5:1 Bandwidth, Dual-Polarized Dielectric Rod Antenna Using a Novel Feed Structure

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Dielectric rod antennas (DRAs) can achieve high gain over a wide frequency range, while having a relatively small form factor. Due to these qualities, they have been widely used as reflector feeds and in ground penetrating radar transceiver front ends. In fact, it is relatively straightforward to design the rod shape to realize the desired radiation pattern, as well as impedance performance by optimizing the rod geometry. Circular cross-section rods can be milled very easily and several tapers regions can independently design for best pattern and best impedance performance. Moreover, circular symmetry also provides polarization purity, another attractive feature for dual-polarized applications, such as radars and near-field scanning probes. In addition, the isolation between adjacent elements can also be minimized, making them ideal for array applications, particularly in millimeter-wave bands. However, DRA bandwidth typically suffers due to feeding structure at the lower frequencies and due to the onset of higher-order modes within the rod at the high end of the frequency range. Although multi-layered DRA designs can increase the frequency coverage, the complexity of manufacturing such antennas is not desirable.

In this paper, a novel ultra-wideband, single-material dielectric rod antenna using a novel V-shaped transverse electromagnetic (TEM) waveguide feeding structure is presented. A simple rod design machined entirely from bulk Rexolite_1422 material achieves 5:1 bandwidth (6-32GHz) and a tapered dual twin-lead structure integrated on the feed taper of the dielectric rod enables a TEM launcher, avoiding the waveguide cutoff at the low end of the frequency band. The new feed supports dual-polarizations, simultaneously. The dielectric rod is 2.5λ in length and 1λ thick at the widest diameter at 6GHz. It exhibits a stable phase center, a symmetric pattern and a high realized gain (>10dB) over the entire design bandwidth, with side lobe levels (SLL) <-15dB.