# Planar Triple-Band Monopole Antenna with 2-D Photonic Crystal Structure for LMDS (27.5-31.3 GHz), V-Band (40-75 GHz) and WiGig (57-66 GHz) Applications

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Millimeter-wave communication systems in 27.5-31.3 GHz band are being developed for use in Local Multipoint Distribution Service (LMDS) to provide reliable digital voice, data and internet service. The V-band of the electromagnetic spectrum ranges from 40 to 75 GHz. The V-band is not heavily used, except for millimeter wave radar research and other kinds of scientific research. Transmissions at 60GHz have less range for a given transmit power than 5GHz Wi-Fi, because of path loss as the electromagnetic wave moves through the air, and 60GHz transmissions can struggle to penetrate walls. There is also a substantial RF oxygen absorption peak in the 60GHz band. The use of millimeter-wave techniques at 60 GHz offers many advantages for short-range systems compared to radio methods at lower frequencies. The main advantages of this frequency band are, on the one hand, the large bandwidth which permits high data rates and in the short wavelength on the other which leads to small antenna dimensions even with multi-antenna systems. Furthermore, there is no interference with existing radio systems. In view of the high radio field attenuation and the high transmission losses of walls, the radio cells are small, but interferences by other millimeter-wave systems and neighboring radio cells are small as well.

In this paper, the design and characterization of a triple-band monopole antenna with covering the entire IEEE 802.11ad (WiGig) frequency band (57–66 GHz), LMDS (27.5-31.3 GHz) and part of V-band (40-75 GHz) applications are presented. The proposed structure for substrate is a triangular lattice of air columns with a radius $r$ and lattice constant $a$ drilled in a dielectric with a dielectric constant $\varepsilon r$ = 11.9 (Silicon). The dimensions of dielectric are $4.78\times6\times0.8$ mm$^3$. The main parameters of the EBG structure can be accurately computed by the program RSoft Photonic's Plane Wave Expansion (PWE) toolbox. We obtained $a$=1.46 mm and $r$=0.468 mm for the operation in 60 GHz. The proposed antenna has different three bands operation in 28 GHz, 48 GHz and 60 GHZ with impedance bandwidth of 71.4%, 10.5% and 10% respectively. The software package Ansoft HFSS has been used for the simulation of proposed antenna.