BD2: Spatial Power Combining

Recent Developments in the Analysis of Coupled Oscillator Arrays

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Arrays of electronic oscillators, mutually injection locked by virtue of nearest neighbor coupling, have been proposed as a relatively simple means of controlling the phase of the aperture field distribution of a phased array antenna in such a manner as to effect steering of the radiated beam. One need only adjust the free running frequencies of the oscillators on the perimeter of the array appropriately to achieve linearly varying phase across the aperture resulting in the steered beam. (Note that in a linear array the perimeter consists of the two end oscillators.) [1] If the oscillators are voltage controlled (VCOs) such adjustment can be done by variation of the applied tuning voltage. An alternative scheme, proposed by Stephan [2], involves injection locking the perimeter oscillators to a master oscillator and varying the phases of the injection signals appropriately. Initially, such arrays were analytically studied by formulating their behavior in terms of a system of first order nonlinear differential equations based on Adler's well known theory of injection locking. [3] However, except in very special cases, such a system could only be solved numerically and this yielded only limited insight into the transient and steady state behavior of the arrays. It was recently noticed that a linearized version of the analysis could be reformulated in terms of a second order partial differential equation which could be solved analytically in a number of interesting cases. [4] These analytic solutions yield vastly increased insight in to the array behavior and the parameters which control it.

Results for several interesting cases are reviewed. These are: a one dimensional array with end oscillators detuned, a one dimensional array with end oscillators injection locked to phase shifted externally generated signals, a two dimensional array with perimeter oscillators detuned, and a two dimensional array with perimeter oscillators injection locked to appropriately phased externally generated signals. These results illustrate several features of the behavior of such arrays. Two significant conclusions are that the time constant of a one dimensional array is roughly proportional to the *square* of the number of elements and that two dimensional arrays are more easily controlled via detuning than via injection.

References

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