

A 0.097 mm² 4.0-31.8 GHz Inverter-based LNA With Parallel-Series Transformer Feedback

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Introduction

Advantages of the multi-band

- To support multiple wireless protocols within a single architecture, enabling flexible and efficient spectrum usage.
- The reduced system cost, area, and power by consolidating functionality.

The necessity of a Low Noise Amplifier (LNA)

- A key gain stage in the receiver that defines system sensitivity and dynamic range.
- To amplify weak incoming signals while minimizing additional noise.

Design

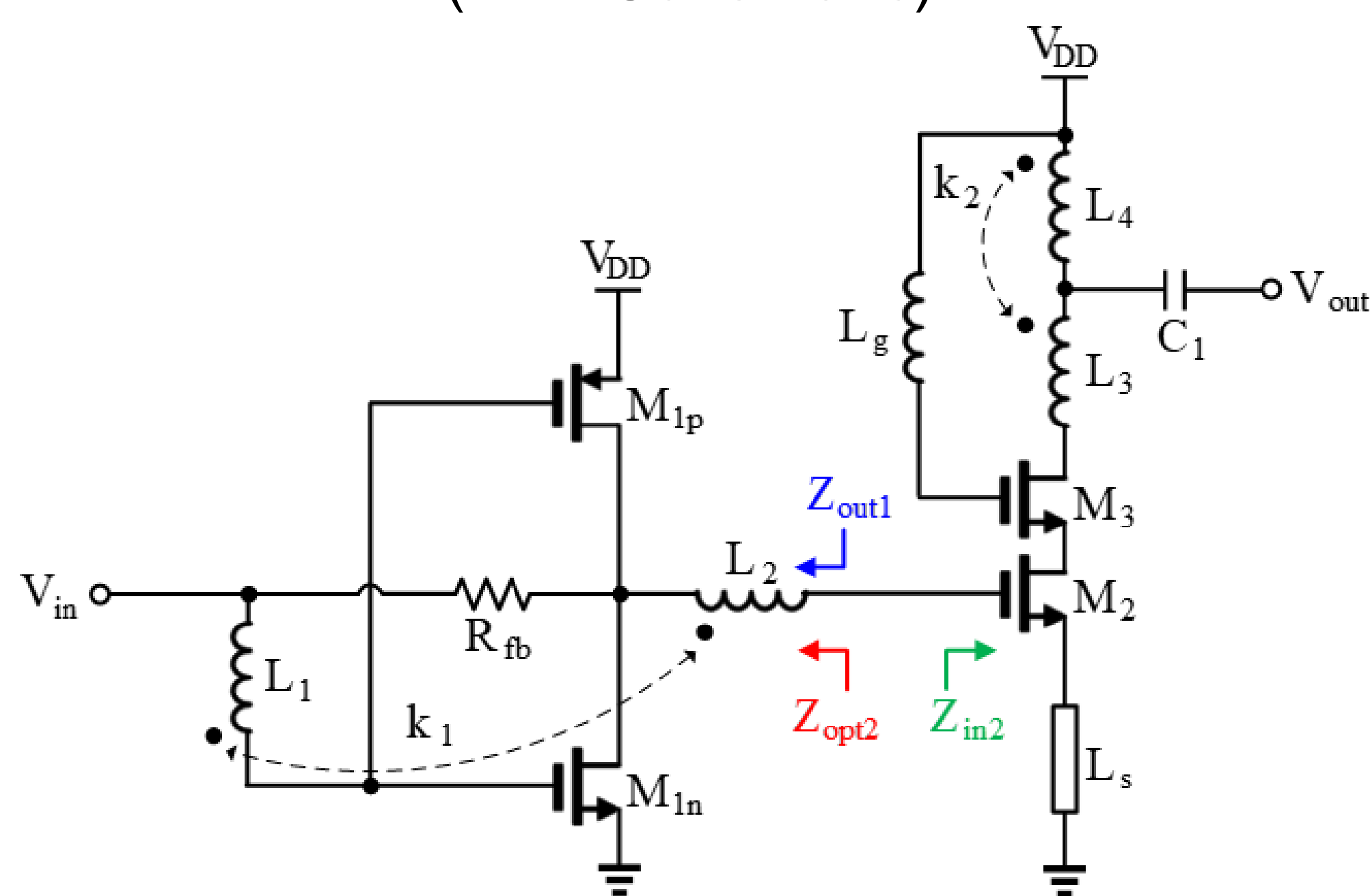
Parallel-series transformer feedback

- The parallel and series inductors optimize NF at high frequencies, enabling flat noise performance.
- The coupling between the inductors provides wideband input matching, similar to a source-degenerative inductor.
- The parallel inductor reduces the first-stage noise contribution from 32.2 % at 5 GHz to 24.6 % at 30 GHz.
- The series inductor alleviates the trade-off between NF and S_{21} by aligning Z_{out1} with Z_{opt2}

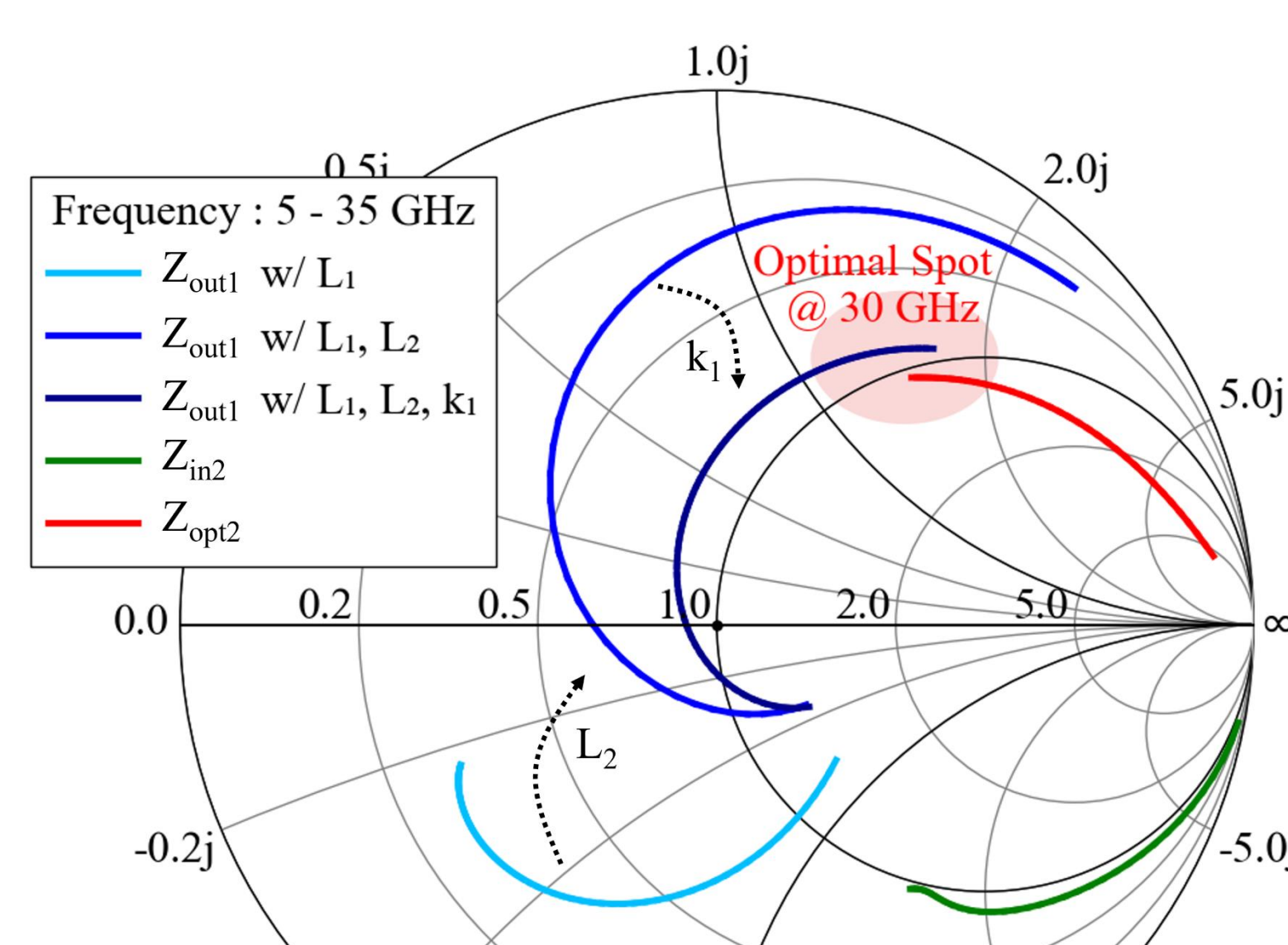
Inverter-based amplifier

- Achieving high gain from low frequencies facilitates the realization of a wide 3-dB bandwidth.
- Self-biasing via resistive feedback simplifies the layout, requiring only two bias lines.

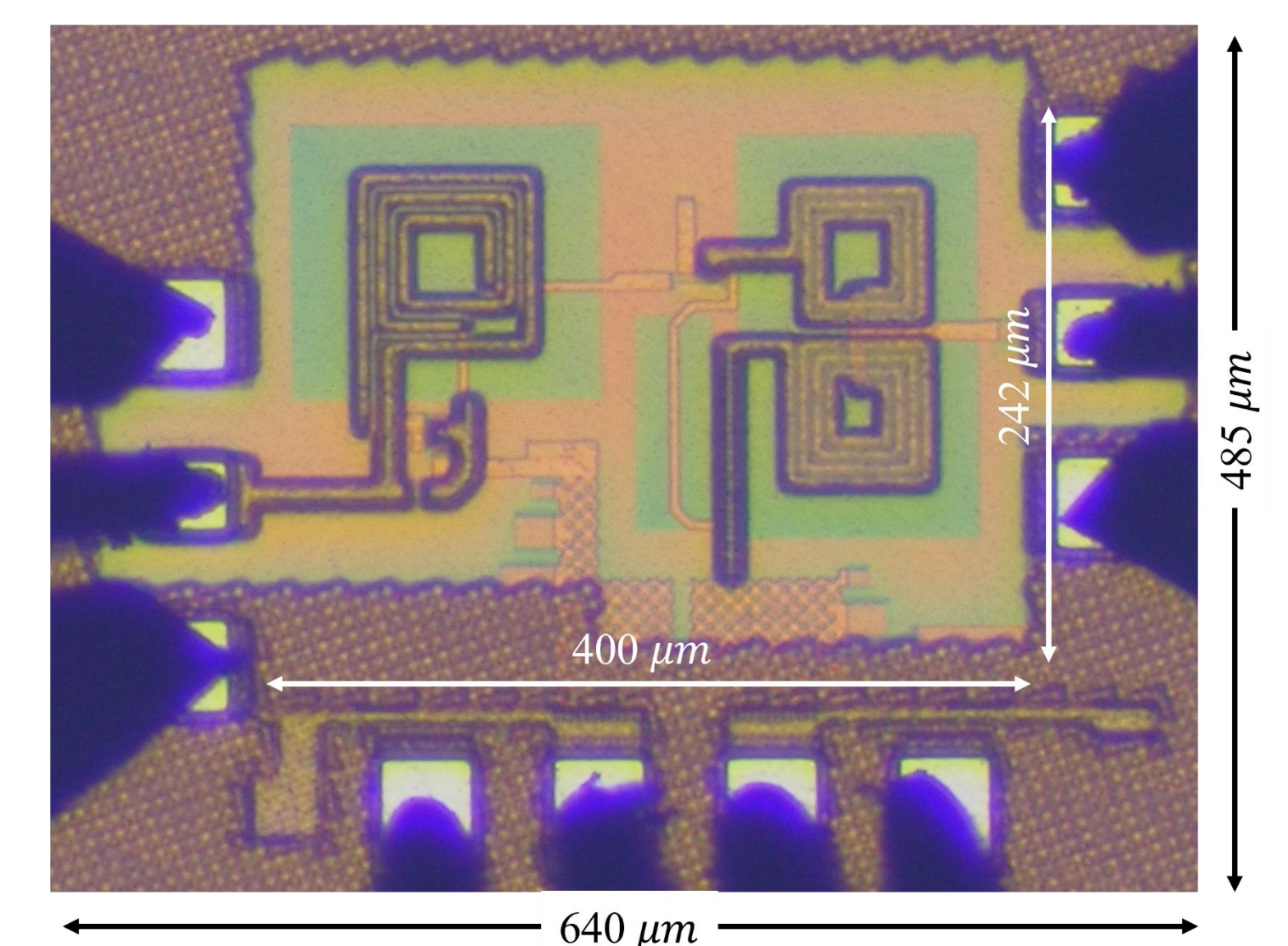
(LNA Schematic)



(Simulated Z_{out1} , Z_{opt2} , Z_{in2})



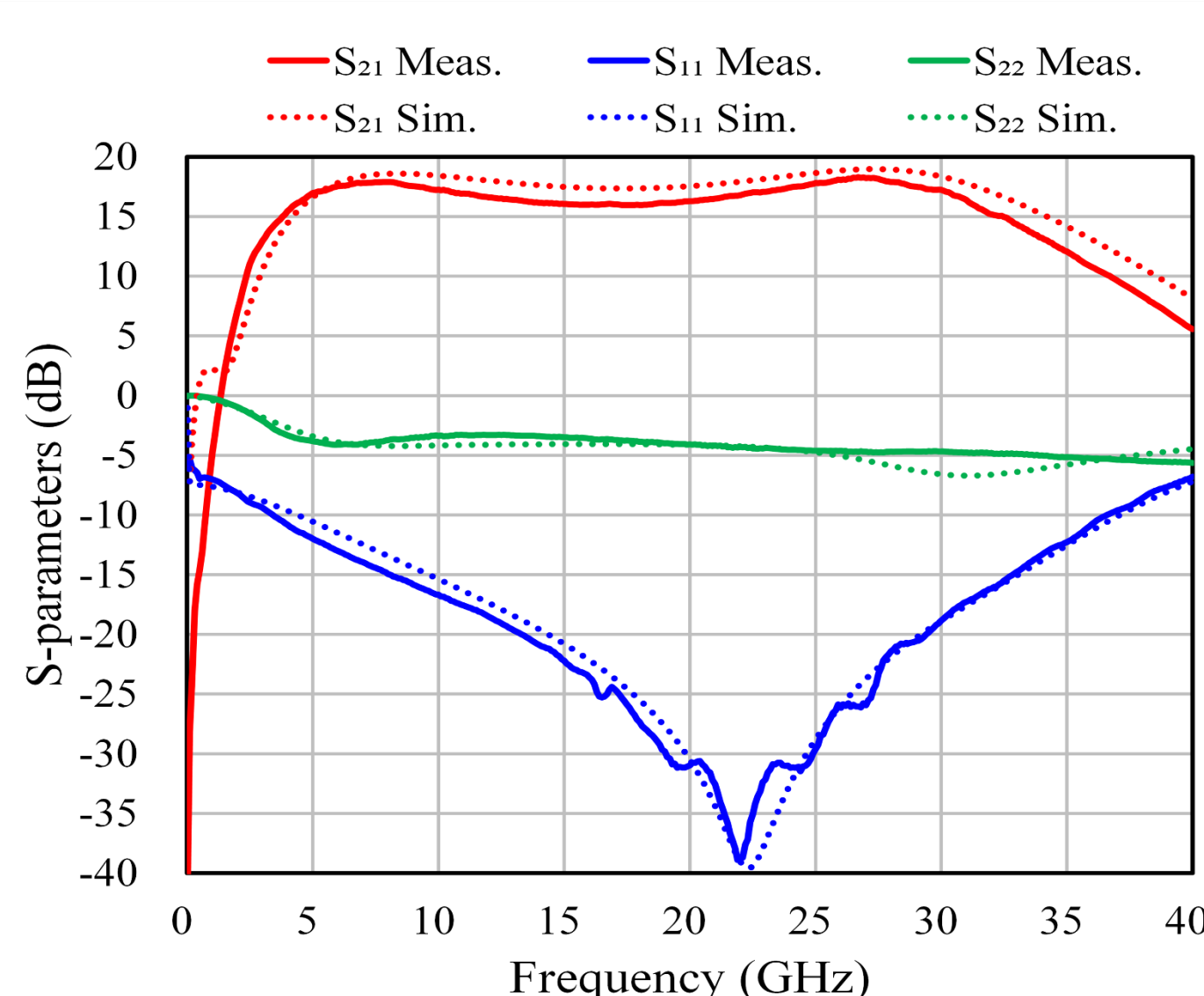
(LNA chip micrograph)



Results

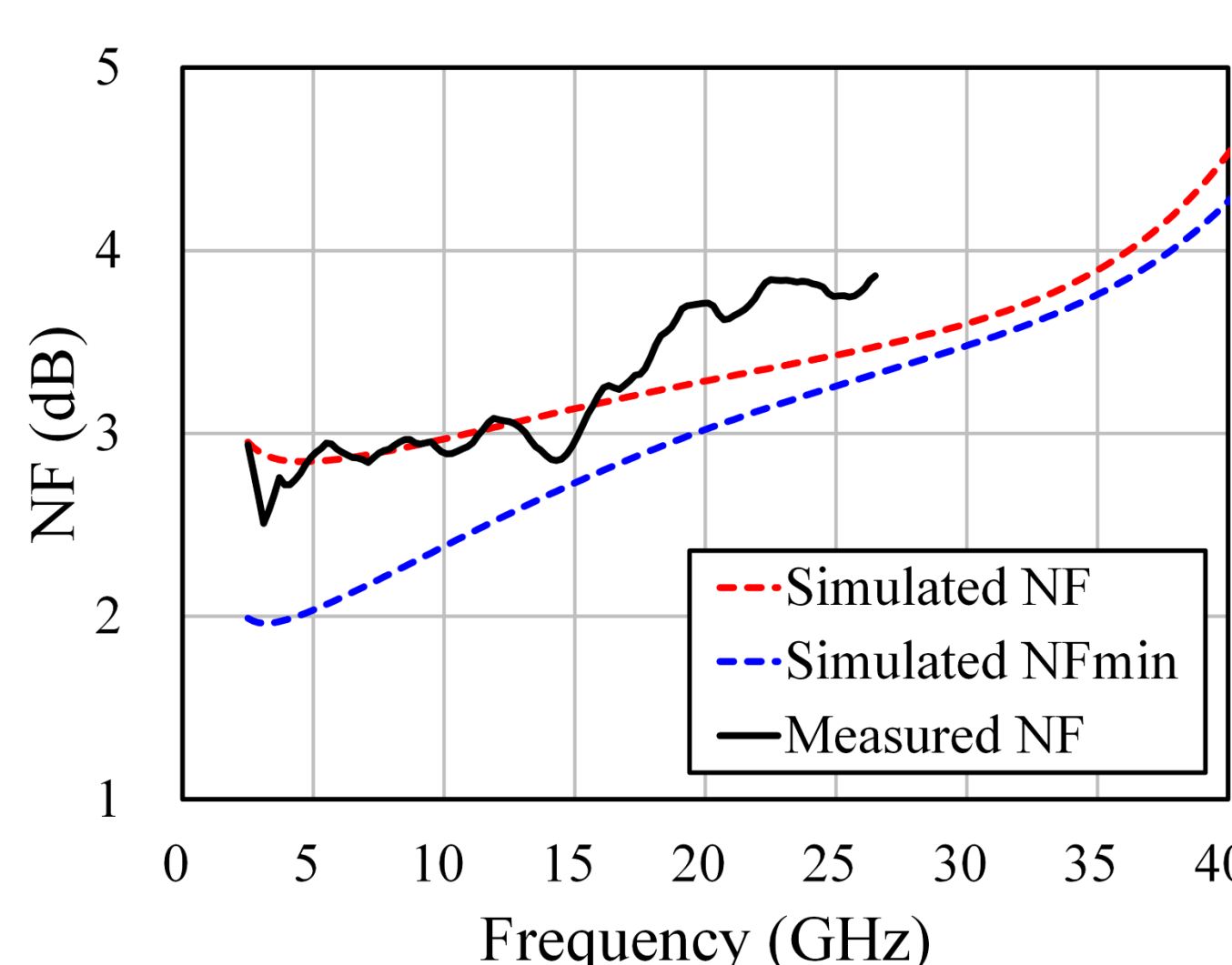
S-parameters measurement

- Peak S_{21} : 18.3 dB
- 3-dB BW : 27.8 GHz (4.0–31.8 GHz)



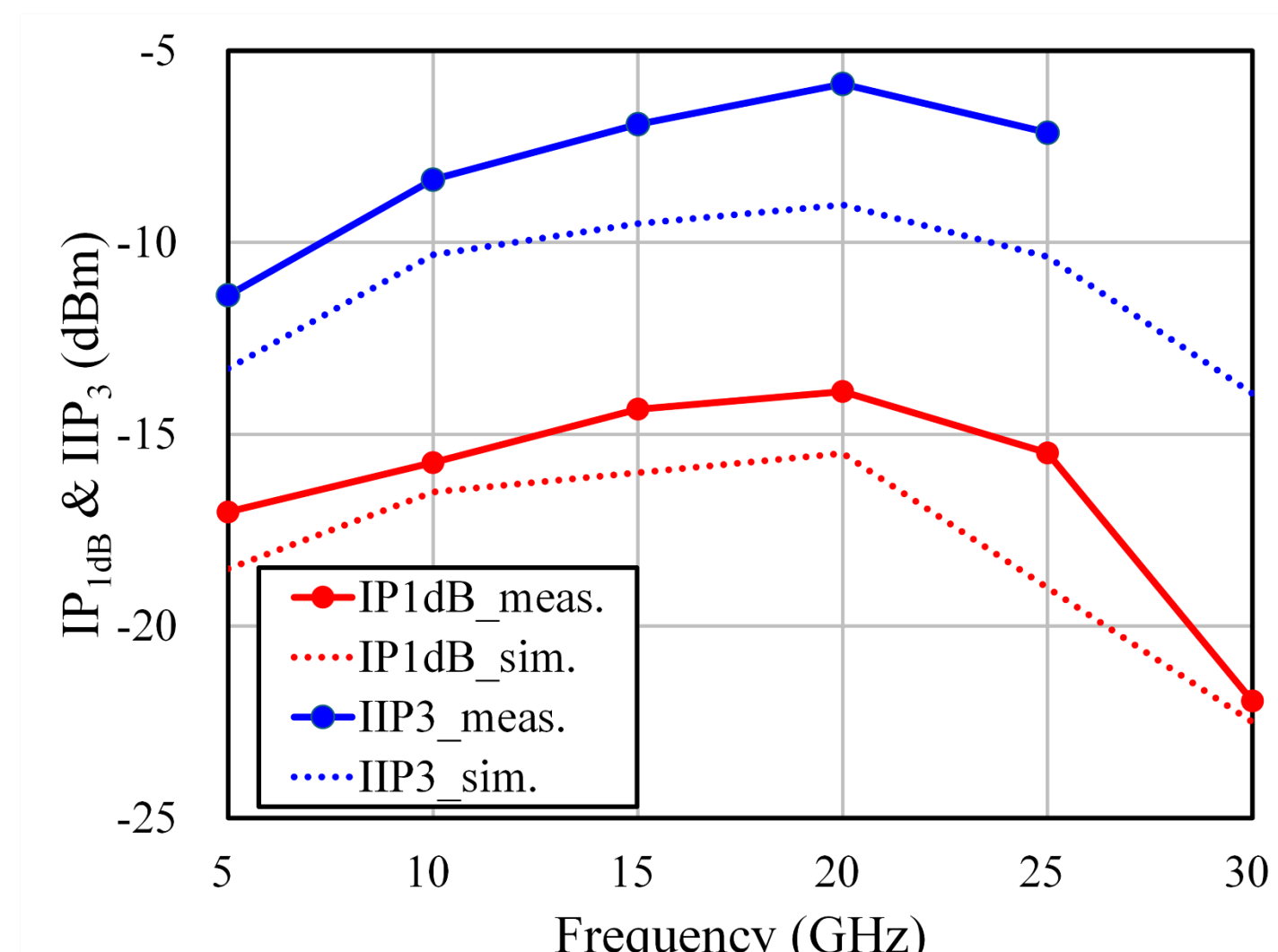
Noise figure measurement

- NF : 2.72-3.86 dB
- Δ NF/BW : 0.02 dB/GHz



Linearity measurement

- IIP_3 : -11.4 - -5.87 dBm
- IP_{1dB} : -21.9 - -13.9 dBm



Conclusion

- We have developed a wideband inverter-based LNA in a 28-nm CMOS process.
- The LNA demonstrates wide 3-dB BW with 4.0-31.8 GHz and low NF with 2.72-3.86 dB.

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