Design of an Ultra Wideband Antenna Operating on LTE/5G/Wi-Fi/DSRC/C-V2X Bands

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V2X (Vehicle to Everything) communication provides various transportation services such as vehicle safety, autonomous driving, and pedestrian protection through major international standards (IEEE 802.11p, 3GPP, etc.). The standard for such V2X communication is basically set to be supported in the 5.9GHz, but the 5G band and higher frequencies are also being used. Accordingly, integrating LTE, 5G, Wi-Fi, DSRC and C-V2X (Cellular-Vehicle to Everything) into a single broadband antenna can reduce the number of antennas required on the vehicle.

Fig. 1 illustrates the geometry of the proposed antenna. The antenna was designed based on a fundamental monopole structure, with an additional branch incorporated at the upper end to enable radiation in the 4GHz band. Adjusting the position of the upper branch improved impedance matching and enhanced the bandwidth. An additional branch was incorporated into the radiator to cover the frequency band required for DSRC and C-V2X (5.9GHz), while a reflector structure was introduced to enable operation in the Wi-Fi/ Bluetooth (2.4GHz). The overall size of the antenna is 31mm x 33mm. The substrate used was Taconic RF-30 with a dielectric constant of 3 and a thickness of 1.52mm.

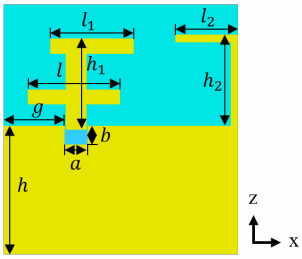

Fig. 1. Geometry of proposed antenna

Table. 1. Parameters of the proposed antenna

Parameter	a	b	g	h	h_1
Value (mm)	3	2.5	8	17	12
Parameter	h_2	l	l_1	l_2	
Value (mm)	12	12.2	11	8.3	

The simulation was conducted by placing a 2500mm x 2500mm metallic plate at a distance of 25mm below the antenna, in order to account for the infinite ground effect of the vehicle roof. Fig. 2 illustrates the reflection coefficient of the proposed antenna, demonstrating that values below -10dB are achieved across the 2.3GHz - 6GHz frequency range. Fig. 3 presents the radiation patterns at the key target frequency bands, namely Wi-Fi/Bluetooth, 5G, DSRC and C-V2X.

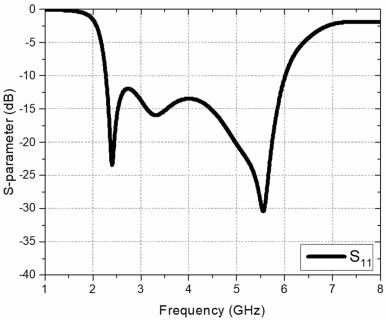

Fig. 2. Simulated Reflection coefficient

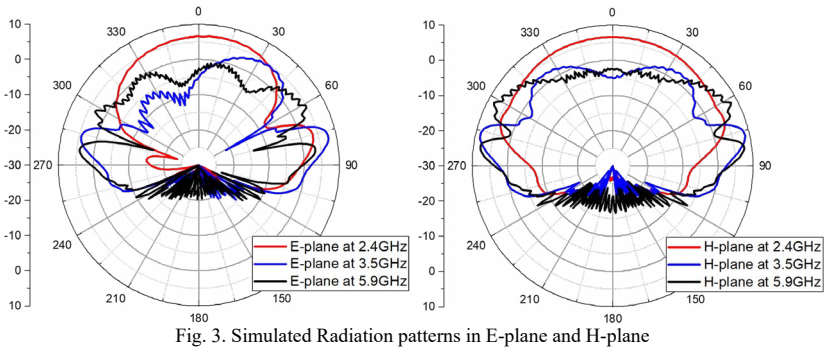

Fig. 3. Simulated Radiation patterns in E-plane and H-plane

In this paper, a wideband antenna was designed to cover the frequency bands required for V2X and vehicular communications. Such an antenna can support multiple frequency bands with a single element, thereby reducing the number of antennas mounted on vehicles, while also accommodating emerging technologies without the need for additional hardware modifications.

REFERENCES

[1] W. Wang, et. al., "Compact Quad-Element Vertically-Polarized High-Isolation Wideband MIMO Antenna for Vehicular Base Station", IEEE Trans. Vehi. Tech. Sep. 2020.