Lab 06
Charge Steering FF

Aug 23, 2023

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High-Speed Serial Links

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Dr. Sameh A. Ibrahim

PART 1: Charge Steering Circuit with Small Input Swing

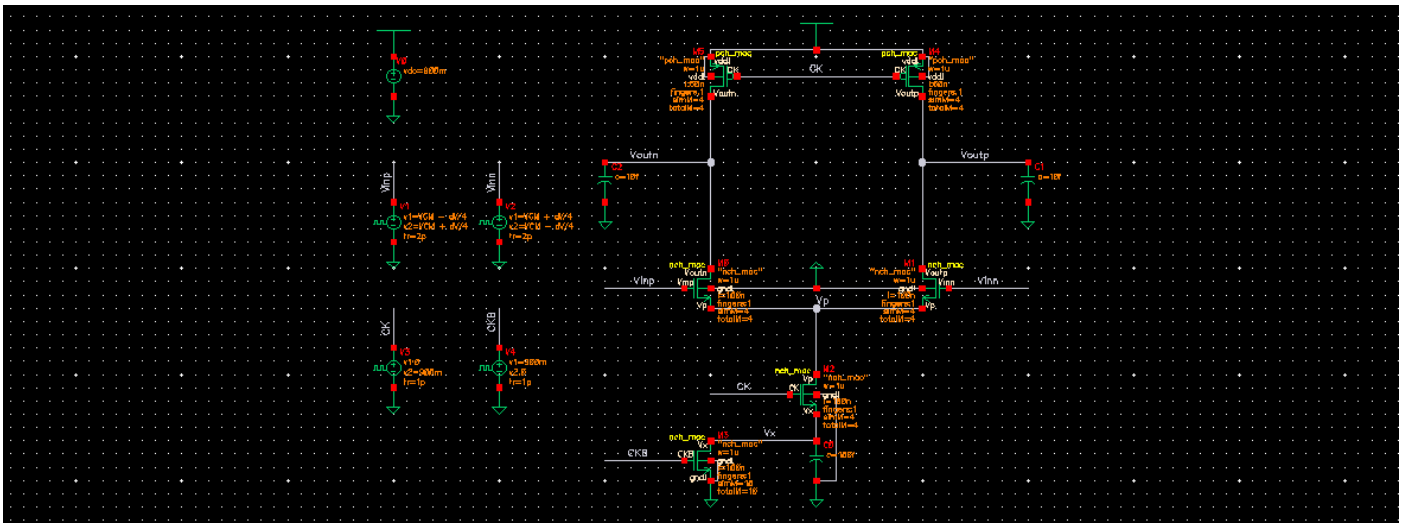

Fig. 1 Charge Steering Schematics

Q1: comment on the size of M6&M7 and the trade off with the gain?

- The size of W6 and W7 should be wide enough to completely pre-charge CD to VDD in a half period which increases the power consumption and decreases the gain.

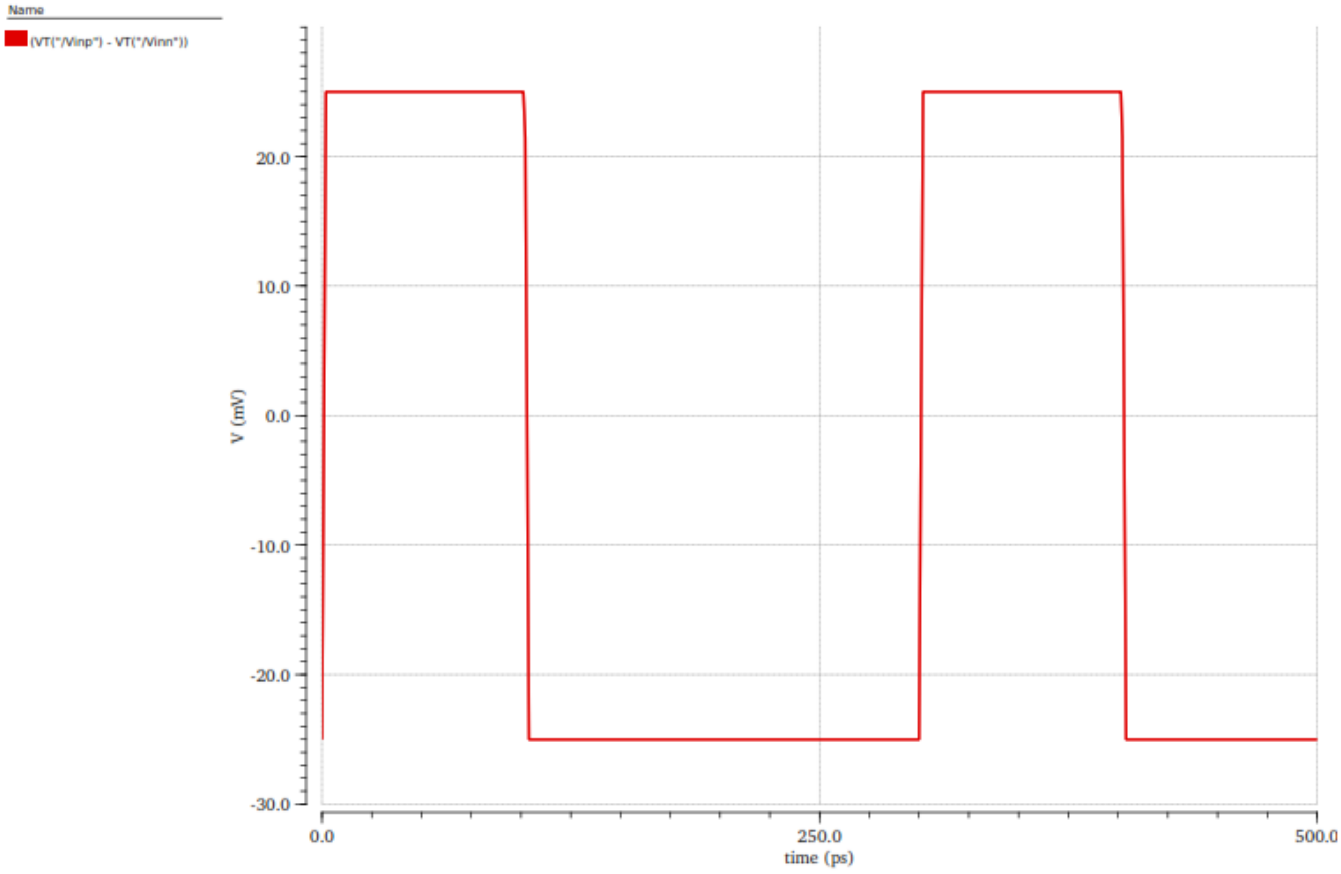

Fig. 2 Charge Steering Vin Differential

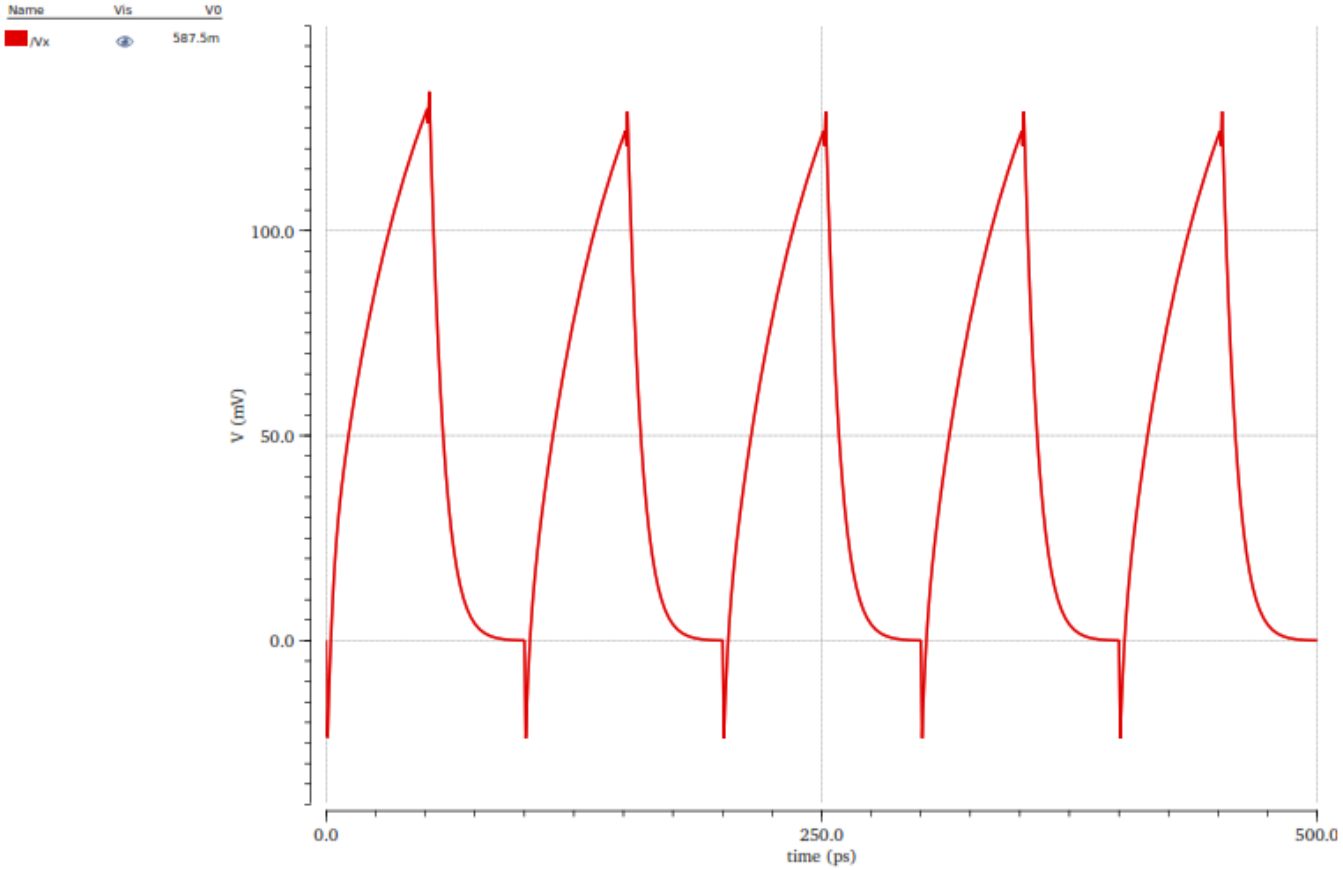

Fig. 3 Charge Steering Vx

Q2: comment on the swing at Vx node?

- The Vx is the Voltage on CT, as CK is High CT is Charge sharing from CD, when CK is Low CT is discharges.
- The spike is shown in the Vx because of the CK fast transition from High to Low and Low to High.

$$i = \frac{\partial Q}{\partial t} = C\frac{\partial V}{\partial t}$$

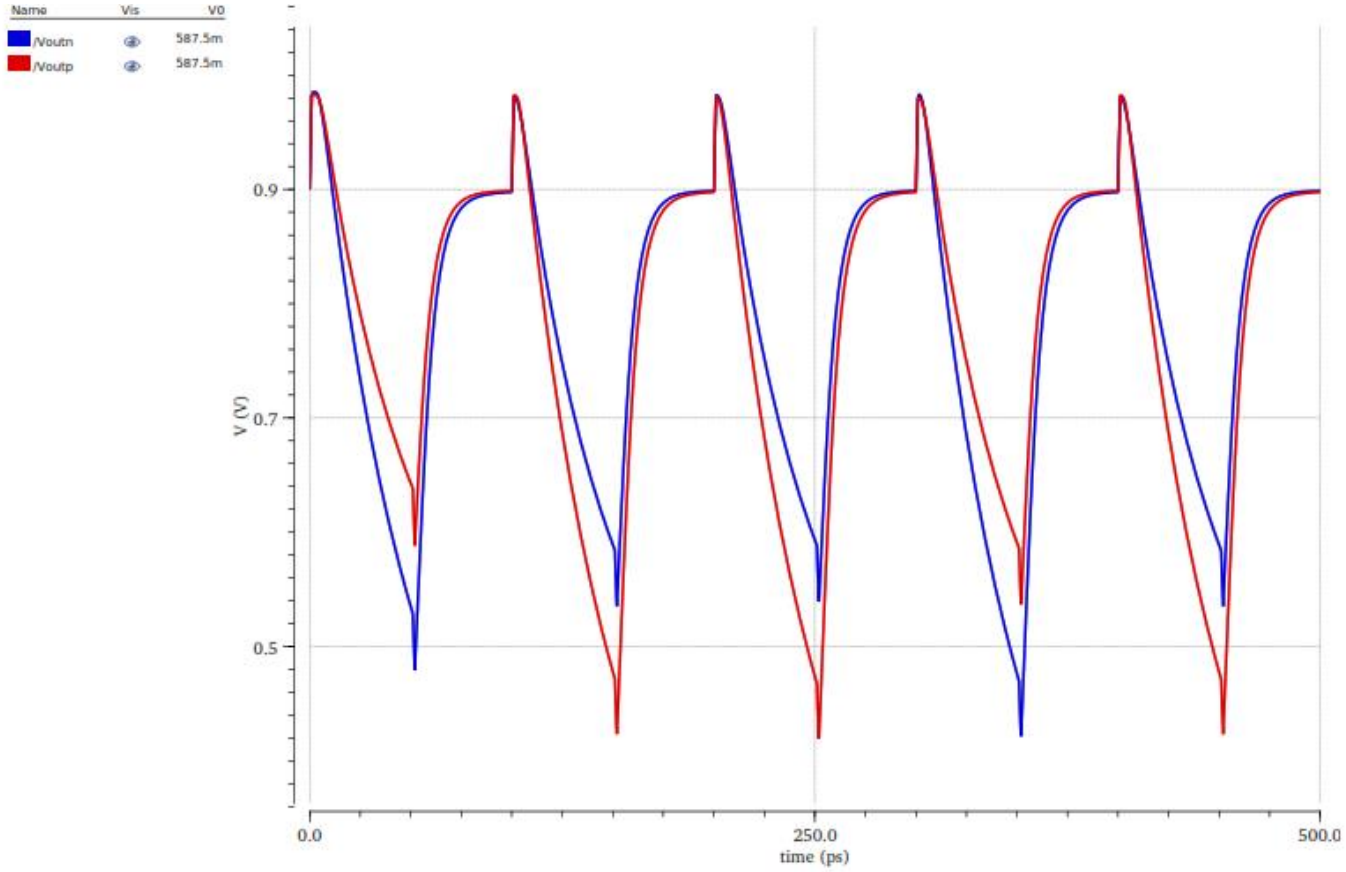

Fig. 4 Charge Steering Voutp and Voutn

Q3: comment on the behavior of the two signals?

- When the CK is high the two CD discharge VB = VCM – VTH – ΔV, for low to moderate differential inputs transistors can be considered as a single source follower with 2W/L.
- When Vinp is greater than Vinn the CD at Voutp discharge more than CD at Voutn and via versa.

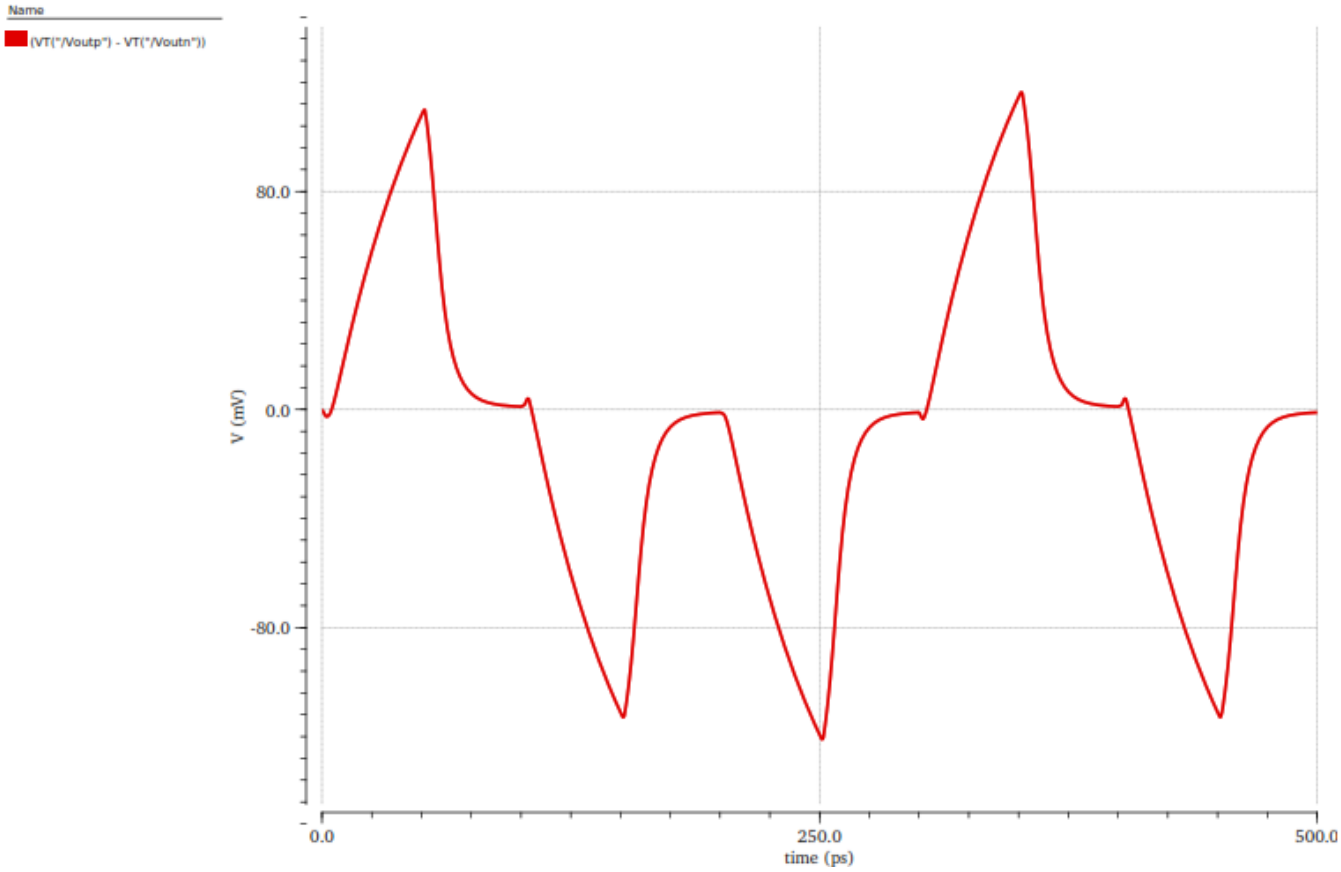

Fig. 5 Charge Steering Vout Differential

Table 1 Power Consumption

Power Consumption
150.7uW

Q4: Mention the effect of increasing CT on the power consumption and the reason for that?

- Increasing CT will result in larger power consumption as M0 and M1 will not turn OFF, as the IDD is direct proportional to CD, and for a given load capacitance CD, CT is chosen to give the required swing. As swing increases CT increases and current increases.

PART 2: Charge Steering Circuit with Large Input Swing

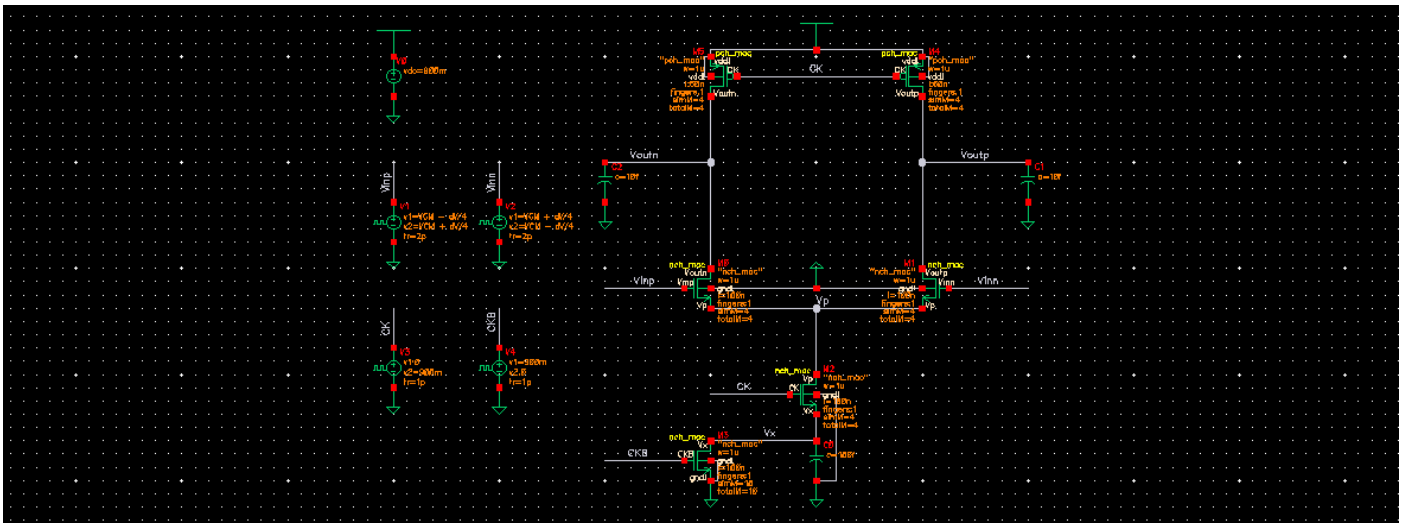

Fig. 6 Charge Steering Schematics

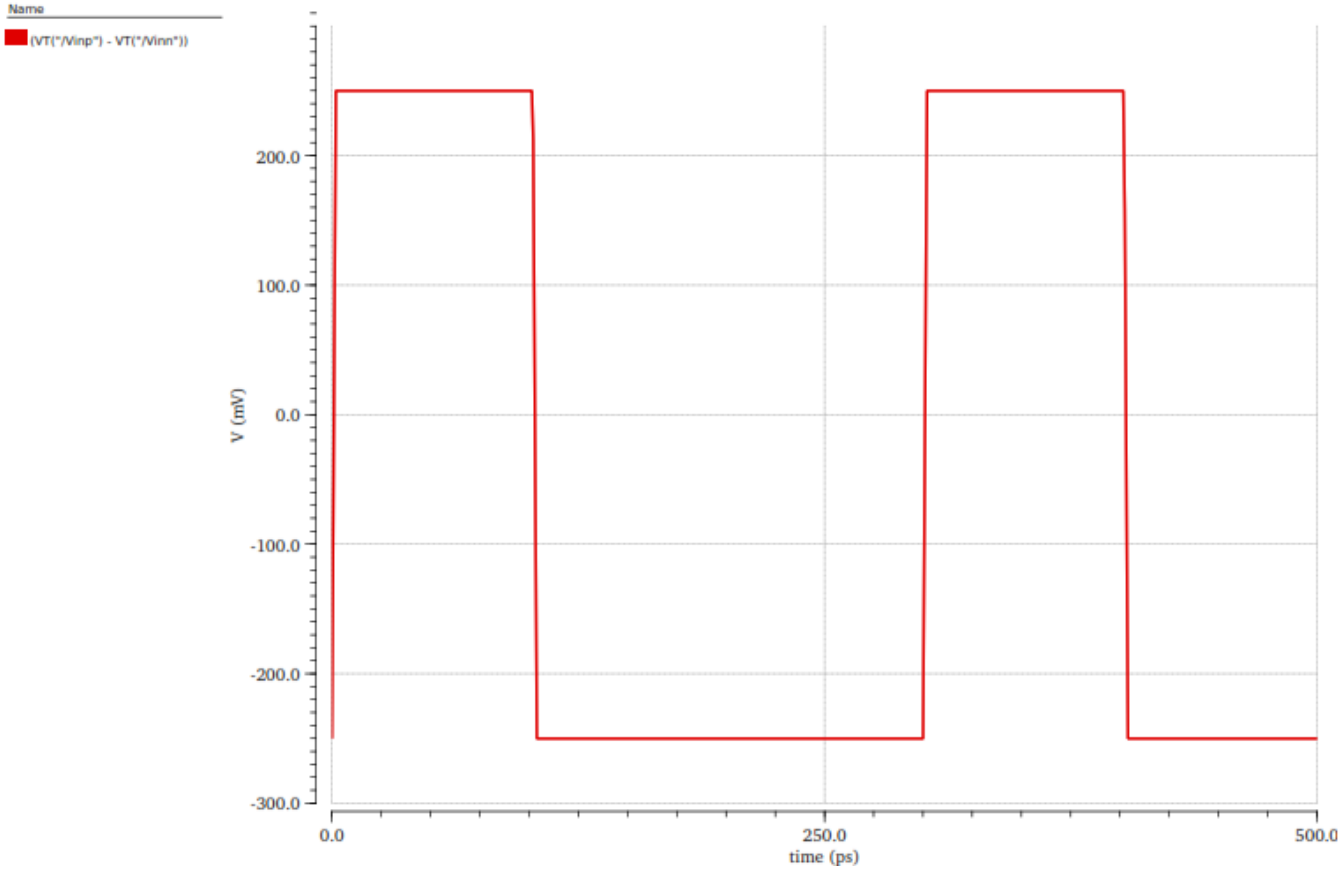

Fig. 7 Charge Steering Vin Differential

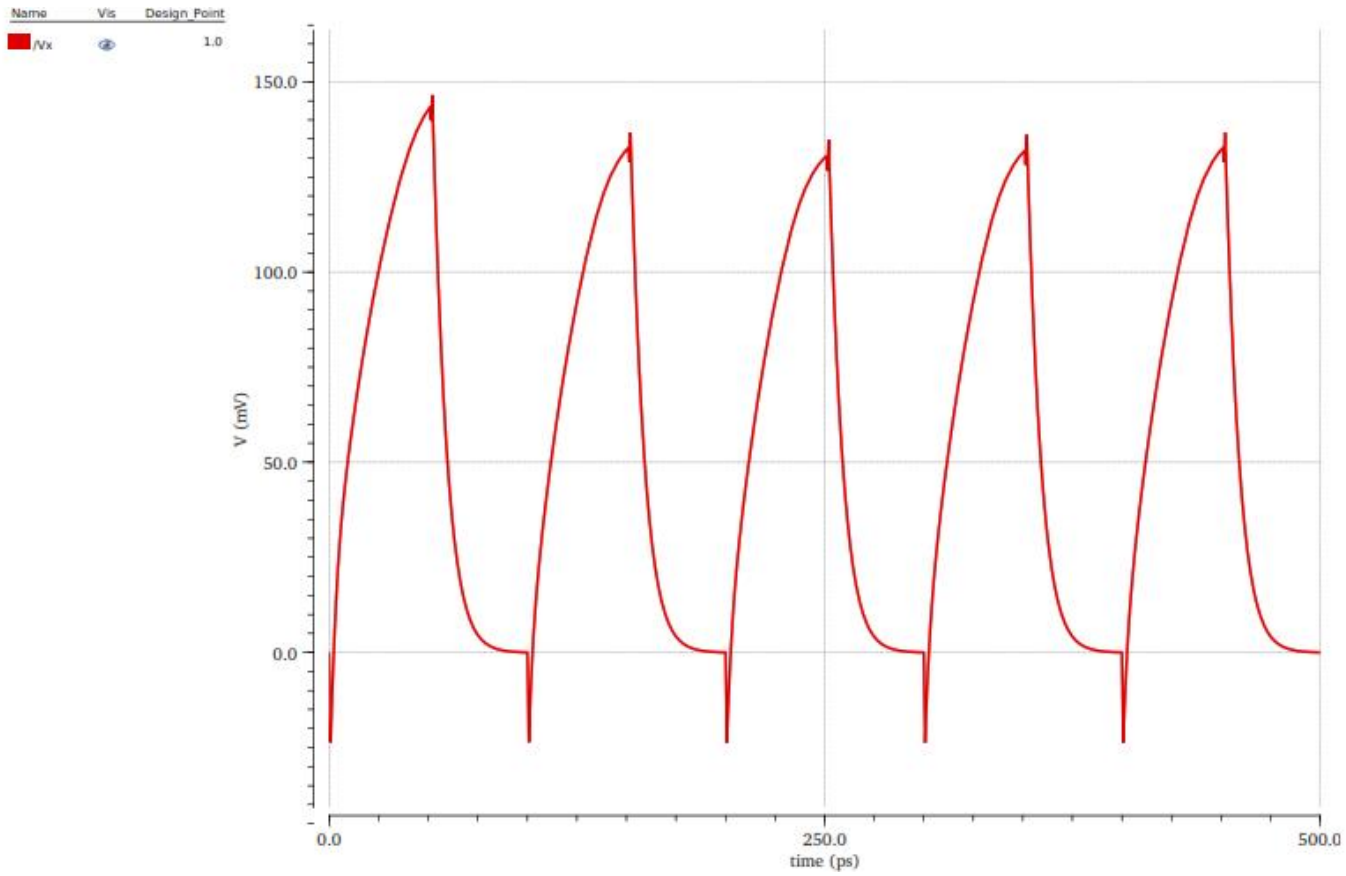

Fig. 8 Charge Steering Vx

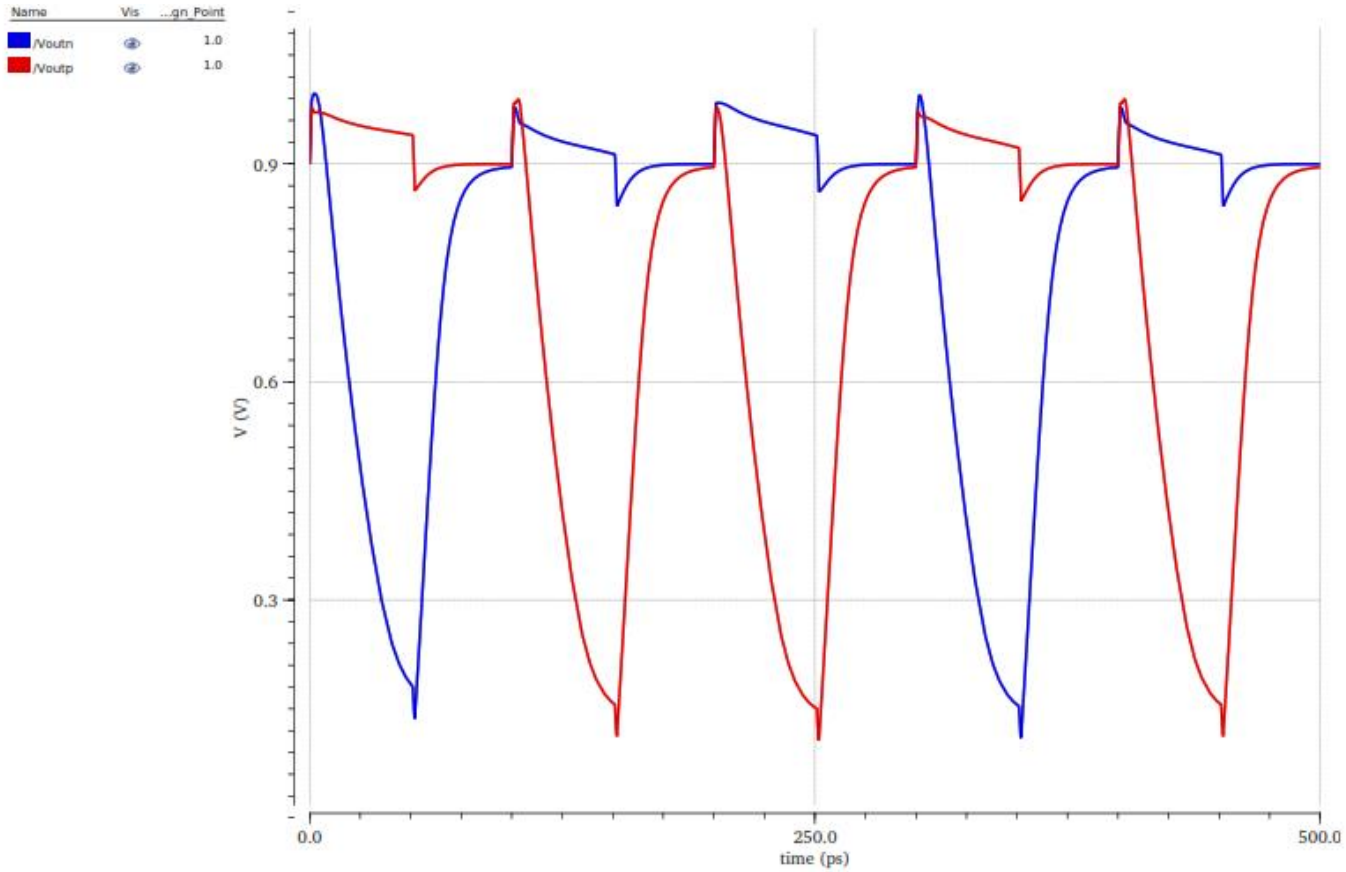

Fig. 9 Charge Steering Voutp and Voutn

Q5: For the Voutp & Voutn, make a comparison between the low swing and large swing inputs "compare with part one"?

- For low to moderate differential inputs the two transistors can be considered as a single source follower with 2W/L, and gain is independent of VCM.

$$A_v \approx \frac{2C_T}{C_D}$$

- When input swing is large, one transistor turns OFF for most of the charging period. The differential output voltage depends on VCM.

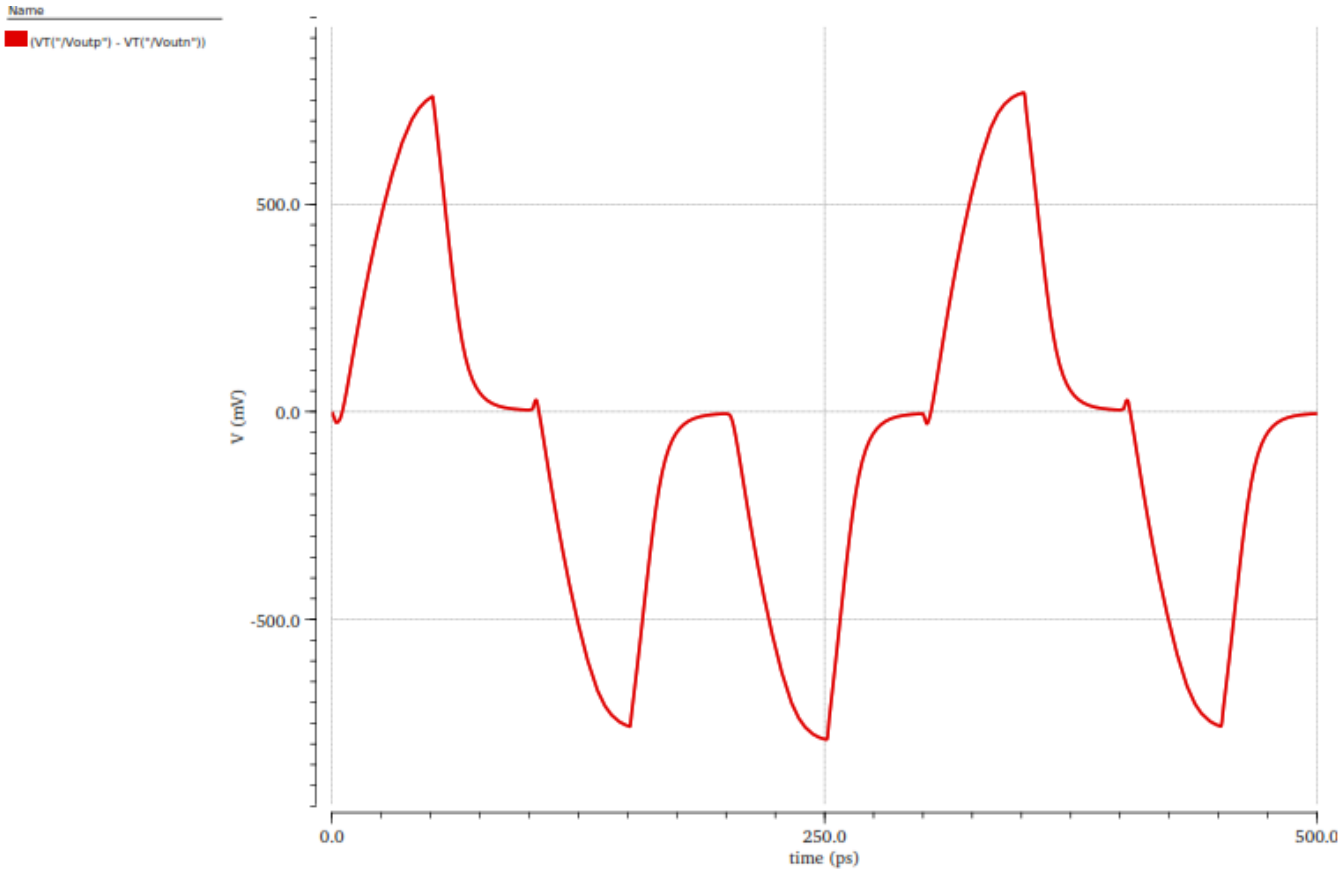

Fig. 10 Charge Steering Vout Differential

Table 2 Power Consumption

Power Consumption
160.3uW

PART 3: Plot Vout Vs Vin for Different Values of the Input Swing and Plot the Gain

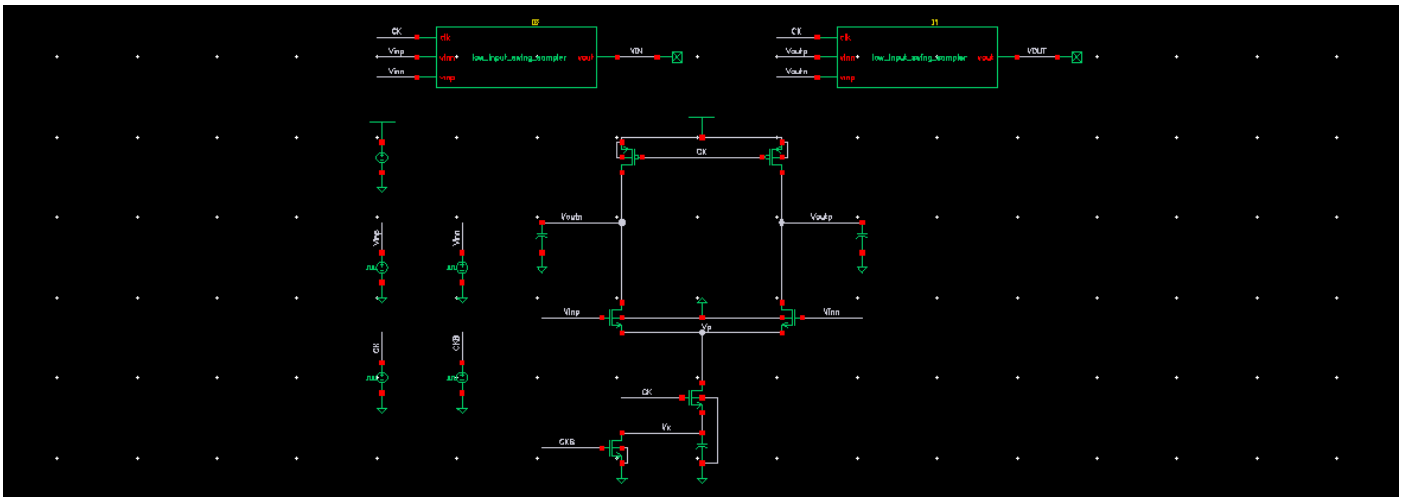

Fig. 11 Charge Steering Schematics

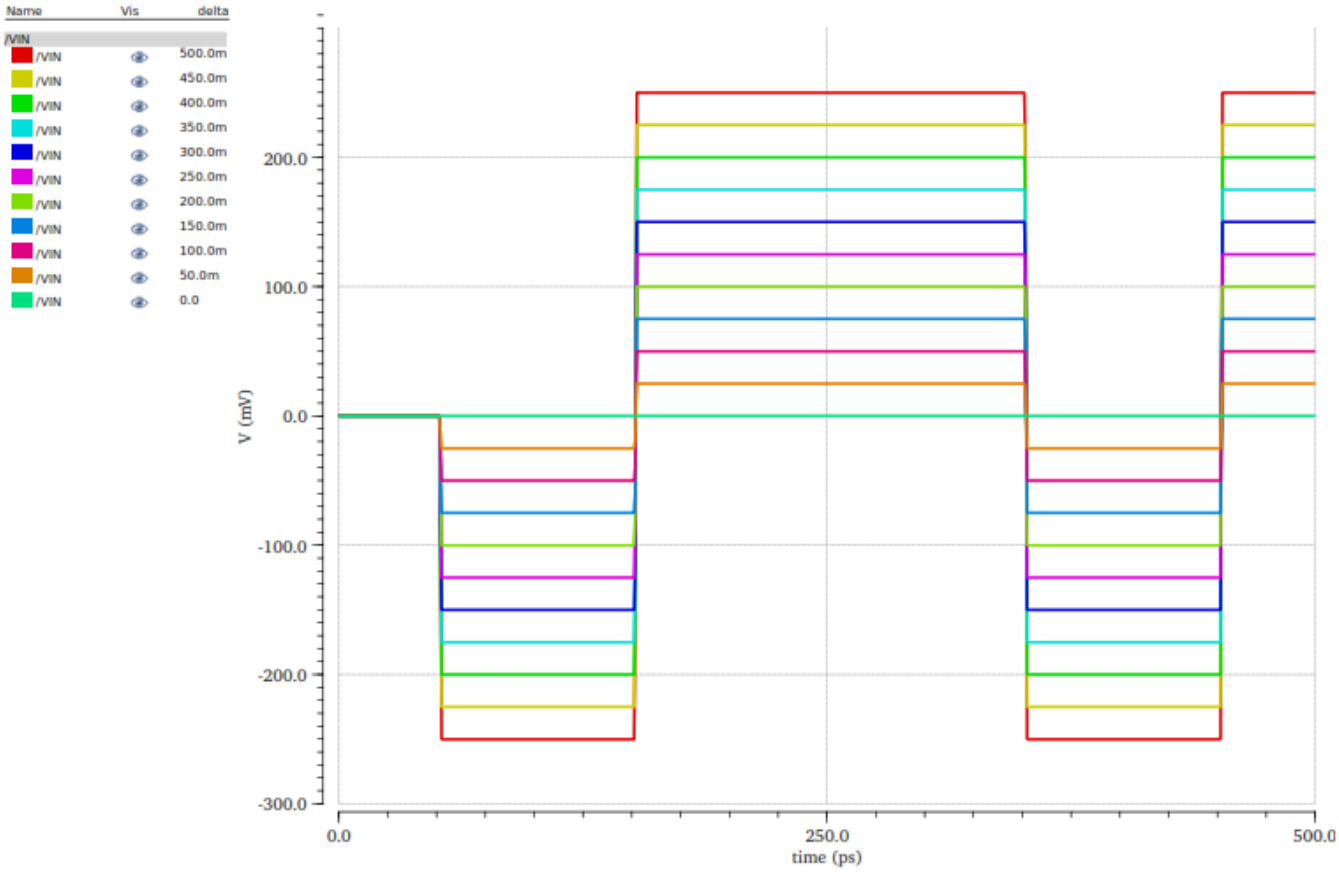

Fig. 12 Sampler Vins

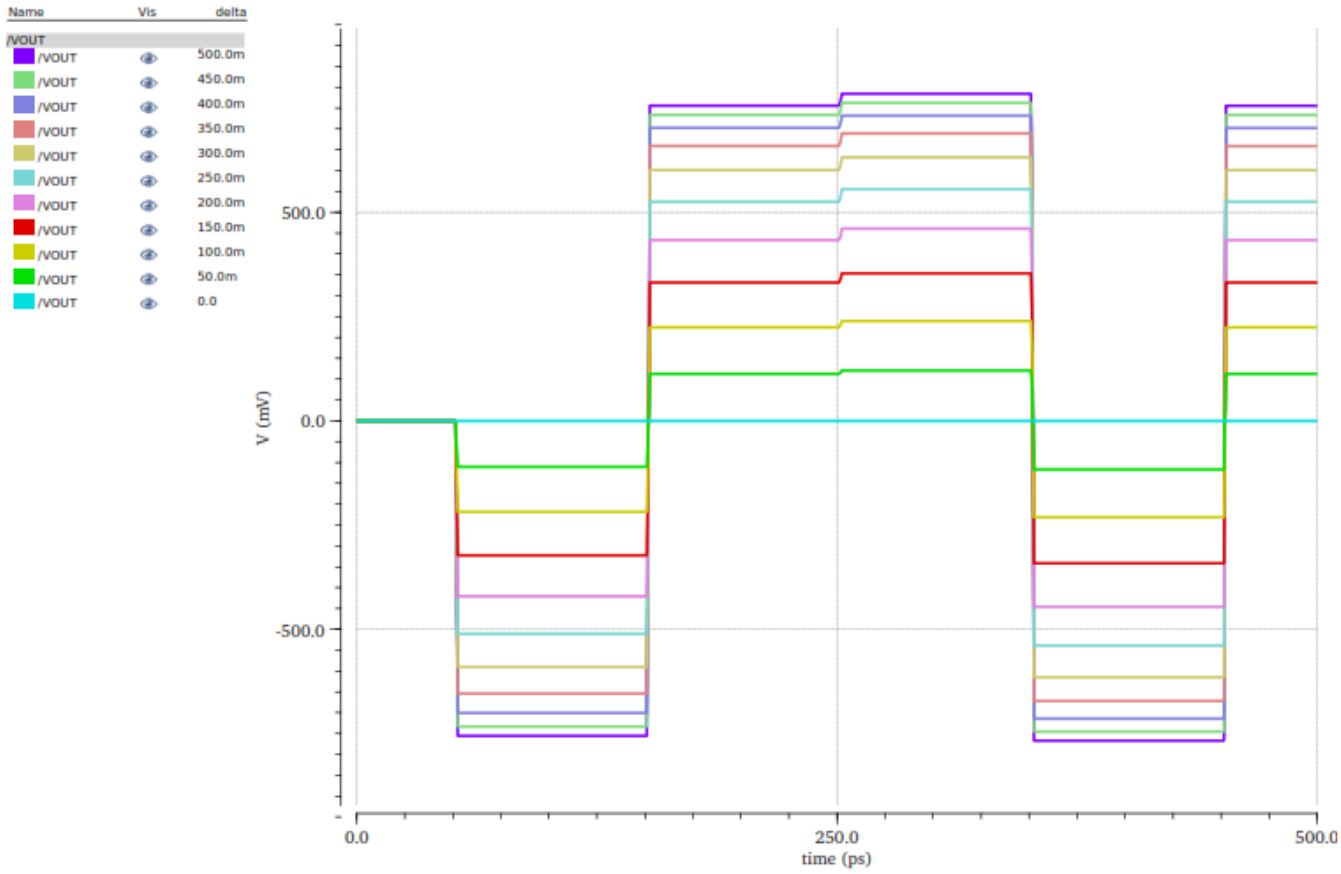

Fig. 13 Sampler Vouts

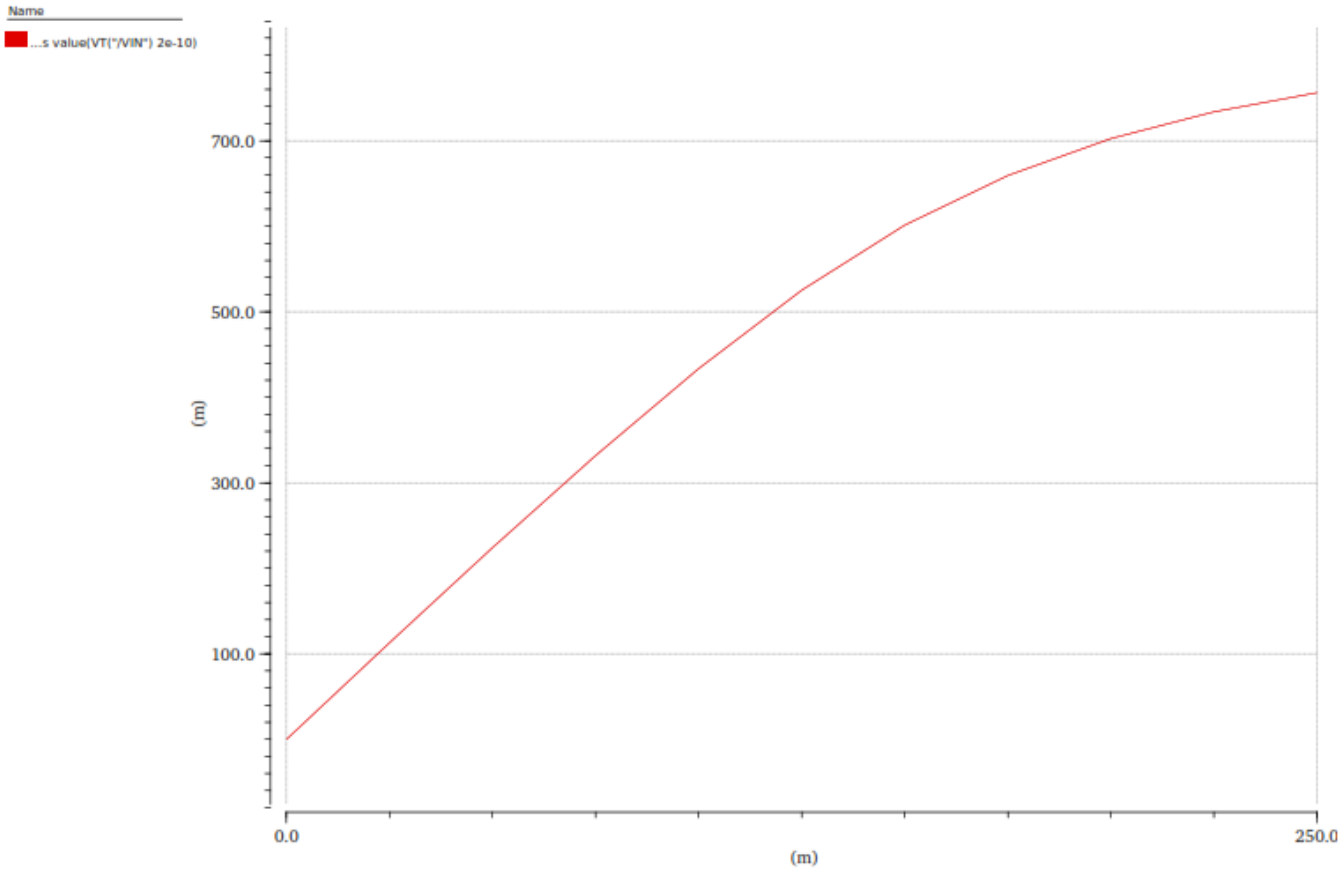

Fig. 14 Vouts vs Vins at 200ps

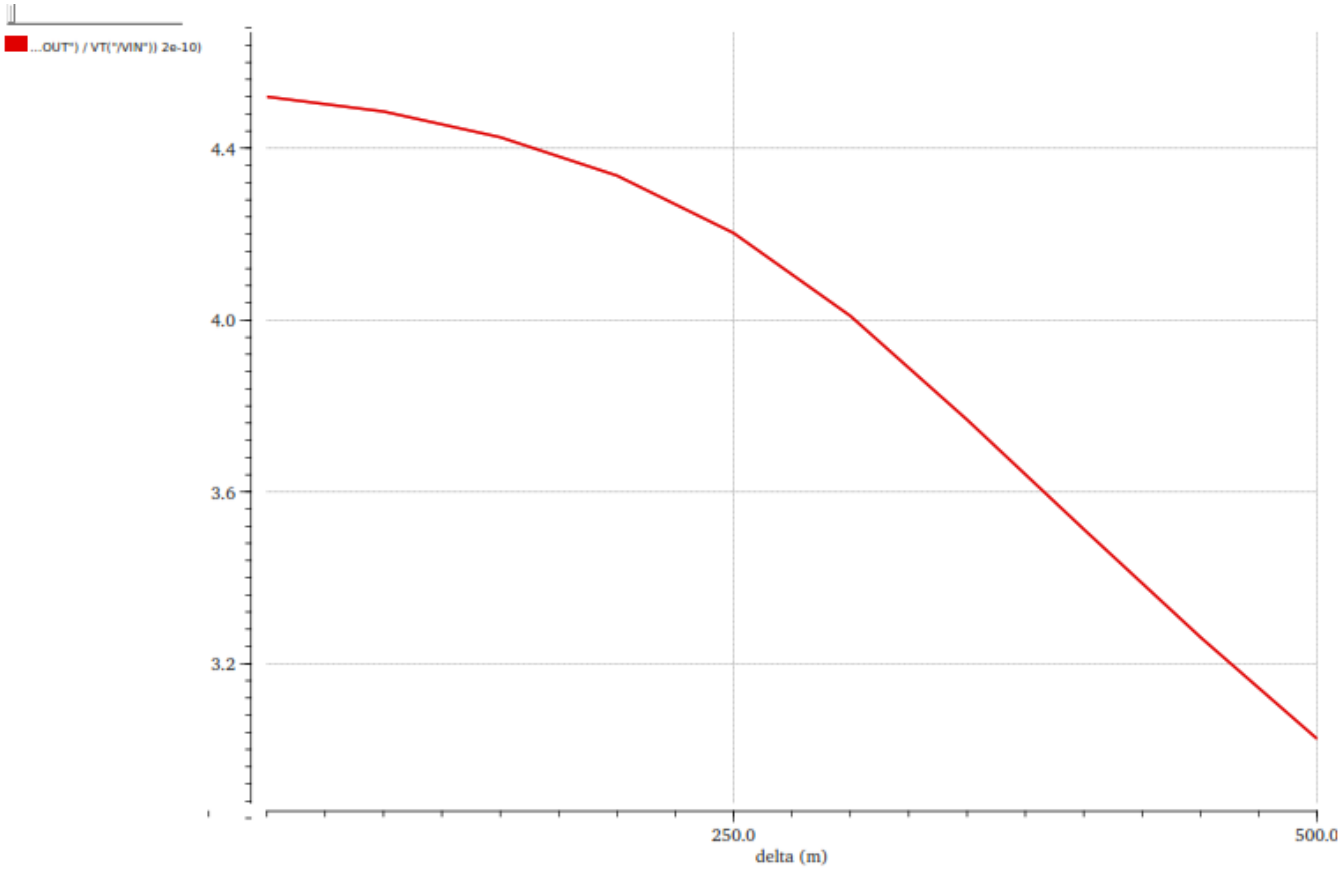

Fig. 15 Gain at 200ps