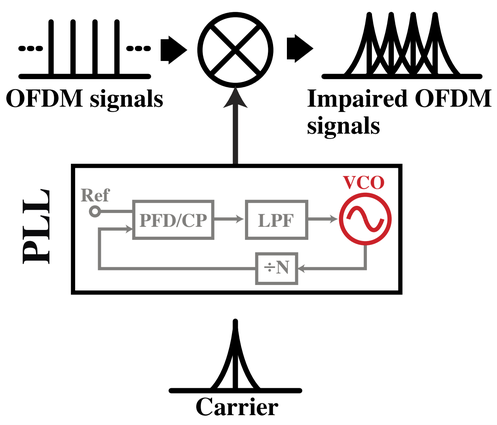
A Tail-Current Modulatd VCO with Adaptive Startup Scheme

Aravind Tharayil Narayanan,Wei Deng,
Kenichi Okada, Akira Matsuzawa
Tokyo Institute of Technology, Japan

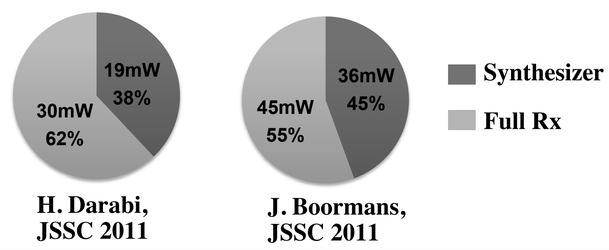
1. Research Background

Effects of Phase Noise



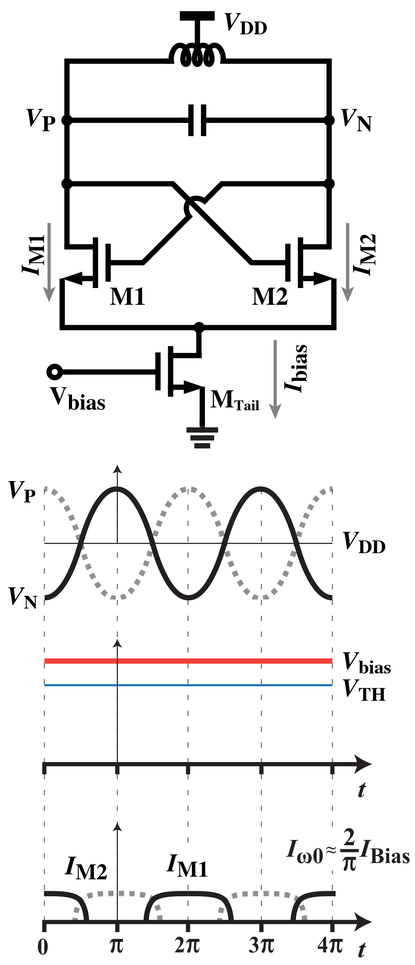
- Voltage Controlled Oscillator (VCO) is dominant component in L.O. in terms of area and power.
- Low-power, area-efficient VCOs are required for supporting emerging wireless technologies.

Transceiver Power Budget

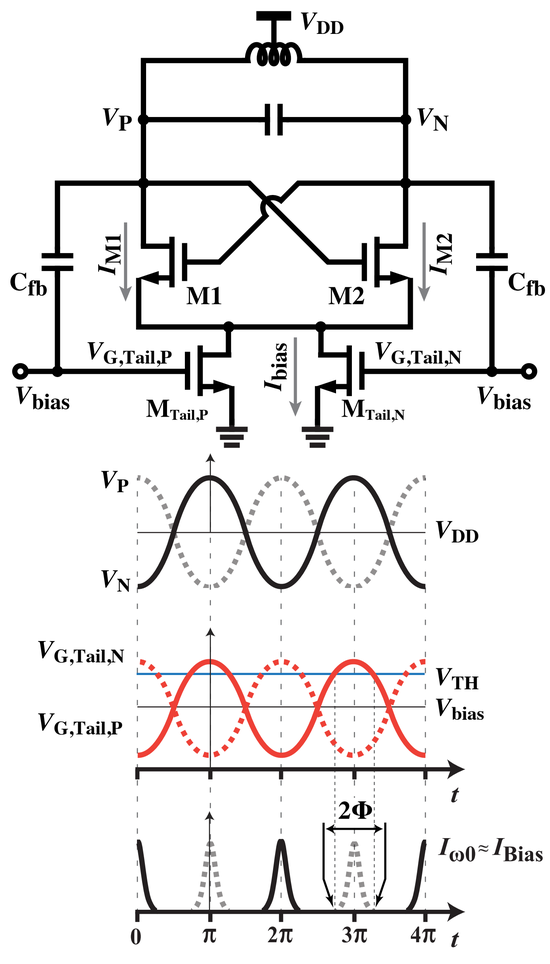


2. Design for High-Efficiency

Class-B VCO



Tail-Feedback VCO

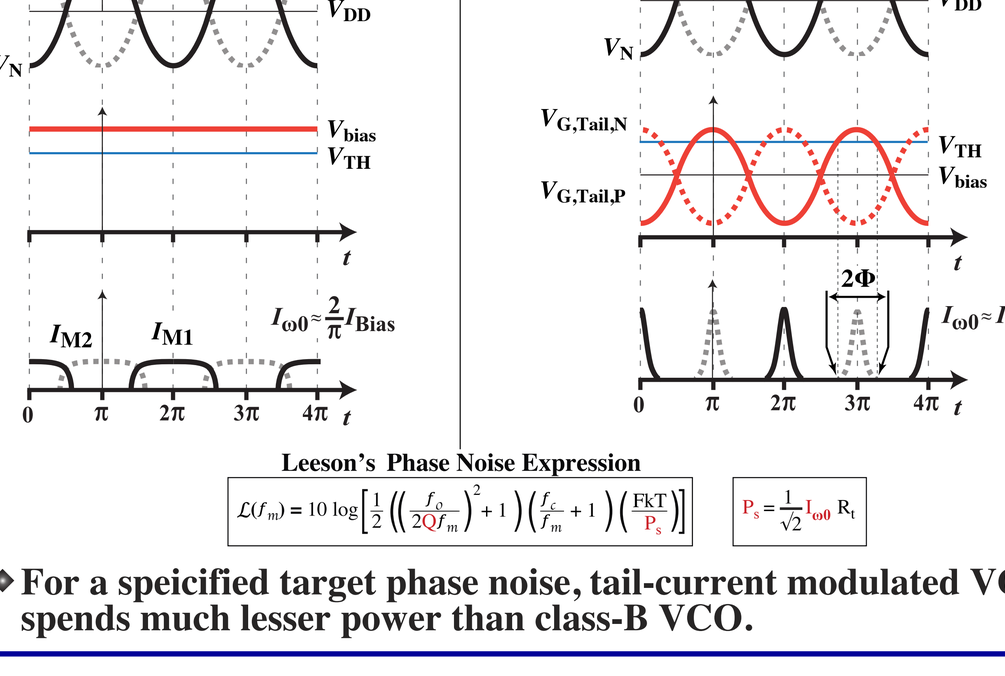


Leeson's Phase Noise Expression

$$\mathcal{L}(f_m) = 10\log\left[\frac{1}{2}\left(\left(\frac{f_o}{2Qf_m}\right)^2+1\right)\left(\frac{f_c}{f_m}+1\right)\left(\frac{FkT}{P_s}\right)\right] \qquad P_s = \frac{1}{\sqrt{2}} I_{\omega 0} R_t$$

- For a speicified target phase noise, tail-current modulated VCO spends much lesser power than class-B VCO.

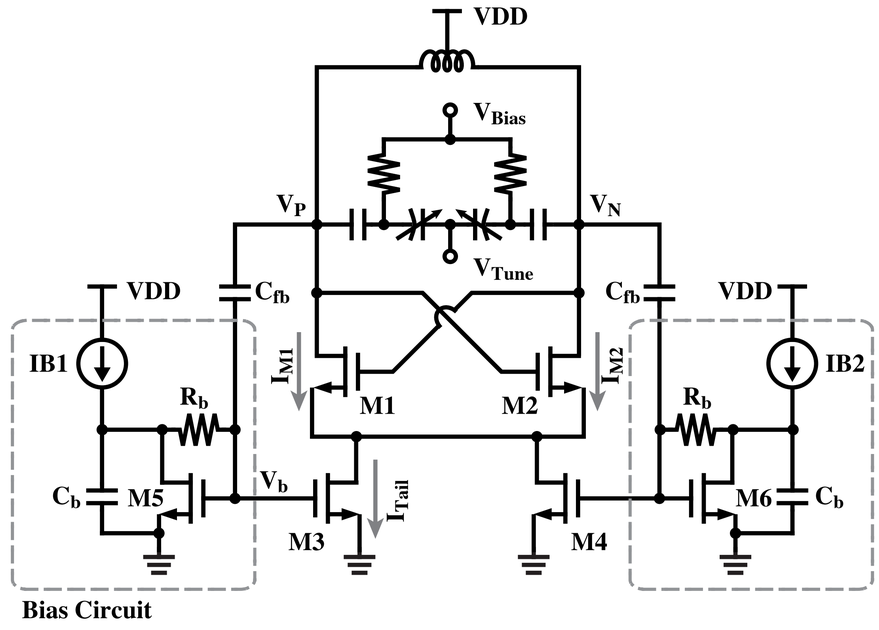
3. Tail-Noise Suppression



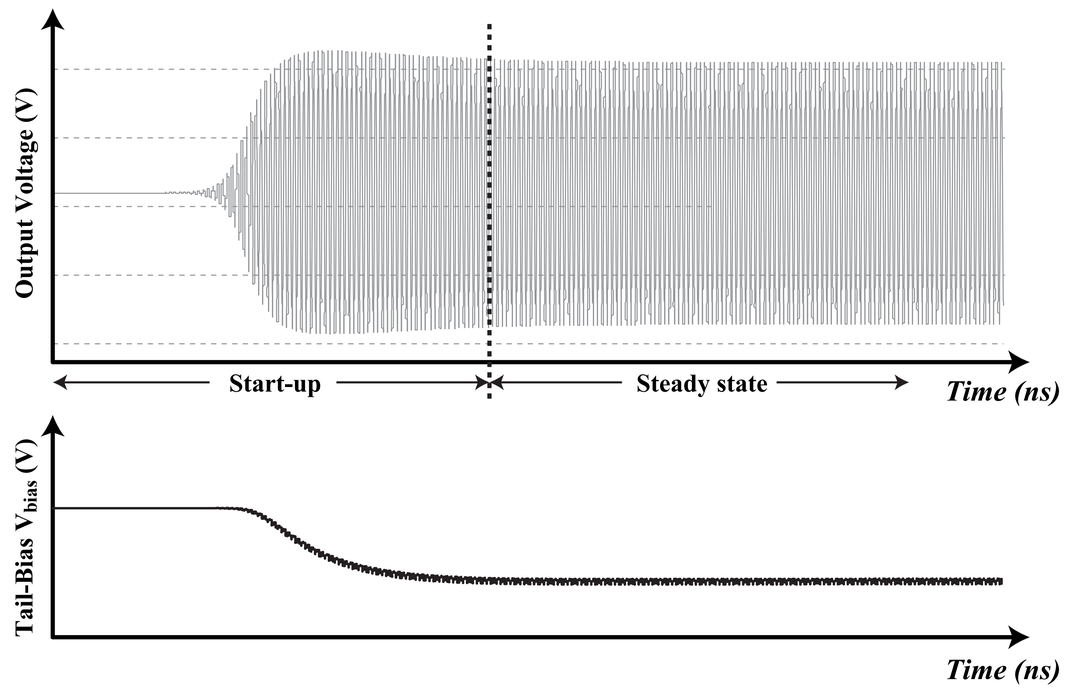
Constant Tail-Bias | Modulated Tail-Bias

4. Proposed Tail-Current Modulated VCO

Schematic Diagram of Proposed VCO



Simulaion Results



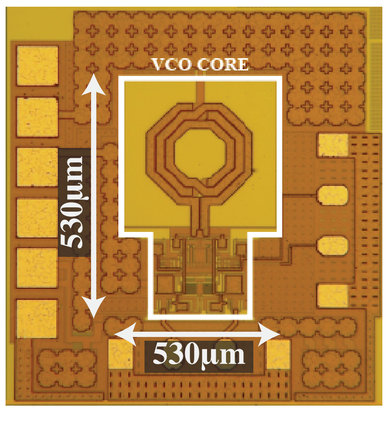
- High V_{bias} during start-up.
- V_{bias} is gradually reduced for optimum enhancing efficiency.

5. Results and Conclusions

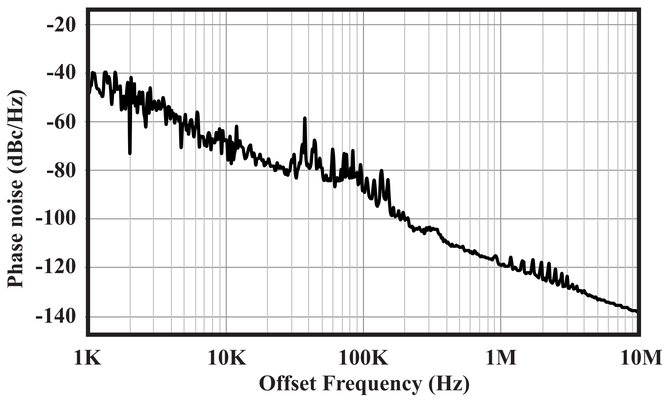
- The proposed adaptive start-up scheme achieves:
  - Reliable start-up.
  - Enhanced DC-RF conversion efficiency.
- These goals are achieved with very little power and area overhead.

	CMOS Process	Frequency [GHz]	Phase Noise [dBc/Hz]	Pdc [mW]	FoM [dBc/Hz]
JSSC2006	250nm	1.75	-125@1MHz	2.25	-186
VLSI2009	180nm	4.5	-109@1MHz	0.16	-190
JSSC2013	180nm	4.84	-125@1MHz	3.4	-193
This Work					
Simulation	180nm	4.8	-124@10Mhz	7.2	-189
Measurement	180nm	4.6	-119@1MHz	6.8	-184

Performance comparison.



Chip micrograph.



Phase noise plot.