IDEC Chip Design Contest

Common source LNA & PA design for 5G application

Songjune Lee, Jinwon Hwang and Junghyun Kim
Department of Electrical and Electronic Engineering, Hanyang University

• Introduction

- ✓ LNA and PA fabricated using a 28nm bulk-CMOS fabrication
- ✓ Designed for 28GHz for 5G application
- ✓ Both the LNA and PA are used common source configuration
- ✓ PDK modeling is validated in designs to minimize error and performance degradation

• Description

◆ Schematic of LNA

- ✓ The proposed design employs a common-source topology with a source-degenerated inductor to achieve simultaneous noise and input matching (SNIM).
- ✓ The V_{DS} was set to 1.1 V, and V_{GS} was set to 700 mV. Under this bias condition, the drain current was 8 mA.
- ✓ The designed gate bias of the LNA is 100 mV higher than the noise-optimum bias, chosen to compensate for the degradation in noise figure (NF) due to reduced gain.

◆ Schematic of PA

- ✓ A simple common source topology is used instead of a complex structure with multiple variables.
- ✓ Common source configuration lack a virtual ground, which introduces a parasitic inductor at the source node and results in gain degradation.
- ✓ Since the power amplifier is an active circuit, a resistor and capacitor are added at the input terminal to ensure unconditional stability
- ✓ Load-pull is used to determine the optimal impedance and perform output impedance matching for maximum output power
- ✓ DC bias is applied through an inductor at the drain due to high current, and through a resistor at the gate to maintain a compact layout

◆ Layout of LNA

- ✓ The inductors used at the gate and drain of the core were designed to exhibit high Q-factors.
- ✓ Both the inductance of the degenerated inductor and the parasitic inductance of the ground plane were extracted and jointly considered in the design.

◆ Layout of PA

- ✓ To implement a small inductance, top metal is used instead of a PDK inductor instance.
- ✓ Bypass capacitors is implemented to keep the resonant frequency above the operating frequency considering the routing line.

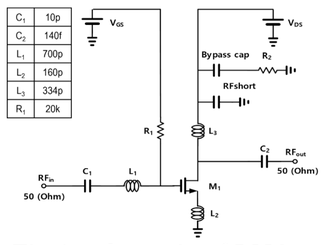

Fig 1. schematic of LNA

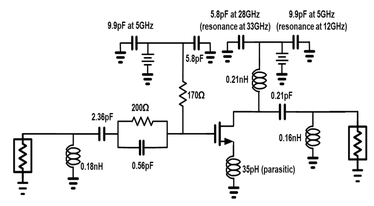

Fig 2. schematic of PA

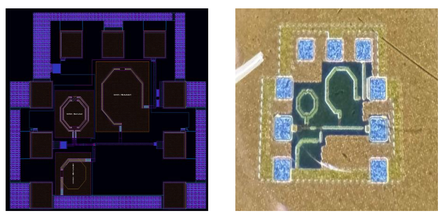

Fig 3. Layout and fabrication of LNA

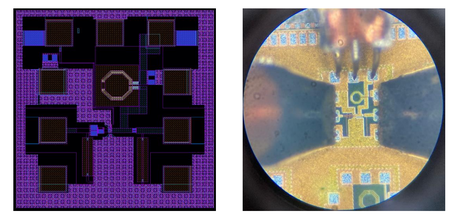

Fig 4. Layout and fabrication of PA

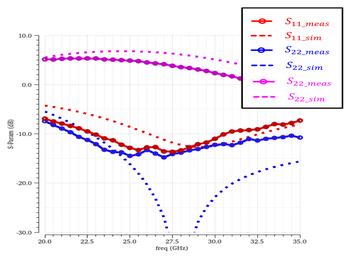

Fig 5. Simulation and measurement of LNA

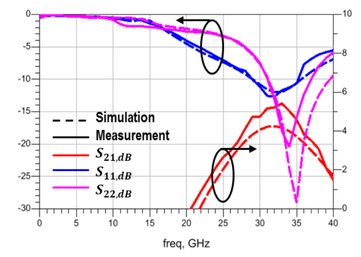

Fig 6. Simulation and measurement of PA

• Conclusion

- ✓ LNA and PA is designed for 5G application
- ✓ PA show good agreement in S_{11} between measurement and simulation, but require external bypass capacitors to eliminate gain instability due to oscillations
- ✓ The S_{11} of LNA showed a low frequency band shift of approximately 2 GHz.