

# Design of a Triple-Band Antenna with Modified Inverted-F Structure for V2X Communications

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In vehicle-to-pedestrian (V2P) communication, omnidirectional antennas are important for minimizing blind spots. This paper presents a triple-band inverted-F antenna (IFA) for V2P communications. The target frequency bands are set to 1.92-1.98 GHz, 2.50-2.57 GHz for LTE uplink and 3.40-3.70 GHz for 5G uplink. To cover these triple bands, an optimized single IFA is designed to provide omnidirectional radiation characteristics.

Fig. 1 illustrates the geometry of the IFA antenna. The IFA consists of two radiators, a ground plane, a shorting stub, and two reflectors. The antenna is designed on a single layer substrate Taconic RF-30. The overall size of the antenna is 37 x 1.52 x 42.3 mm<sup>3</sup>, considering installation on a vehicle roof. The optimized design parameters for the IFA are summarized in Table 1.

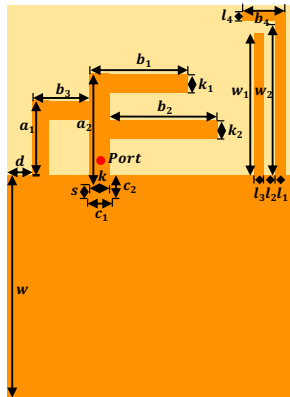


Fig. 1. Geometry of the IFA

Table 1. Parameters of the proposed antenna

Parameters	$a_1$	$a_2$	$b_1$	$b_2$	$b_3$
Values (mm)	8	11.7	11.3	14.3	7
Parameters	$b_4$	$c_1$	$c_2$	$d$	$s$
Values (mm)	4.1	3	2.5	1	0.9
Parameters	$l_1$	$l_2$	$l_3$	$l_4$	$k$
Values (mm)	1.1	2.4	1.1	2.2	2
Parameters	$k_1$	$k_2$	$w$	$w_1$	$w_2$
Values (mm)	2.1	2.1	24	14.3	17.3

The simulated reflection coefficient of the proposed IFA is shown in Fig. 2. To consider the ground effect of the vehicle roof, a 1000 x 1000 x 0.035 mm<sup>3</sup> metal ground was placed 25 mm away from the bottom of the IFA. The antenna operates in triple bands, with the lower band of 1.805-2.026 GHz, the middle band of 2.455-2.580 GHz, and the upper band of 3.443-3.666 GHz. Fig. 3. shows the radiation patterns at the target frequencies, and it can be seen that the proposed IFA provides wide coverage. The antenna gain is 6.863dBi at 1.891 GHz, 6.624dBi at 2.527 GHz, and 7.430dBi at 3.589 GHz.

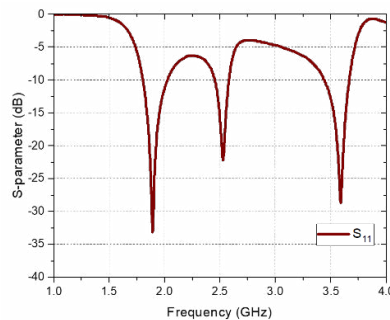


Fig. 2. Simulated reflection coefficient

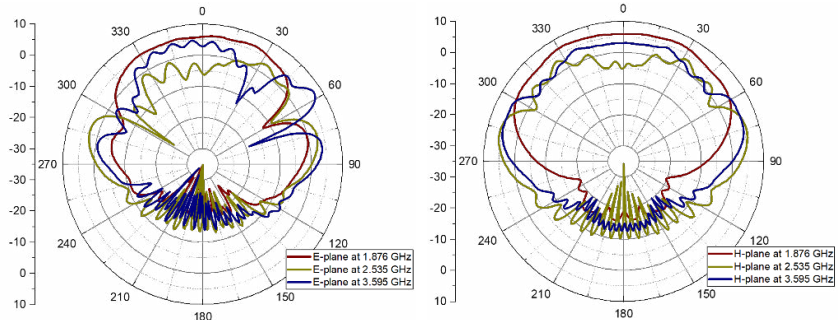


Fig. 3. Simulated radiation patterns in E-plane and H-plane

The proposed IFA exhibits desired omnidirectional radiation characteristics and operates effectively in the designated mobile frequency band. It is suitable for V2P communication and can be applied in collision avoidance and other automotive intelligent systems. Verification of the proposed antenna's compatibility with 5G NR and C-V2X standard releases will be conducted to ensure interoperability with evolving vehicular communication protocols.

## 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.