Analysis, Design, and Measurement of Continuous Frequency-Scanning Polarization-Rotating Antenna

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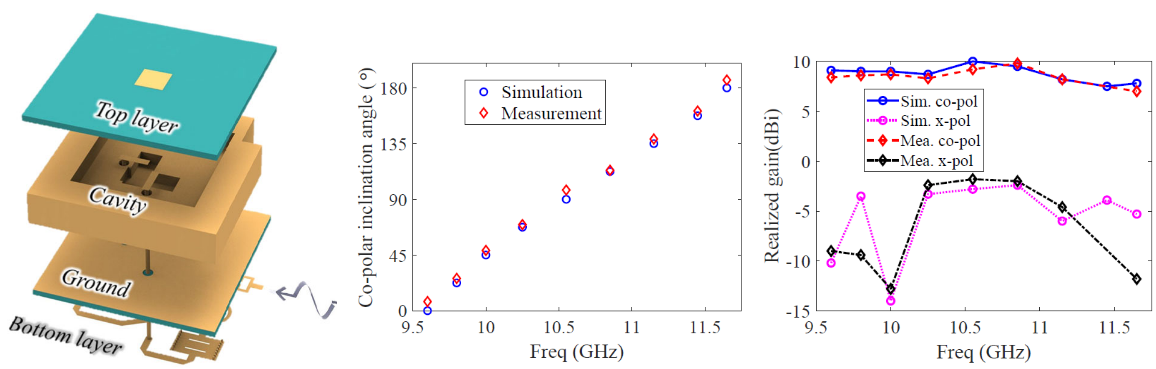
Polarization reconfigurable antennas are useful in certain wireless systems to adapt to different incident polarizations or in measurement systems [1] – [3]. In this work, we develop an innovative and simple frequency-controlled polarization rotating antenna. The antenna provides continuous adjustment of the orientation of linear polarization (LP) over a range of 180°, making it suitable for applications such as identifying objects with diverse orientations in sensing and detection systems. We introduce a general model of a LP antenna in which the orientation of polarization can be controlled with an adjustable phase shift. By substituting the phase shift in the model by one that is frequency dependent, a 180° LP rotation can be attained by sweeping the source frequency across a custom-designed bandwidth. This allows implementation of an antenna system that can continuously adjust the orientation of LP in response to frequency scanning over a wide operating bandwidth. As demonstrated in a prototype, a 180° polarization scan with a realized gain varying between 7.0 and 9.8 dBi is achieved by sweeping the frequency from 9.6 to 11.65 GHz. The continuously frequency-scanning polarization rotation behaviour offers a novel and efficient solution for polarization reconfiguration.



(a) (b) (c)

Fig. 1. (a) Antenna configuration. (b) Co-pol linear polarization inclination angle. (c) Realized gains.

Fig. 1(a) shows the exploded view of the obtained frequency-controlled polarization-rotating antenna. The dual-port dual-polarization radiator is a cavity-backed proximity-coupled patch antenna, which is evolved from our previous design reported in [4]. Fig. 1 (b) shows the simulated and measured co-pol LP inclination angle as a function of the source frequency. Theoretically, the inclination angle can vary continuously from ϕ = 0° to 180° by sweeping the frequency from 9.6 to 11.65 GHz. To display the data from both simulation and measurement, we discretise the co-pol angle from ϕ = 0° to 180° with a step of 22.5°. As a result, we obtain nine corresponding operating frequencies {9.6, 9.8, 10, 10.25, 10.55, 10.85, 11.15, 11.45, 11.65} GHz, as shown in Fig. 1(b). One observes a slight deviation of the inclination angle between the simulation and measurement. This may be due to potential mounting alignment inaccuracy during the measurement and antenna fabrication tolerance. Fig. 1(c) shows the co-pol and cross-pol realized gains as functions of the source frequency. The simulated realized gain varies from 7.8 to 10.0 dBi, and the measured one ranges from 7.0 to 9.8 dBi. The measured results agree reasonably with the simulated ones.

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