Cylindrical Leaky-Wave Antenna Using a Metallic Strip Grating as a Superstrate

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In this paper, the radiation characteristics of a cylindrical leaky-wave antenna (CLWA) excited by a line source are investigated and compared to a planar leaky-wave antenna (PLWA). The planar structure is basically a grounded dielectric slab loaded with a metallic strip grating (MSG). The height of the dielectric slab is h, its relative permittivity is ϵ_r, the strip width of the MSG is w, and the distance between two adjacent strips is p. The cylindrical structure consists of a perfectly conducting circular core having radius a, surrounded by a dielectric layer whose thickness is h. The dielectric layer is, in turn, covered by an MSG having the same aforementioned parameters. An infinite line source, in parallel with the metallic strips is considered as the source, which is placed in the dielectric slab. Previously, it has been established that the planar configuration can produce highly directive beams when it is designed properly. Our goal is to develop a CLWA, or in general a conformal LWA, based on an MSG superstrate, which is analogous to an earlier work that used a high-permittivity dielectric superstrate (R. Paknys and D. R. Jackson, IEEE AP-S/URSI Intl. Symp., Albuquerque NM, 2006).

In the planar case, the phenomenology is described based on the multiple reflections between the PEC ground plane and MSG superstrate, or equivalently based on the wave leakage due to proper design values of propagation and attenuation constants. Either way, having proper values for h, ϵ_r, w and p, one can design a highly directive PLWA as addressed in the previous literature, for example, in (P. Burghignoli et al., *IEEE-TAP*, pp. 3873-3883, Dec. 2010).

In the cylindrical case, however, multiple reflections between the core PEC cylinder and MSG superstrate do not produce a coherent phase-front. Therefore, the curvature results in beam defocusing which in turn makes the CLWA less directive than its planar counterpart. It will be shown that the CLWA directivity is more affected by the radius a as compared to the bare metal cylinder. These results, which are obtained using the FEKO software package, indicate that curvature has a significant role in the defocusing. By varying p and w, one can control the propagation constant and attenuation rate of the leaky-wave, resulting in a phase compensation of the initial incoherent phase front. This fact suggests possibilities for novel design of CLWAs based on modulated MSG or metasurfaces that are being explored and will be presented.