Quasi-Analytical Model of an Infinite Leaky-Wave Slot Coupled to Microstrips

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In [A. Neto, S. Maci, IEEE Trans. on Antennas Propagat, Vol. 51, No. 6, 2003] the Green's function of an infinite slot printed between two different homogeneous dielectric media has been studied. There, the formulation is structured by deriving, under non-restrictive assumption, an analytical expression of the magnetic currents, providing next a uniform asymptotic approximation for the field radiated in every observation point. For that geometry, the exciting dipole was located on the slot, as needed for the analysis of coplanar-waveguide fed slot. This latter feed configuration has been analyzed in [A. Neto, P. de Maagt and S. Maci, , IEEE Trans. on Antennas Propagat, Vol. 51, No. 6, 2003] by constructing, via the previous Green's function based magnetic currents, suitable entire domain basis functions to be applied in the Method of Moments (MoM) solution. For the described geometry, the asymptotic dominant contribution in the denser medium is a conical leaky-wave field. This suggest to use this structure to realize a leaky wave antenna by covering the slot with a dielectric lens in order to provide the denser medium were the energy must leaks, while narrowing the conical beamwidth in the transverse plane.

In this paper, we continue the investigation by analyzing the same slot when fed by means of an electromagnetic coupled microstrip line. When using multiple microstrip feed arrangement, the leaky wave antenna is presently being designed and breadboarded at TNO-Fel for a multifrequency application in the millimeter wave range.

The problem is approached by first formulating an electric field integral equation on the microstrip domain. Inside the integral kernel we use the slot's Green's Function (GF) derived in [A. Neto, S. Maci, IEEE Trans. on Antennas Propagat, Vol. 51, No. 6, 2003] and extended to the present case to include the effect of the microstrip substrate. The integral equation is next solved by a method of moments (MoM). In this solution, a problem matched entire domain basis function is defined to represents the fringe (*i.e.*, non-modal) microstrip currents in vicinity of the microstrip-slot transition. This latter is obtained on the basis of the canonical microstrip GF problem. To this end, a minor modification of the GF formulation presented in [C. Di Nallo, F. Mesa, D. R. Jackson, IEEE Trans. on MTT, Vol. 46, no.8, pp 1062-1071, August 1998] has been applied.

The use of the slot GF in the integral equation kernel, accompanied by the microstrip-GF-based basis function for the MoM solution, leads to a quasi-analytical formulation, elegant, rich of physical insight, and accurate in a reasonable range of slot and microstrip widths. This accuracy has been successfully validated by a conventional full-wave analysis applied to a slot very long in terms of a wavelength.