. Further optimizations are also possible to achieve for other bands required operating frequencies. The exclusive feature of this microstrip resonating structure antenna is its compacted and small size to get better operation. This paper presents a geometric arrangement of the a variety of Defect ground Structure Microstrip patch antenna for wireless applications, which provides a means to gain multiple bands by having slots on ground plane without by using DGS techniques [7-10]. In addition, better impedance matching, broader bandwidth, and higher RG are obtained by inserting the FR_4 epoxy substrate. It is noted that the low-loss FR4 epoxy substrate plays a key role in improving antenna performance of the low-profile wideband antenna.

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