



Columbia Integrated Systems Laboratory

A Blocker-Tolerant RF Front End with Harmonic Rejecting N-Path Filter Yang Xu, Jianxun Zhu, and Peter Kinget

Motivation

Key requirements for a software-radio (SDR) front end are tolerance to out-of-band (OB) interference and strong harmonic rejection to reduce the requirements on off-chip tunable band-pass filters. N-path filters (NPF) offer good OB linearity, but their drawbacks are LO leakage and harmonic response.

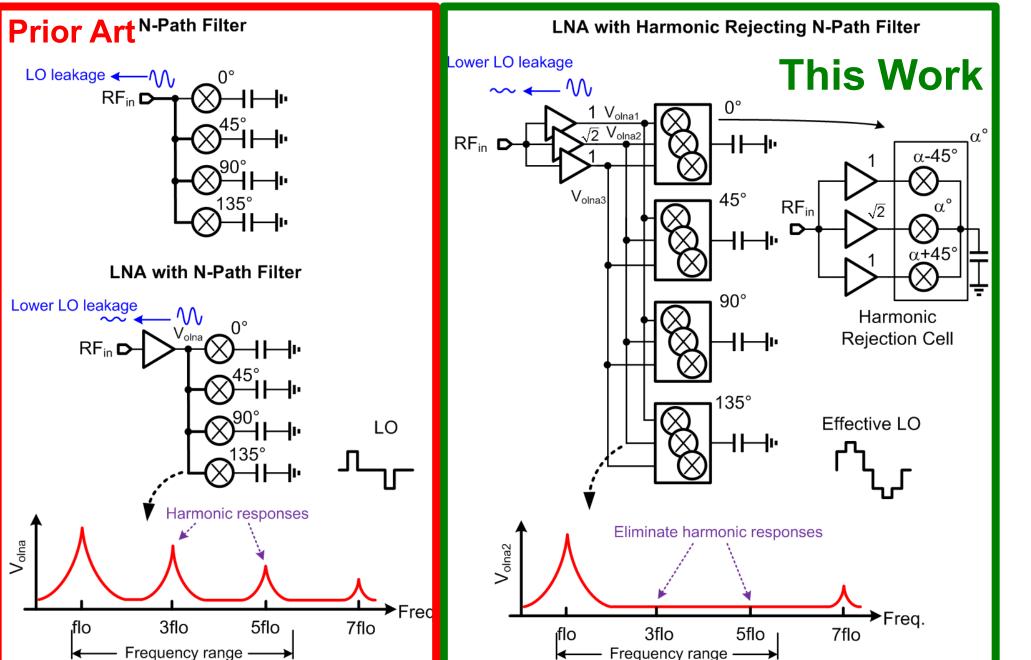
In this work:

(1) preceding the NPF with an LNA offers reverse isolation and reduces the LO leakage;

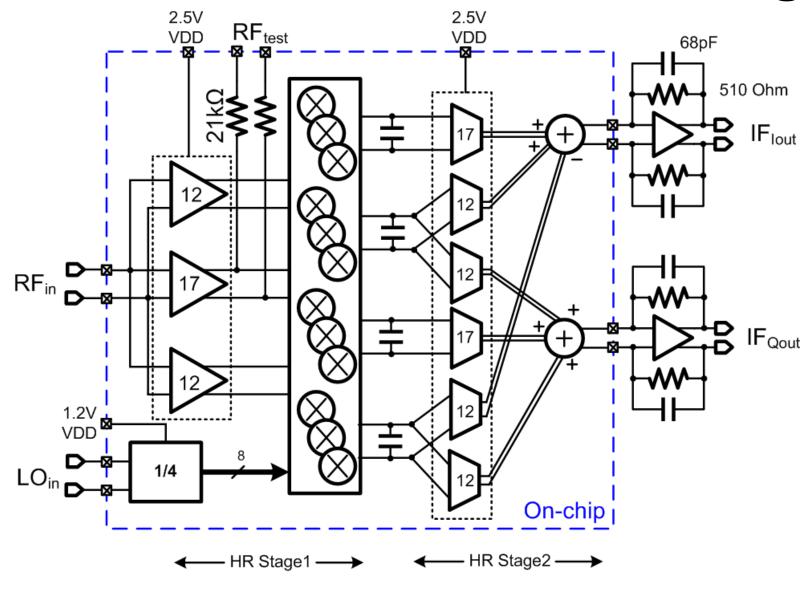
(2) including harmonic rejection eliminates the harmonic responses of NPF to improve the OB linearity at the LO harmonics;

(3) a two stage harmonic rejection architecture offers high harmonic rejection ratio (HRR) without calibration;

(4) a high VDD is used so the LNA can handle larger output voltage swing for improved OB linearity.



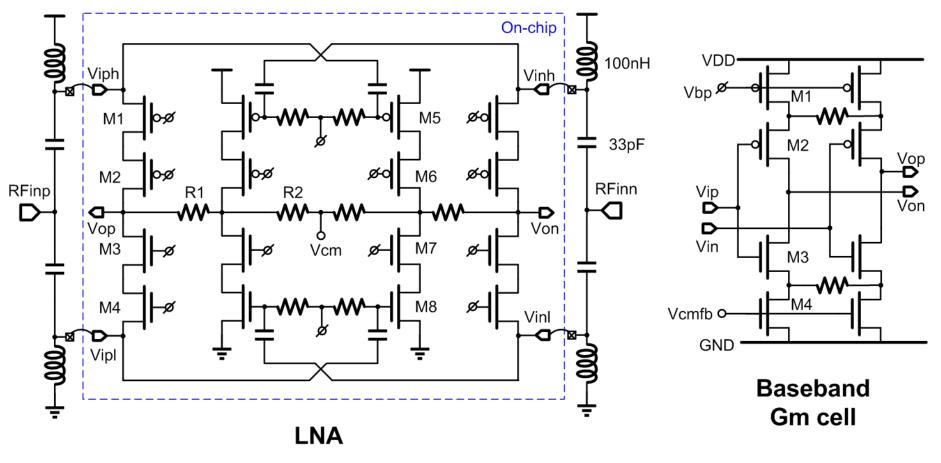
Front-End Block Diagram



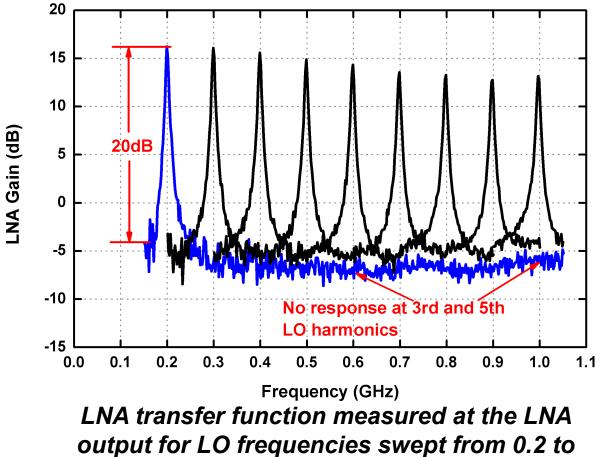
The direct conversion RF front end consists of a noise-cancelling LNA with harmonic-rejecting NPF, baseband transconductors (Gm) and LO divider. The baseband capacitors have an effective capacitance of 60pF.

Three sections of LNA and baseband Gms realize a two stage harmonic rejection architecture.

Front-End Circuits



The noise-cancelling LNA and baseband Gm use currentreuse to lower the power consumption and can operate from 1.8V to 2.5V

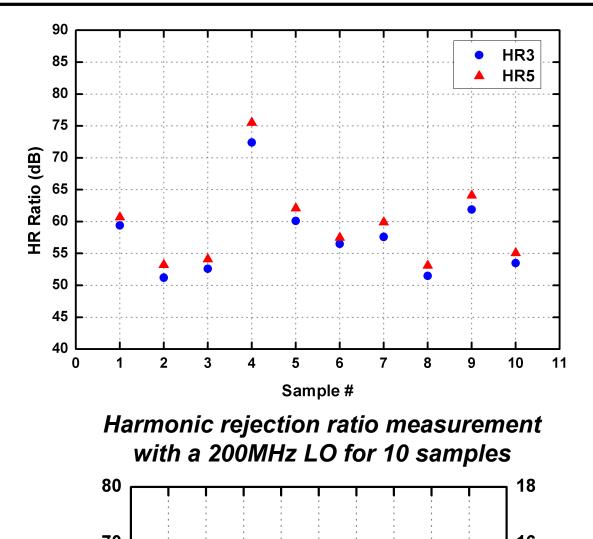


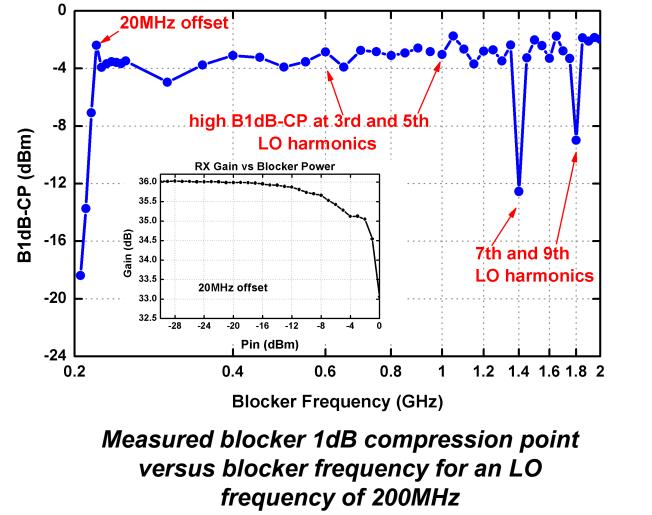
1GHz with a 0.1GHz step

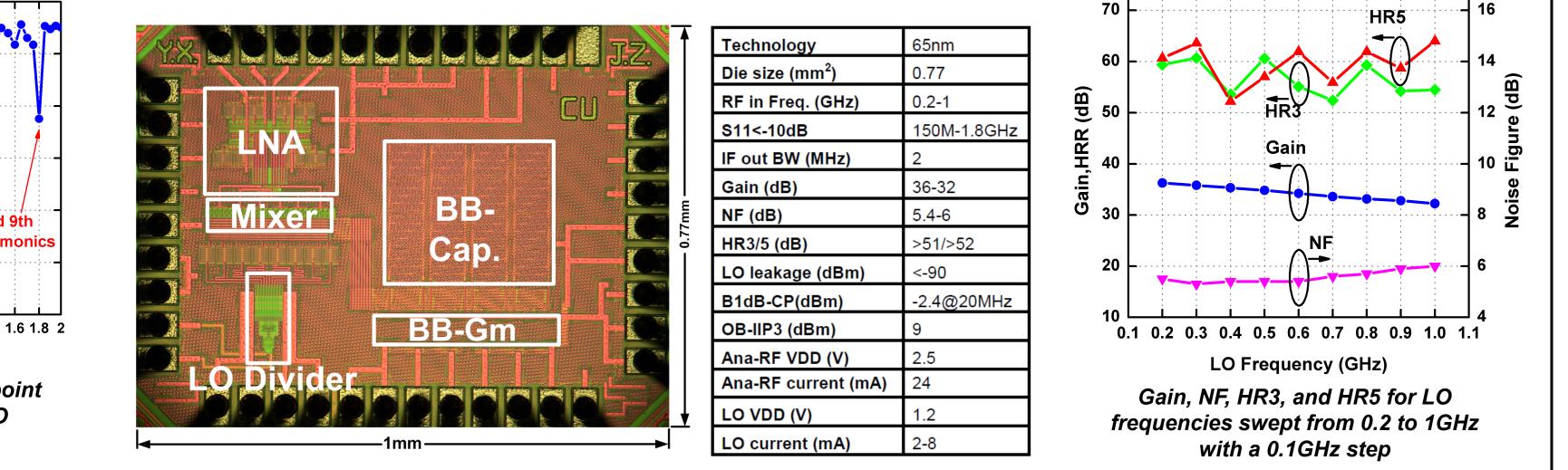
Measurement Results

The chip was fabricated in 65nm CMOS process. All the measurement are done with a 2.5V analog/RF supply to achieve maximal linearity and a 1.2V LO supply. An off-chip 180° hybrid drives the differential RF inputs and the hybrid loss is calibrated out.

The LNA output shows the transfer curve of the harmonic rejecting NPF. The high 1dB-blocker compression point (B1dB-CP) proves that the chip has good blocker tolerance both at a low frequency offset and at the LO harmonics, the 7th LO harmonic is out of the frequency range, and can be rejected with an external passive input low-pass filter.







Conclusions

A 0.2-1GHz RF front end with an harmonic-rejecting N-path filter features tunable narrow band filtering and high attenuation at the 3rd and 5th order LO harmonics at the LNA output. The B1dB-CP is -2.4dBm at a 20MHz offset, and remains high at the 3rd and 5th LO harmonics. The reverse isolation of the LNA helps keep the LO emission below -90dBm. A two-stage harmonic rejection approach

offers >51dB harmonic rejection ratio at the 3rd and 5th LO harmonics without calibration.

Acknowledgments

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Analog & RF

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