

An UTD Rapid Phased Array Antenna Coupling Package

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This paper presents a summary of the rapid antenna/phased array antenna coupling tool suite using Uniform Theory of Diffraction (UTD). Part of the work of this tool suite has been reported in two papers published previously (H. Z. Zhang, P. H. Pathak & J. H. Morrill, IEEE AP-S/URSI 2013 & H. Z. Zhang, J. A. Catton, J. H. Morrill & P. H. Pathak, IEEE AP-S/URSI 2012). This paper focuses on the Phased Array Antenna (PAA) coupling functionality and implementation of the tool suite.

Two methods have been implemented in the package as the primary methods for PAA to single antenna or PAA coupling. The first is the element-by-element and the second is the pattern-in-array method. The element-by-element method is also able to account for the element to element mutual coupling by importing the element mutual coupling S matrix from the 3rd party CEM tool kits. The pattern-in-array method is a patent pending (USPTO Application # 15/637980) technology which is able to manipulate the element far-field pattern to synthesize a beam as requested by the user. The pattern-in-array method offers a flexibility to sub-group a large number of element PAA to a small number element PAA and then uses element-by-element method to evaluate the coupling with other antennas. The combination of pattern-in-array and element-by-element method results in significant reduction of the number of elements in PAA calculation while not losing any of the critical information such as element to element mutual coupling within the sub-array.

The tool suite is able to calculate multiple ray paths from individual PAA element to receiving antenna through different ray mechanisms. The ray mechanisms include direct free space ray, geodesic surface ray (creeping wave), wedge diffraction, geodesic surface ray wedge diffraction and their combinations. This feature enables the tool not only for PAA to single antenna coupling application, but also for analyzing multiple antennas to a single victim receiver. Regarding the element representation, if the element is a simple structure, such as monopole or slot, the tool suite is able to use a closed form solution to evaluate the element performance. If the element is too complex for closed form representation, the tool is able to use the far-field pattern of the element for the coupling calculation. The far-field pattern can be obtained from other CEM tools and also can be obtained from measurement. The far-field pattern method offers a unique capability for analyzing the complex PAA structure.

The single antenna and PAA coupling result obtained by using this tool suite has been validated using other 3rd party CEM tools and measurement. It has been used in a number of projects within Boeing. The tool suite offers a unique capability for analyzing antenna and PAA coupling on electrically large platforms.

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