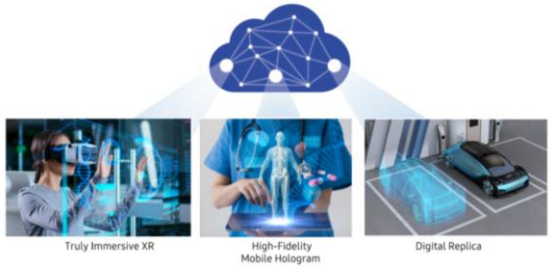
A W-Band Phase-Shifter-Embedded PA in 40-nm CMOS for 6G Applications

Chun Wang, Pin-Chun Chiu, and Chun-Hsing Li

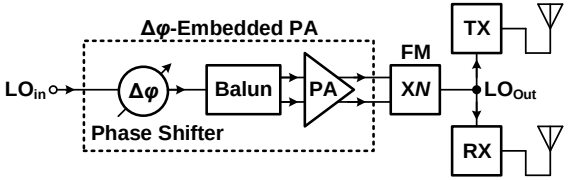
6G Wireless Communication System



6G White Paper, Samsung 2020

- ✓ THz band operation
- ✓ High data rates and wide bandwidth
- ✓ Extends the capabilities of 5G application
- ✓ High path loss at THz frequencies

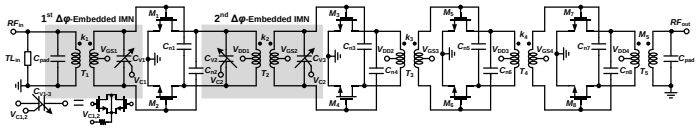
LO-Phase-Shifting Phased-Array Transceiver



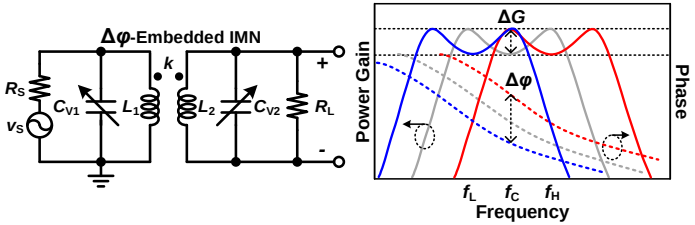
LO-phase-shifting phased-array transceiver with the proposed Δφ-embedded PA

- ✓ Without additional phase shifter design
  - ➢ Low cost since saving chip area
  - ➢ No additional insertion loss from phase shifter
  - ➢ Easy implementation for LO-phase-shifting generation in phased-array transceiver

W-Band Δφ-Embedded PA



W-Band Phase-Shifter-Embedded PA

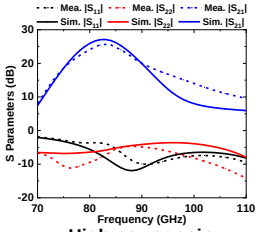


Multifunctional Δφ-Embedded IMN

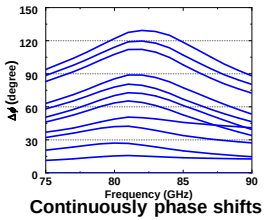
The W-Band phase-shifter-embedded PA is mainly composed of two parts:

- ✓ Multifunctional Δφ-embedded IMN
  - ➢ Single-ended to differential conversion
  - ➢ Impedance matching
  - ➢ Continuously phase-controlled phase shifts
  - ➢ High gain flatness
  - ➢ Compact layout and small chip area since using transformer
  - ➢ Provide dc feeding and ac-couple operation
- ✓ 1-way 4-stages differential CS amp. with C_{neu}
  - ➢ High power gain
  - ➢ High stability

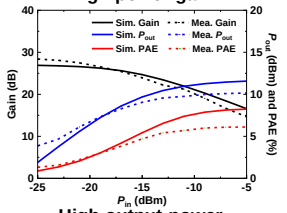
Experimental Results



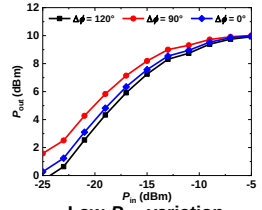
High power gain



Continuously phase shifts



High output power



Low-P_{sat} variation

Conclusion

Phase-Shifter-Embedded PA featuring:

- ✓ Full 360° continuously phase-shifting range with frequency multiplier design for sub-THz/THz system
- ✓ Low cost since using 40-nm digital CMOS technology without ultra-thick top metal available
- ✓ A phase-controlled sub-THz/THz LO signal with high output power and fine phase resolution for 6G high-speed wireless communication system