A TRIANGULAR PHASED ARRAY EXCITED BY
OSCILLATORS COUPLED ON A HEXAGONAL LATTICE

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When a set of electronic oscillators is coupled so as to mutually injection lock, it can be used to produce excitation signals for the elements of a phased array antenna which have a linear phase distribution over the array. [R. A. York, IEEE Trans., MTT-41, pp.1799-1809] [P. Liao and R. A. York, IEEE Trans., MTT-41, pp. 1810-1815] The slope of this phase distribution can be controlled by adjustment of tuning of the oscillators on the perimeter of the array. This has been studied both theoretically and experimentally over the past several years in the context of coupling on a Cartesian lattice with a rectangular aperture each oscillator being coupled to four nearest neighbors. [R. Ispir, S. Nogi, M. Sanagi, and K. Fukui, IECE Trans. Electron., E80-C, 1211-1220, Sept. 1997] [R. J. Pogorzelski, Microwave and Guided Wave Letters, 10, pp. 478-480.] [J. Shen and L. W. Pearson, 2001 Nat. Radio Sci. Mtg, Boston, MA] More recently, a triangular aperture was investigated in which the oscillators were coupled on a triangular lattice; that is, coupled to six nearest neighbors. [R. J. Pogorzelski, 2002 Nat. Radio Sci. Mtg, Boulder, CO]

In this paper, a triangular array is proposed with oscillators coupled on a hexagonal lattice. The analyses of such an oscillator array using the full nonlinear formulation based on a Van der Pol model of the oscillators, a linearized version of this formulation, and a continuum model of the array are outlined. It is shown that the response time of the array is scaled by a factor of four relative to the rectangular case making the steering rather slow. More importantly, and somewhat counter-intuitively, it is shown that, unlike the rectangular and triangular coupling schemes, for the hexagonal scheme, a planar phase distribution is not a solution of the differential equations describing the array dynamics for all azimuth angles. Thus, although approximately achievable, a planar aperture phase is theoretically not exactly achievable for arbitrary azimuth angle without adjustment of the tuning of all the oscillators, not just those on the array perimeter. The primary impact on the array performance is a small degradation in the gain. There are, however, discrete azimuth angles for which the planar distribution is in fact an exact solution of the equations and, thus, for these angles a planar distribution is achievable and there is no gain degradation.