

Vertically Integrated 25:1 mmWave TCDA Using a Hybrid Fabrication and Assembly Approach

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The congestion and expansion of the Electromagnetic spectrum calls for methods to better utilize it. Notably, traditional narrow-band approaches dictate the use of multiple antennas operating separately, leading to redundancies and inefficiencies. By contrast, ultra-wideband (UWB) arrays can consolidate multiple frequency bands into a single aperture, to lower space requirements, cost, weight and power consumption. Especially, the FR-bands dedicated to the 5G/6G communications are extremely fragmented, with operating frequencies spread across the microwave to mm-Wave spread. This paper proposes a solution to unify the disperse FR bands under a single UWB antenna array.

We enable operation across large bandwidths, we will employ the Tightly Coupled Dipole Array (TCDA) concept to realize the first vertically integrated mm-Wave array. This TCDA can operate across a 25:1 bandwidth. Notably, previous UWB mm-Wave arrays, strictly employ modular and planar architectures that bring the ground plane in close proximity to the radiating element. Consequently, their operation is often limited to small bandwidths. Our approach combines PCB printing technologies with 3D printing to seamlessly assemble vertical boards and achieve an unparalleled 25:1 bandwidth at mm-Waves. First, all components of the array including the balun, impedance transformer, dipoles and the FSSs are printed in a single plane. Subsequently, the antenna boards are placed vertically inside a periodic metamaterial-like 3D printed dielectric structure. Notably, carefully designed perforations lower the dielectric constant of the dielectric base to ensure correct operation without unwanted surface modes. Additionally, a compact double-Y balun is employed to achieve extremely low-cross polarization levels using balanced excitations. Full, wave simulations reveal continuous operation across 2-50 GHz with VSWR<3 and scanning capabilities down to 60 degrees. Concurrently, the proposed design has a very low-profile of only $\lambda/16$ at the lowest frequency of operation. The proposed concept is validated through measurements of a fabricated prototype.