A High Gain Filtering Horn Antenna with Flexible Polarization Direction

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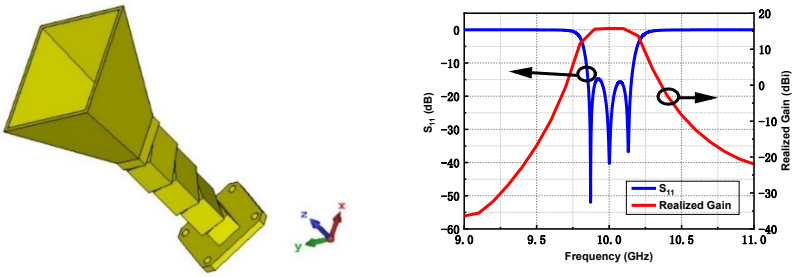
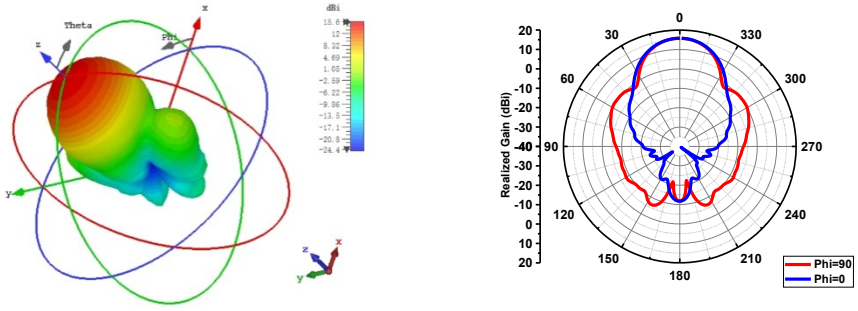
The escalating evolution of contemporary wireless communication technology has engendered a growing need for compact, intricately integrated, and versatile wireless communication devices. In addressing this imperative, the concept of filtering antennas has emerged, combining filtering components with antenna structures to simultaneously achieve filtering and radiation functionalities. Over the past decade, various types of filtering antennas have been proposed, encompassing microstrip antennas, dielectric resonator antennas, dipole antennas, and substrate-integrated waveguide (SIW) antennas. [1]-[3], Nevertheless, these antennas exhibit limited gain, and furthermore, there is a shortage of examples involving horn antennas with filter responses. To enhanced the flexibility of polarization direction, a twisted filtering structure has been integrated into this design.

Fig. 1(a) delineates the configuration of the designed filtering horn antenna. The filtering antenna comprises an input waveguide, three rectangular resonators, intercoupling irises, segments of transition waveguides, and the horn antenna. Polarization rotation is accomplished by gradually rotating three rectangular resonators around a symmetrical axis, with a constant angular interval Δα of 11.25 degrees. The third-order Chebyshev filtering characteristics are achieved using the coupling-matrix-based filter design methodology detailly outlined in [4]. The filtering response features a passband centre frequency (f_o) of 10 GHz, an absolute bandwidth of 300 MHz, and a passband return loss (RL) of 15 dB. The associated normalized coupling matrix entries are represented by $M_{S1} = M_{3L} = 0.945$, $M_{12} = M_{23} = 0.8799$, and the external quality factor (Q_e) is specified as 37.3. Fig. 1(b) depicts the simulated S-parameter response and the filter-like realized gain of the filtering horn antenna. Fig. 2(a) illustrates the simulated three-dimensional total realized gain patterns as well as the corresponding realized gain patterns at the Phi=0 and Phi=90{see Fig. 2(b)}.



(a) (b)

Fig. 1: (a) Configuration of filtering horn antenna (b) Its simulated performance.



(a) (b)

Fig. 2: (a)Simulated 3D total realized gain patterns (b) realized gain patterns of designed prototype at Phi=0 and Phi= 90 plane.

This paper introduces a monolithic high-gain filtering horn antenna with enhanced polarization rotation flexibility. The device integrates radiation, filtering functionality, and flexible polarization direction. For demonstration purposes, an antenna prototype is designed and simulated. The results of the simulation indicate a fractional bandwidth of 3%, spanning from 9.85 to 10.15 GHz, and a notable high gain of 15.75 dBi. The fabrication of this filtering horn antenna is well-suited for emerging 3D printing technology processes, enabling efficient production as a monobloc device.

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