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Research Article

Fractal Slotted Leaky-Wave Antenna Based on SIW and Balanced CRLH Transmission Line with Enhanced Backward Bandwidth Scanning and Gain in X-Band

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Abstract

A first-order Vicsek box fractal-shaped slotted leaky-wave antenna based on a balanced composite right/left-handed transmission line (Balanced CRLH-TL) is presented to improve frequency bandwidth and achieve high constant gain. The proposed antenna consists of an array of "substrate-integrated waveguide" (SIW) unit cells, configured by a first-order Vicsek box fractal slot etched on the top layer of the SIW, and two patches embedded beneath the Vicsek box fractal slots. The CRLH cells used in this antenna are balanced, which allows for frequency scanning from backward to forward directions without a cut-off band in the broadside direction. The proposed antenna improves the backward scanning bandwidth compared to conventional planar SIW leaky-wave antennas. Additionally, a measured beam radiation range of -79 to 81 degrees has been achieved over the frequency range of 7.3 GHz to 13 GHz, with a constant gain greater than 12 dB across the entire X-band frequency range.

Keywords: Leaky-wave antenna, Beam scanning, Antenna gain, Composite Right/Left-Handed Transmission Line (CRLH), Slotted waveguide, Substrate-Integrated Waveguide (SIW).

Highlights

- Using Fractal Structure to Enhance Bandwidth and Achieve Broader Frequency Coverage.
- Antenna Design Based on balanced CRLH-TL for Cutoff-Free Broadside Scanning.
- Maintaining a Constant Gain Across the Entire Frequency Band.
- Improvement of Backward Scanning Bandwidth.

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