

Stopband Investigation of Periodic Leaky-Wave Antenna based on Wide Microstrip Line with Dual Circular Apertures

Nanik Ram and David R. Jackson

Department of ECE, University of Houston, Houston, TX USA
(nram@uh.edu, djackson@uh.edu)

Periodic leaky-wave antennas (LWAs) are well known for producing a narrow beam with the potential to be used in millimeter-wave applications. However, periodic LWAs often suffer from the open stopband problem, which inhibits the ability to scan the beam through broadside. In this work, a periodic leaky-wave antenna based on a wide microstrip line with dual circular apertures (two circular apertures inside each unit cell) is proposed that can eliminate the stopband problem, enabling the LWA to scan from backward endfire to the forward endfire with minimum disruption in the pattern.

The proposed LWA has a very simple structure, producing a narrow beam with very low cross polarization. This LWA can be used for many practical applications as it can achieve a variety of attenuation constants by adjusting the slots sizes. Figure 1 shows the proposed LWA, consisting of a wide microstrip line with two circular apertures (slots) in each unit cell with a period of p . Each slot in a unit cell has an equal radius of a and the two slots are separated by distance l , which is taken to be $p/4 - \delta_s$. The open stopband suppression is achieved by adjusting the distance between two slots, i.e., by changing the value of δ_s .

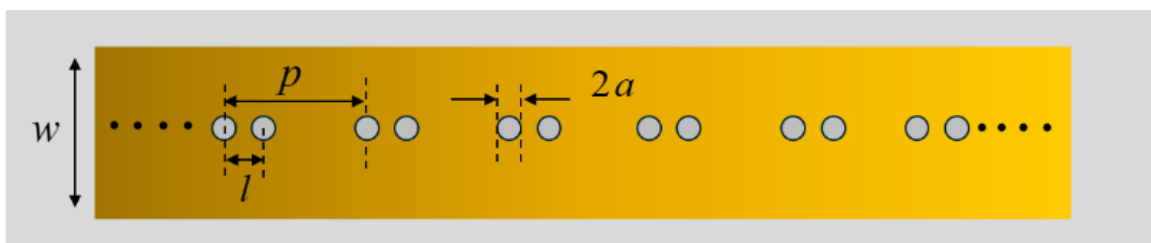


Fig 1. Proposed LWA consisting of a wide microstrip line with two circular slots in each unit cell.

For small slots of equal size, an approximate condition is derived for eliminating the stopband, namely $\tan(\delta_a) \approx X_s / (2Z_0)$, where $\delta_a = \beta\delta_s$, and (β, Z_0) are the phase constant and characteristic impedance of the microstrip line, and X_s is the series reactance of each slot.

Results show that the optimized LWA can almost completely eliminate the open stopband and also obtain radiation patterns with low crosspol. This stopband elimination technique works even for larger slots partially overlapping with each other. However, this approach is not completely successful when two very large slots almost merge into a single slot.

Results will be presented to show how the attenuation (leakage) constant of the LWA varies with the structural parameters such as the width of the microstrip line, the relative permittivity of the substrate, the substrate thickness, and the slot size. Results will also be presented to show the beam scanning properties and the low crosspol.