A Wideband Tightly Coupled Dipole Array with Novel Differential Feeding Network

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Low profile wideband antennas and arrays are key components in high data rate communications systems and high resolution radar. Their small footprint offers orders of magnitude reduction in power, cost, and space for the system. In addition, such ultra-wideband (UWB) arrays improve spectral efficiency by enabling spatial multiplexing and simultaneous transmission and reception. Besides being wideband and low profile, such arrays must have advanced beamforming capability allowing for wide angle spatial scanning.

Among UWB arrays, the Tightly Coupled Dipole Antenna (TCDA) arrays have been shown to deliver impedance bandwidths exceeding 14:1 (J. Moulder, et. al, "Superstrate-Enhanced Ultrawideband Tightly Coupled Array with Resistive FSS," IEEE APT, 2012) and scanning performance greater than 70° in all directions (E. Yetisir, et. al, "Ultra-wideband Array with 70° Scanning using FSS Superstrate", IEEE AWPL, 2016.). All of these TCDAs employ an integrated balun feed network, which serves as a higher order impedance matching network to realize wide bandwidths. TCDAs have been designed and measured from 0.3 GHz up to 90 GHz with VSWR < 3.

Until now, TCDAs were fed by balanced coaxial cables which are not compatible with commonly used differential RF components. Recently, advancements in differential RF front–end components, such as push-pull amplifiers, have significantly increased the operational bandwidths of transceivers. However, differential phased arrays are not inherently UWB. With this in mind, we propose a novel approach to the well-established UWB Tightly Coupled Dipole Array for differential feeding applications. The compatibility of this UWB differential array with current wideband differential transceivers significantly impacts high data rate communications systems and high resolution radars.

More specifically, in this paper, a novel differential phased array is proposed for S-Ku band communications. To accommodate a differential signal, a novel Dual-Balun feed structure is presented. A major challenge in the design of a differential radiating system is the reduction of common mode currents present at the aperture, and mutual coupling between the ports that feed the aperture. Given the performance of the integrated Marchand Balun presented in past works, the differential design presented here uses a parallel combination of Marchand baluns to achieve cancellation of the common modes for 6:1 impedance bandwidth. The infinite array simulation shows a VSWR < 3 from 3-18 GHz with scanning down to 45° in all planes. This card based antenna is integrated with a breakout printed circuit board (PCB), making it the first differential phased array created solely through PCB processes. This array has direct differential strip-line/micro-strip compatibility to standard chip-based RF transceiver chains, eliminating the need for connectors and cables. A prototype has been built and tested to verify the array's performance. Results will be presented in the conference.