Physical Insight into Wideband Connected Bowtie Arrays

Norma W. Riley [1], Douglas J. Riley[1], Robert L. Acree[2] , Joseph R. Chavez[2]
(1) Northrop Grumman 100 Sun Ave. N.E., Suite 300, Albuquerque, NM 87109
(2) AFRL/VSSE, 3550 Aberdeen Ave. S.E., Kirtland AFB, NM 87117

Physical phenomena determining the bandwidth of wideband connected phased arrays are identified. Time domain responses of total voltage, at the terminals of a radiator in the array, provide visualizations of those physical phenomena.

The fact that self-complementary arrays of connected bow-tie elements exhibit very wide bandwidth, without a ground plane, was established as early as 1970 (Baum, *AFWL Sensor Simulation Note 100*, March 1970). The present paper focuses on answering the question of *why* a connected array of bowtie elements supports wide bandwidth. Specifically, what physical characteristics do connected bowtie arrays posses that support wide bandwidth? Physical insight is provided using time domain RF predictions of total voltage at the terminals of a radiator in the connected bow-tie array, and comparing to similar predictions for connected arrays of thin dipoles, which do not exhibit wideband characteristics. It is demonstrated that element shape can be used to minimize both reflections from the edges of the array as well as interactions between neighboring elements.

Ideally, wideband performance requires that a signal impressed on the port of an element in the array travels away from that port, and that no signal travels back into that observation port. Reflections, as well as signals arriving from adjacent radiators, cause undesirable variation in the impedance of an element in the array.

The present paper demonstrates that achieving the widest possible bandwidth from a phased array requires minimization or cancellation of signals traveling into the observation port. An investigation of currents on various connected arrays demonstrates that shaping the radiating element to minimize reflections from the end of the array and interactions with neighboring sources is an important first step toward wideband phased array designs. Finally, it is demonstrated that scan impedance and far field patterns remain well behaved for scan angles on the order of 45 degrees. The RF predictions included in this paper do not include ground plane and multi-layer substrate effects, which is a topic of future research.

Figure 1: Connected Bowtie Array