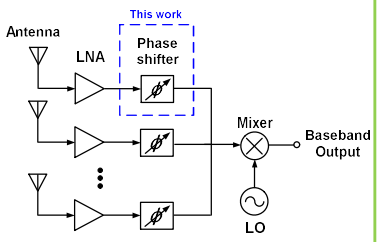
A 265–320 GHz 180° Reflection-type Phase Shifter in 250-nm InP DHBT

Eunjung Kim and Sanggeun Jeon
School of Electrical Engineering, Korea University

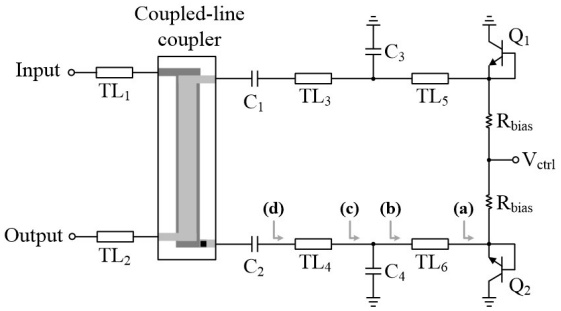
Introduction

- The wide bandwidth of the terahertz band (0.3 – 3 THz) is drawing attention to the use of high-speed wireless data links and post-5G wireless communications.
- As one of the solutions to overcome the high channel loss and tight link budget of high frequencies, a phased array is widely adopted.
- A phase shifter is a core circuit block that controls the phase of each channel of the phased-array system.
- This paper presents a compact and wideband reflection-type phase shifter (RTPS) covering the upper WR-3.4 (220-320 GHz) band.

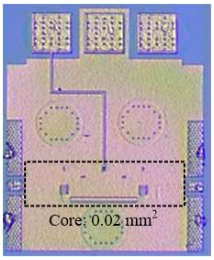


Design

- RTPS consists of a 90° hybrid coupler and two identical reflective loads.
- The 90° hybrid coupler for combining reflected signal is implemented using a coupled-line coupler which is broadside-coupled two metal layers.
- The C-L-C π-type reflective load is implemented using a diode-connected varactor, an inductor, and a shunt capacitor.
- The simulated varactor capacitance varies from 8.2 to 132 fF with a Q-factor ranging from 1 to 14.4 at 280 GHz.
- The transmission line (TL5 and TL6) is used for resonating the varactor and therefore enhancing the phase control range.
- To further enhance the phase control range, shunt capacitor (C3 and C4) is used.
- The chip area is 0.37 x 0.46 mm^2 including all probing pads.



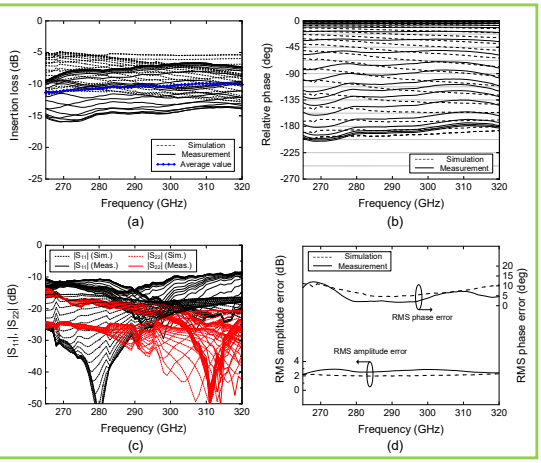
< Schematic of proposed RTPS >



< Chip micrograph>

Results

- The WR-3.4 phase shifter is fabricated in a 250-nm InP DHBT technology.
- Fig (a) presents the simulated and measured insertion loss. The phase shifter has an average loss between 9.9 dB and 11.3 dB from 265 to 320 GHz versus V_{ctrl}.
- The measured and simulated relative phase shift with 22 phase states is shown in Fig (b). The relative phase shift referenced to the lowest control voltage achieve 180° shift from 265 to 320 GHz.
- The input and output port matching performance are shown in Fig (c). The input and output ports are well matched over the operating frequency.
- Fig (d) shows the root-mean-square (RMS) amplitude and phase errors of the RTPS. Over all sweep values of the control voltage, the RMS errors maintain below 3.1 dB and 12° from 265 to 320 GHz.



Conclusion

- This paper presents a WR-3.4 reflection-type phase shifter (RTPS) in a 250-nm InP DHBT technology.
- The RTPS provides a continuous 180° phase shift with an average insertion loss over different phase states of 9.9-11.3 dB, from 265 GHz to 320 GHz.

The chip was fabricated using the Teledyne 250-nm InP DHBT process supported by the IC Design Education Center(IDEC), Korea.