

Coupling Screw Mode Polarizer Feed for Dual-Polarized Horn Antennas

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Waveguide-fed horn antennas are a popular choice for communications and sensing systems, as they can provide a relatively directive beam over a broad bandwidth in a single element. The waveguide feed is commonly excited by a coaxial probe that excites the first dominant mode in the waveguide and radiates a linearly polarized wave. In a traditional horn, the waveguide feed needs two orthogonal coaxial probes for dual-linear or circular polarization. The second coaxial probe in a traditional dual-polarized horn requires additional parts to be manufactured, manifolds to split power from the source to the two separate coaxial probes, and the space to implement them orthogonal to each other on the square waveguide. These problems multiply when using dual-polarized horns in an array. Many waveguide mode polarizers such as septum polarizers, iris and pin-loaded polarizers, ridge polarizers, and substrate-loaded waveguide polarizers have been proposed to eliminate the need for the second coaxial feed. However, these methods are often complex and present manufacturing difficulties.

This work proposes a novel feed network for a dual-polarized horn antenna based on the theory of modal coupling prevalent in cavity resonator filters. The horn feed consists of a single coaxial probe excitation in a square waveguide with a modal coupling screw implemented at a 45-degree angle to the electric field component of the dominant mode excited by the coaxial probe. The modal coupling facilitates dual-polarized propagation from the horn antenna using only one coaxial probe excitation. The reduction in coaxial probes is ideal for size, weight, power, and cost optimized radiating structures where dual-polarization is required. The proposed mode polarization method is confined to the waveguide and eliminates the need for an additional coaxial feed, reducing cost and improving ease of manufacturing.

The proposed feed operates by coupling the orthonormal modes that exist in a square or circular waveguide at the same natural frequencies using modal coupling screws. These two degenerate modes will not propagate concurrently in the cavity without perturbation. The modal coupling screw introduces a perturbation that allows the two modes to couple and propagate simultaneously. This work presents the design, optimization, fabrication, and testing of this structure. The measured results of the antenna, fabricated using additive manufacturing and electroplating, are shown.