A Wideband Tightly Coupled Dipole Array with Novel Differential Feeding Network

Alexander Johnson*, Elias A. Alwan, and John L. Volakis
ElectroScience Laboratory, Electrical and Computer Engineering Dept.
The Ohio State University, Columbus, Ohio, 43212
E-mail: johnson.6919@osu.edu

Low profile wideband antennas and arrays are key components in high data rate communications systems and high resolution radars. Ultra-Wideband (UWB) arrays offer orders of magnitude reduction in power, cost, and space for these systems. Such UWB arrays will also enable increased spectral efficiency, spatial multiplexing, and simultaneous transmit and receive applications. In addition to being wideband and low profile, such arrays must operate across a wide scanning range to communicate across long distances.

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 our integrated balun feed network, which serves as a higher order impedance matching network in addition to common-mode currents. TCDAs have been designed and measured from 0.3 GHz up to 90 GHz with VSWR < 3.

An issue with existing TCDAs implementation on an integrated module stems from the manner in which the array is excited. The aforementioned 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.

More specifically, in this paper, a novel differential phased array is proposed for S-Ku band communications. In order to accommodate a differential signal, a novel Dual-Balun feed structure was designed. 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 array operates with a simulated VSWR < 3 from 3-18 GHz and with scanning down to 45° in the E-plane. The compatibility of this UWB differential array with current wideband differential transceivers significantly impacts high data rate communications systems and high resolution radars. Prior to the conference, the scanning performance of the array will be optimized in the H plane with scanning down to 45°. Measured results will be compared to simulations to verify the design.