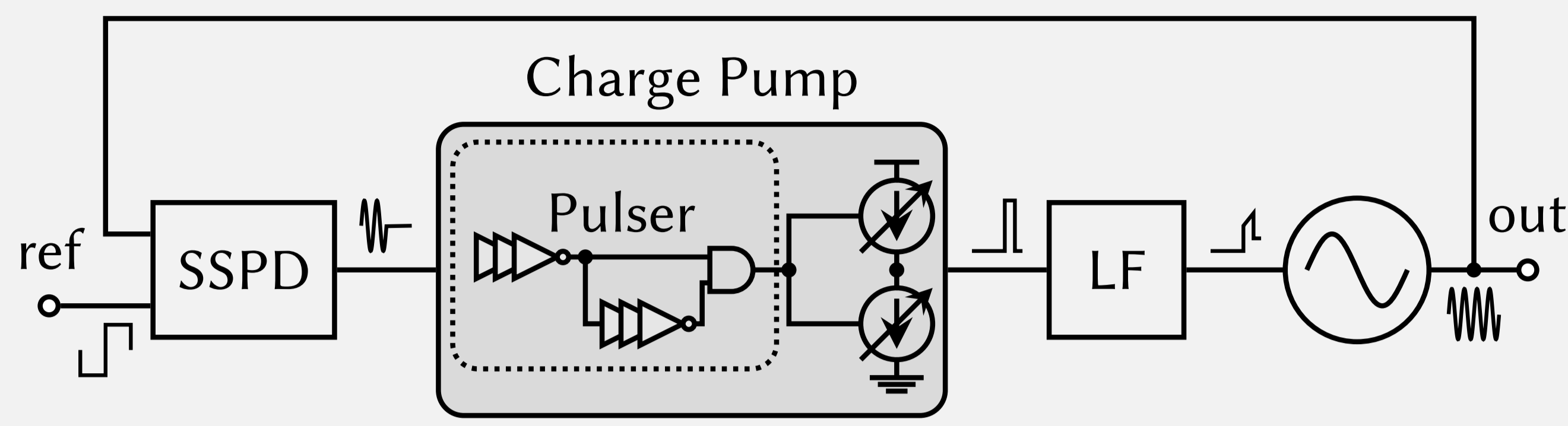


A Charge Pump for Sub-Sampling Phase-Locked Loops with Virtual Reference Frequency Doubling

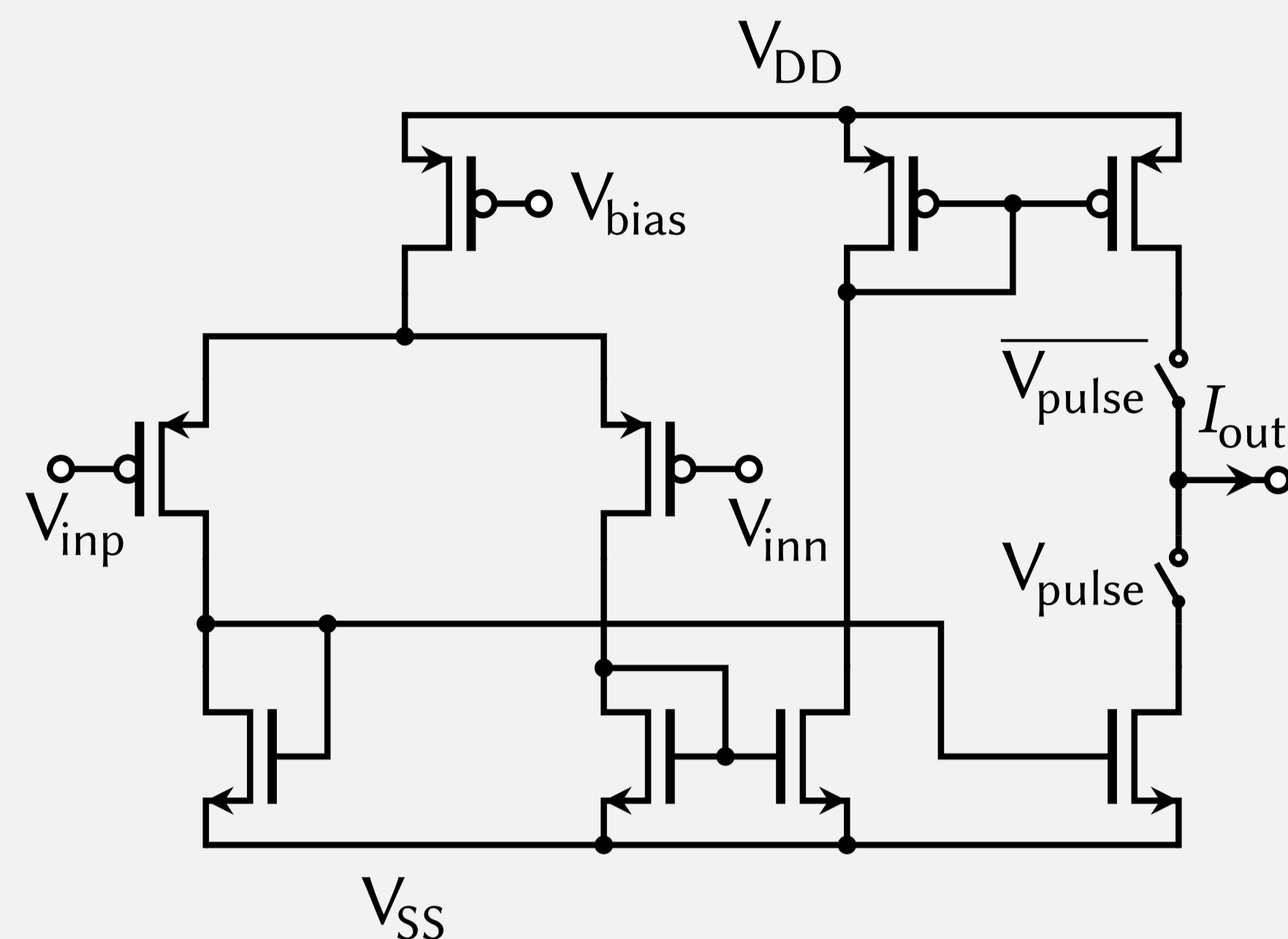
P. Kurth, U. Hecht, F. Buballa, S. Linnhoff, H. Ordouei and F. Gerfers

Motivation: Sub-Sampling Phase-Locked Loop with Conventional Charge Pump

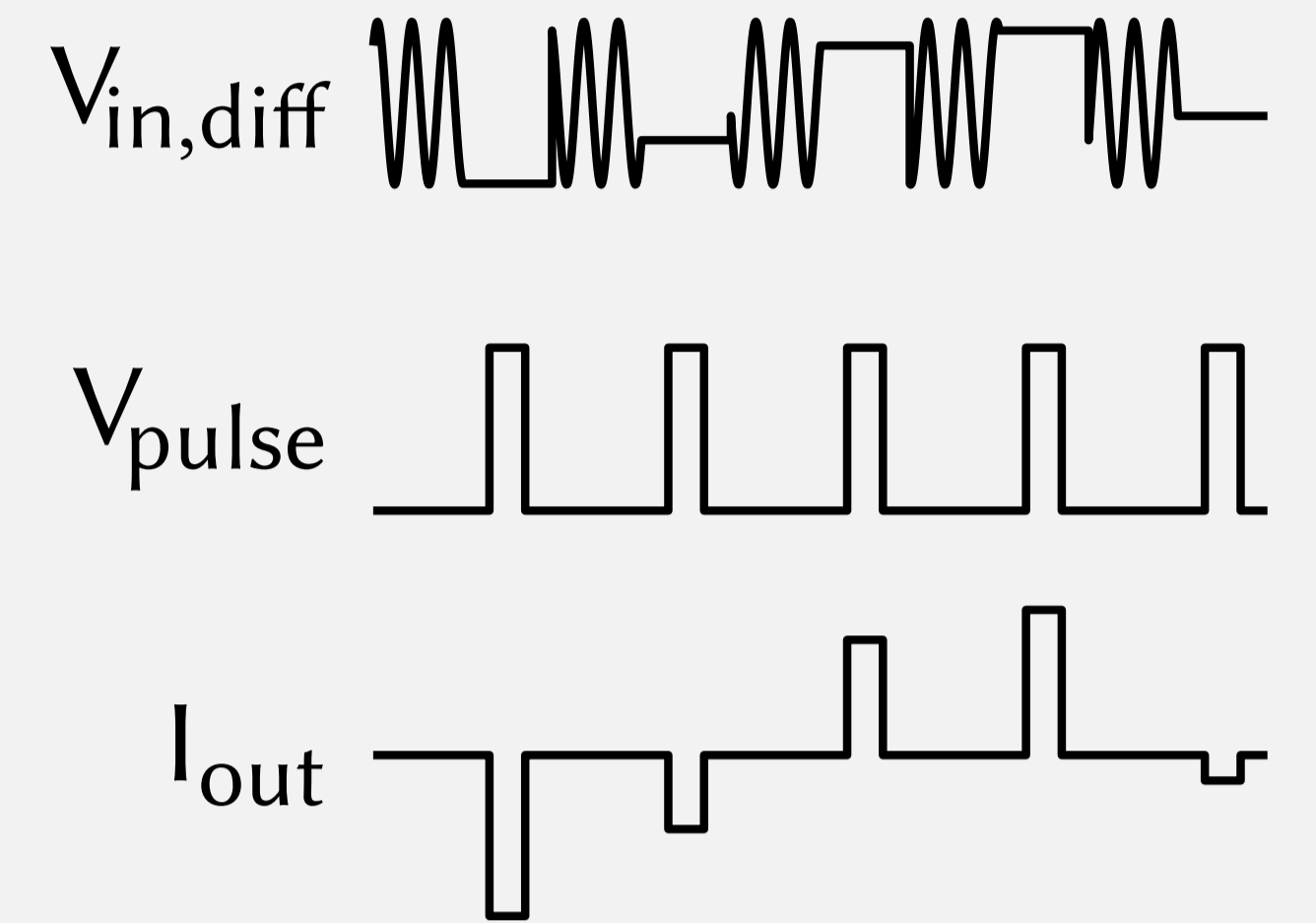


- ▶ Charge pump with pulser
- ▶ Track-and-hold signal as input signal
- ▶ Only every second sample is used
- ▶ Non-continuous output current
- ▶ Pulser has significant power consumption

Conventional Charge Pump Implementation

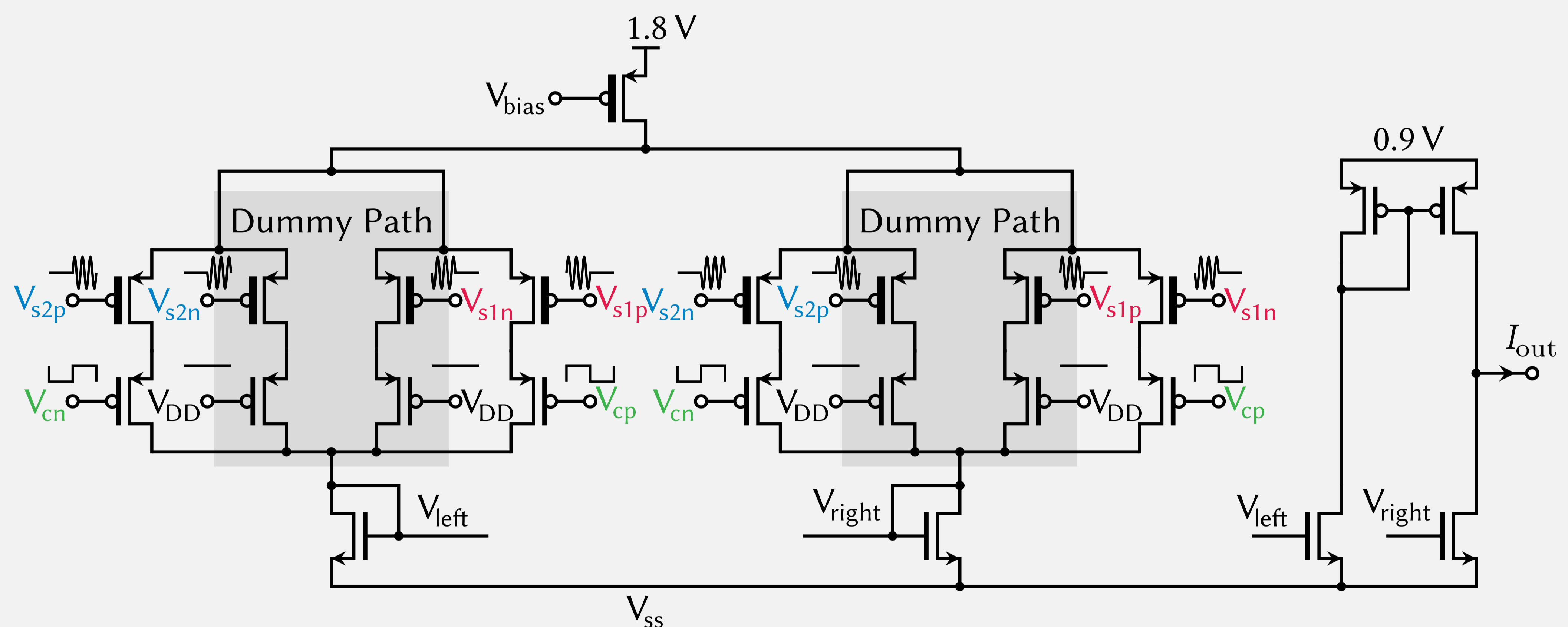
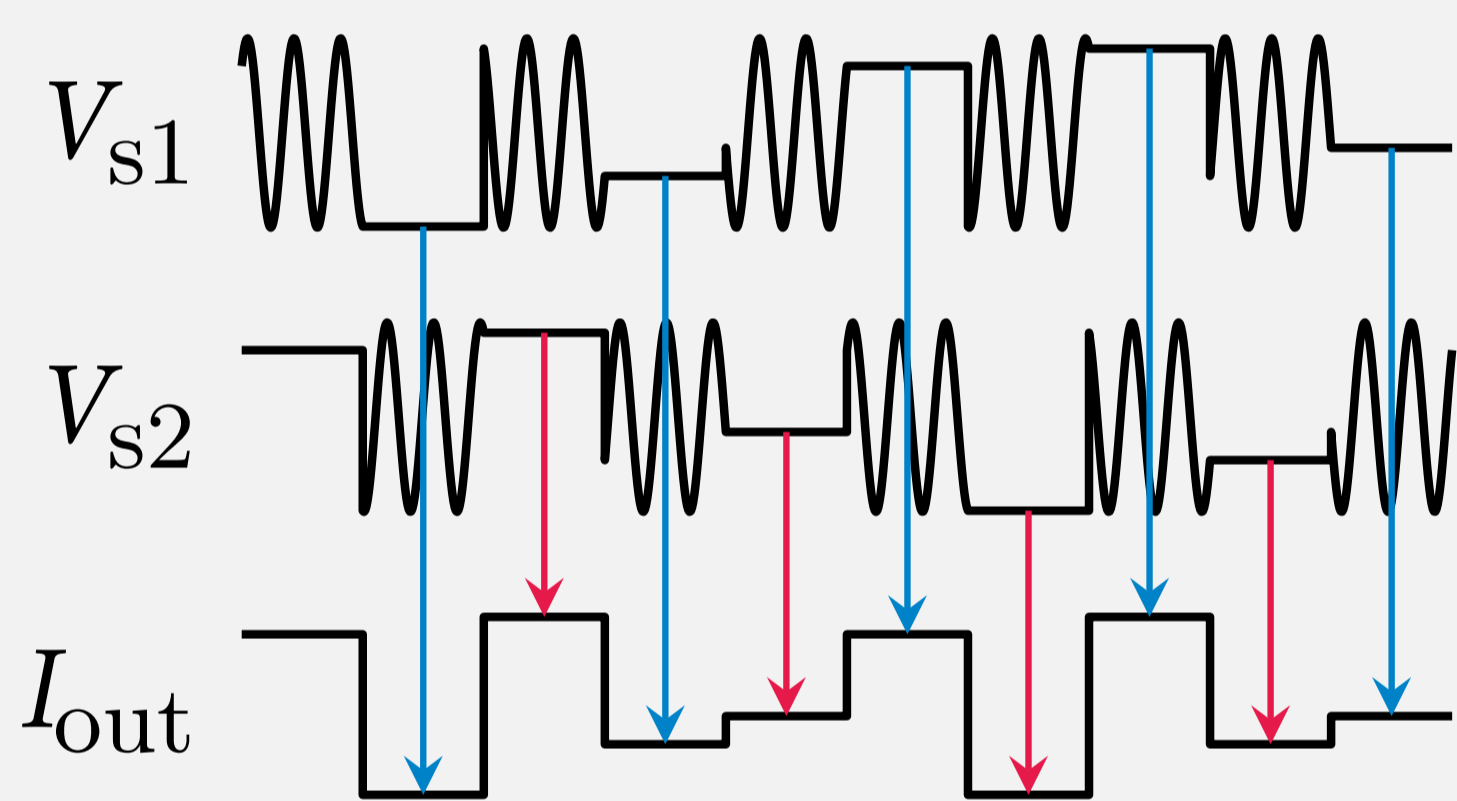


Signals



Proposed Sub-Sampling Phase-Locked Loop Charge Pump

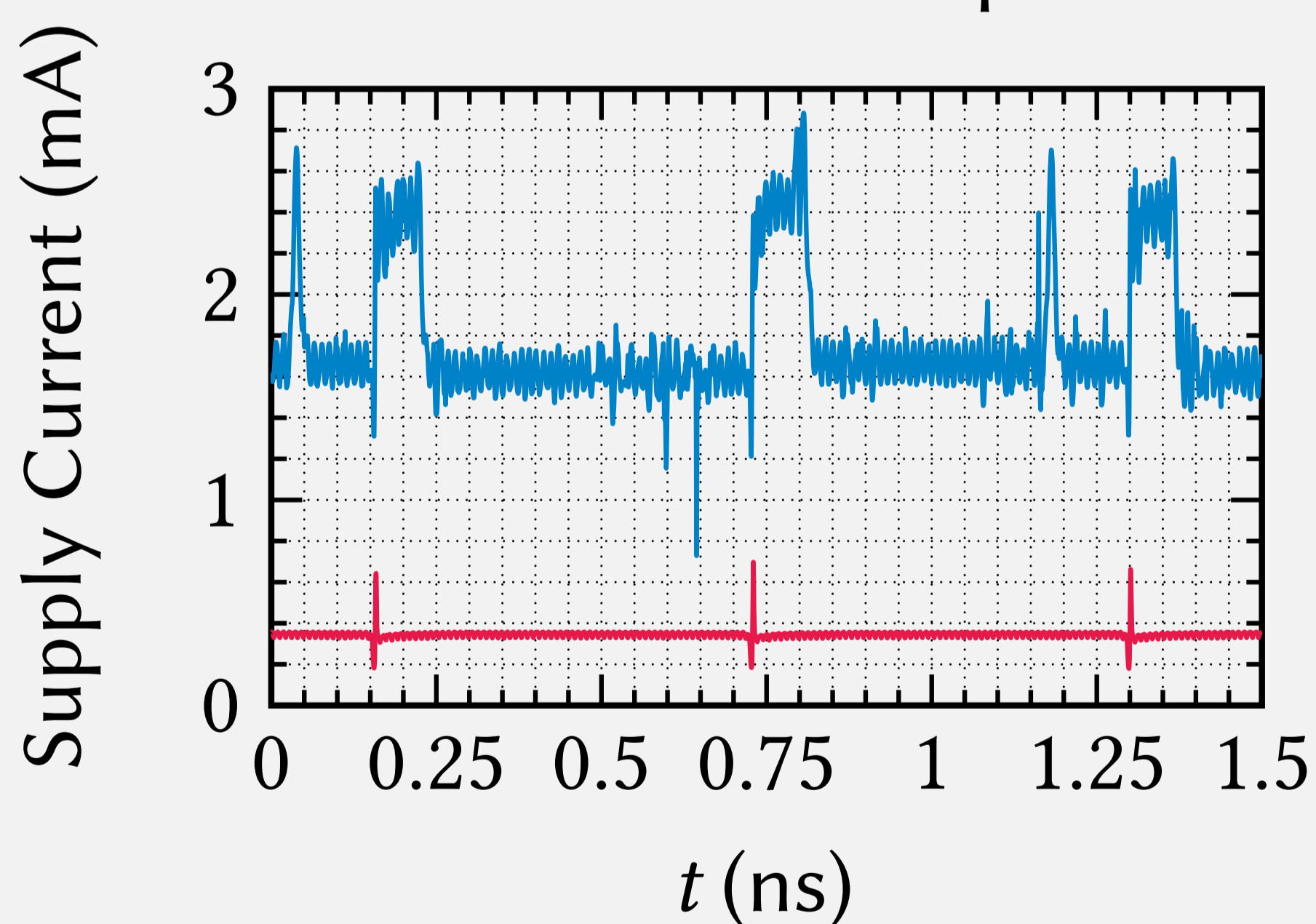
- ▶ Switch voltage inputs
- ▶ No pulser needed
- ▶ Continuous (non-pulsed) current at output
- ▶ No high-frequency signals at diode-connected devices



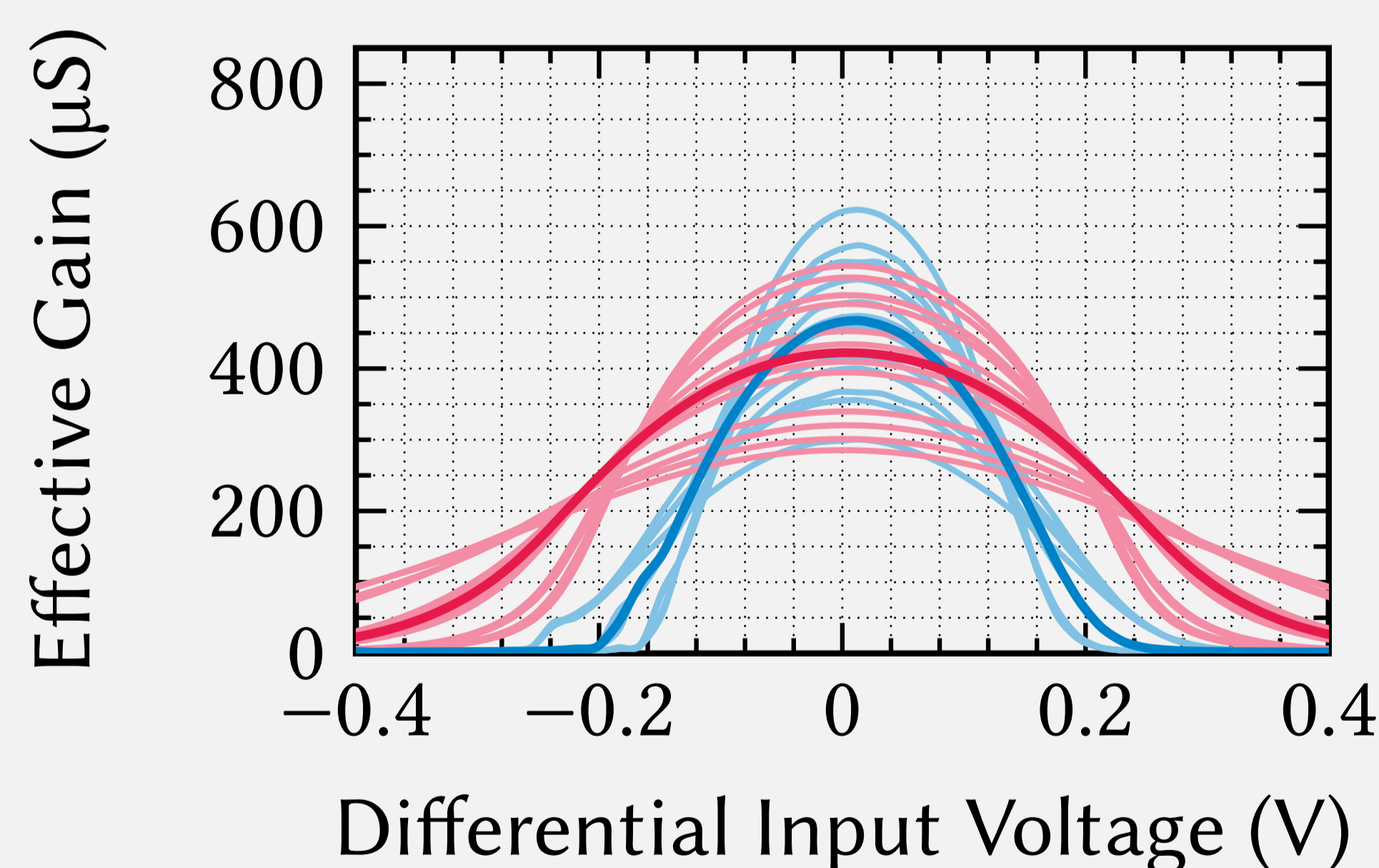
Simulation Results: Current Consumption, Trans-conductance and Output Noise

— Conventional — Proposed

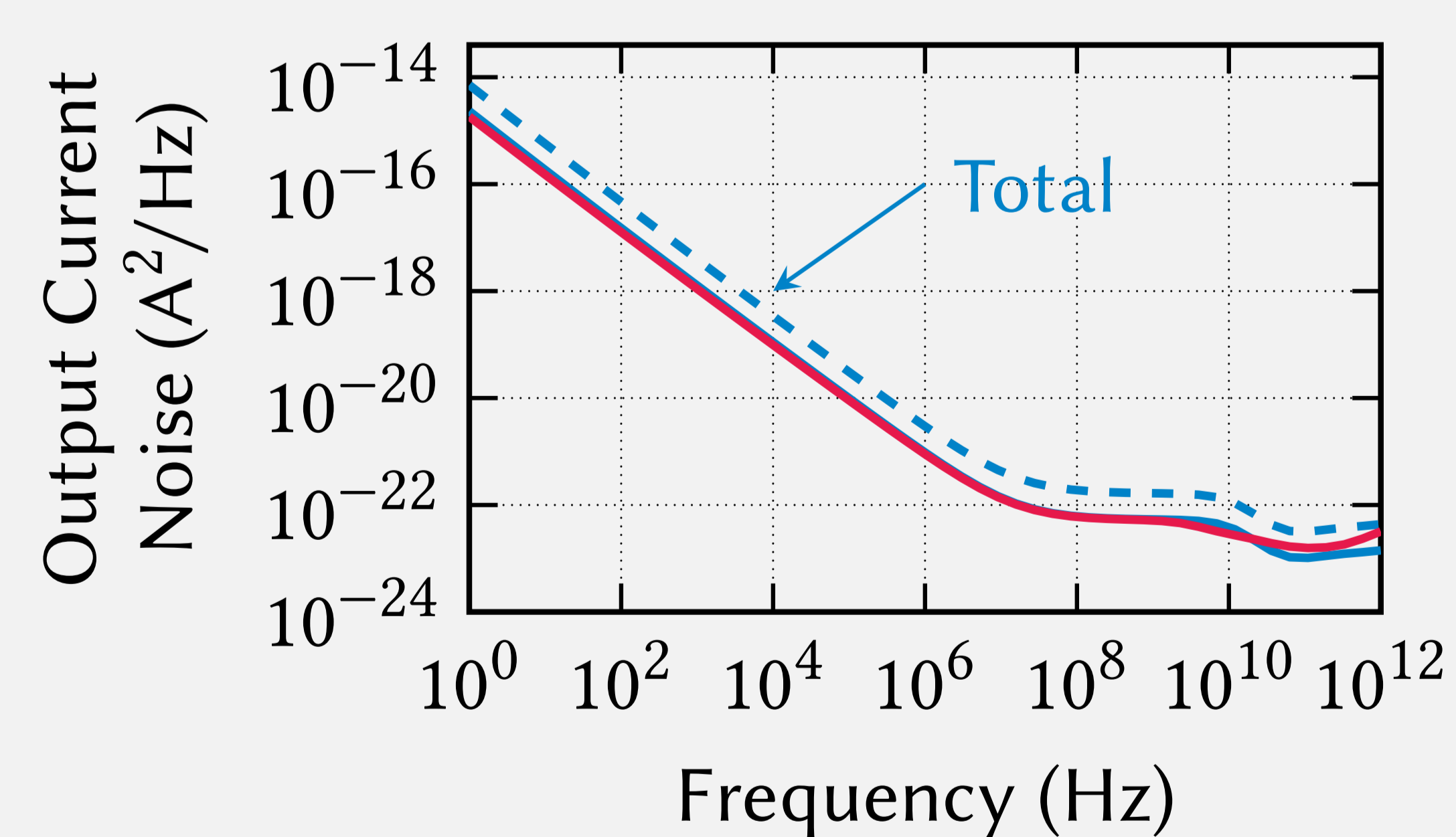
Current Consumption



Transconductance



Noise



Comparison with Conventional Design

Parameter	Unit	Conventional	Proposed	Change (%)
RMS Supply Current	mA	1.756	0.374	-78.7
Gain Variation	%	70	64	-8.6
Input Offset Voltage (σ)	mV	11.24	15.2	+35.7
Supply Current Ripple	μ A	217.2	28.6	-86.8
Active Transistor Area	μ m ²	12.48	5.39	-56.8

Summary

- ▶ Charge Pump without Pulser
- ▶ Significantly reduced power consumption
- ▶ Significantly reduced supply current ripple
- ▶ No noise penalty compared to conventional design
- ▶ Virtual doubling of reference frequency