A Noise Cancelling Resistive Feedback Receiver Front-End

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Outline

- Introduction
- Implementation
- Results
- Conclusions

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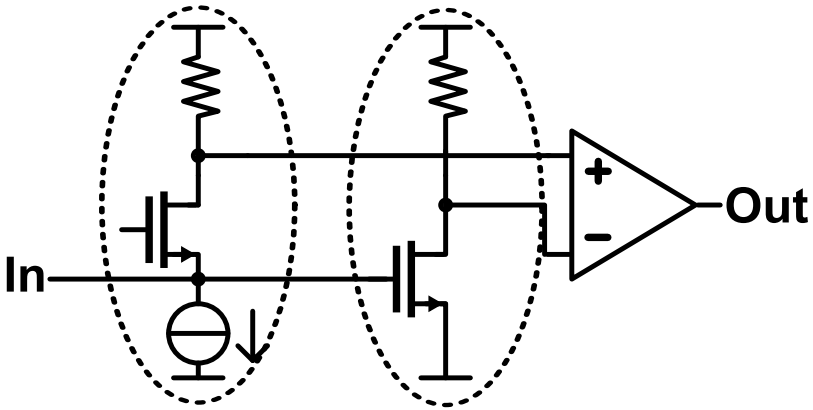
Motivation

- Past years, many techniques using the bi-directional frequency translational properties of passive mixer have been demonstrated

- Low noise critical for cellular applications

- Noise cancellation translational techniques

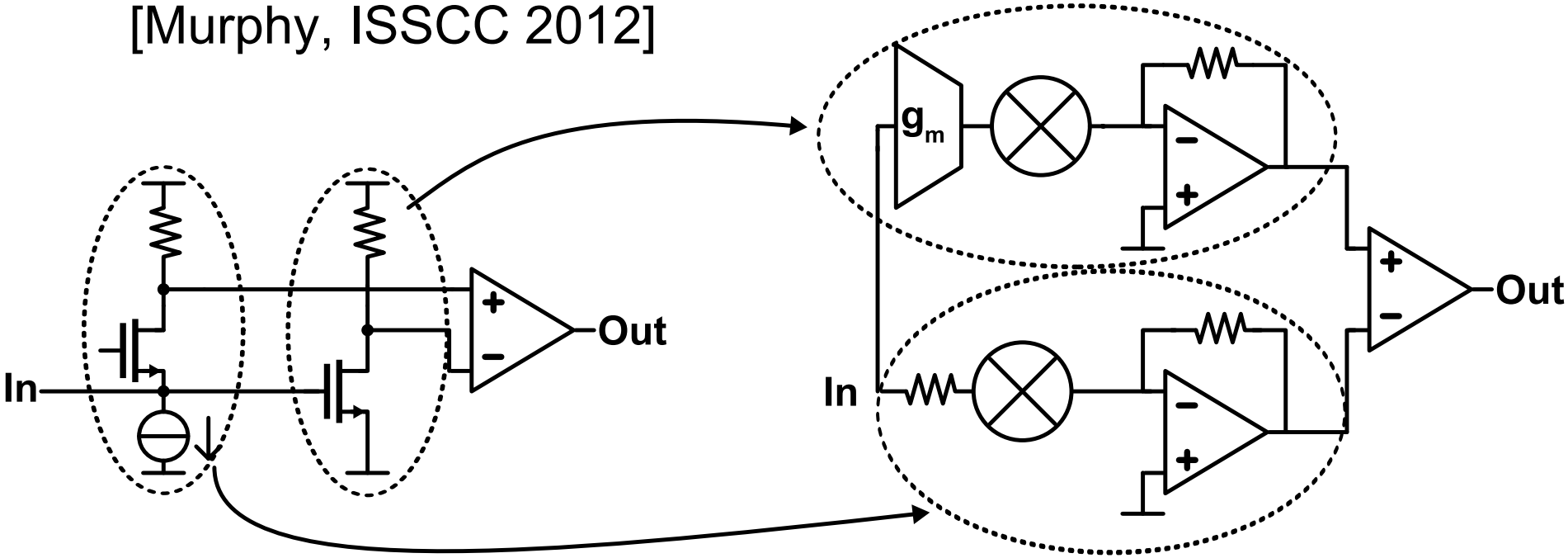
Previous art



- CG-CS Noise-Cancelling LNA

Previous art

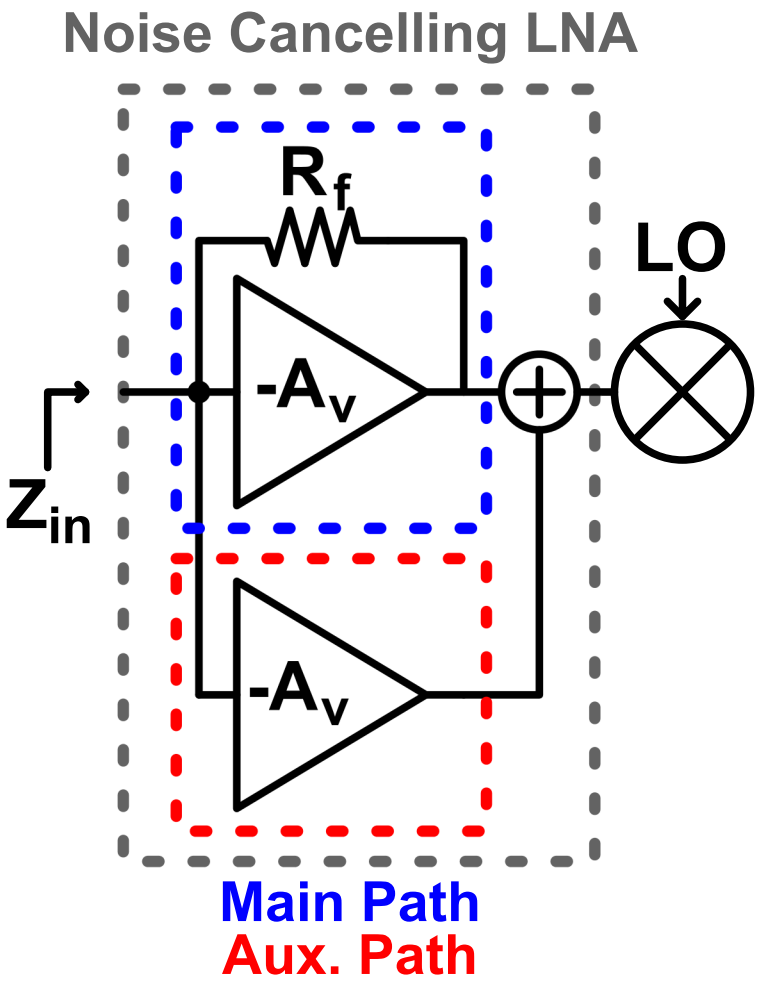
[Murphy, ISSCC 2012]



- CG-CS Noise-Cancelling technique used in Receiver Front-End

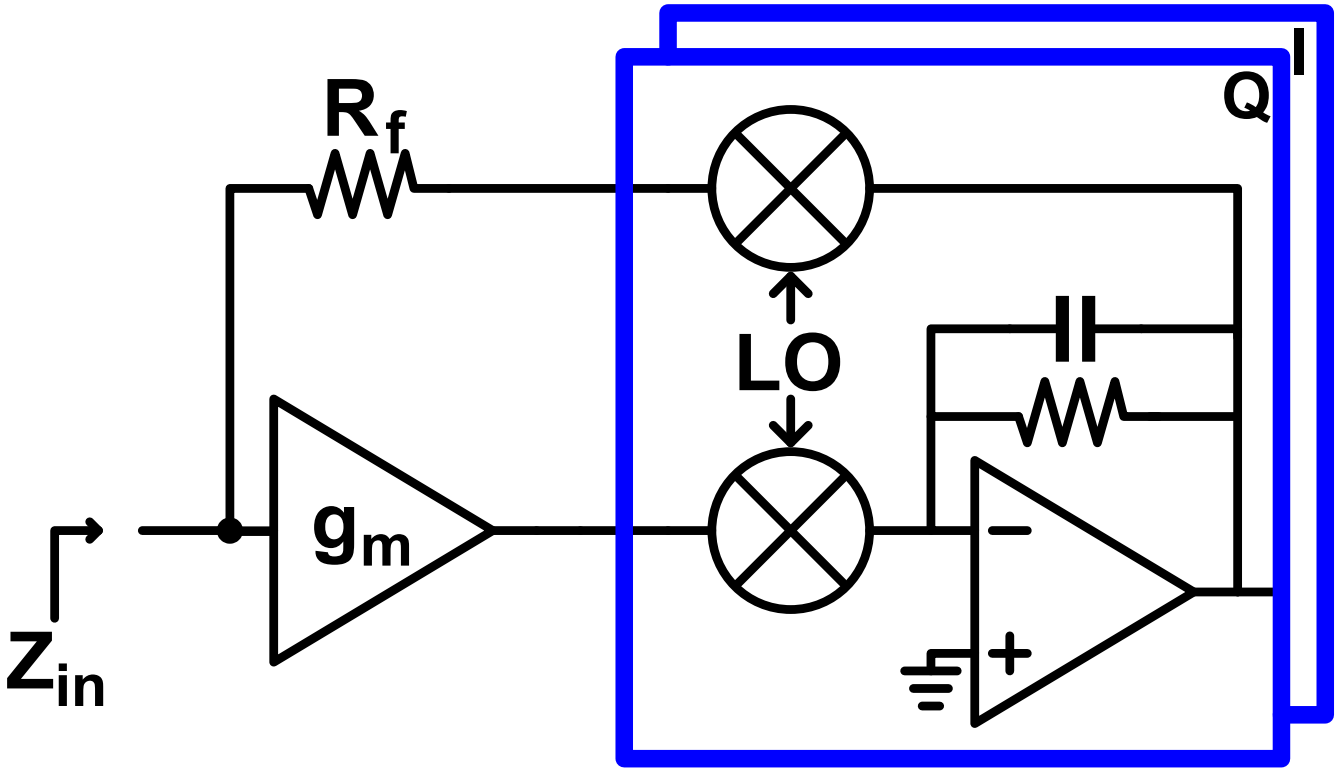
Noise cancelling feedback LNA

- Wideband input match
  - By Main path
- Noise cancellation
  - By Aux. Path
- All processing at RF
- More processing in BB



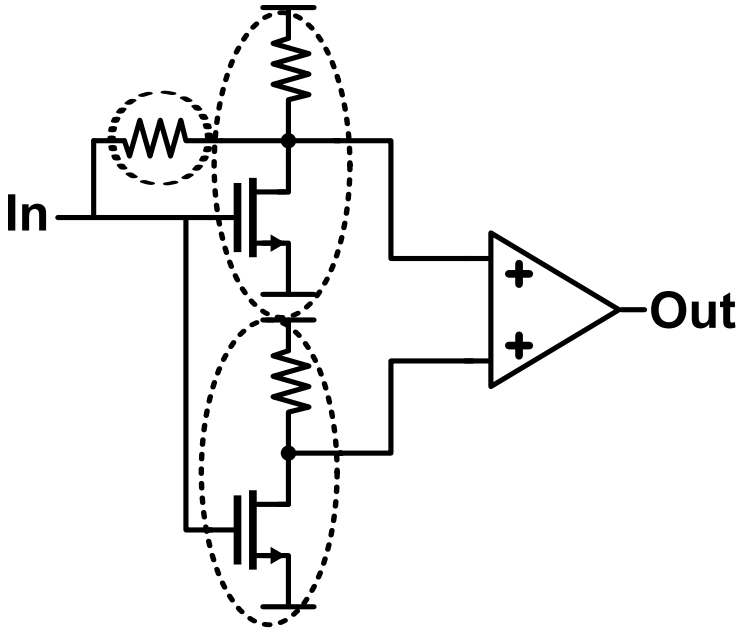
Shunt Fb Receiver Front-End

- No voltage gain at RF [He, ISSCC 2011]



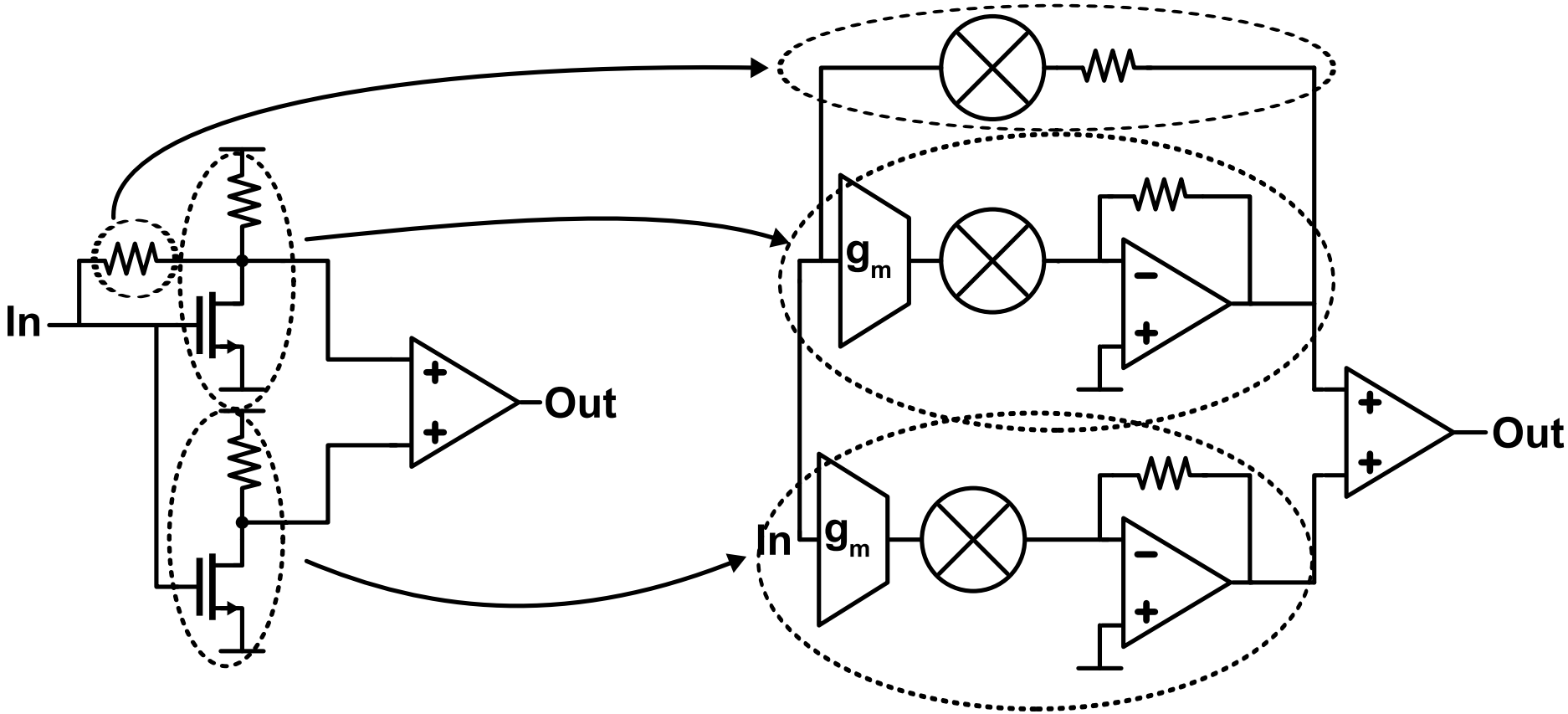
- Frequency selective input match at f_{LO}

Noise Cancelling Principle



- Amplifiers implemented with CS-stages

Noise Cancelling Principle



- Is Z_s not resistive, feedback phase can be tuned

Noise cancelling FB Front-End (I)

- Input match

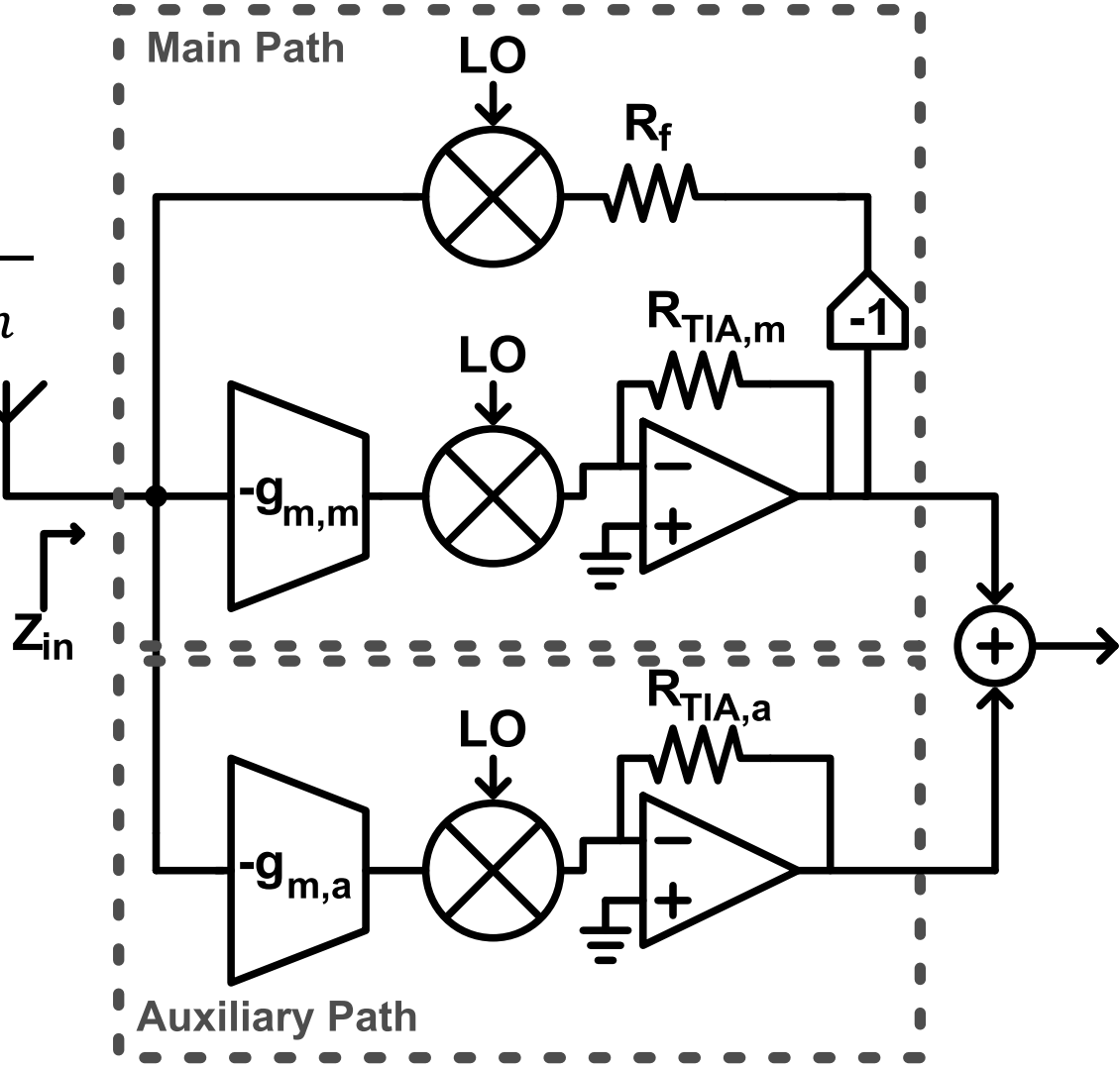
$$Z_{in} \approx \frac{R_f}{1 + g_{m,m} R_{TIA,m}}$$

- Gain main path

$$A_v \approx 1 - \frac{R_f}{R_s}$$

- Gain aux. path

$$A_v \approx g_{m,a} R_{TIA,a}$$



Noise cancelling FB Front-End (II)

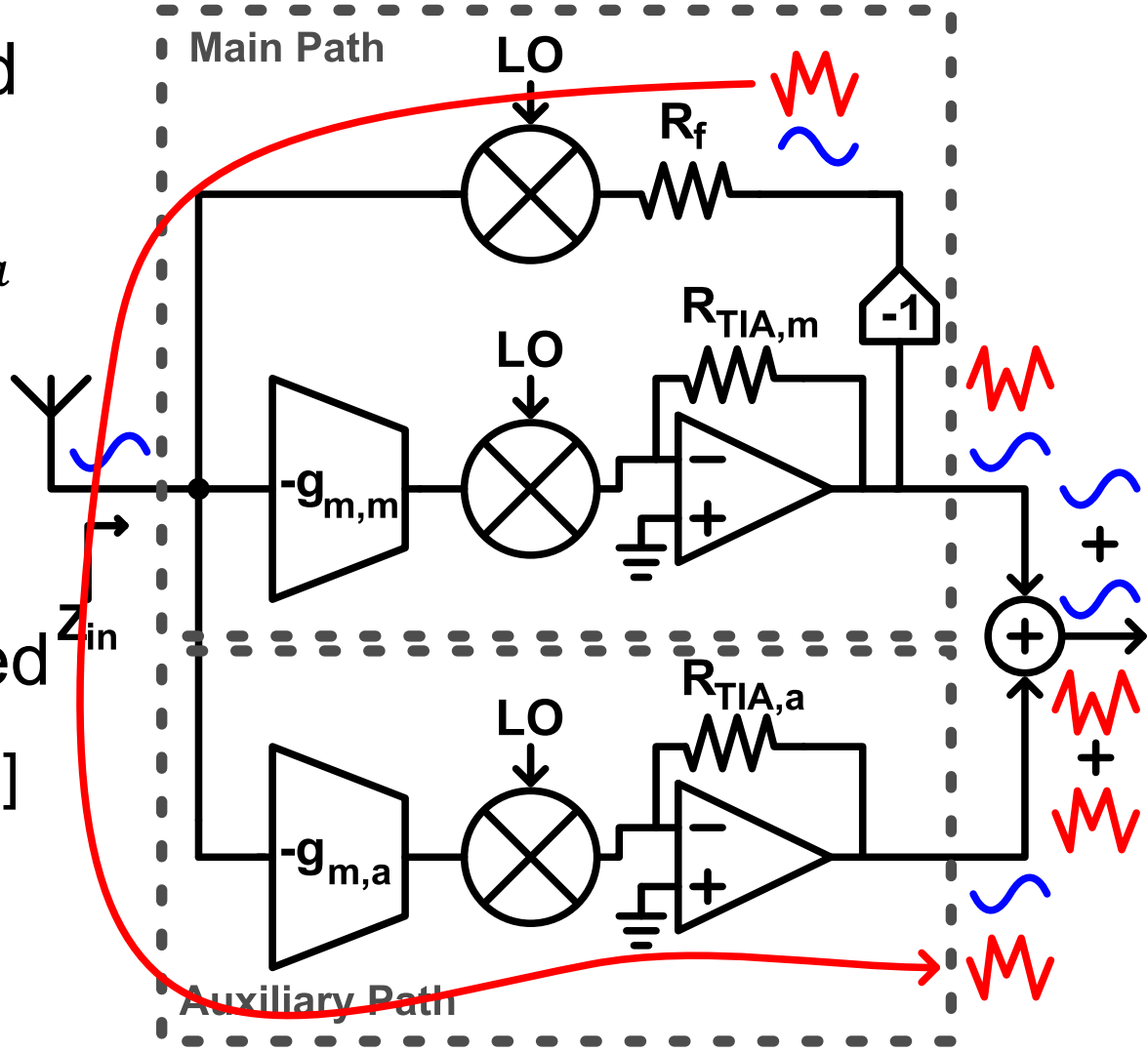
- Noise cancelled

$$1 + \frac{R_f}{R_s} = g_{m,a} R_{TIA,a}$$

- If resistive Z_s

- Aux phase tuned

[Murphy, CICC 2013]



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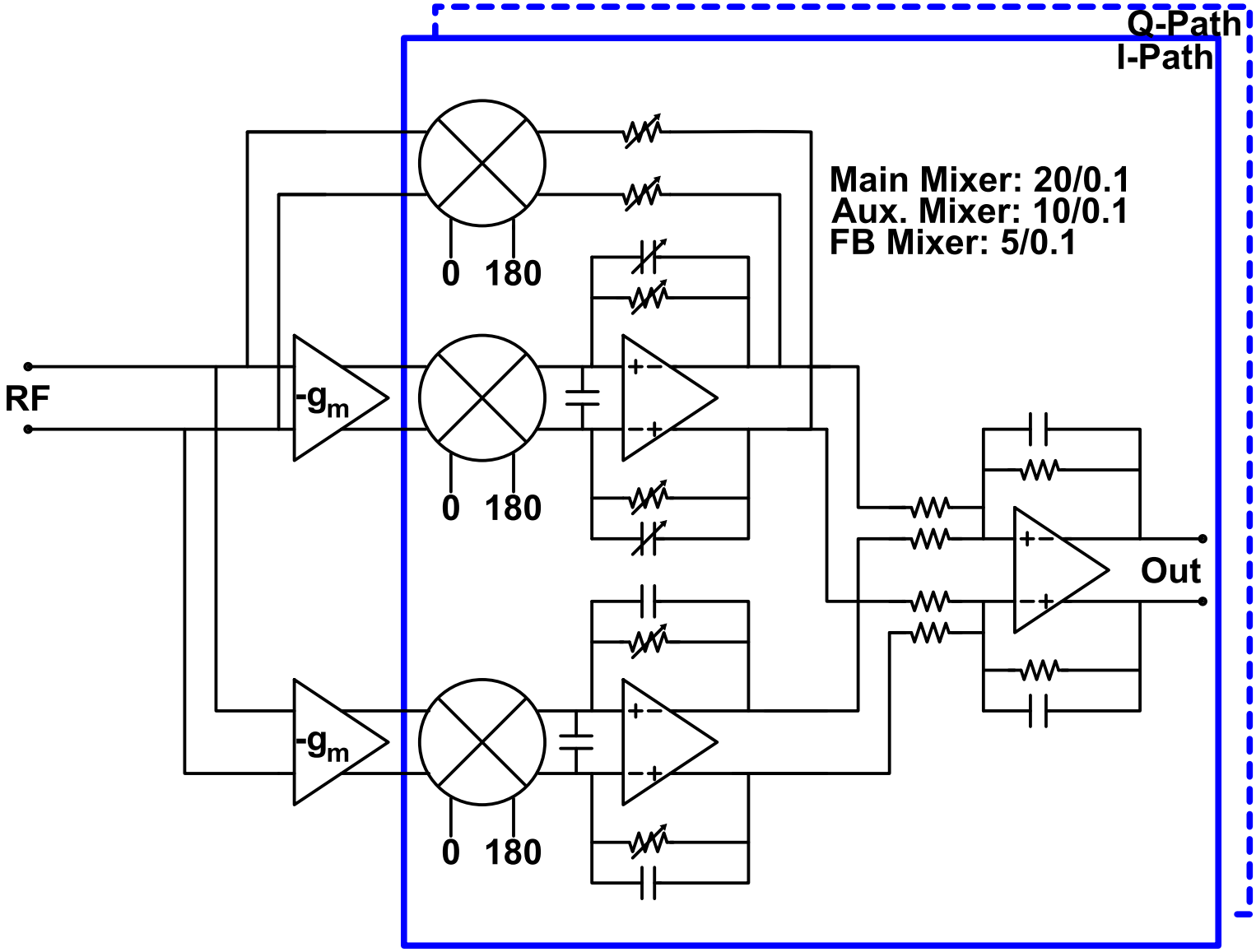
Implementation



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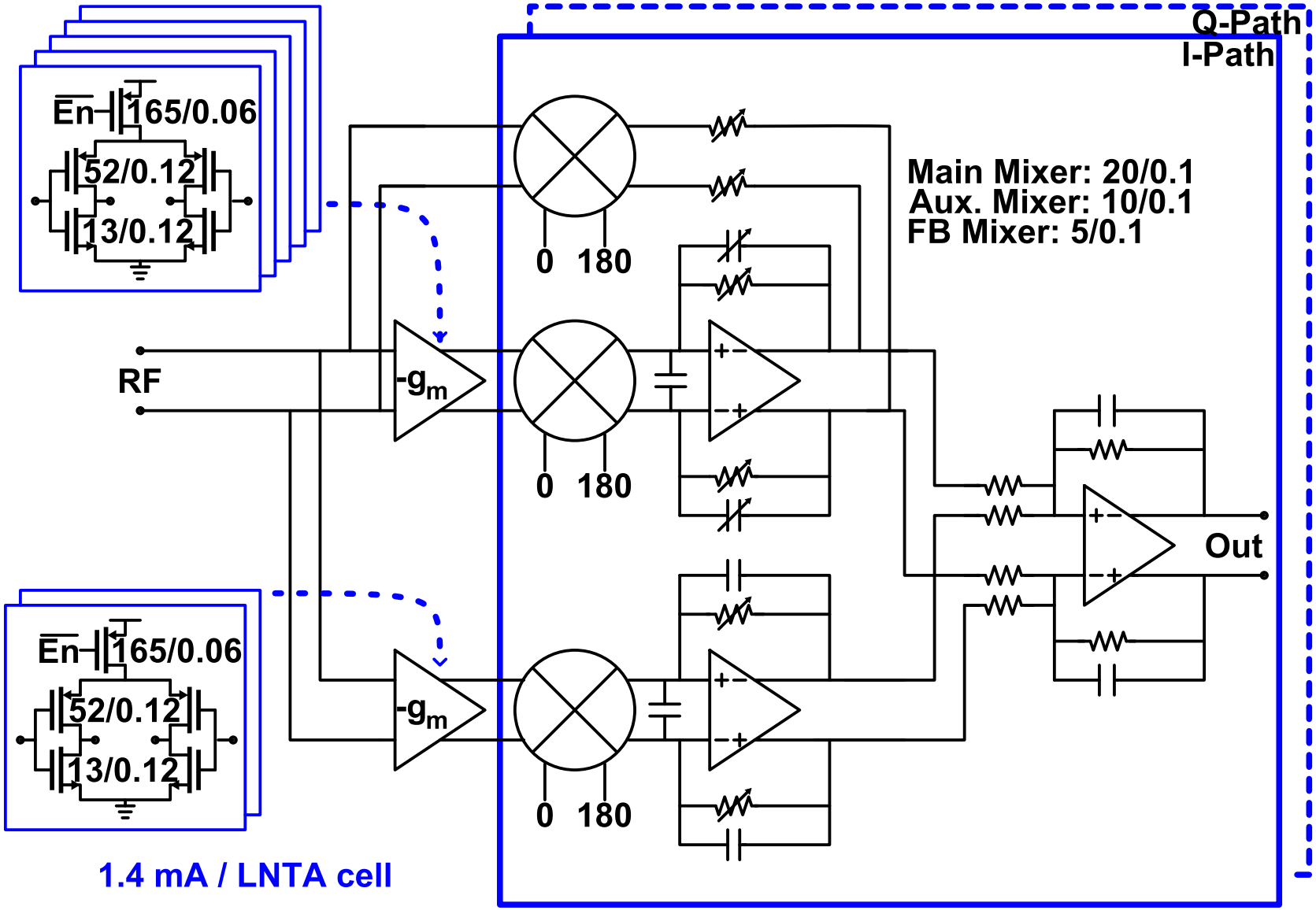
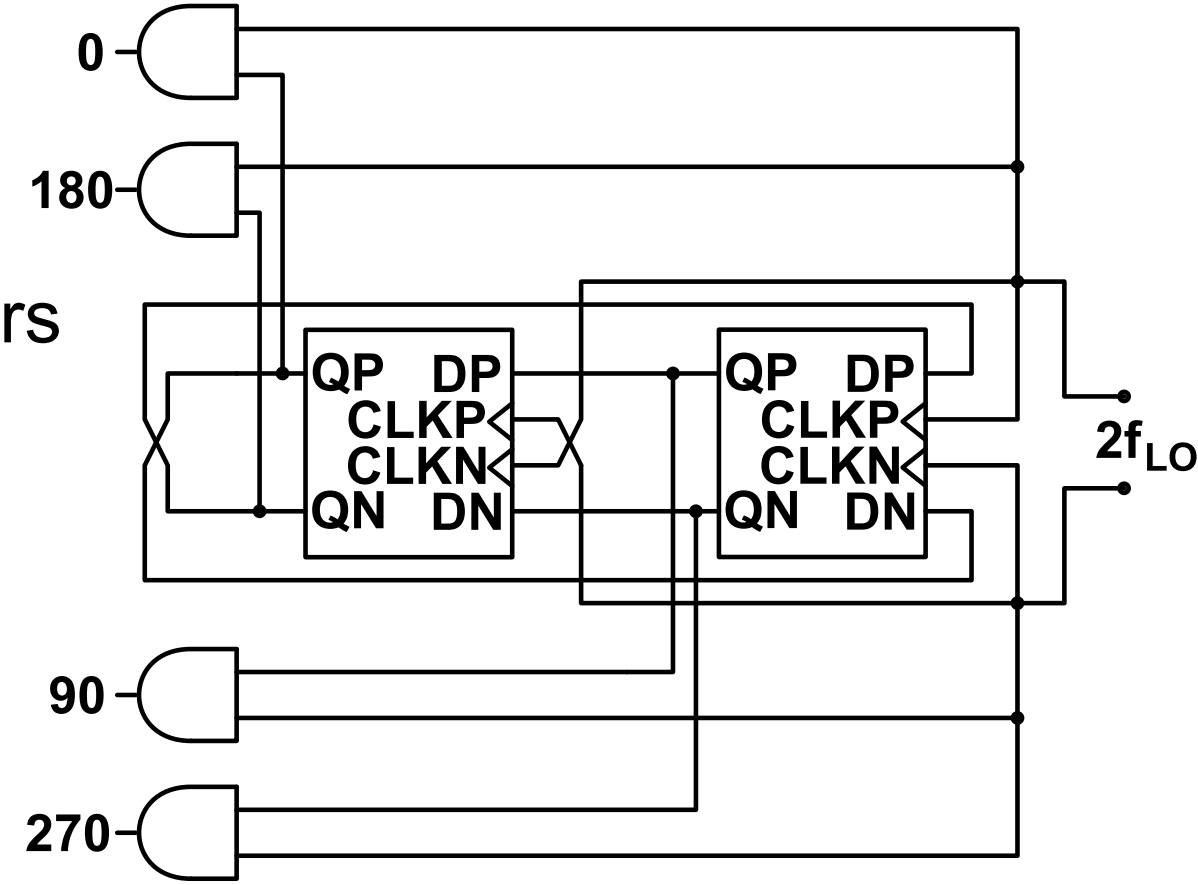


LO generation, CML

- CML Div-by-2 core + NAND with inputs
- Fed to all mixers



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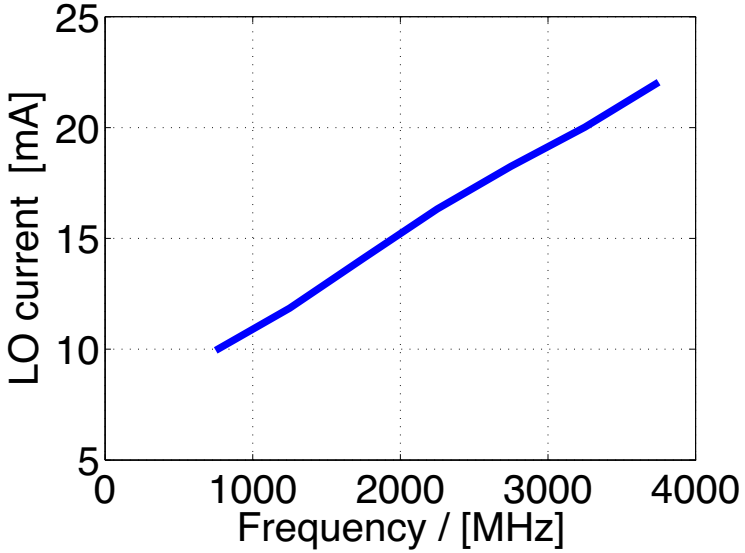

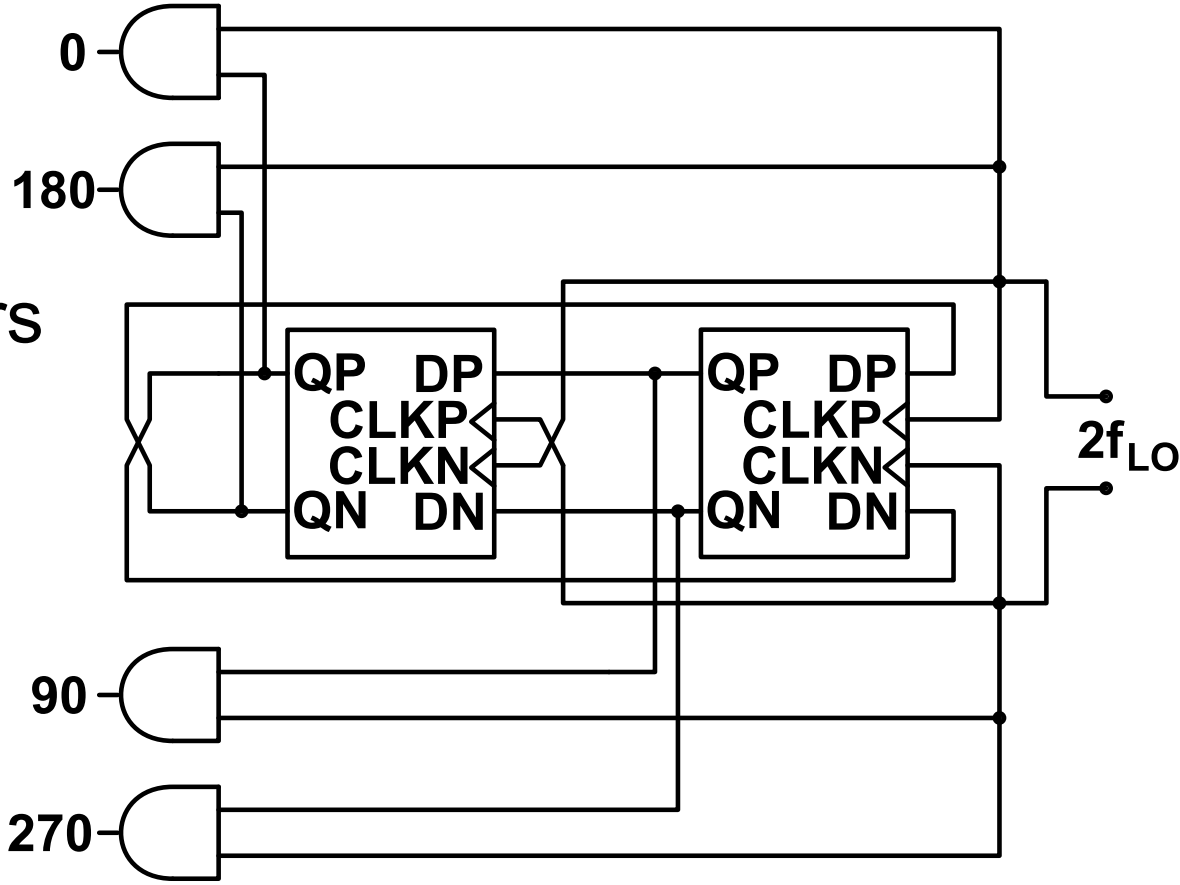

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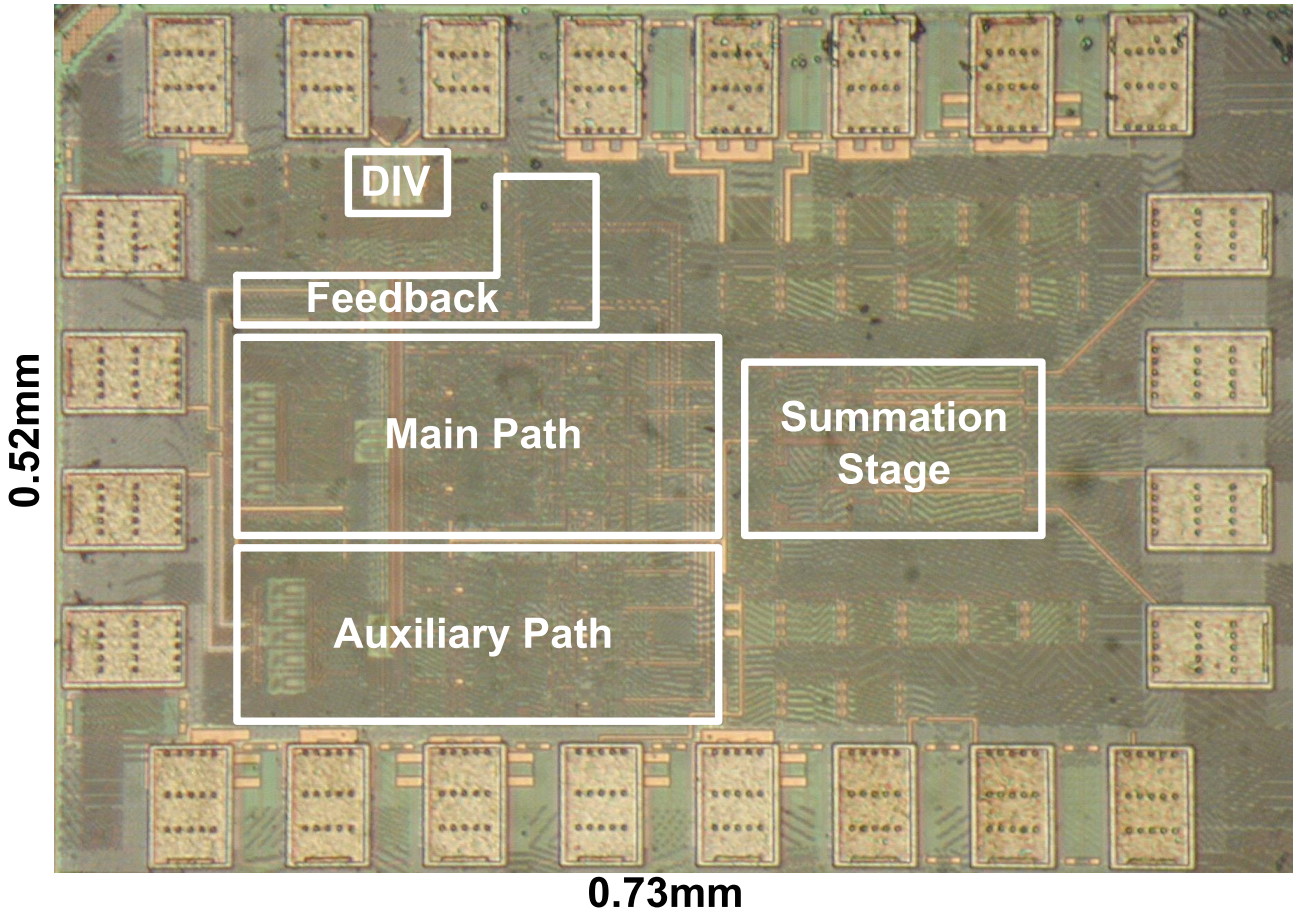
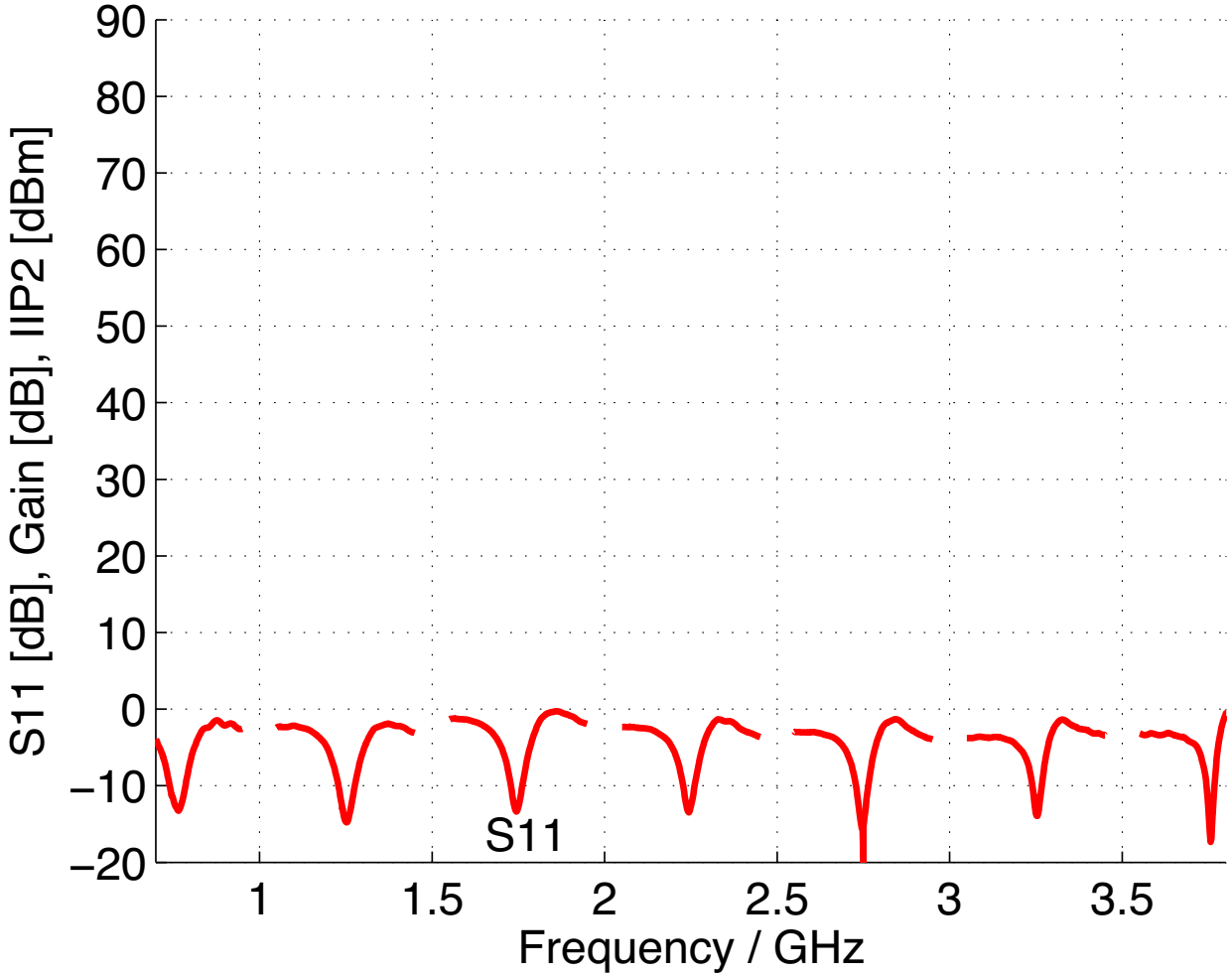


- STMicroelectronics 65nm process
- Total active area: 0.15mm^2

Input Matching, Gain, IIP2



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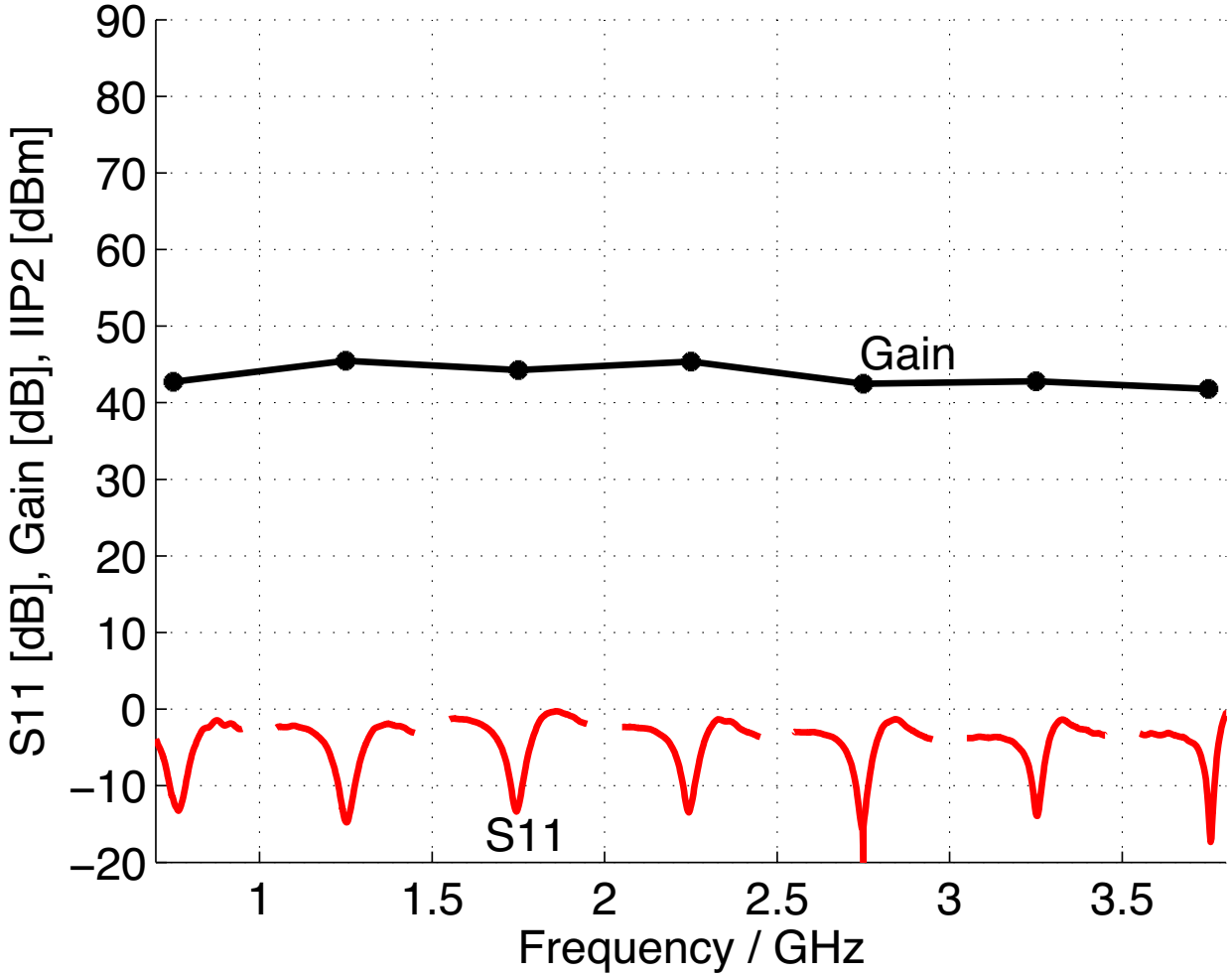

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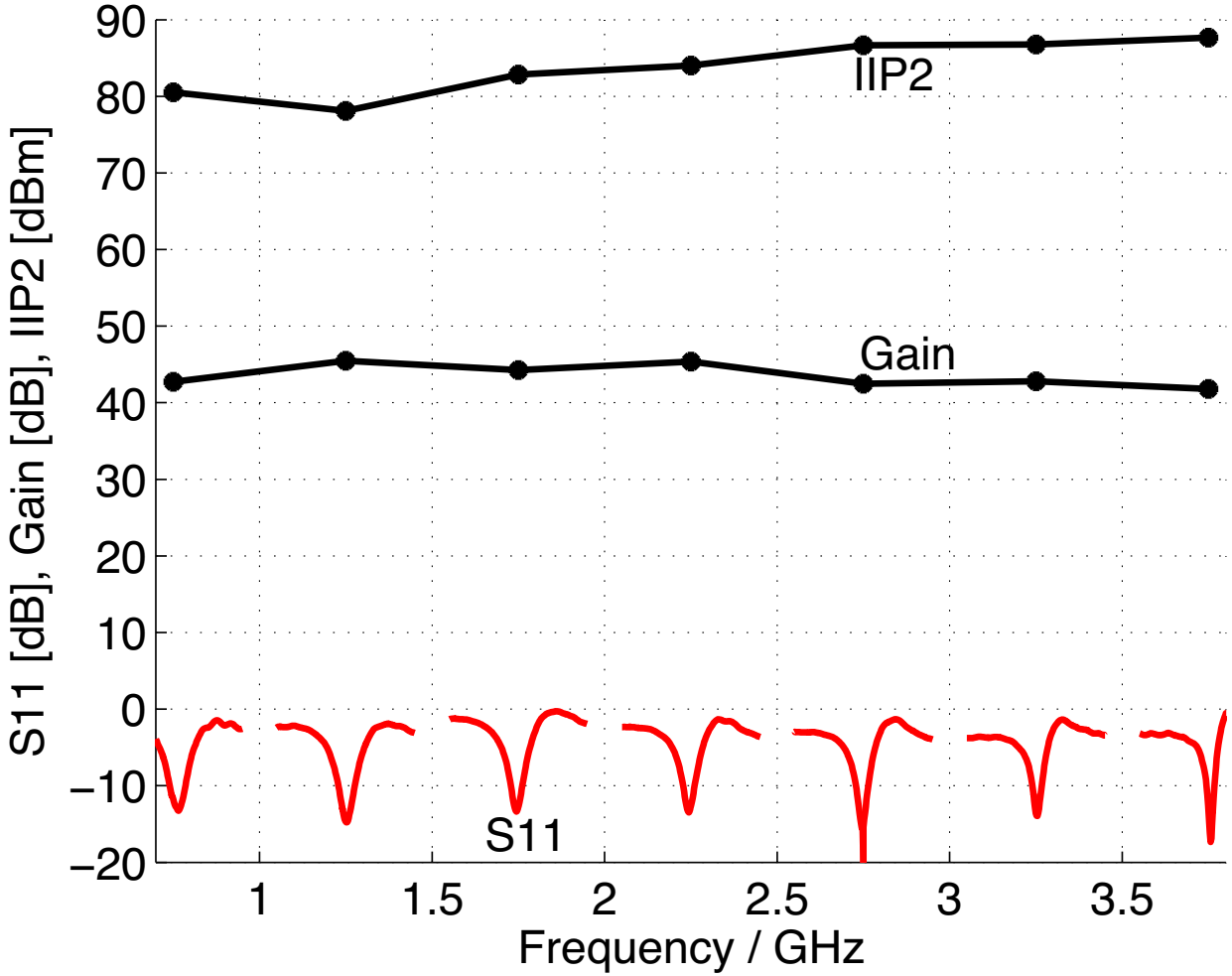
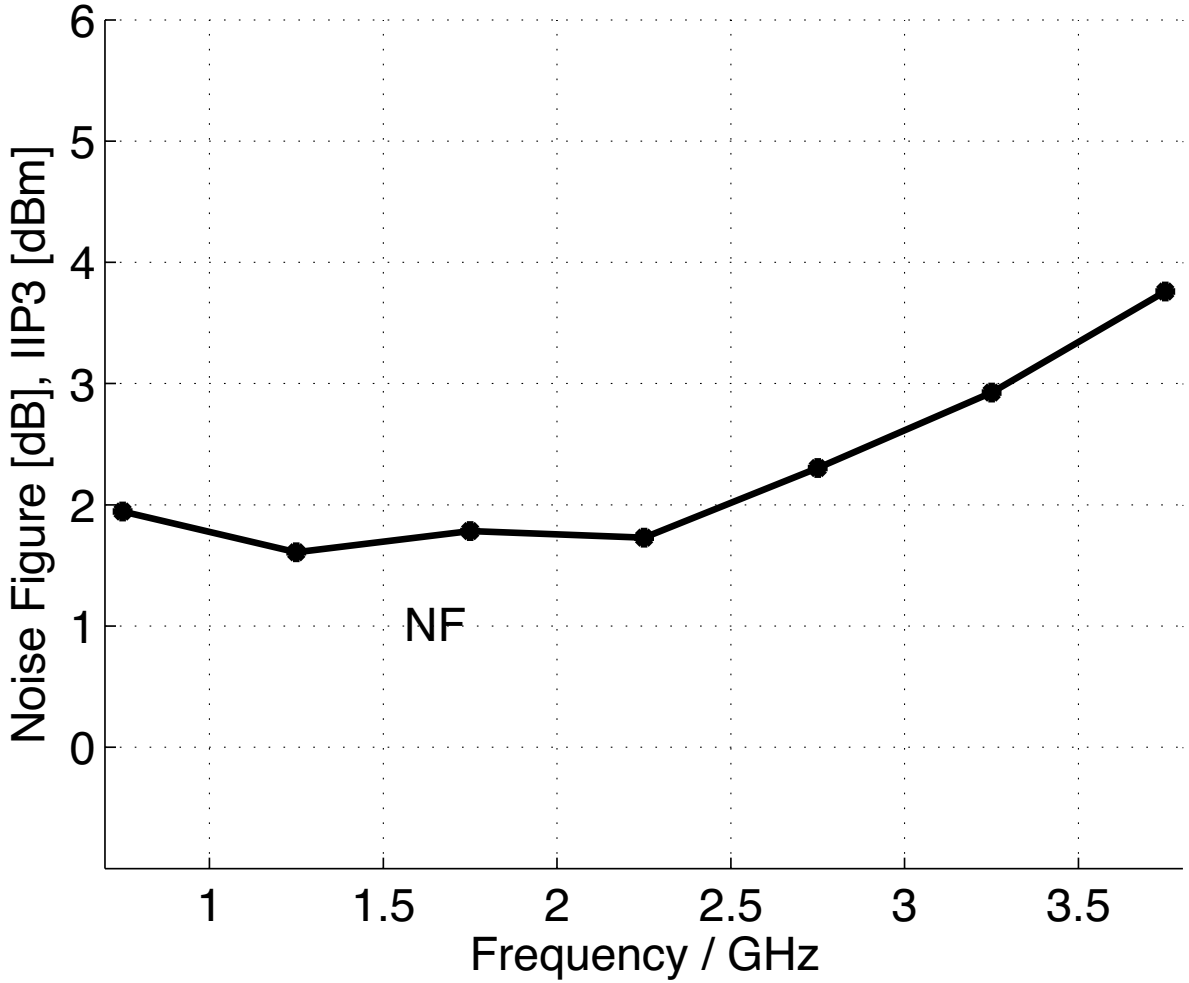
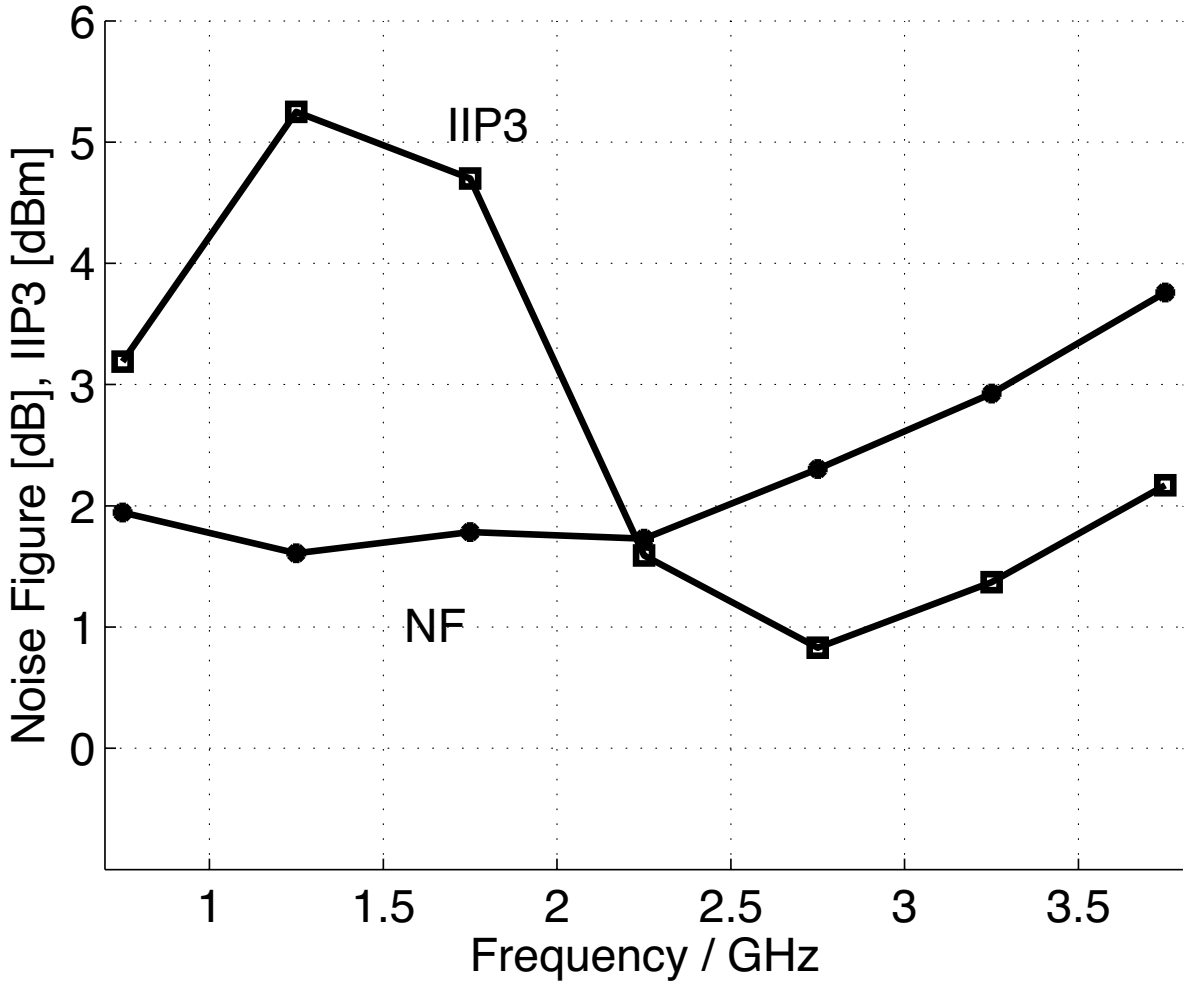


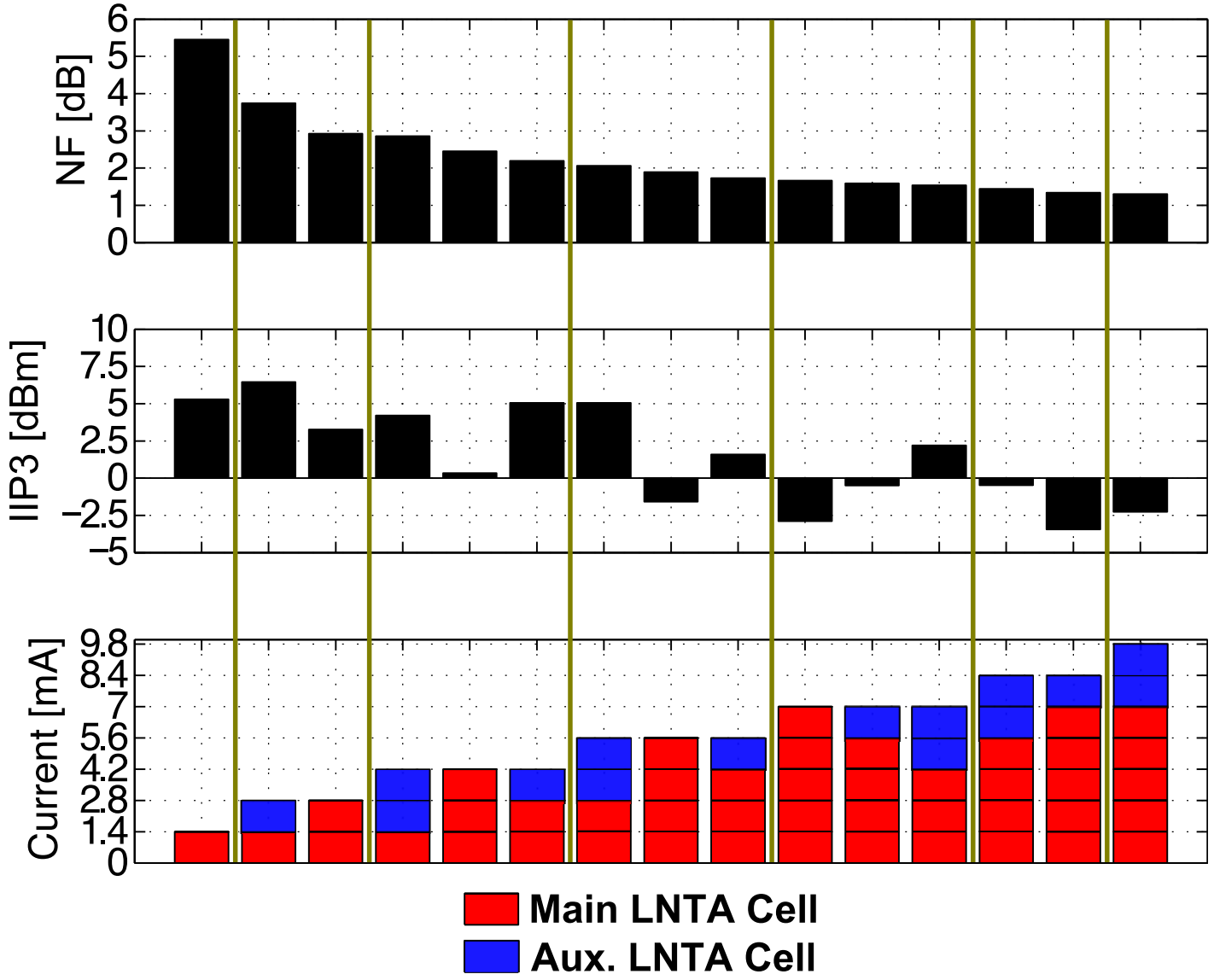
Noise Figure, IIP3



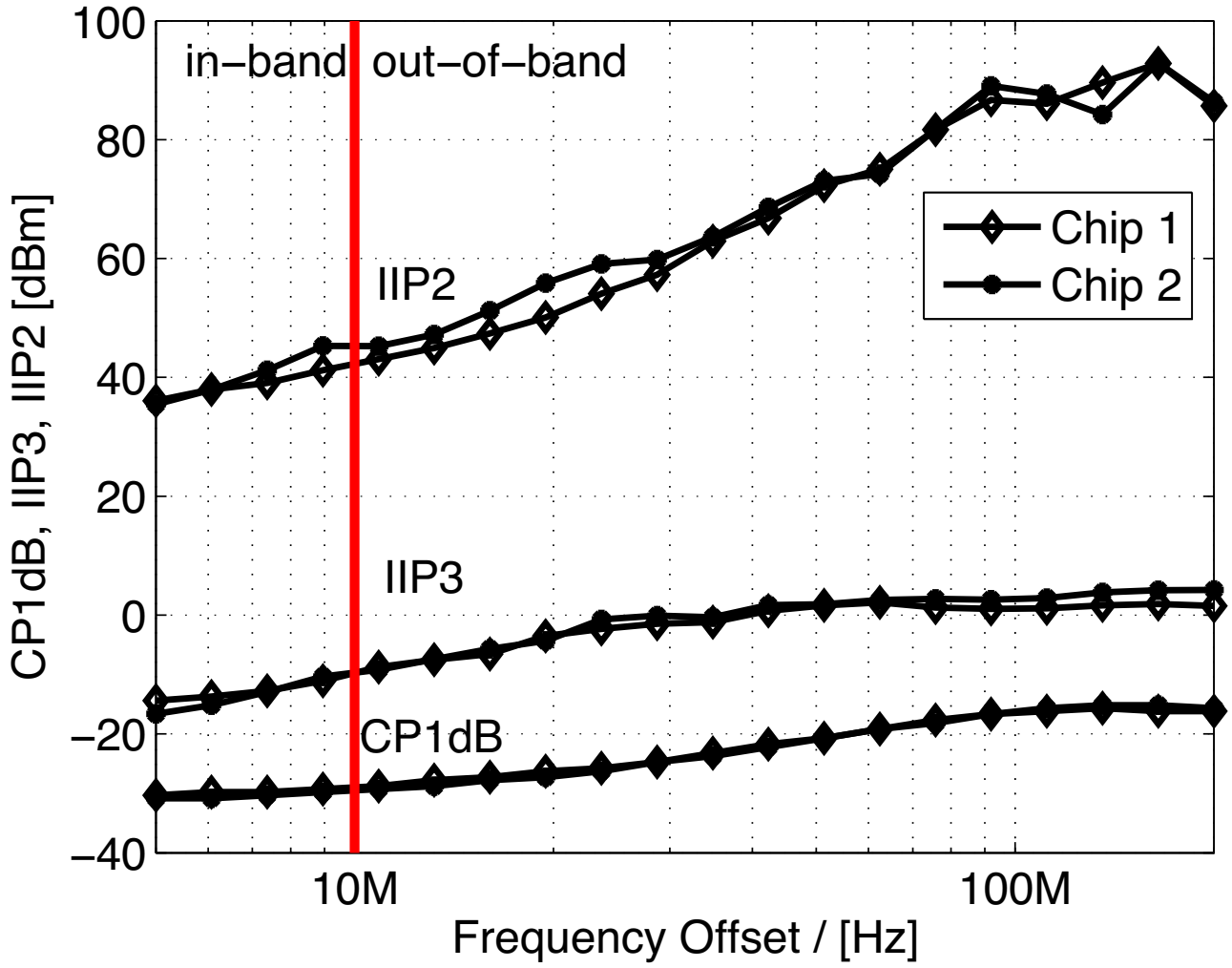
Noise Figure, IIP3



Noise Figure, IIP3 vs. Current



CP1dB, IIP3, IIP2



Performance summary

	ISSCC 2012	ISSCC 2011	RFIC 2013	This Work
Type	Noise Cancelling	Resistive Feedback	Sampling	**Noise Cancelling**
Frequency / [GHz]	0.01-2.7	0.7-2.1	0.5-3	**0.7-3.8**
NF / dB	1.9	2.2-2.7	6.8-13.2	**1.6-3.8**
Gain / dB	70	37	35	**45**
Current / mA	27-60*	7.3**	208-500*	**22.8-34.9**
Supply / V	1.3	1.3	1.2	**1.2**
IIP3 / dBm	+13.5	-3.5	+11.7	**+1**
IIP2 / dBm	>54	>40	>58	**>75**
Area / mm^2	1.2	0.2	5.9	**0.15**
Process / nm	40	45	65	**65**

*Incl. Harmonic Rejection, **Excl. LO drivers

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Conclusions

- Feedback receiver front-end with frequency selective input match has been demonstrated
- By introducing auxiliary path, noise from main path can be cancelled, and the linearity is better compared to using more current in the main path
- Low noise figure, high linearity, small area

Acknowledgement

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