D-band 360° Phase Shifter in 65-nm CMOS technology

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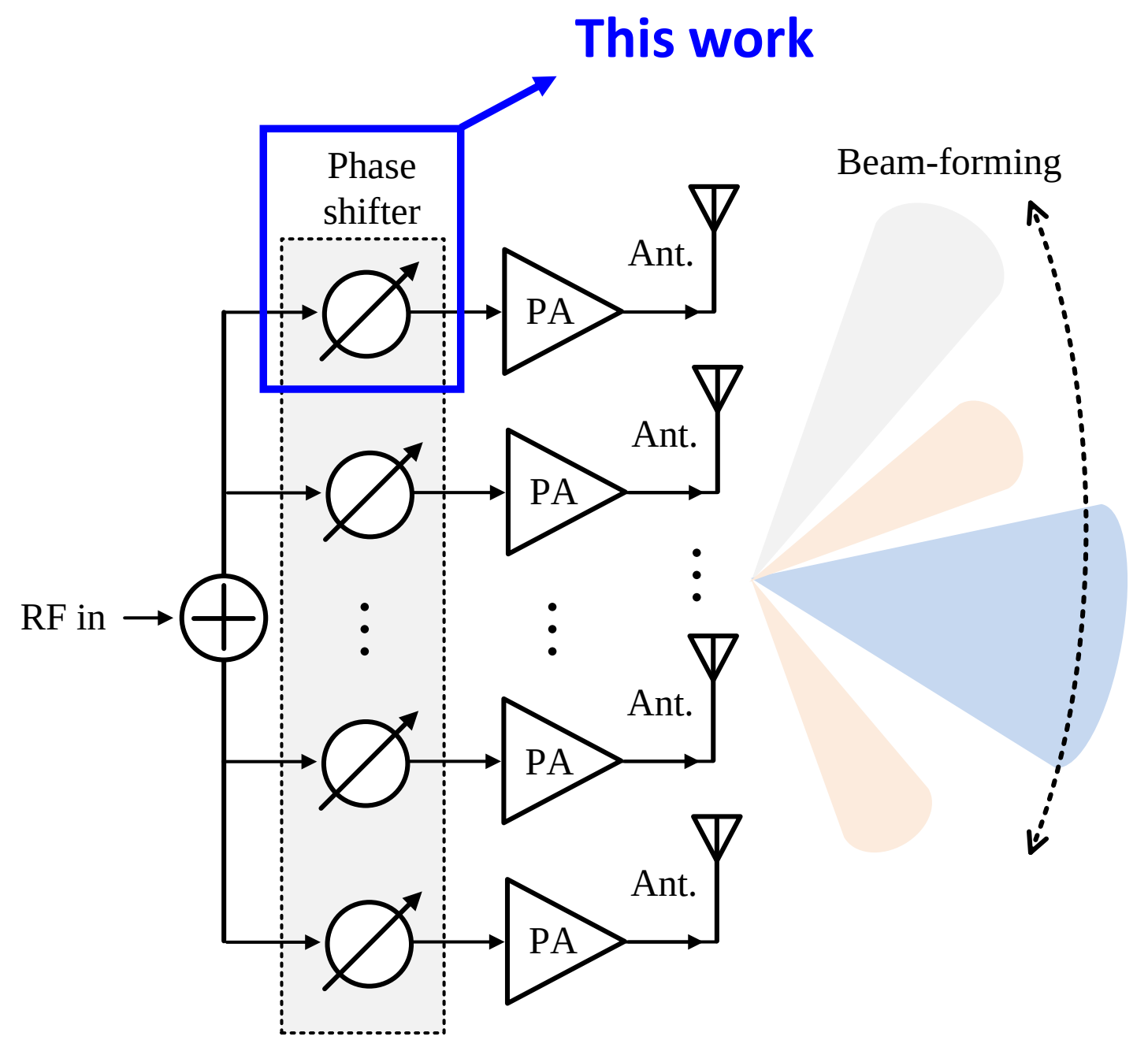
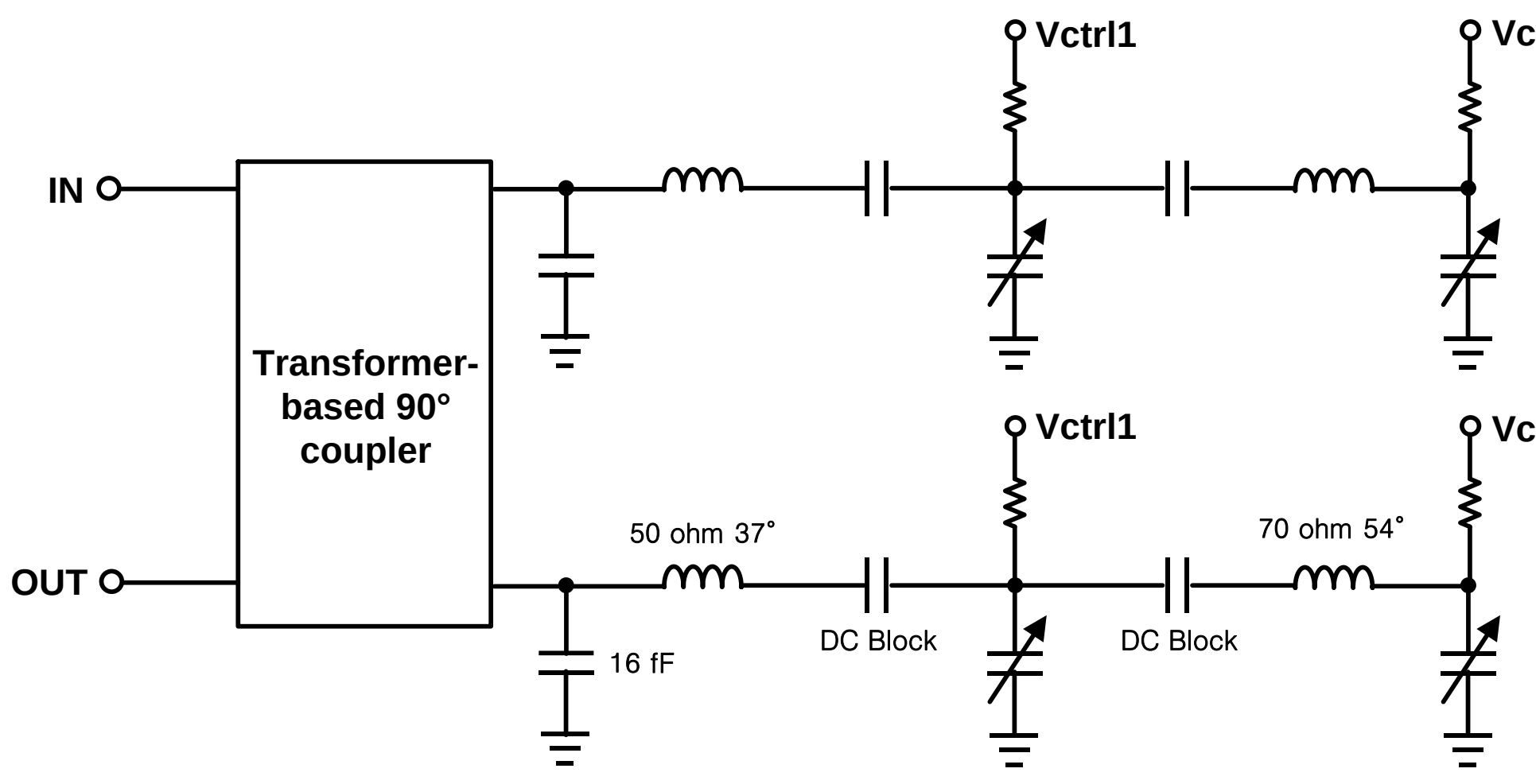
Introduction

- The sub terahertz band including the D-band (110-170 GHz) is expected to be used for high-speed wireless communication and various applications.
- A Phased array is widely adopted as one of the solutions to overcome the high channel loss and tight link budget of high frequencies.
- A phase shifter is an essential circuit block that controls the phase of each channel of the phased-array system.
- This paper presents a D-band 360° phase shifter.

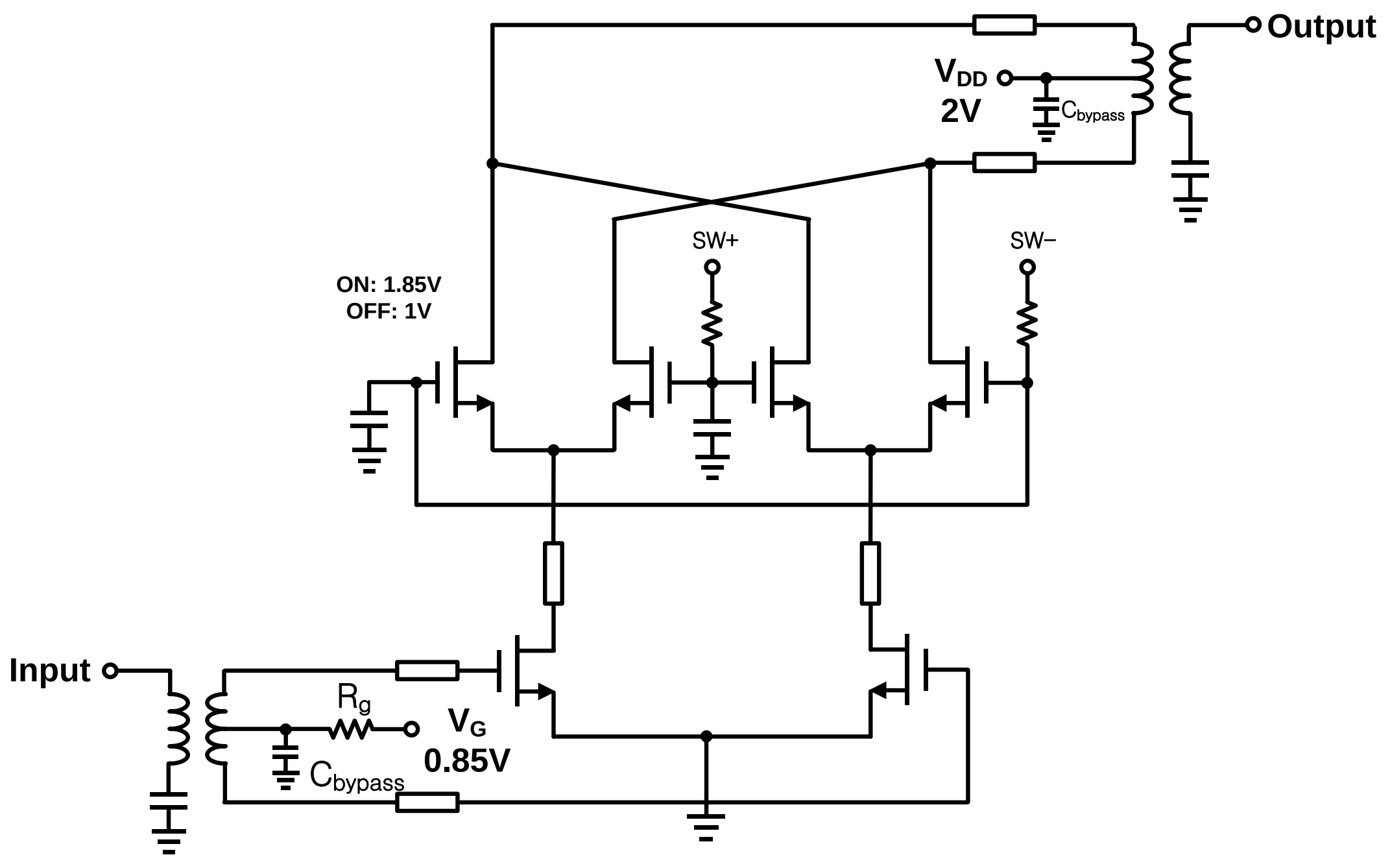


Design

- 360° phase shifter consists of a 180° reflection-type phase shifter(RTPS) and 180° phase inverter(PI).
- The RTPS consists of a transformer-based 90° hybrid coupler and π-type (varactor-inductor-varactor) reflective load.
- An inductor and a capacitor are used for impedance matching between the coupler and reflective load.
- The phase inverter for 0°/180° phase switching is implemented using a Gilbert cell structure.
- To improve the gain, a transmission line is added between the CS and CG stage of the Gilbert cell.
- The chip area is 0.64 x 0.57 mm^2 including all probing pads.
- The dc power consumption is 12mW.



< Schematic of 180° RTPS >



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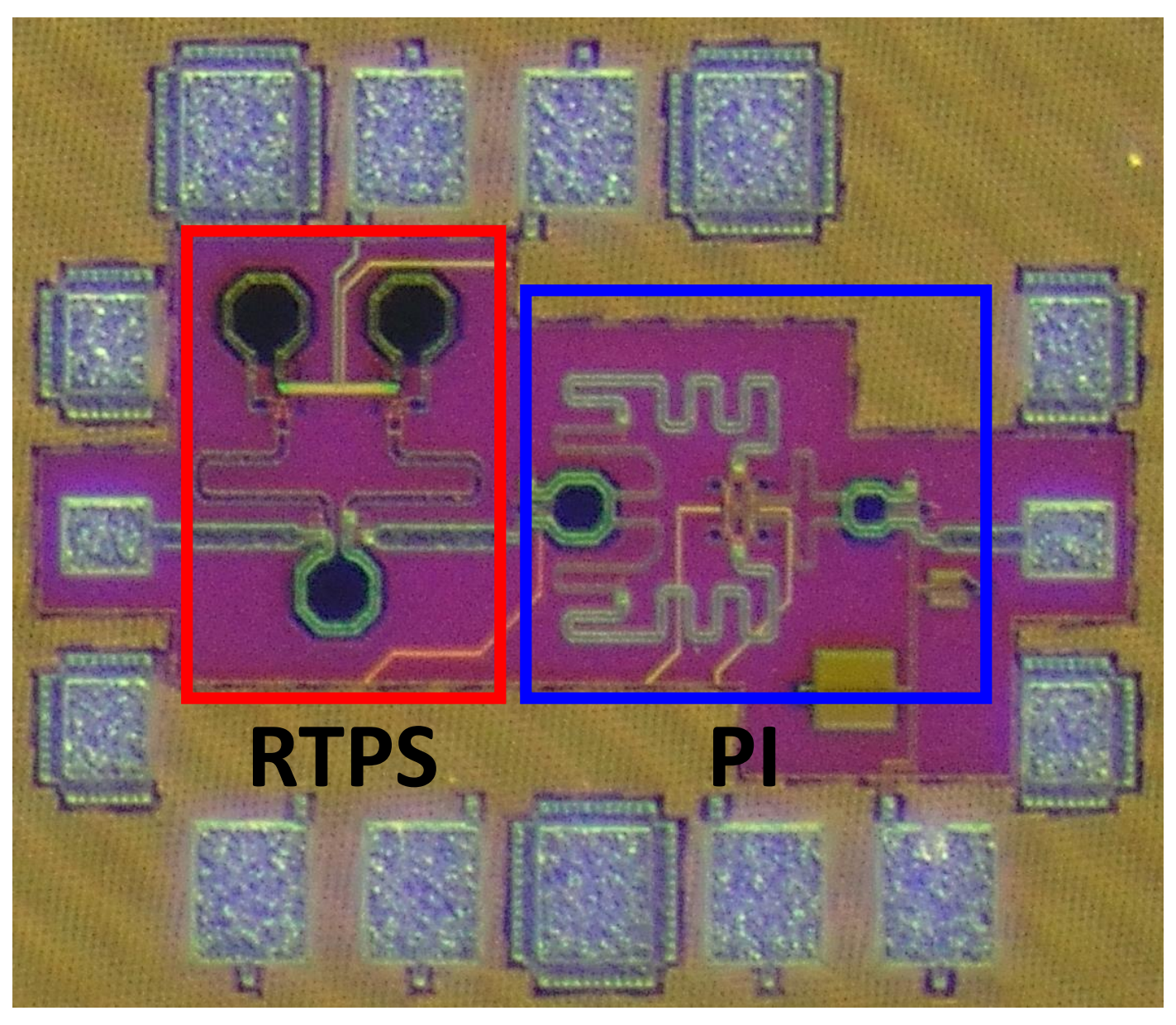
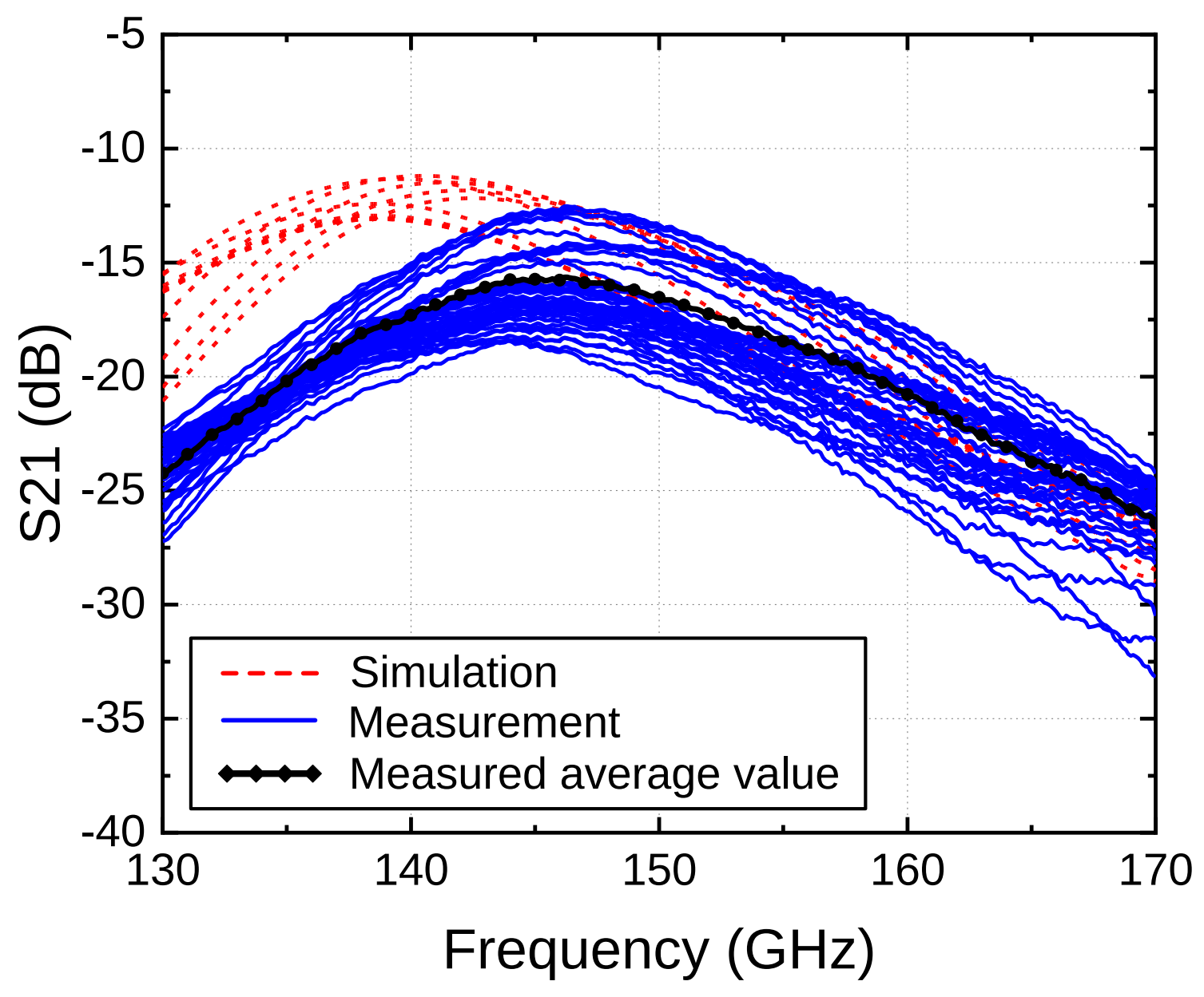
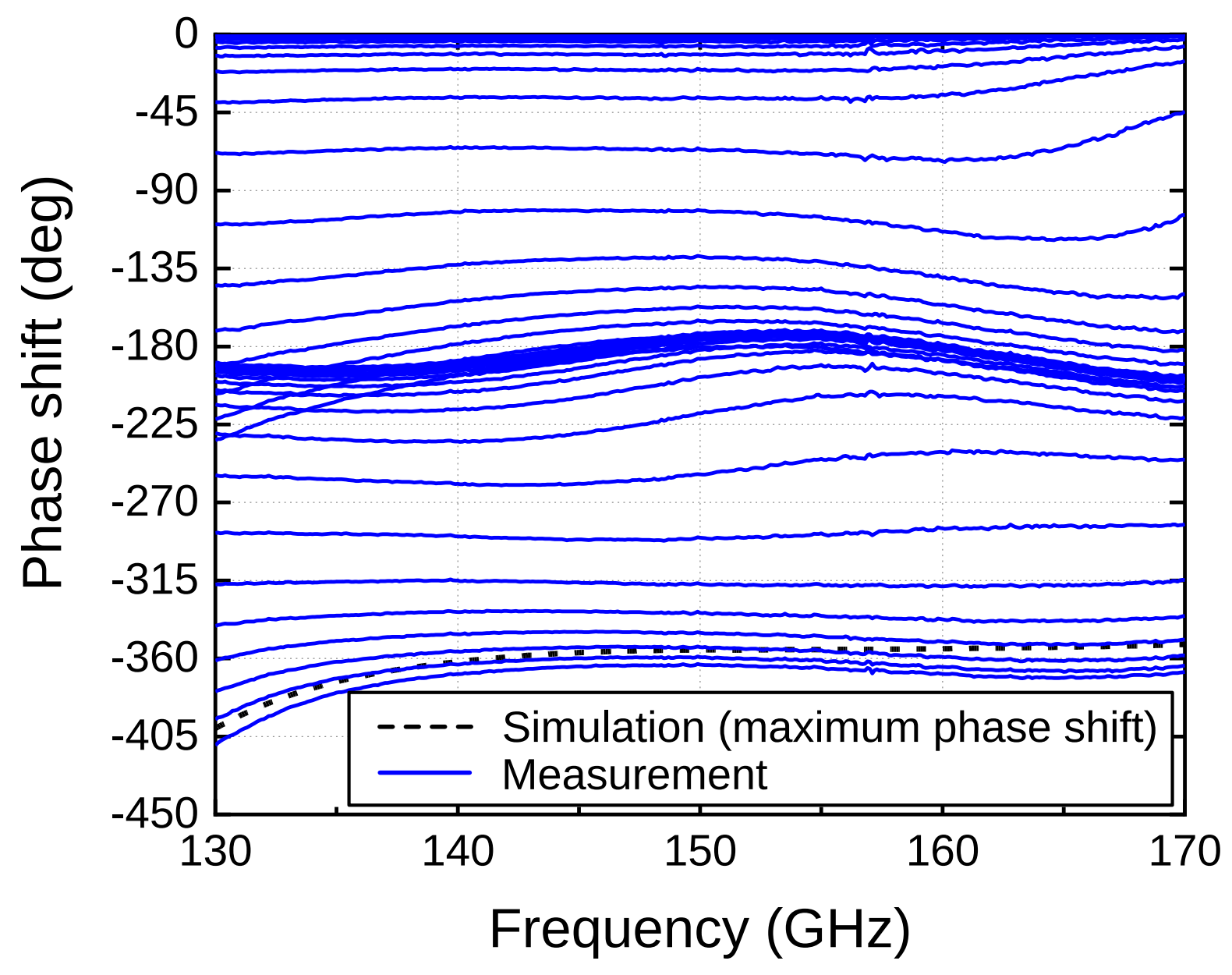
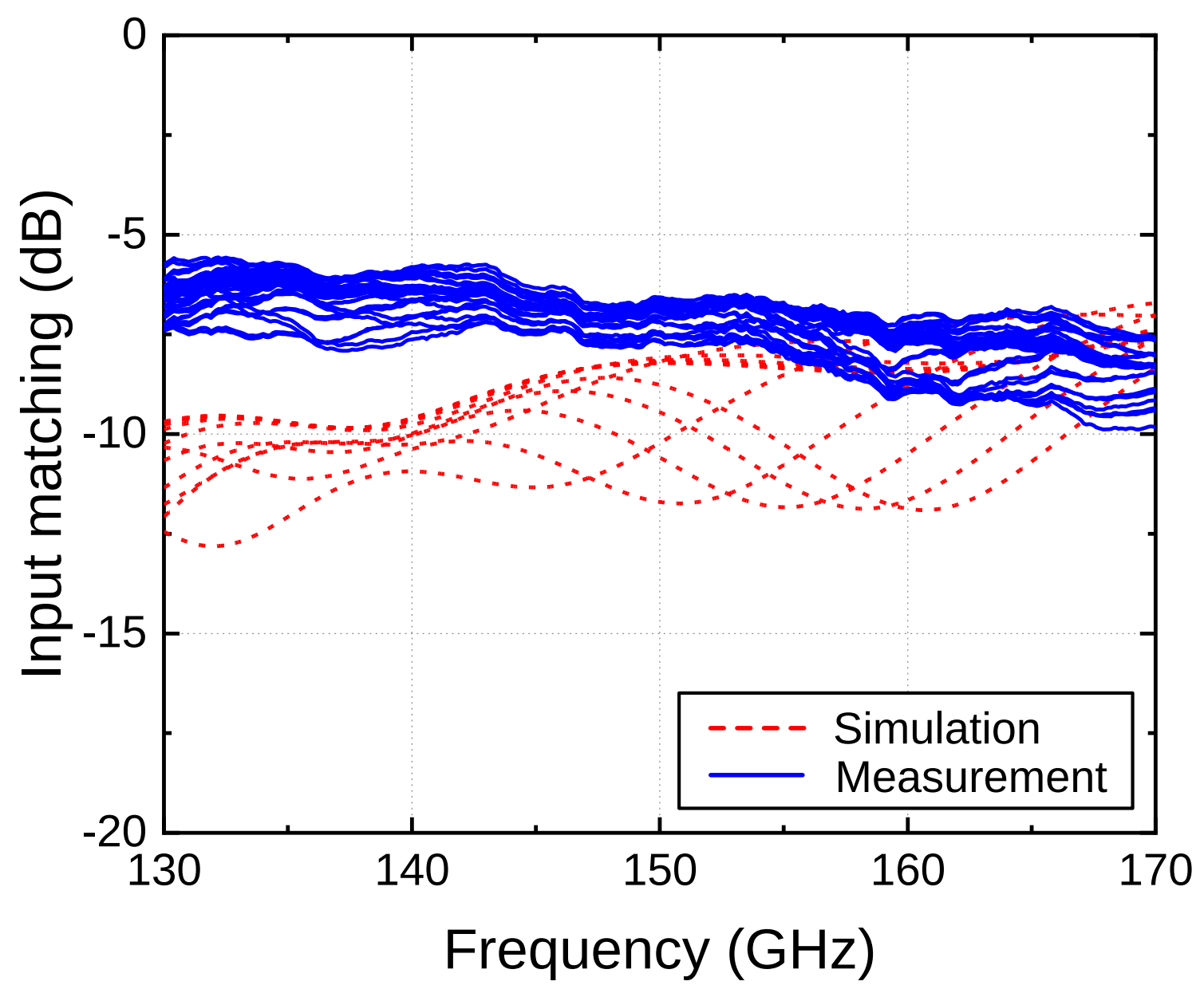


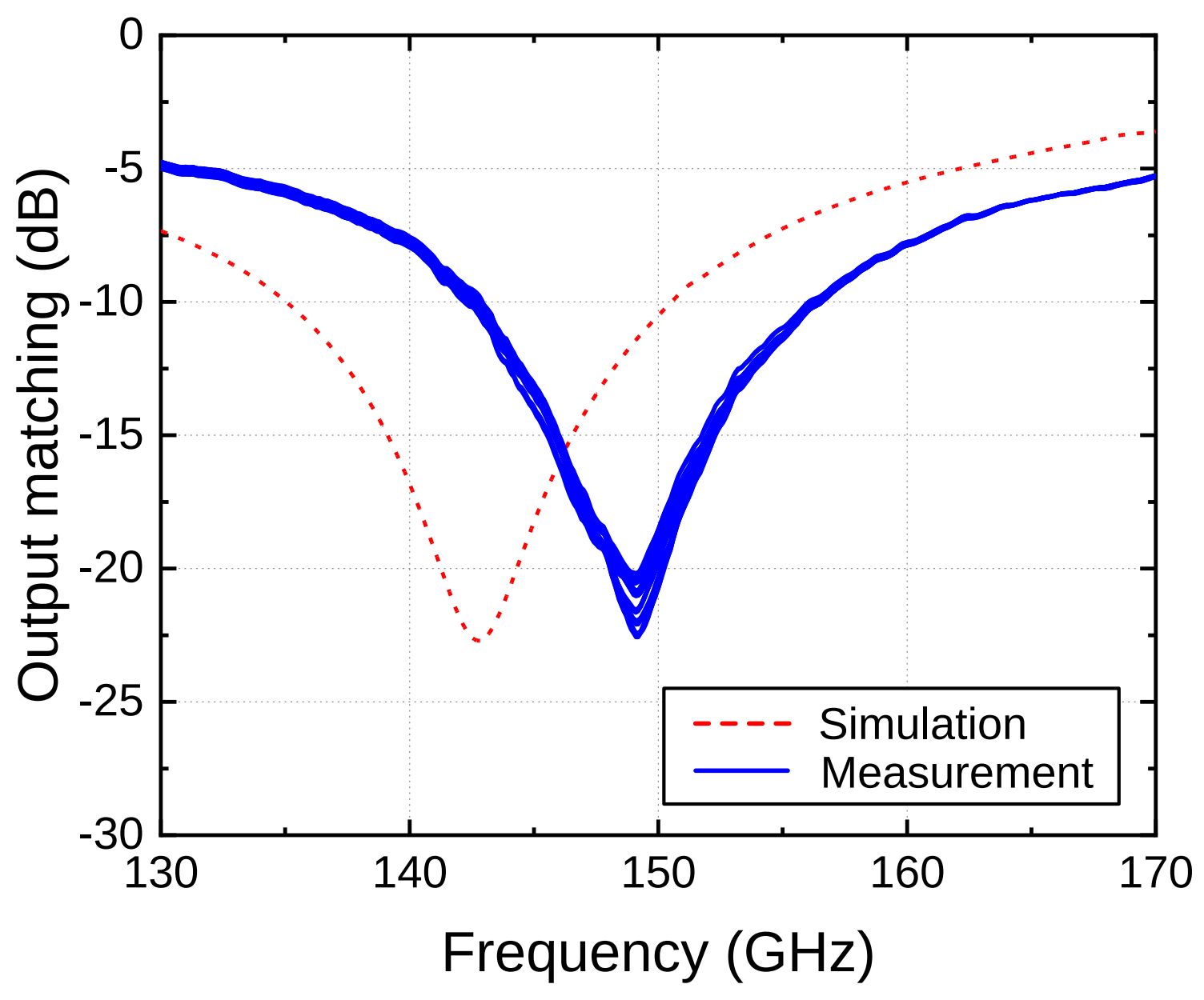
< Chip photograph >

Measurement Results









- The D-band phase shifter is fabricated in 65-nm CMOS technology.
- The phase shifter has a peak gain of -12.5 dB at 146.3 GHz and a 3-dB bandwidth of 18.4 GHz.
- The relative phase shift referenced to the lowest control voltage achieves a 360°.
- The input and output ports are well matched over the operating frequency.

Conclusion

- This paper presents a D-band 360° phase shifter in a 65-nm CMOS technology.
- The phase shifter provides a continuous 360° phase shift with a peak gain of -12.5 dB at 146.3 GHz.

The chip was fabricated using the TSMC 65-nm CMOS process supported by the IC Design Education Center(IDEC), Korea.