Design Procedure for 2D Slotted Waveguide Antenna with Inclined Coupling Slots for Sidelobe Level Control

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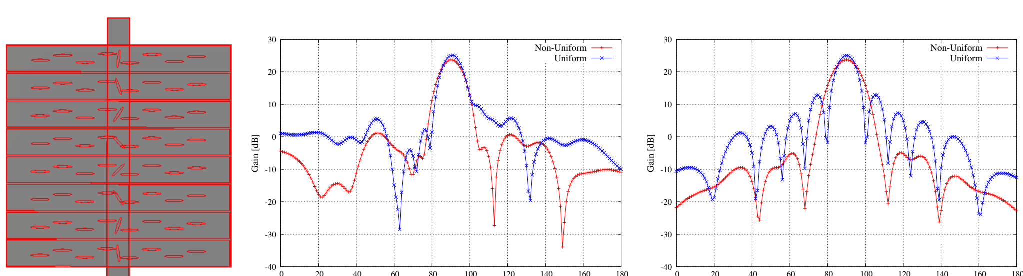
Abstract— Slotted Waveguide Antennas (SWAs) radiate energy through slots cut in a broad or narrow wall of a rectangular waveguide. They offer clear advantages in terms of their design, weight, volume, power handling, directivity, and efficiency. SWAs can be resonant (standing wave) or non-resonant (traveling wave). Resonant SWAs outperform the non-resonant SWAs in terms of efficiency due to its termination with a short circuit, compared to matching load in the case of the latter, but with a narrower bandwidth. For broad-wall SWAs, the slot displacements from the wall centerline determine the antenna's sidelobe level (SLL). In addition, the rotation angle of the coupling slot in a 2D system array of SWAs determines the power fed by each slot into each branchline SWA.

This paper presents an inventive simple procedure for the design of a two-dimensional (2D) SWA array system with desired sidelobe level (SLL). The system consists of multiple branchline waveguides with broadwall radiating shunt slots. A main waveguide is used to feed the branch waveguides through a series of inclined coupling slots with well-defined rotation angles for low SLLs. For a specified number of identical longitudinal slots, the described procedure finds the slots length, width, locations along the length of the waveguide, and displacements from the centerline, for each branch waveguide. Furthermore, for a specified number of branch waveguides, the method finds the rotation angle of each of the coupling slots.

To explain the controllable-sidelobe 2D SWA design procedure, an SWA with 8×8 elliptical slots, designed for an SLL lower than -20 dB, is taken as an example. An 8-element 1D SWA with a desired SLL is designed first. Eight identical such SWAs are then attached side by side. The proper design of the 1D SWAs ensures having the desired SLL in one principal plane. To enforce the same SLL over the whole 3D pattern, special care should be given to the design of the feed SWA, whose slots should power the radiating SWAs according to a correct distribution. For the taken example, the feed SWA should have 8 slots, separated consecutively by a distance related to the radiating SWA aperture width and wall thickness. The power fed by each slot in the feeder and fed to the branchline waveguide is controlled by the inclination angle of the coupling slot.

Figs. 1(b) and 1(c) show a comparison of the gain patterns for the following 2 cases: Case 1 where the radiating slots have a uniform displacement and the coupling slots have a uniform rotation angle; and Case 2 where the radiating slots have non-uniform displacements and the coupling slots have non-uniform rotation angles as per the design procedure. As inspected, the SLL decreased from -12.1 dB in case of uniform displacements and rotation angles to less than -20 dB with the non-uniform displacements and inclinations calculated using the presented simple design procedure.



(a) (b) (c)

Figure 1: (a) 2D System, Compared gain pattern results of the uniform and non-uniform displacements and rotation angles design cases: (b) E-plane, (c) H-plane.