

## **Low Cost Multi-layered Array Design for mm-Wave Communications**

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Millimeter wave (mm-wave) applications have been gaining attention, and interest will continue with the approval of the 5G bands: 27.5-28.35 GHz, 37-38.6 GHz, 38.6-40 GHz, and 64-71 GHz. Several array antennas have already been published for mm-wave operation. However, fabrication and testing of these arrays is challenging due to the small size of the overall structure and feed characteristics. Different fabrication techniques have considered to overcome manufacturing challenges. Nevertheless, the complexity and high cost of previous approaches are still an issue, particularly as relates to measurements.

In this paper, we introduce a low cost multi-layered mm-wave array using PCB fabrication techniques to minimize costs. The array operates from 56 to 66 GHz, and a standard milling machine is used to print the array antenna on top of the substrate. Also, a low loss Duroid ( $\epsilon_r = 2.2$ ) superstrate is used to improve wideband matching and beam scanning. A feed line is used to connect the antenna elements to a microstrip feed network implemented below the ground plane. Simultaneously, a measurement technique is developed to accurately characterize the fabricated array to avoid direct coax connections. For measurement and testing purposes, each element is tested independently and then combined via post-processing to produce the array pattern. It is noted that the microstrip line from the feeding network is extended up to the top layer and connected to a probe pad for characterizing the array.

At the conference, we will present the mm-wave array design, its fabrication and measurement setup to validate our concepts. Measured responses of the array will also be presented and discussed.