Dual Polarized UWB Millimeter-Wave Phased Arrays

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With rapidly increasing demand for high data rates, personal electronic devices like cell phones, cars, and watches need multi-functional radios at millimeter-wave (mm-wave) frequencies. To accommodate multiple communication platforms, antennas must be low cost, ultra-wideband (UWB), and integrated with the transceivers. Further, the high path-losses at these frequencies require high gain arrays. At present, many of available UWB arrays are fabricated using expensive micro-fabrication techniques such as Low Temperature Co-fired Ceramic (LTCC). Recent UWB arrays have addressed the expensive fabrication problem with flip-chip printed circuit board (PCB) antenna fabrication in mind. However, these arrays lack the polarization diversity necessary for 5G applications.

In this paper, we present two dual polarized ultra-wideband arrays with low scanning at mm-waves. Our arrays belong to the family of tightly coupled dipole arrays (TCDA). These arrays have demonstrated large impedance bandwidths and scanning performance in a low profile of (λLow/10). Such arrays are extensions of the Current Sheet Array (CSA) concept. The first CSAs achieved 4:1 bandwidth by introducing capacitive coupling between antenna elements to counter the effect of ground plane inductance. The most recent TCDA have ultra-wide bandwidths exceeding 58:1 with low angle scanning capability down to 70° due the use of novel feeds and frequency selective surfaces.

The feeding networks of the two low-profile and low-cost arrays presented here are optimized to enable balanced and differential feeding at mm-waves with low angle scanning capability and simple fabrication using standard PCB processes. The single-ended dual-polarized array operates with VSWR < 3 across the Ku to 5G bands (viz. 17.5-65 GHz) with scanning down to 60° in both planes in full wave simulation. Likewise, the dual-polarized differential array operated across the K to 5G bands (viz. 24.4-79.4 GHz) with scanning down to 45° using the metric of VSWR < 3.

For validation, the dual polarized mm-wave TCDA prototypes will be fabricated and measured. Both arrays employ standard PCB processes and dimensions for low cost and high yield, making them well-suited for mass-production. However, the pressing issue with mm-wave arrays is how to feed a densely populated space with impedance-matched low-inductance leads. Due to their small size and low inductance, a secondary feed board will be constructed with ball-grid-array (BGA) mounts to route the antenna feeds to a connectorized test board. Future fabricated prototypes will directly integrate with RFIC transceivers for high efficiency millimeter-wave flip-chip radios.