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DESIGN OF RAISED PRINTED MONOPOLE FOR AUTOMOTIVE 5G WIRELESS COMMUNICATIONS

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Abstract: Currently the vehicle structure has been transubstantiating to a smart device which consists of numerous detectors and wireless technologies to support independent driving norms. 5G and Vehicle to Everything (V2X) are forthcoming norms for vehicle communication with girding terrain. The phrase "V2X," which stands for "vehicle to everything," is used to refer to the car's communication system, through which data from detectors and other sources is transmitted in a high-bandwidth, low-latency manner, high trustability links, paving the way to completely independent driving, perfecting business safety, and connecting the vehicle to different bumps in an Internet of Things (IoT) network.

The proposed design consists of raised monopole printed on substrate. The design's low profile and strong electrical performance make it a great candidate to be implemented in shark-fin casing. The antenna is dissembled using High Frequency Structure Simulator (HFSS) interpretation 2022 software. The antenna is designed by three different substrate materials using FR4 material, Epoxy-Kevlar material & Duroid material. The effect of change in base material or substrate material of antenna is analyzed. The simulated results of the proposed design are presented and plotted in terms of Return Loss, VSWR, Gain, and Diversity. The proposed antenna exhibits excellent qualities that make it appropriate for automotive sector.

IndexTerms: V2X, HFSS, Return Loss, VSWR, Gain, Directivity.

I.INTRODUCTION

The advent of numerous technologies in telecommunications, lead to increasing number of wireless services made available on vehicles. These wireless services in 4G and 5G networks brought us to the 5G-based vehicle-to-everything (V2X) communication, which has gained immense popularity for its capabilities. Technologies used in developing an independent vehicle frequently center around three types of detectors camera, radar, and LiDAR. Still, vehicle-to-everything(V2X), another wireless technology that formerly existed, brought significant added value to independent vehicles. V2X refers to high-bandwidth, low-quiescence, and dependable communication between a broad range of transport and business-related detectors.

5G mobile networks will give connectivity for vehicle-to-vehicle(V2V) and vehicle-to- structure(V2I) dispatches. This vehicle-to- everything technology is a means of two- way communication that enables the transmission of information between an automotive or electric vehicle and any girding reality that might affect that vehicle. Even before full autonomy becomes a reality, V2X activities will significantly affect convenience and safety.

V2X technology will also enable lower deadlock, reduce environmental impact, and add further vehicle comforts for motorists and passengers. From a communication technology perspective, unborn Intelligent Transportation System (ITS) services are extensively accepted. This will eventually lead to independent driving and bear a high position of connectivity in vehicles via advanced communication technology similar as 5G V2X. After extensive research fueled by academia and diligence, as well as the delivery of technological enablers for 5G that are now mature, the 3GPP established the standard for 5G V2X, beginning with Release 16. As defined by Wikipedia, 3GPP is a marquee term for a few norms associations that develop protocols for mobile telecommunications. 5G, coupled with V2X, will enhance vehicle and rambler safety with capabilities similar as vehicle announcement and control for approaching exigency vehicles with distance/ direction information or for climbers crossing in a crosswalk (business lights signals will be controlled or extended for safety and during unanticipated events, allowing the identification and avoidance of a rambler zipping into business). When an accident is near, a announcement of its position and distance will be transferred. effects similar as academy machine announcements, including unloading/ lading academy children in the area, will also keep climbers safe.

To achieve the requirements for 5G and V2X autonomous communications, raised printed monopole antenna system should be implemented. One of the best antennae for achieving a high bandwidth and omnidirectional radiation pattern is the printed monopole antenna (PMA). For various wireless communication applications, such as wireless LAN and Wi-Fi, multiple printed monopole antenna topologies have been proposed over the past ten years, and such antennas have been built using various simulation software.

II.NEED OF THE STUDY

The proposed design's main objective is to:

1. Satisfy the criteria for automotive communications standards.
2. Increase data rate without increasing the frequency spectrum.
3. Rely on a system with low latency.

III.PROPOSED DESIGN

The raised printed monopole antenna is designed with FR4(ε_r=4.4), Epoxy Kevlar(ε_r=3.6) and Duroid(ε_r=2.2) as substrate and Copper is used as conducting material. The geometrical parameters of the proposed design are as shown in the below Table 1.

Table1: parameters of the proposed antenna

Parameter	**Value(mm)**	**Parameter**	**Value(mm)**
H	30	L_g	27
L	27	H_g	8
W	0.8	S_r	4
H_a	6.25	L_r	23
L_a	5.25	H_r	12.75
F_h	11	F_l	3
L_{ge}	7.8	L_{te}	1.5
L_{re}	5.25	L_{fe}	4.25
S_l	1.5	S_h	9
The	4.2	H_{re}	1.85

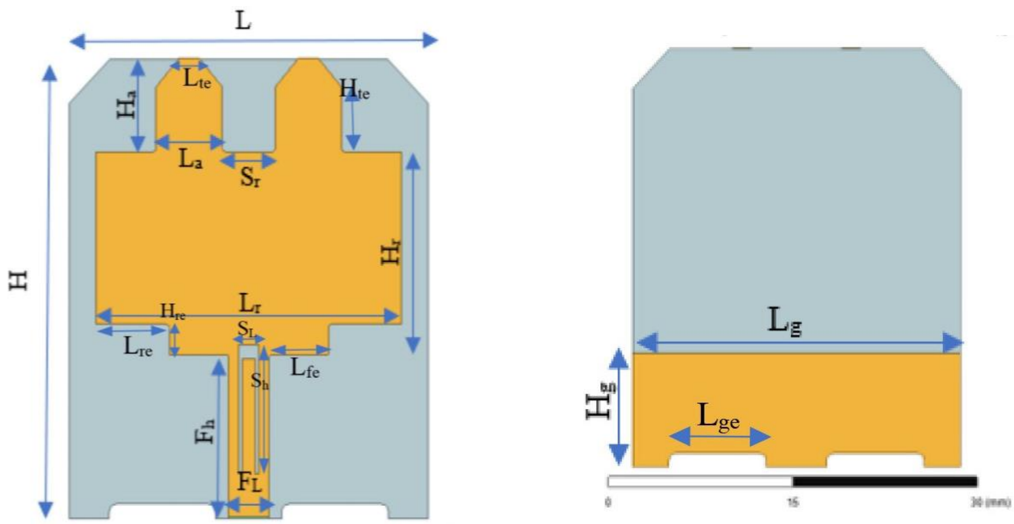


Figure 1: design of raised printed monopole antenna.

The above figure shows the proposed design of the raised printed monopole antenna.
Now, a slot is inserted in the wide rectangular region of the above antenna as shown below.

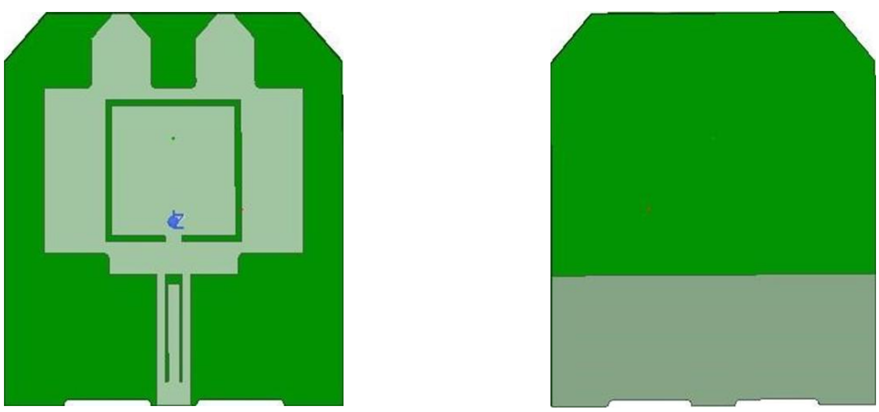


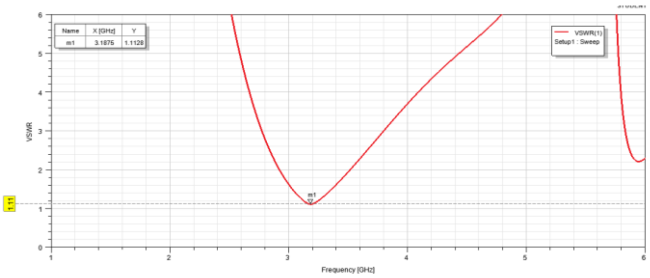
Figure 2: design of raised printed monopole antenna with slot

With the help of the HFSS tool, these antennas are simulated. Antenna performance is evaluated using characteristics like gain (G), directivity (D), return loss (S11), bandwidth (BW), and VSWR. Simulation is performed for different substrates and introducing slots in the patch.
Here antenna is designed for 3.6GHz operating frequency and the thickness of the substrate is 0.8mm. The microstrip feed line is used as a feeding technique and A lumped port is used to excite the antenna.

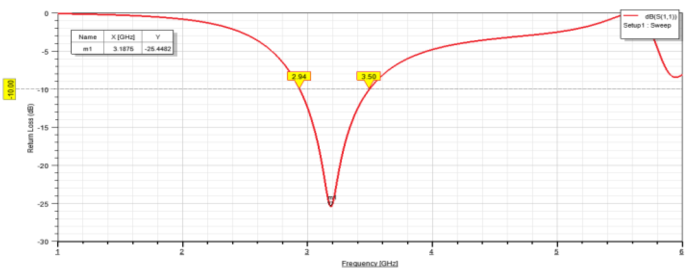
IV.RESULTS AND DISCUSSION :
After simulation, the following results were obtained:

Table 2: simulation results for different substrate materials.

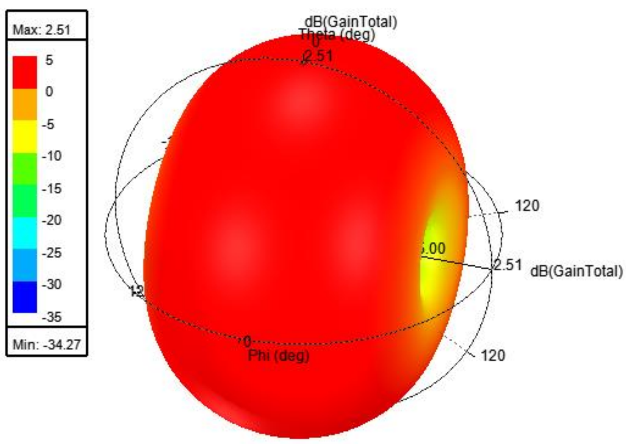
RAISED PRINTED MONOPOLE	MATERIALS	PARAMETERS				
		RETURN LOSS	BAND WIDTH	VSWR	GAIN	DIRECTIVITY
WITHOUT SLOT	FR4 SUBSTRATE	-36.9dB	490MHz	1.02	2.23dB	2.48dB
	EPOXY KEVLAR SUBSTRATE	-25.4dB	560MHz	1.11	2.51dB	2.45dB
	DUROID SUBSTRATE	-14.4dB	710MHz	1.47	3.40dB	3.28dB
WITH SLOT	FR4 SUBSTRATE	-45.5dB	1180MHz	1.01	2.51dB	2.69dB
	EPOXY KEVLAR SUBSTRATE	-36.51dB	1560MHz	1.03	2.90dB	2.81dB
	DUROID SUBSTRATE	-57.21dB	2250MHz	1.00	2.79dB	2.73dB



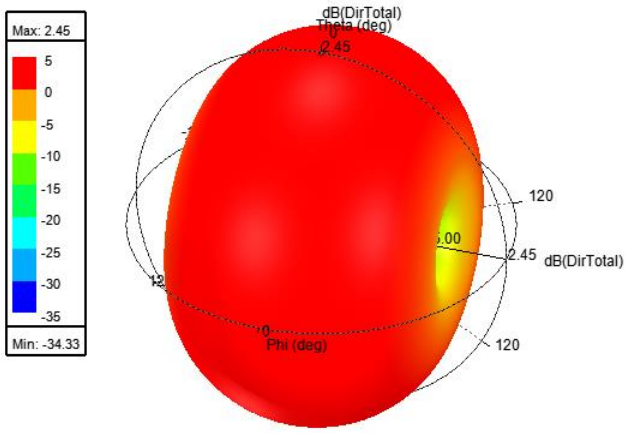
(a) vswr



(b) return loss

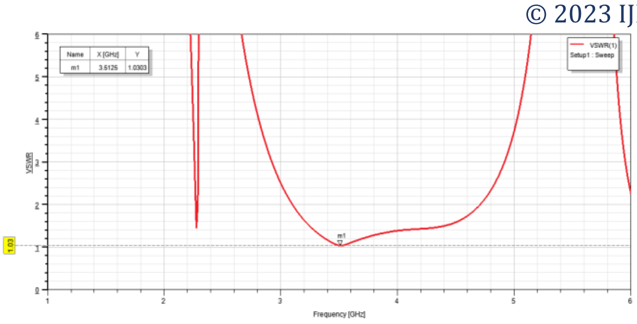


(c) gain

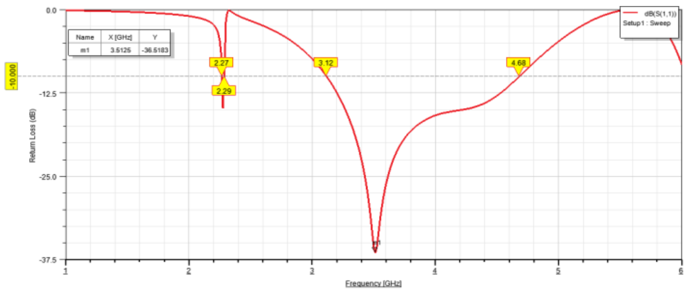


(d) directivity

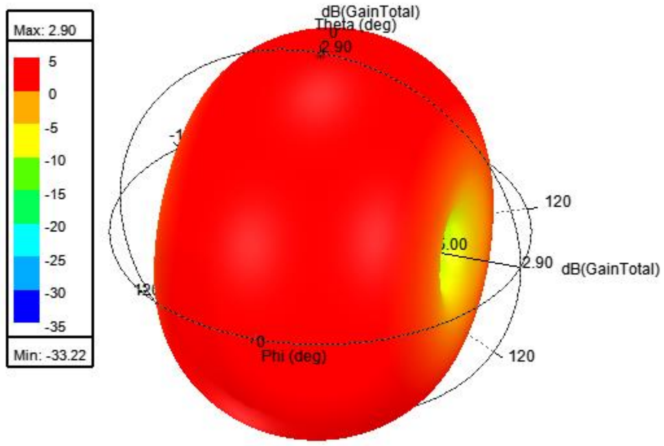
Figure 3: simulation results of raised printed monopole antenna using epoxy kevlar substrate



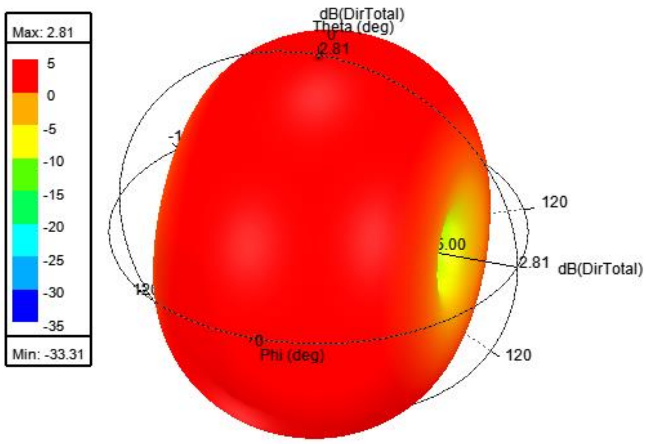
(a) vswr



(b) return loss



(c) gain



(d) directivity

Figure 4: simulation results of raised printed monopole antenna with slot using epoxy kevlar substrate

V.CONCLUSION

Different comparative approaches of various substrate materials like FR4, Epoxy Kevlar and Duroid have been used in the proposed design and are simulated using HFSS. Antenna parameters like VSWR, return loss, Gain and Directivity are analyzed. The proposed design without slot using FR4 substrate has high Return loss and the Duroid substrate has high Bandwidth, Gain and Directivity. When a slot is introduced in the design, the Return loss, Bandwidth are high for Duroid substrate and Gain, Directivity are high for Epoxy Kevlar substrate.

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