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Two-bit dual-polarized reconfigurable intelligent surface with low power consumption for 6G near-field communication

Key words: Reconfigurable intelligent surface (RIS); Dual polarization; Near-field communication; 6G communication

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Motivation

- The hardware of reconfigurable intelligent surface (RIS) is applicable for both near-field and far-field communications. However, the array scale of RIS is much larger in near-field communication to expand the near-field coverage region, and the cost and power consumption of RIS are crucial factors that determine the massive application in the future 6G near-field communication.

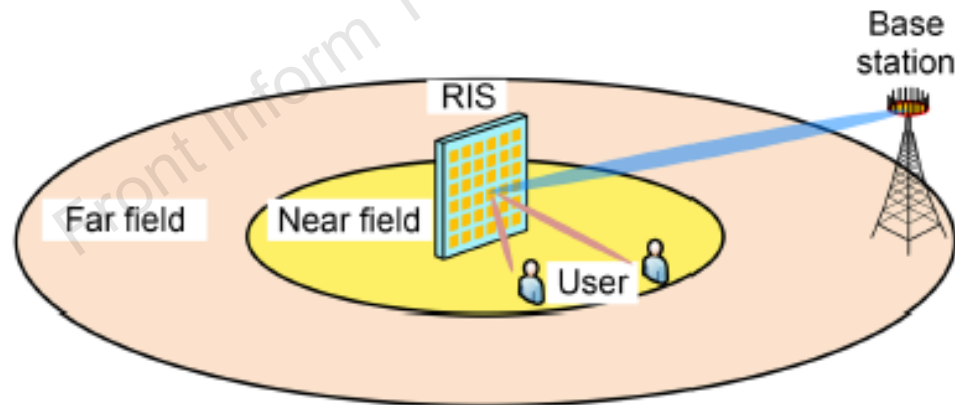


Fig. 1 Typical reconfigurable intelligent surface (RIS) aided scenario for near-field and far-field hybrid communication

Main idea

- In this paper, a novel 2-bit dual-polarized RIS operating at 3.6 GHz band is presented which has low power consumption. Instead of using the p-i-n diodes, a single-pole-four-throw (SP4T) switch is adopted to build the 2-bit phase shifter. The complementary metal oxide semiconductor (CMOS) fabrication process makes the switch have very low biasing current.
- Dual polarization is generated by placing two orthogonal slots with two 2-bit phase shifters. The total power consumption of the 15×15 RIS is about 100 mW. To the best of authors' knowledge, it is the first dual-polarized RIS that uses merely one tunable component to achieve 2-bit phase shift.

Method

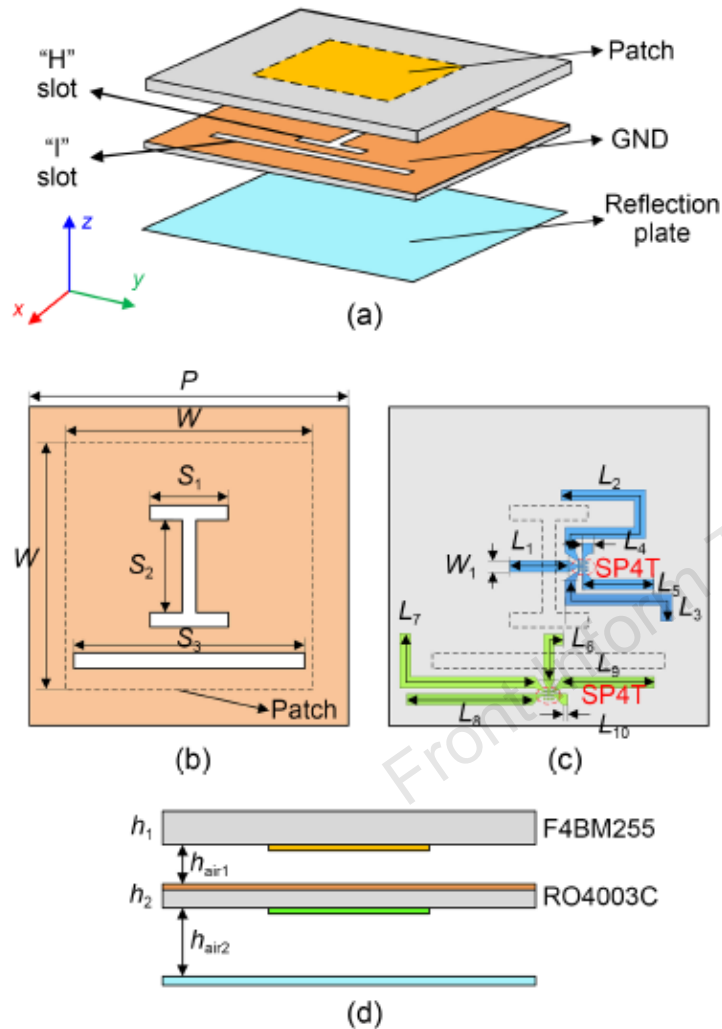


Fig. 2 Structure of the proposed 2-bit dual-polarized element: (a) 3D exploded view; (b) ground (GND) layer; (c) transmission line layer; (d) side view of the element

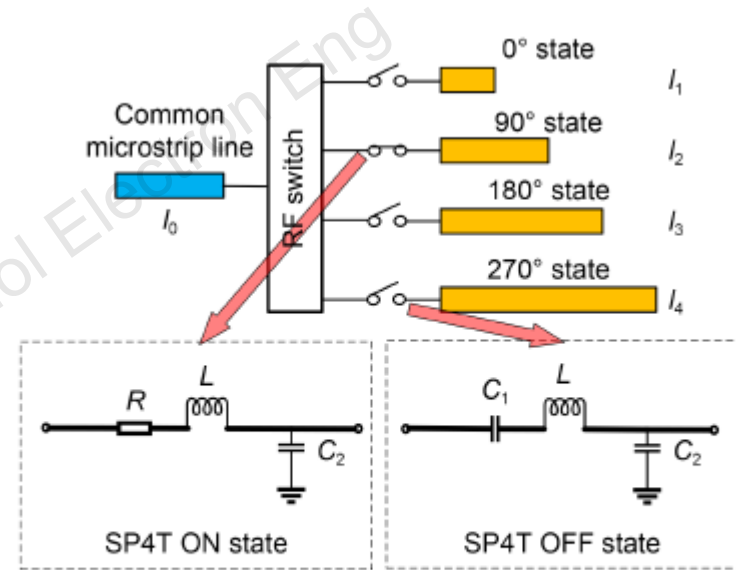


Fig. 3 Equivalent circuit of the single-pole-four-throw (SP4T) switch

Method

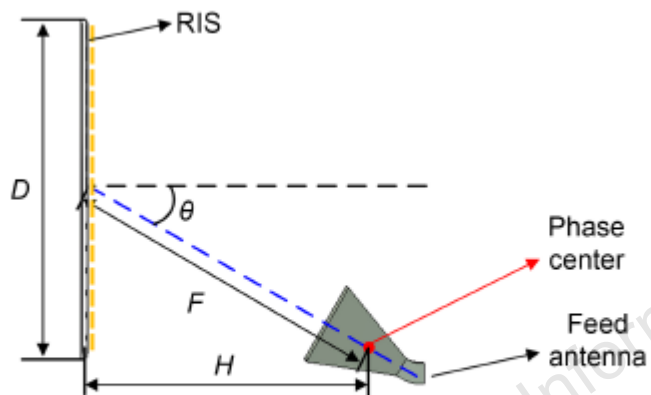


Fig. 17 Simulation model of the 15×15 RIS fed by a horn antenna

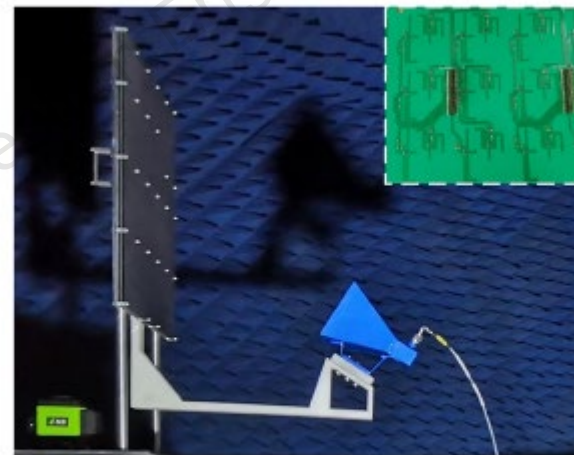


Fig. 20 Photograph of the fabricated RIS prototype in the far-field anechoic chamber

Results

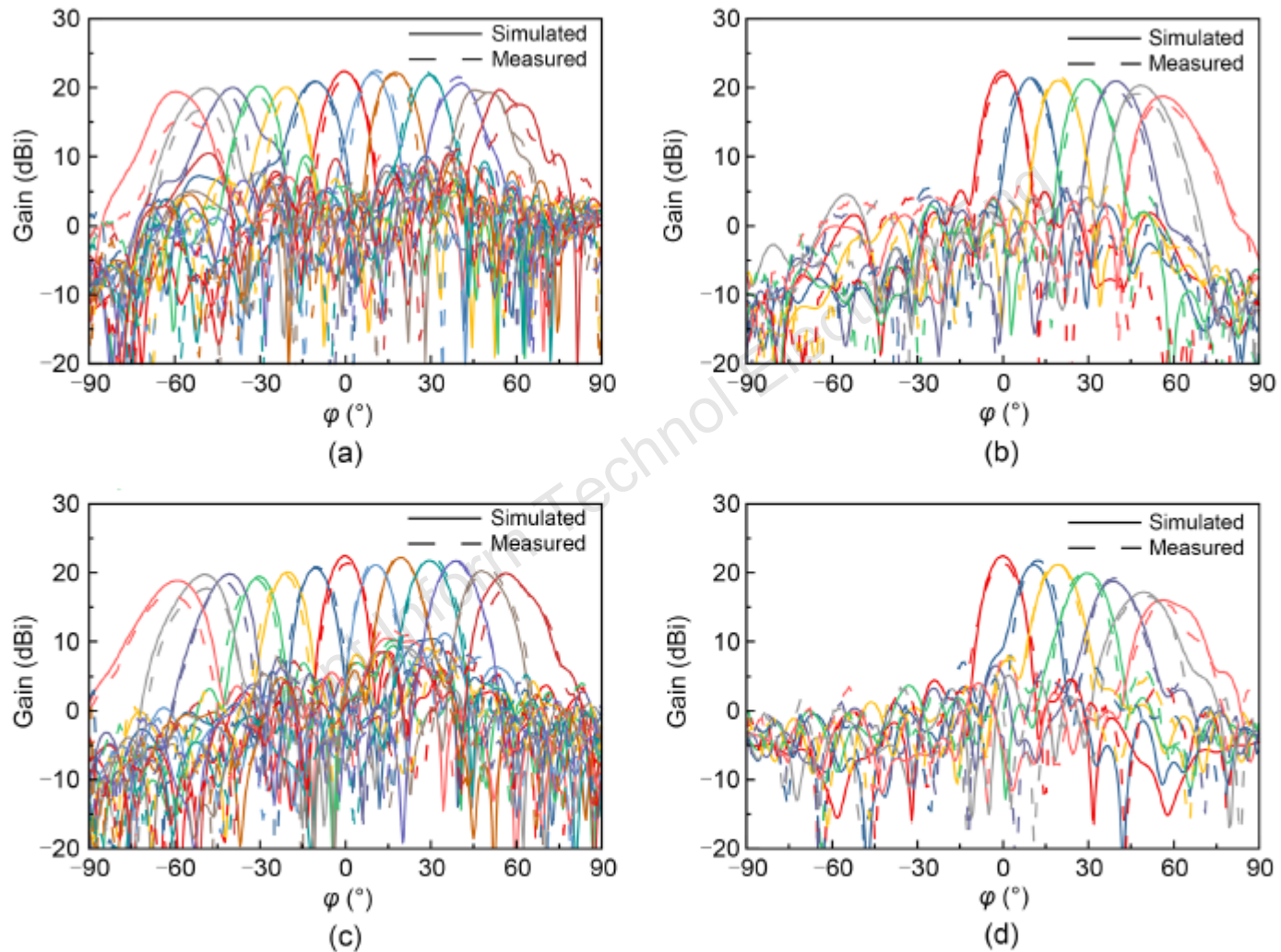


Fig. 21 Simulated and measured radiation patterns of the 2-bit dual-polarized RIS with vertical polarization in the xoz plane (a), vertical polarization in the yoz plane (b), horizontal polarization in the xoz plane (c), and horizontal polarization in the yoz plane (d)

Conclusions

In this article, a 2-bit dual-polarized electronically beam scanning RIS is proposed for 6G near field applications. The element is based on a dual-polarized slot-coupled patch antenna. Each polarization needs only one SP4T switch to generate 2-bit phase quantization. The two orthogonal polarizations are capable of being controlled independently. A 225-element RIS is fabricated and measured. The measured peak aperture efficiencies for the two polarizations are 40.1% and 38.3%, separately.



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