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D-Band Antenna for Sub-THz 6G-V2X Vehicular Applications

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In the context of vehicular networks, numerous emerging wireless applications have gained considerable attention from both academia and industry. For instance, 6G-V2X (Vehicle-to-Everything) technology is being explored to develop more versatile and diverse communication networks by integrating terrestrial and various non-terrestrial communication systems, such as satellite and UAV networks [1]. This advancement aims to establish truly intelligent and ubiquitous V2X systems with significantly improved reliability and security, ultra-high data rates (e.g., terabits per second), and extensive, ultra-fast wireless connectivity—reaching sub-millisecond latency while supporting billions of connected devices. Additionally, it will enable smarter, more extensive, and energy-efficient 3D communication coverage.

In recent years, several groundbreaking 6G-V2X technologies have emerged, including brain-vehicle interfacing, tactile communication, and terahertz (THz) communications. The latter, operating within the THz spectrum (0.1–10 THz), is considered a promising solution to alleviate congestion in lower frequency bands. However, numerous challenges remain, including transceiver architecture, materials, antenna design, propagation measurements, channel modeling, and the development of new waveforms.

Antenna-in-package (AiP) is an advanced antenna packaging technology designed for high-frequency telecommunications. Utilizing the short wavelengths characteristic of mmWave or sub-THz applications, AiP facilitates the development of compact antennas that can be seamlessly integrated into semiconductor packages, unlike conventional discrete antennas mounted separately on PCBs. This integration of antennas with transceivers onto a single chip offers multiple advantages, such as improved antenna performance and significantly reduced package size.

This paper presents a preliminary design of a D-band (140–160 GHz) AiP. The layout of the radiating element and array is examined, along with the design of the embedded feeding network. Furthermore, at sub-THz frequencies, it becomes essential to evaluate the impact of any nearby elements, including the plastic casing (bezel). A theoretical and numerical analysis has been conducted to optimize the geometrical and dielectric properties of the dielectric cover.

References

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