A Linearized 0.7 to 3 GHz Receiver Front-End

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Outline

- Background information

- Circuits,
  - LNA, Mixer, Prescaler

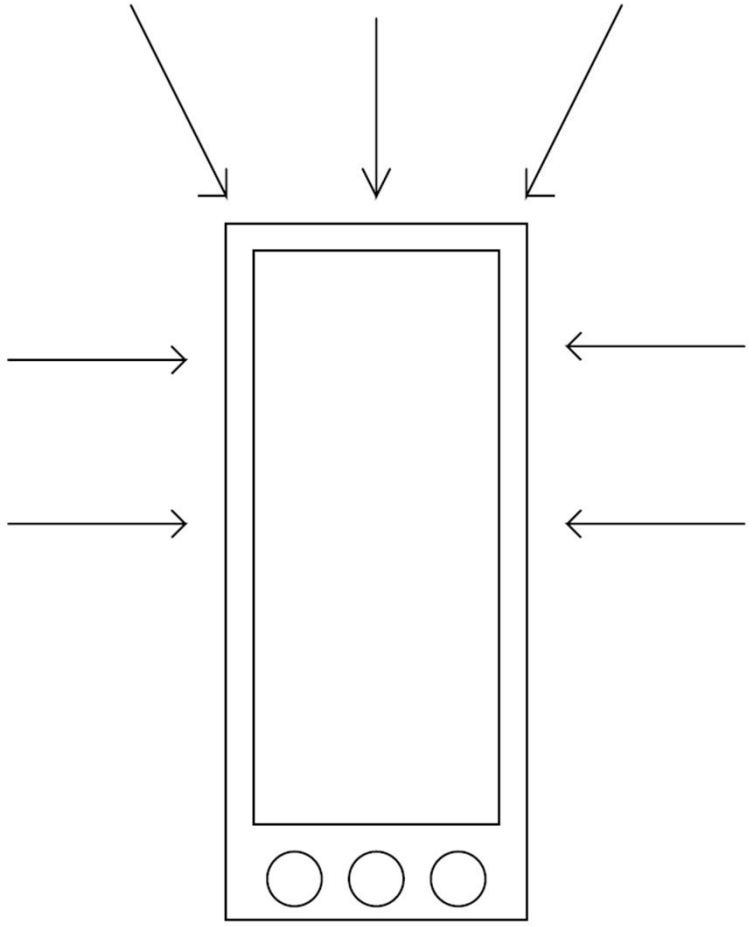
- Measured results

- Final remarks

Why is there a need for more linear circuits?

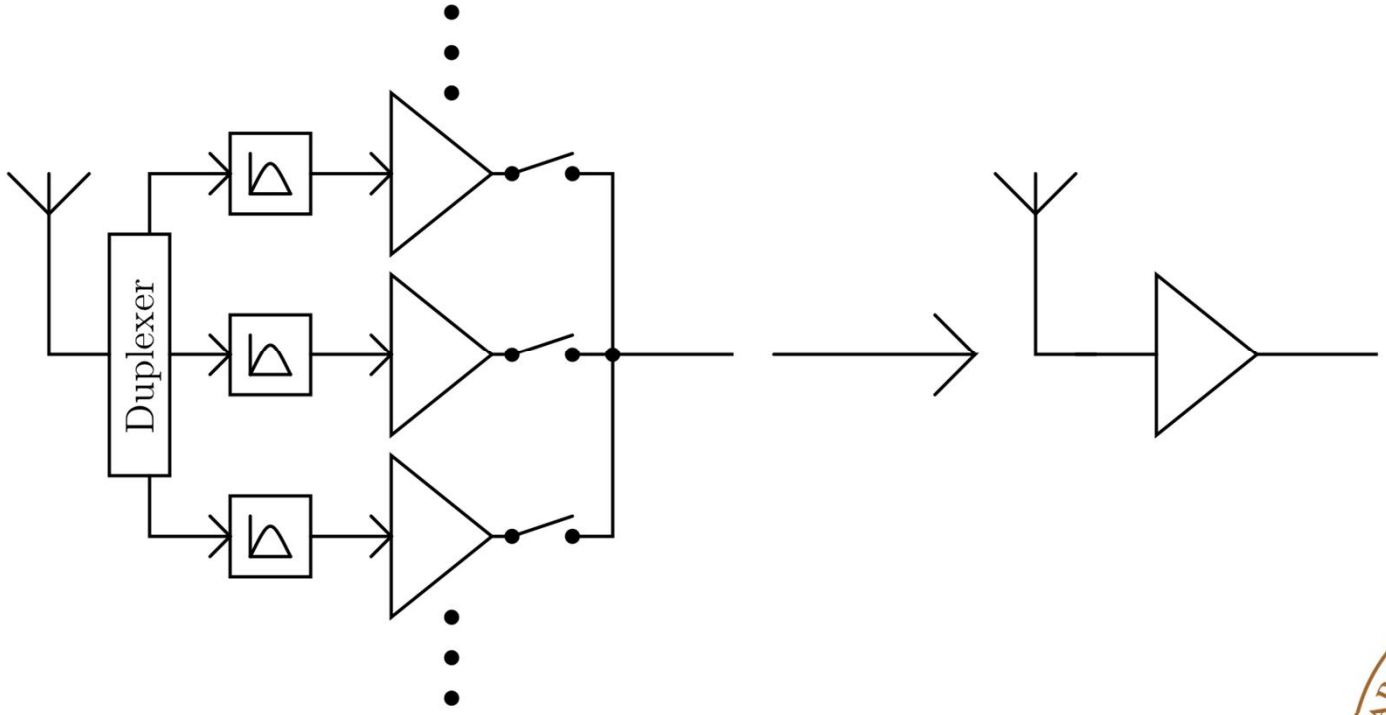
More communication standards

- GSM
- WCDMA
- Bluetooth
- WLAN
- Radio
- GPS
- LTE
- …



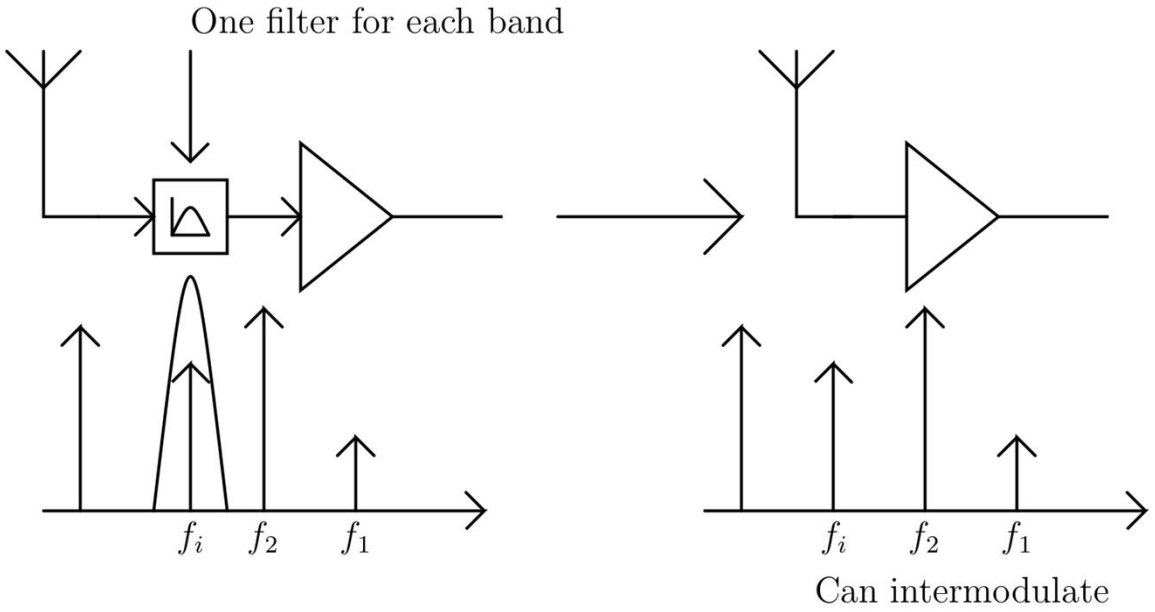
More communication standards, cont.

- More focus on wideband receivers

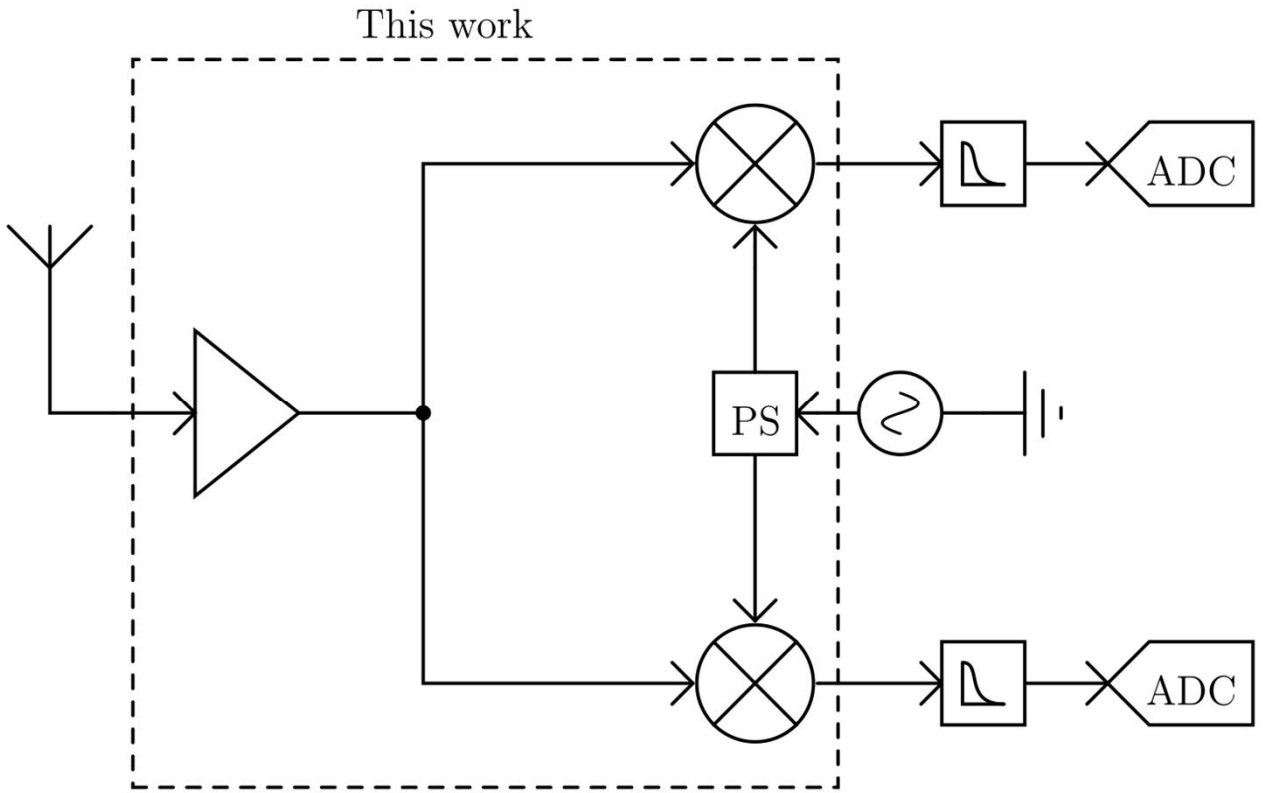


More communication standards, cont.

- More focus on wideband receivers
- Remove bulky components such as SAW-filter
- A lot of interferers at the receiver input
- Intermodulation
  - Third order can fall in-band



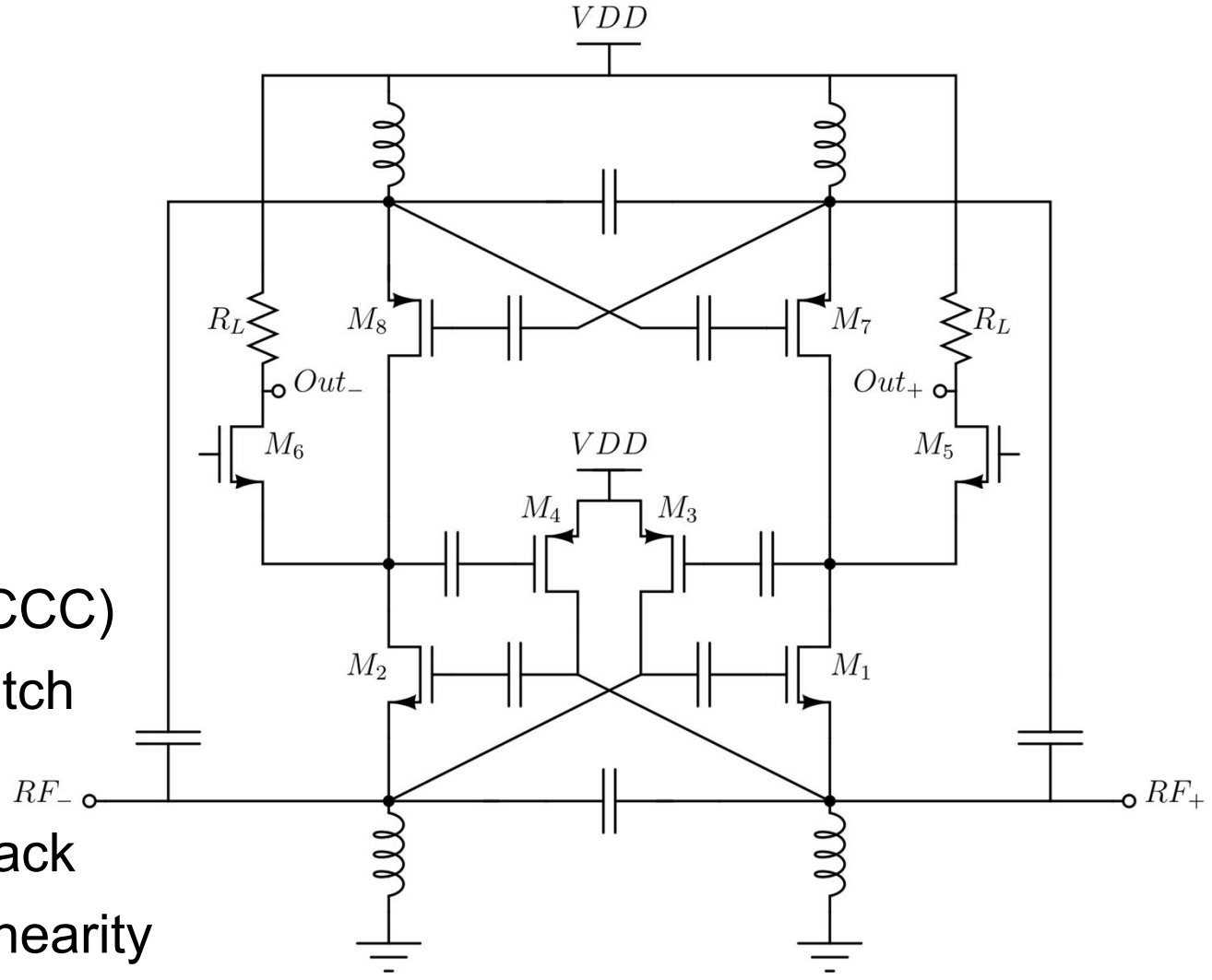
Circuits implemented in this system



- Part of SSF Digitally Assisted Radio Evolution (DARE)

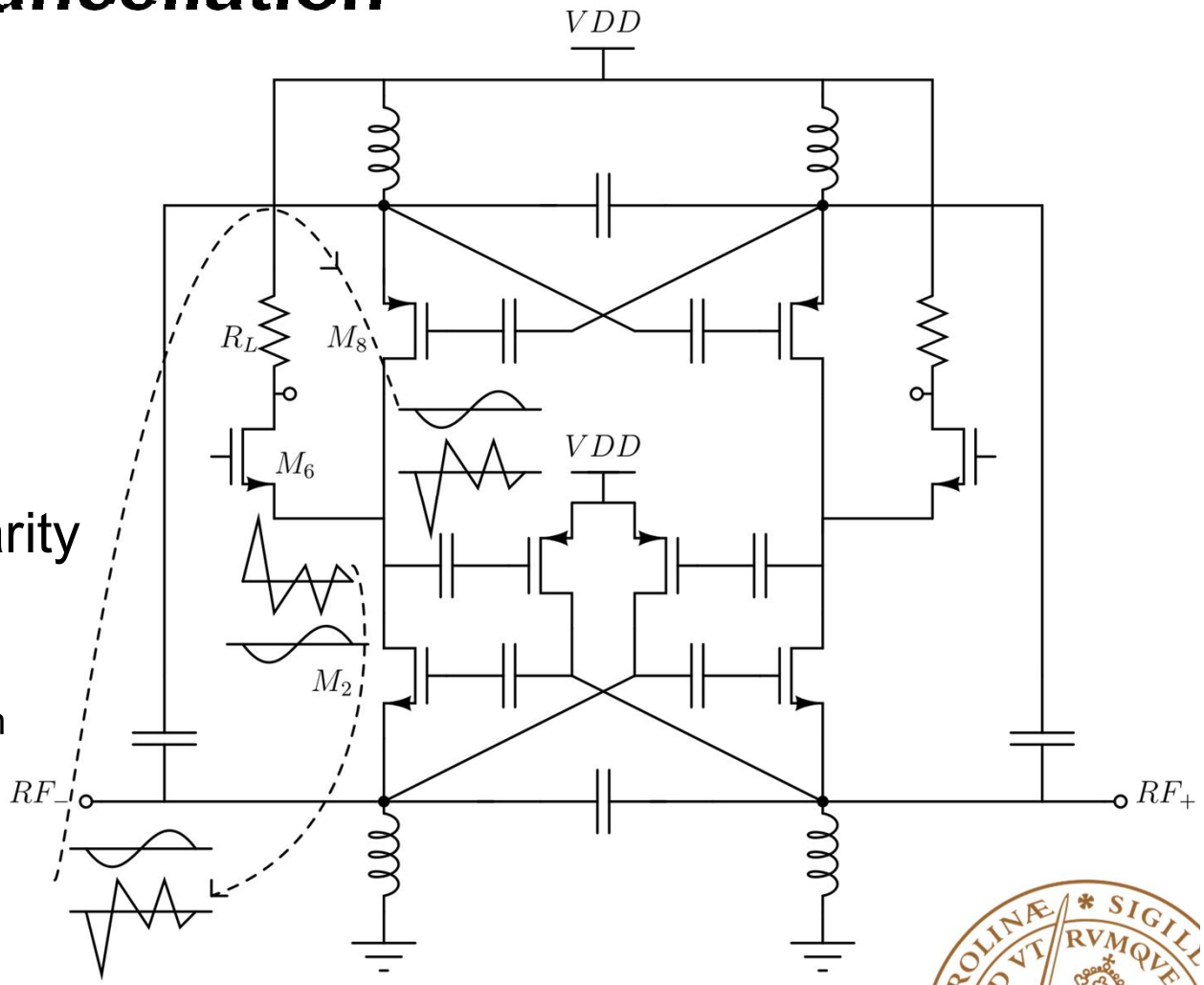
LNA

- CG-LNA
  - $1/g_m$ match
- G_m-boosting (CCC)
  - $1/(2g_m)$ match
- Positive feedback
  - Increase linearity
- More wideband load
  - Resistive



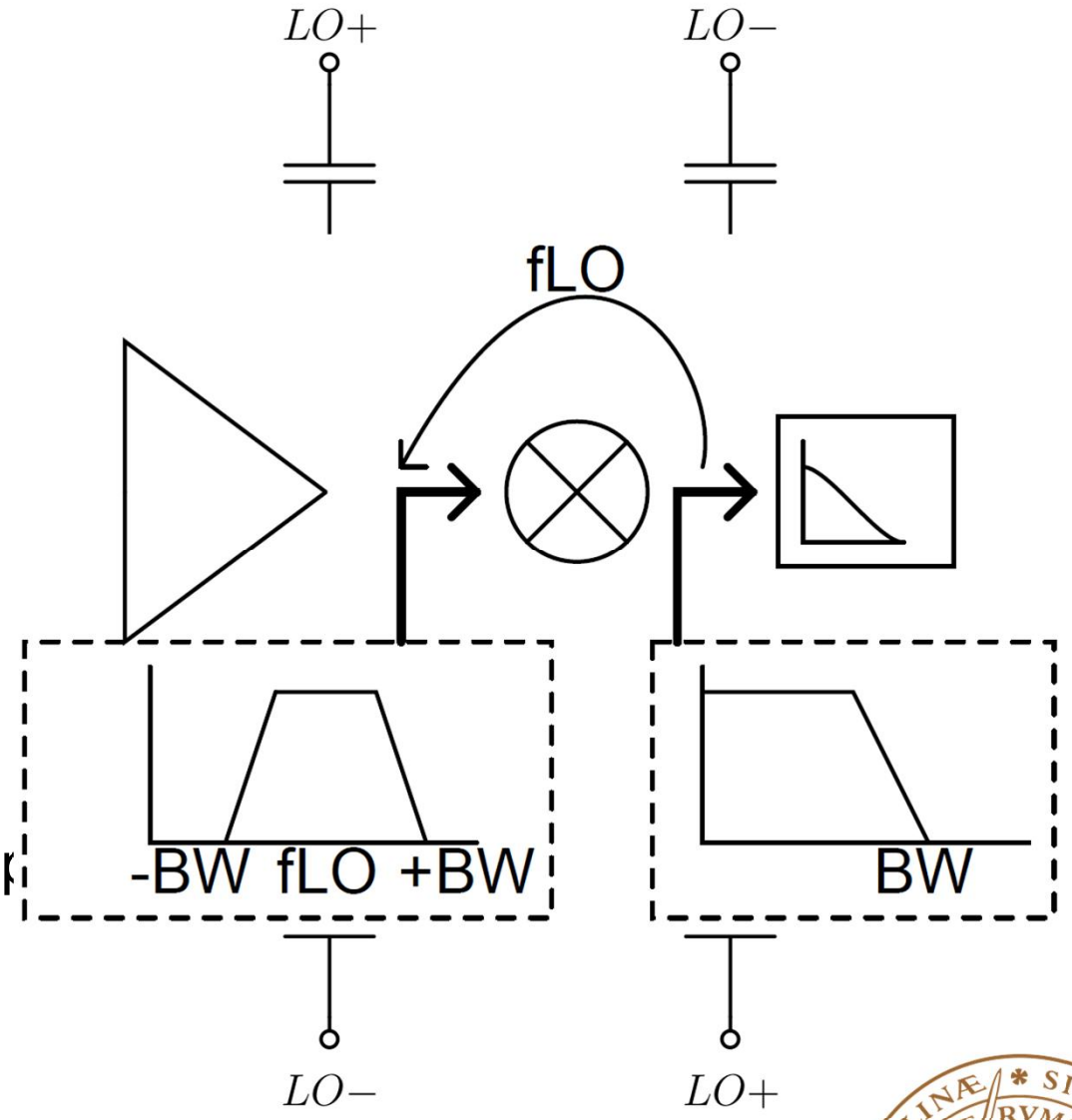
LNA, Noise Cancellation

- Current bleeding
- Cancel noise
- Cancel non-linearity
- CCC for extra g_m



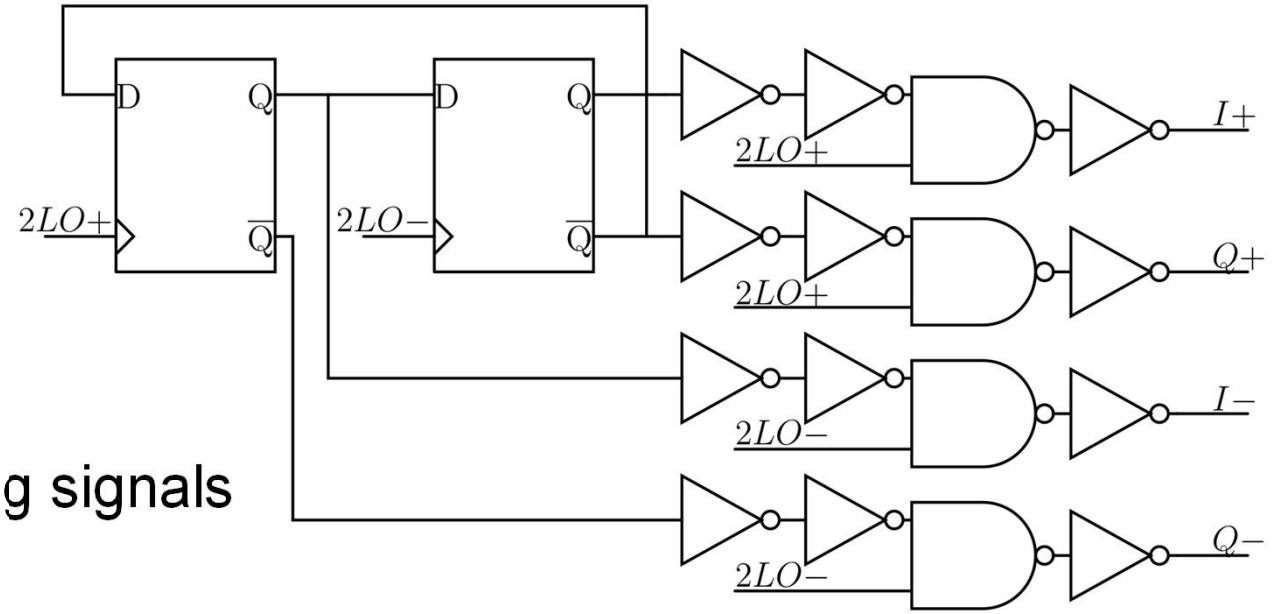
Mixer

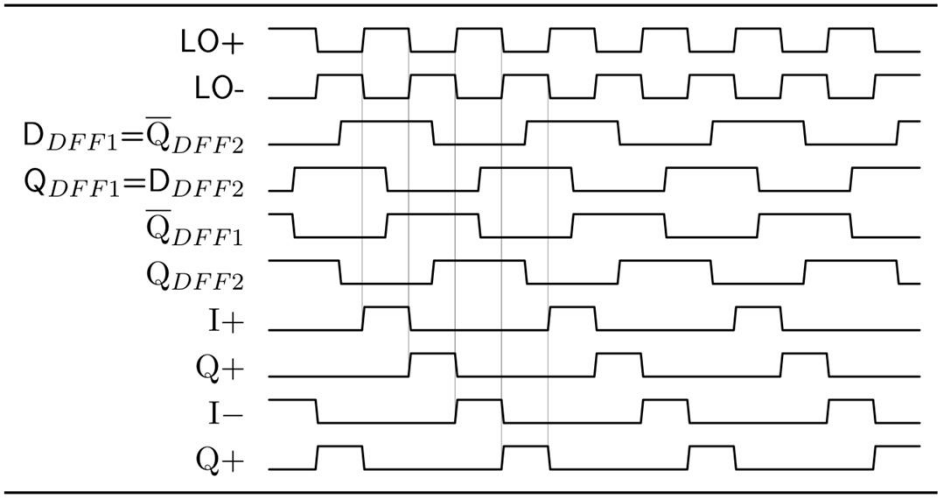
- Passive mixer
- Bootstrapped
- Increase linearity
- By adding a feedback
  - Low pass filter
- IF filter to RF filter



Prescaler

- 25% duty cycle
- Non-overlapping signals
- Inverter-based buffer



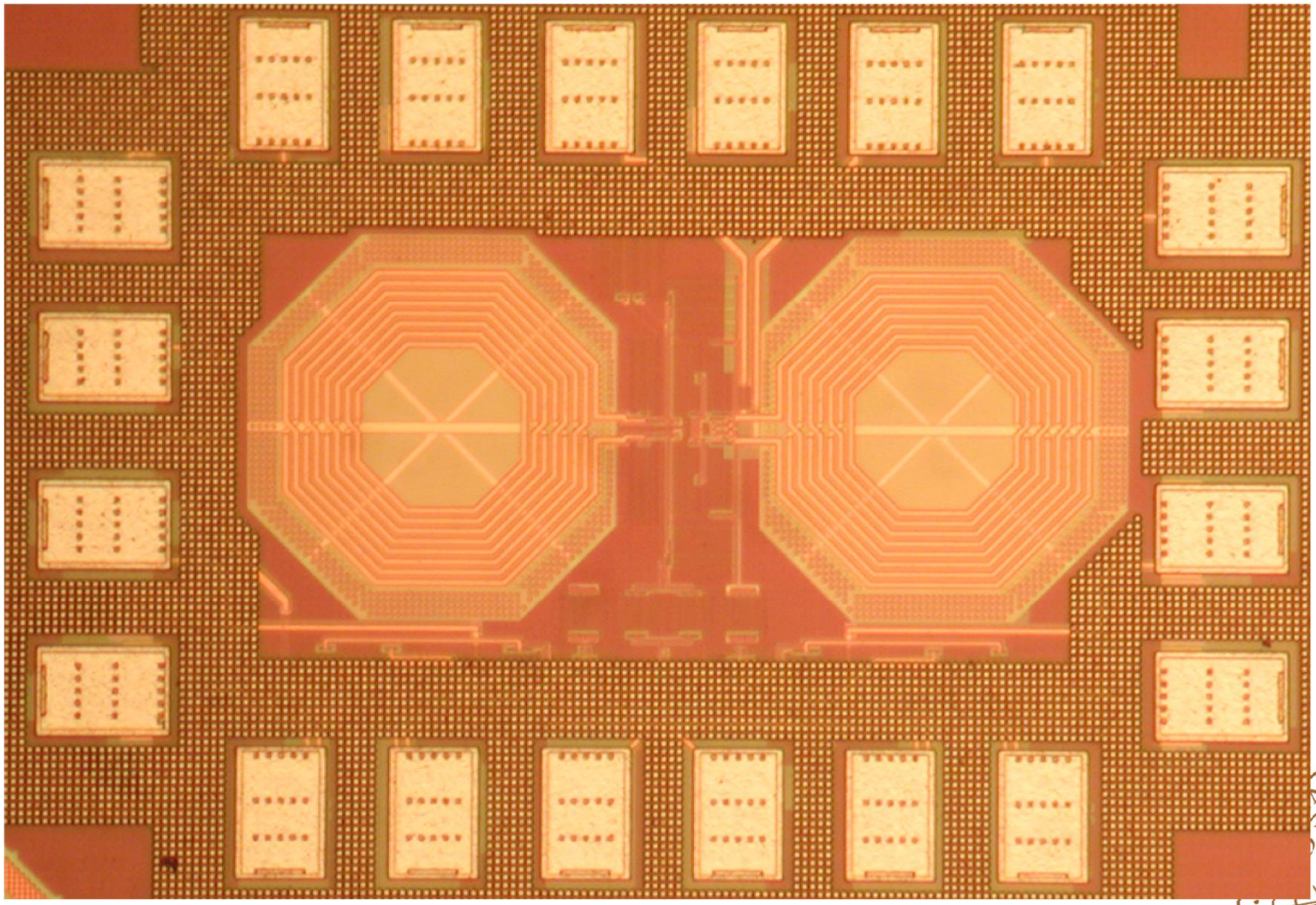


Layout

0.711 mm

STM 65 nm

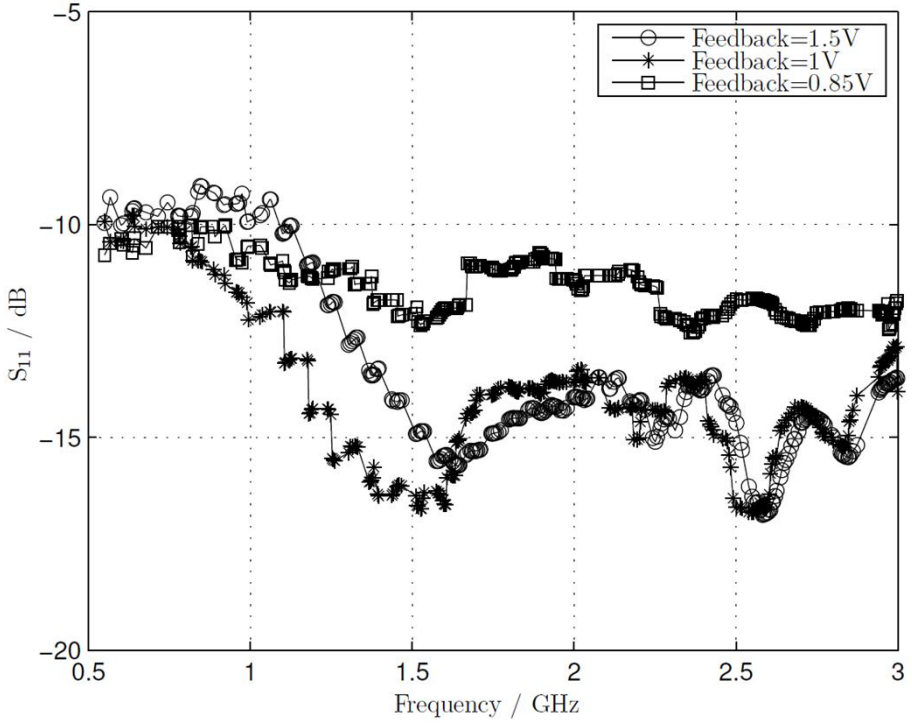
0.489 mm



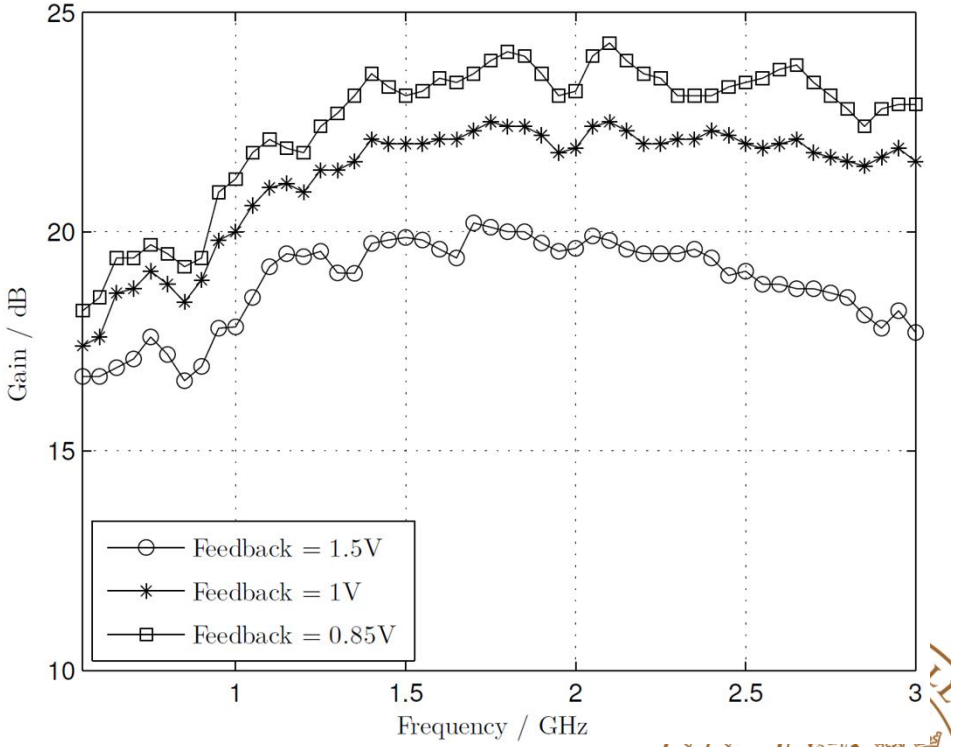
Measurements Results

Input matching and gain

S11

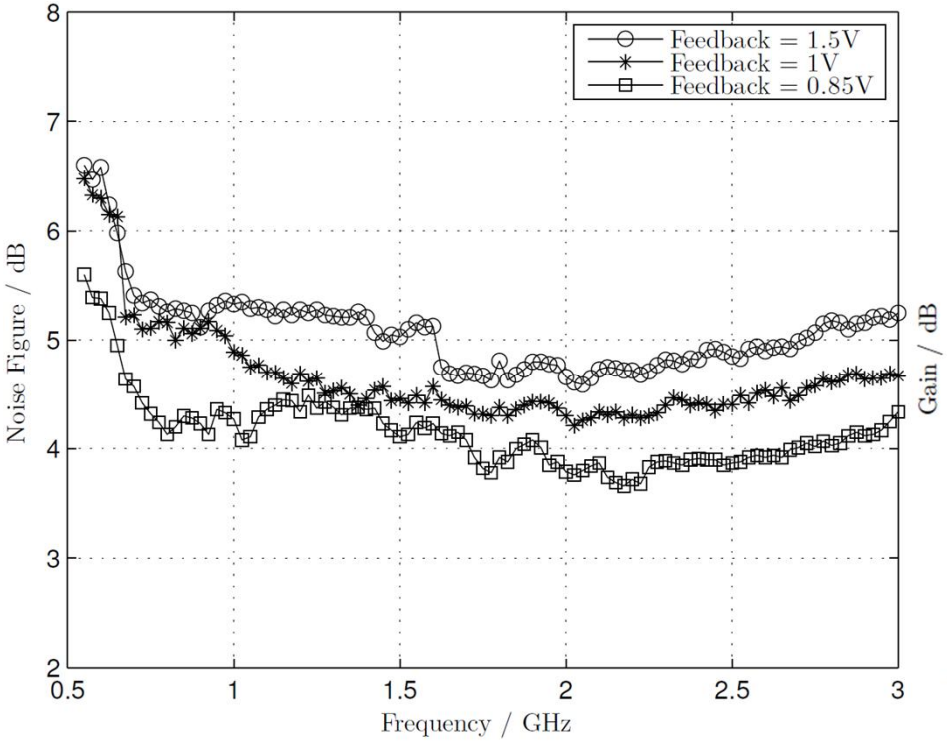


RF Gain

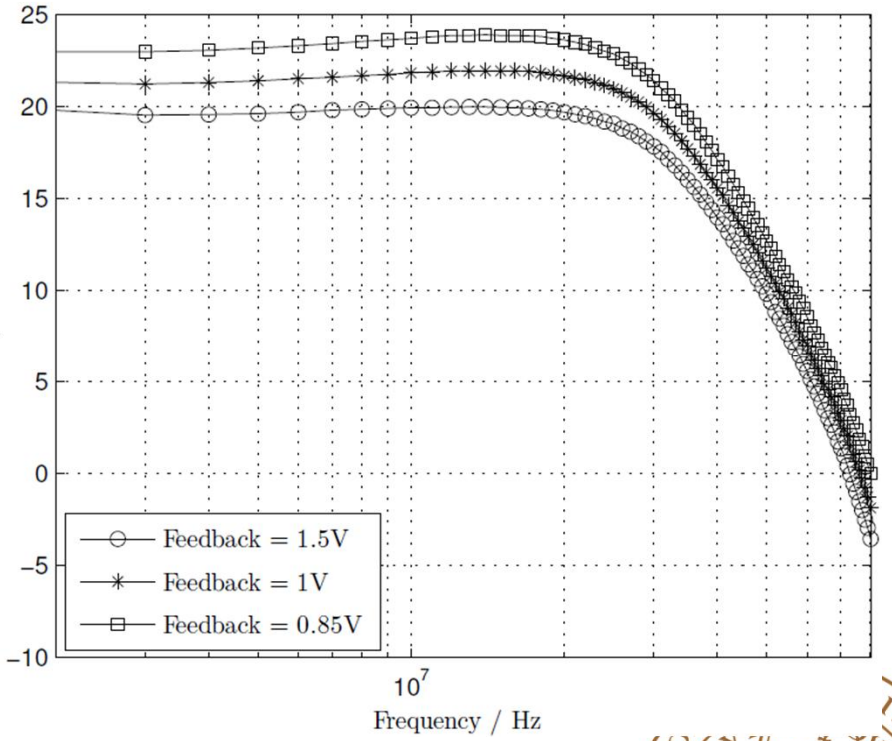


Noise figure and gain

Noise figure vs. RF

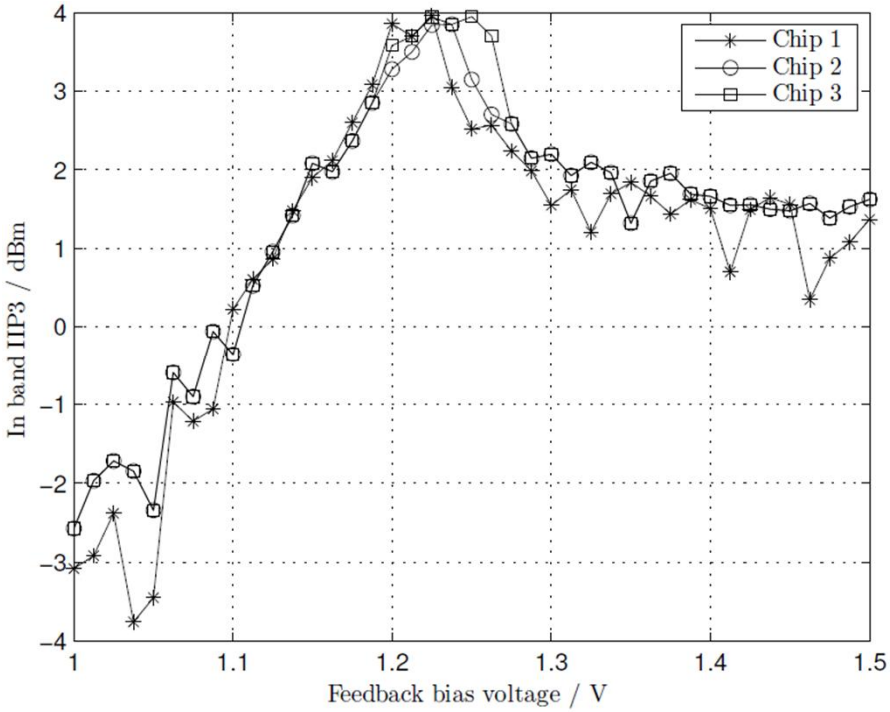


Gain vs. IF

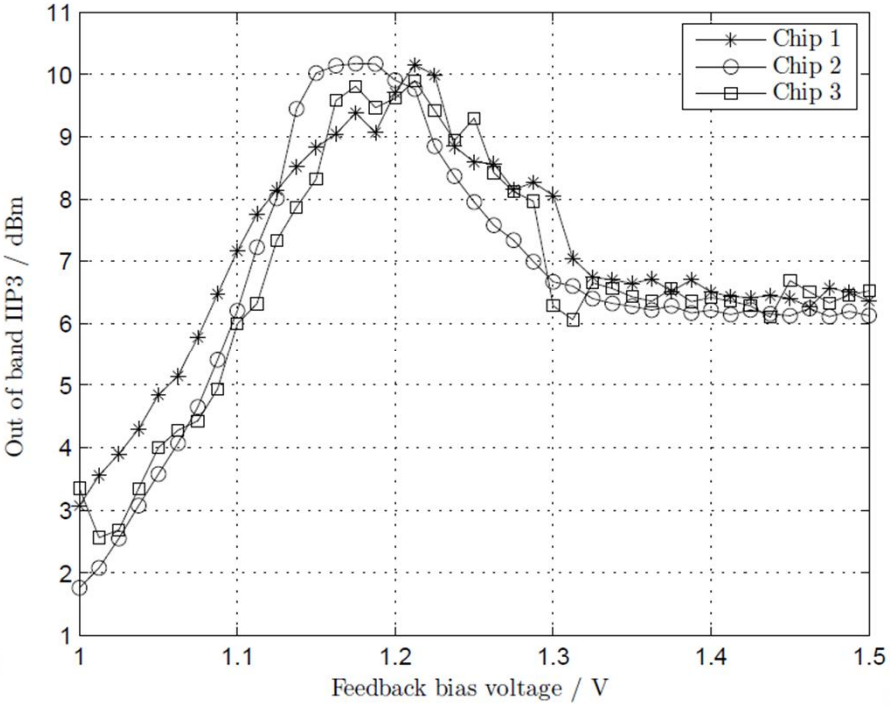


IIP3

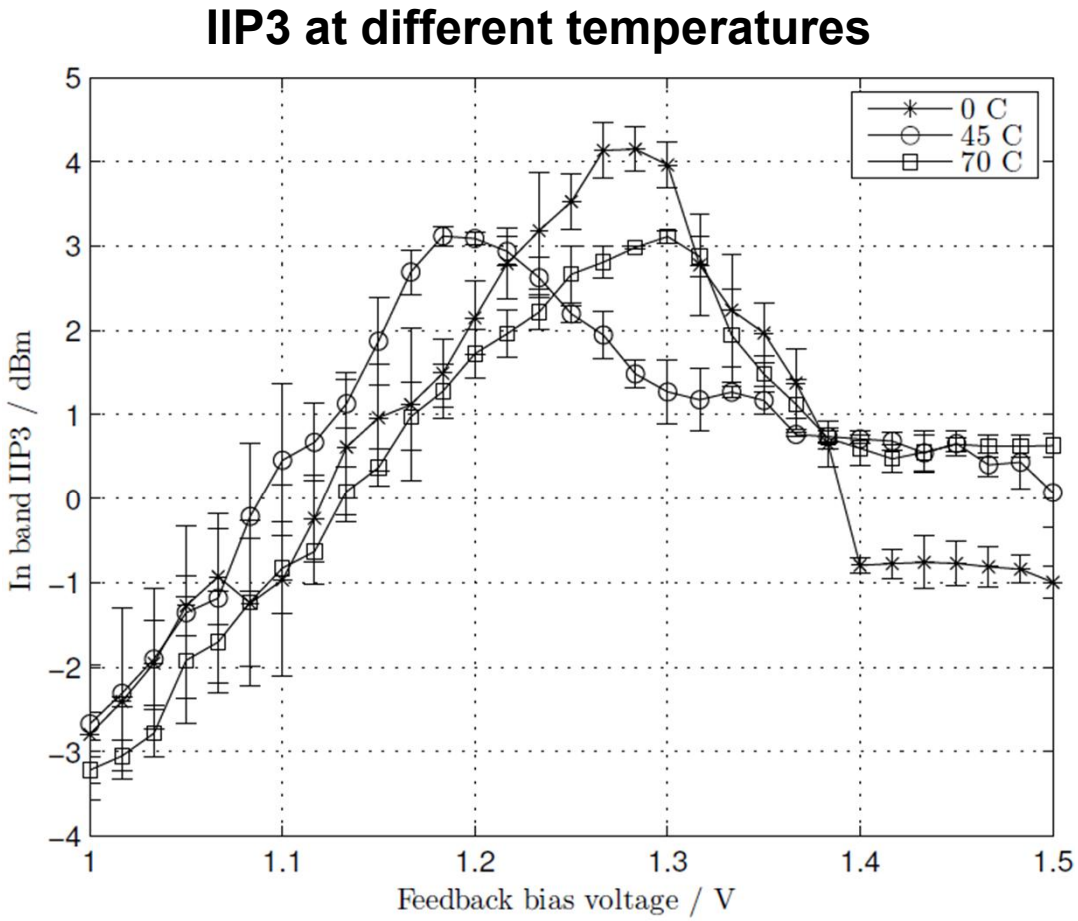
In band IIP3



Out of band IIP3



IIP3, cont.


IIP3 at different temperatures
0 C
45 C
70 C
In band IIP3 / dBm
Feedback bias voltage / V
5
4
3
2
1
0
−1
−2
−3
−4
1
1.1
1.2
1.3
1.4
1.5

Performance summary

	Value
Power consumption LNA + Mixer	4.38 mA from 1.5 V supply = 6.6 mW
Maximum voltage gain	20 dB @ 1.5 V, 22.5 dB @ 1 V, 24 dB @ 0.85 V
Bandwidth	0.7 to 3 GHz
Noise Figure	Below 5.5 dB @ 1.5 V, Below 4.2 dB @ 0.85 V
IIP3 (In-band)	+4 dBm (2.5 dB improvement)
IIP3 (Out-of-band)	+10 dBm (3.5 dB improvement)

Final remarks

- Wireless Receiver Front-End implemented in 65 nm CMOS
- Feedback in LNA can be used to:
  - improve linearity with feedback transistors in sub-treshhold,
  - improve gain with feedback in the active region
- Bootstrapped Mixer to increase performance
- Published in Springer Analog Integrated Circuits and Signal Processing vol. 73 2012

Thank you for your attention!

Questions?

Swedish Foundation for Strategic Research