Broadband Artificial Magnetic Conductor implemented with a Hexagonal 60 GHz Phased Array Antenna

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Millimeter wave applications with a strong emphasis at 60 GHz are currently being actively researched for close range, Gbps high speed wireless communication. Most recently, addressing the technical challenges regarding implementation of 60 GHz phased array antennas with the rest of the wireless module is increasingly becoming crucial in the consumer electronics industry.

A first-of-the kind, 60 GHz antenna which was monolithically devised using ultra-low cost FR4 PCB has been proposed and presented by the authors (W. Hong, K.H. Baek, and A. Goudelev, IEEE Tran. Antennas Propagat., Vol. 60, pp. 5932-5938, 2012). However at the commercial product level development stage, unexpected field interaction and surface wave resonance modes are likely to occur when such antennas are fully implemented with the rest of the 60 GHz carrier board that consists of the RF transceiver chip, digital interface and accessories. Often times, this can result in a severe degradation of the far-field radiation pattern of the original 60 GHz phased array antenna. This becomes especially detrimental in scenarios when the main beam of the array antenna is maximally tilted, and can potentially lead to link communication failure in worst case scenarios. Therefore elimination of undesired surface waves surrounding the 60 GHz phased array antenna becomes a crucial matter in ensuring the stable operation amid a robust wireless environment. Here, we present a 16-element, hexagonal 60 GHz phased array antenna integrated with a broadband artificial magnetic conductor (AMC). The 60 GHz AMC consists of a periodic repetition pattern of two different unit cells, each resonating at 59 GHz and 63 GHz respectively. The devised AMC pattern is determined to feature a stopband bandwidth from 57 - 66 GHz based on various measurements. The AMC and the phased array antenna are cohesively designed and fabricated using low cost FR4 PCB. Measured and simulated far-field radiation patterns indicates the devised antenna array to exhibit more than 50^{o} maximum beam scan angle in both the E- and H-plane. At such scan angles, the AMC is confirmed to improve the side lobe levels by approximately 3 dB in comparison to measured side lobe levels of the identical antenna array without the presence of the AMC.