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Planar Helix in a Waveguide
(Miniaturization of microwave components)

Inspiration

Conventional 3-D helix — slow wave structure

The helical coil slows down the electromagnetic waves propagating along its axis because the current has to travel around the axis.

This is useful in Antennas and Traveling-Wave Tubes

Disadvantage: Bulky and impossible to fabricate as a planar circuit

SOLUTION:

THE PLANAR HELIX, produces the slowing effect but has a planar construction.

Design of the Planar Helix in a Waveguide

Equally spaced, symmetrically oriented (at angle, \( \alpha \))

Discrete conducting strips

Basic planar helix, consisting of conducting strips on both sides of a planar substrate

Characteristic equation

\[
\frac{\cot(k_y h/2)}{\cot(k_y (d - b)/2)} \left( k_x^2 - k_x^2 \right) \left( k_y^2 - k_y^2 \right) \beta^2 k_{x1} \beta^2 k_{x2} = 0
\]

Where \( k_{x1}, k_{x2}, k_y \) are eigenvalues; \( k_{x1}, k_{x2} \) are wave numbers in different media; \( \beta \) is the propagation constant

Dispersion characteristics

Slow-wave nature of the structure: Fig 1 and Fig 2 illustrate the slow-wave nature of the helix; the phase velocity \( \omega/\beta \) decreases for decreasing \( \alpha \).

Effect of dimension ‘a’: Fig 3 shows the effect of varying ‘a’ on cutoff frequency which reduces with increasing ‘a’. This means, one can transmit higher frequencies at smaller values of a.

Comparison with dielectric loaded waveguide

The dielectric waveguide of same dimensions shows a cutoff 5 times larger, indicating that for the same frequency, the dielectric loaded waveguide is much larger. Thus excellent size reduction is achievable with the proposed structure.

Applications: The present structure has potential applications in radiating and guiding devices of several kinds. Example: Leaky wave antennas

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Project Title: Investigations on a novel microwave structure using MATLAB
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