5G Vertical and Horizontal Polarized Antenna Integrated with a Metallic Frame of the Cellular Phone

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In Recent years, the usage of millimeter wave (mmWave) frequency band for 5th generation (5G) mobile communication systems has been discussed to meet the exponentially increasing traffic demand. As one of the candidate frequency, recent studies demonstrate the feasibility of 28 GHz frequency band for 5G cellular applications. The omnidirectional patterns of 3/4G cellular phone antennas today are advantageous, likewise, at mmWave frequencies the incoming waves on the antenna are predicted to be distributed across the entire sphere. To receive these signals, two end-fire array antenna has to be located on the top and bottom portion of the cellular phone. However, realization of a beam steering antenna applicable to cellular handsets remains one of the biggest bottlenecks. The metallic brackets located behind the LCD panel limit the placement of cellular phone antennas to the edges of the device. The available antenna area is further diminished by the increasing number of sensors as well as speaker, the camera modules and microphone units, which in general incorporate a certain amount of metallic frames.

Due to the high signal attenuation at 28 GHz, the antenna must be placed in very close proximity to the 28 GHz RFIC and the front-end module. Implementing the antenna array directly on the printed circuit board (PCB) of the 5G cellular device will therefore keep the insertion loss between the antenna and RFIC to a minimum. Taking these into consideration, a minimum set of two 28 GHz antenna arrays is proposed for mmWave 5G cellular applications. For polarization-multiplexing-based multiple-input multiple-output (MIMO) systems, vertical and horizontal antenna arrays are realized simultaneously. As the thickness of cellular phone PCBs are thinner than 1 mm and the free-space half wavelength is larger than 5 mm, it is difficult to implement dual polarized antenna embedded in the PCB.

In this paper, 4 x 1 vertical and horizontal polarized antenna array structures integrated with metallic frames are presented. A proposed structure of antenna feeding network is realized in the multi-layered PCB substrate. Using the metallic frame which are fabricated with computerized numerically controlled (CNC) machine tool, the radiators of vertical and horizontal polarization antenna are implemented. The design procedures, the simulation results, and the measured results will be discussed in the presentation.