Genetic Algorithm Optimization of Traveling Wave Slot Arrays Using Full Wave Method of Moments Analysis

Sembiam R. Rengarajan
California State University
Northridge, CA 91330 USA

Extended Abstract

Traveling wave arrays using rectangular waveguide feeds may be designed using longitudinal offset broad wall slots. If all the slots are on one side of the waveguide center line, the array acts like a leaky wave antenna with the beam pointing direction independent of slot spacing given by

$$\theta_0 = \cos^{-1}(\beta / k_0) \tag{1}$$

where θ_0 is the angle measured from the (array) z-axis, β is the phase constant of the TE_{10} mode and k_0 is the free space wavenumber. For example, if $\beta / k_0 =$ 0.707, θ_0 is 45°. In some applications the spacing is only slightly greater than half wavelength in free space [1]. It has been found that there is a significant coupling between adjacent slots through many higher order modes, even though such modes are evanescent. Traveling wave slot arrays may also be designed with alternating slot offsets to produce the beam on either side of the broadside direction. The beam pointing direction in this case is given by

$$\theta_0 = \cos^{-1}[\beta / k_0 - \lambda_0 /(2d)] \tag{2}$$

where λ_0 is the free space wavelength and d is the slot spacing. The slot spacing relative to free space wavelength becomes less as the beam points farther from broadside and towards the direction of the feed. As the element spacing reduces the amount of higher order mode coupling becomes significant. The conventional design, even with the inclusion of the TE_{20} mode coupling may not produce accurate results [2].

In this paper we examine some conventional traveling wave array designs that exhibit significant higher order mode coupling. A genetic algorithm (GA) optimization using a full wave method-of-moments (MoM) analysis is shown to produce accurate results. In the GA MoM optimization, the slot lengths, offsets as well as the spacing are varied over a small range of values near the original designs using Elliott's procedure [1, 2]. The goal is to optimize the directivity, sidelobe level and the return loss.

References

1. R. S. Elliott, "On the design of a traveling-wave-fed longitudinal shunt slot arrays," IEEE Transactions on Antennas and Propagation, 27, 1, pp. 717-720, Sep. 1979.

2. R. S. Elliott, and W. R. O'Loughlin, "The design of slot arrays including internal mutual coupling ," IEEE Transactions on Antennas and Propagation, 34, 9, pp. 1149-1154, Sep. 1986.

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