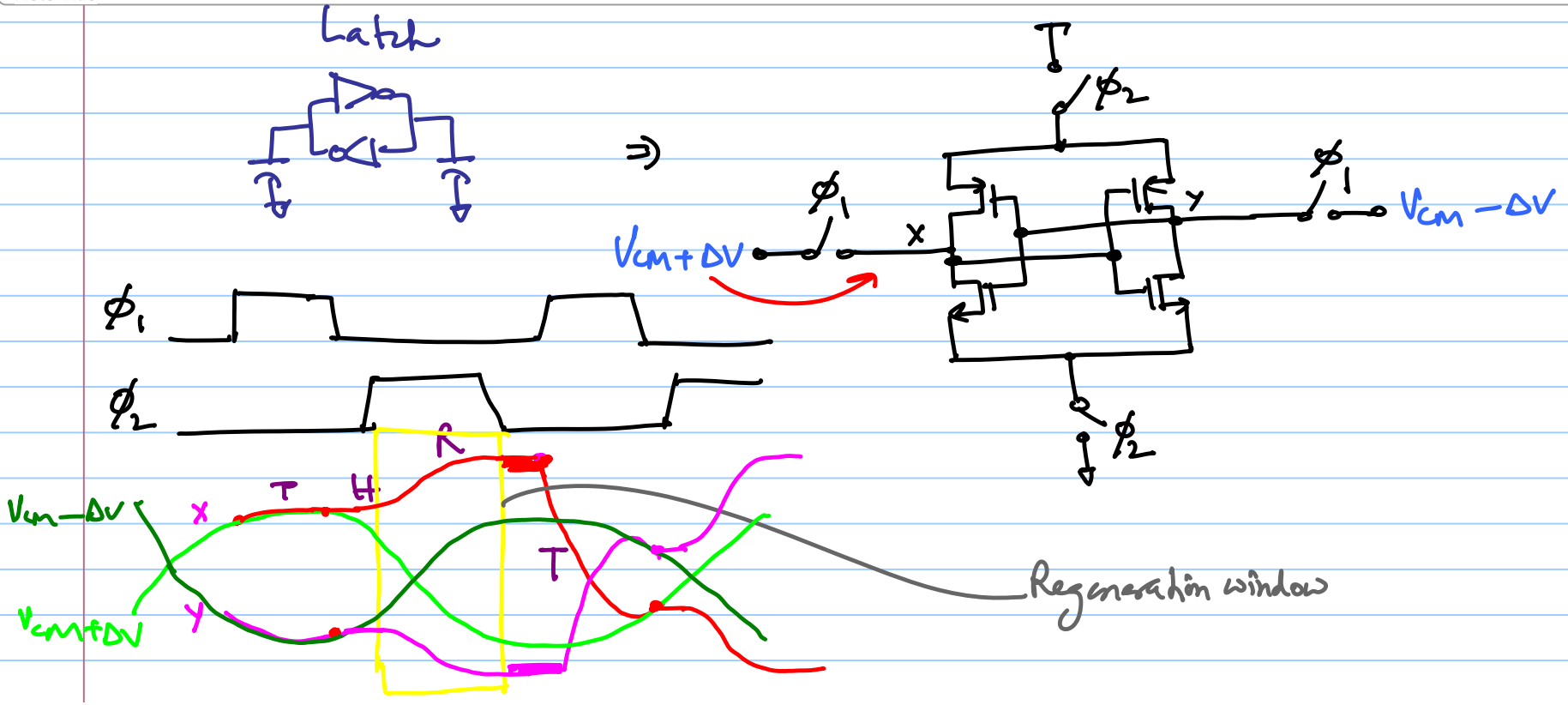
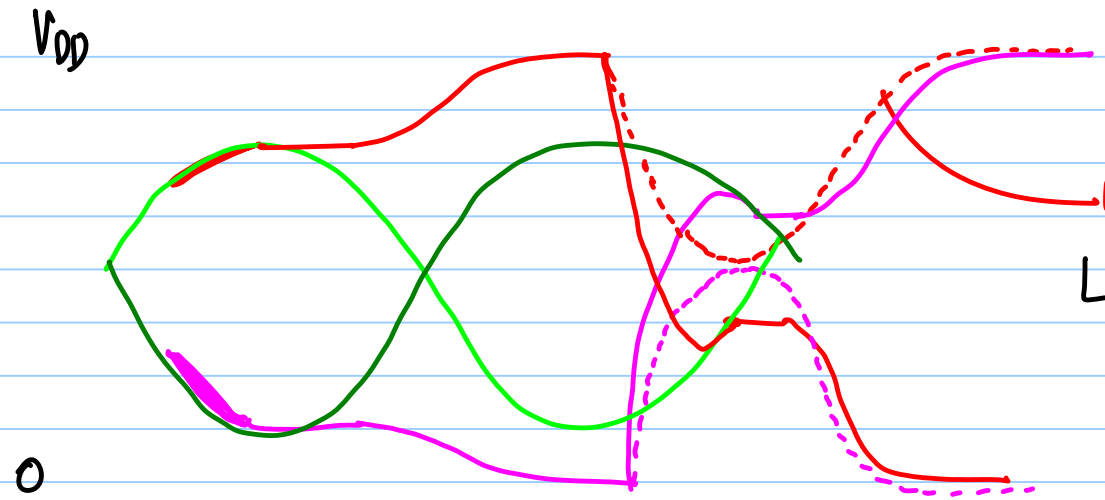
ECE 517 – Lecture 8

Note Title 2/9/2017





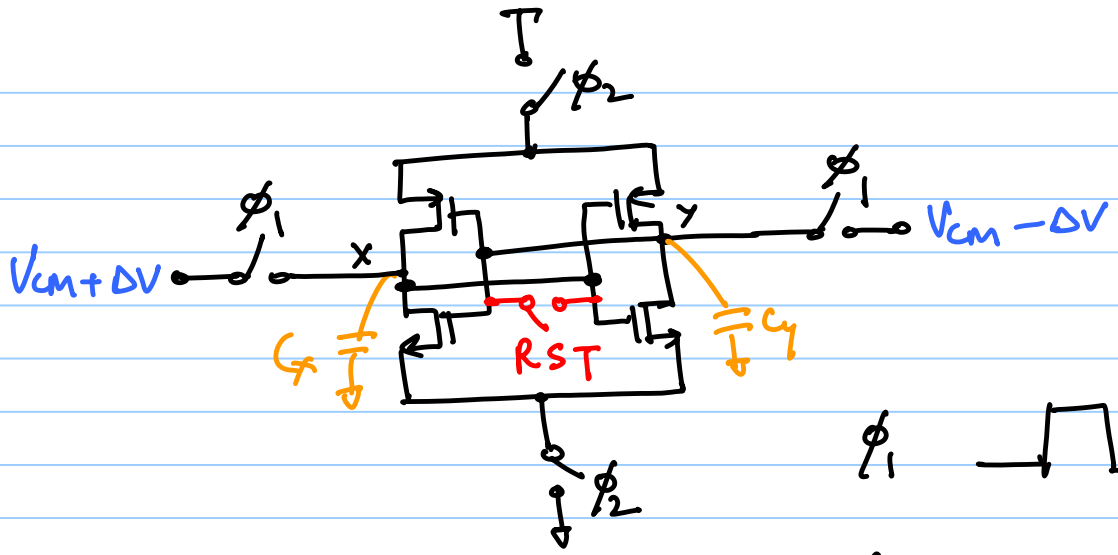
wrong decision

↳ finite RC time-constant at the latch input

* Latch has hysteresis

↳ remembers the past which affects future decisions

↳ memory effect



During the RST phase the latch outputs will be shorted and reach V_{cm}

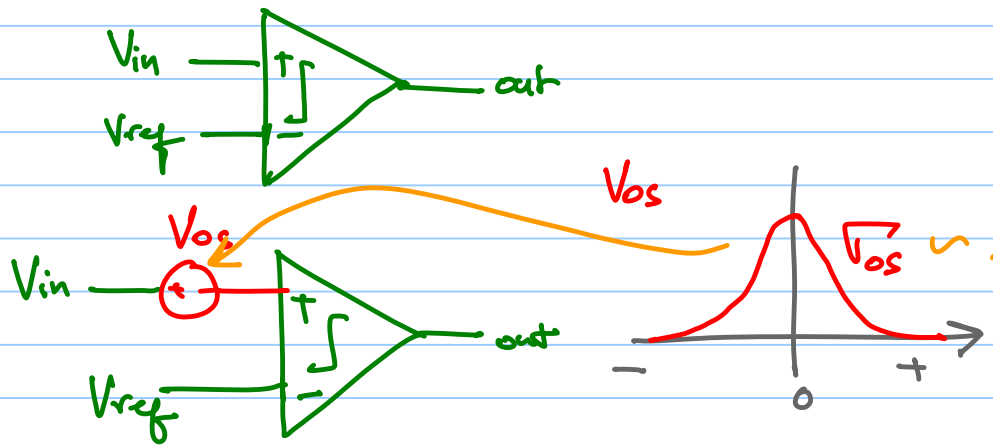
↳ ready to track the inputs in the next cycle

Cross-coupled

⇒ Latch → offset → static mismatch → random offset (PVT)

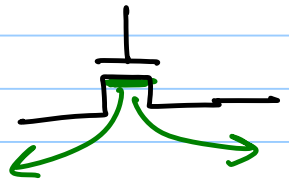
→ dynamic mismatch → mismatched capacitive loads

* or large change in the input common-mode voltage relative to the natural CM of the circuits



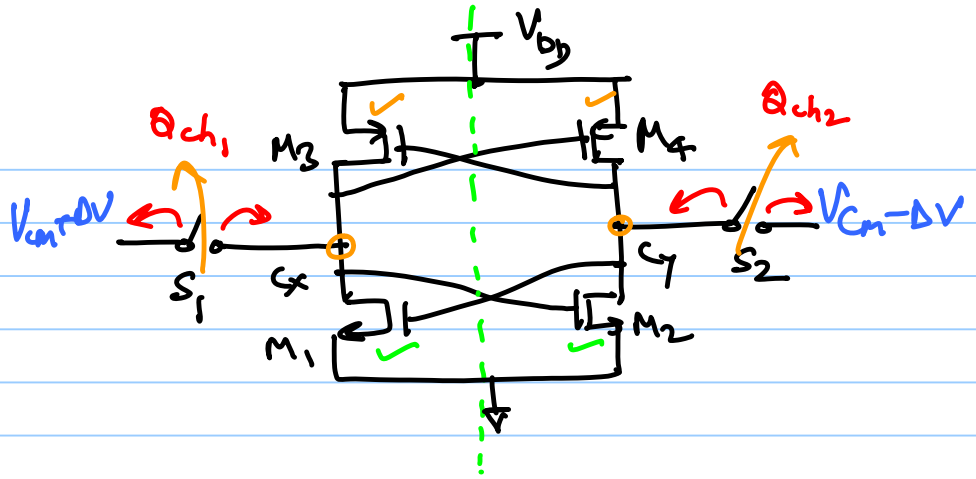
σos ~ few mVs to 10's of mV

Static offset



charge injection

Q_{ch}



$\Delta Q = Q_{ch_1} - Q_{ch_2}$ ⇒ mismatch in charge injection from S_1 & S_2

V_{os} due to M_1 & M_2

$$V_{os_{1,2}} = \Delta V_{THN_{1,2}} + \frac{1}{2}\frac{\Delta(W/L)}{W/L}\left(V_{GS_{1,2}} - V_{THN_{1,2}}\right)$$

→ 'Razavi Book'

overdrive voltage

$V_{OV} = V_{GS} - V_{THN}$

Variance

$$\sigma^2_{V_{os_{1,2}}} = \sigma^2_{\Delta V_{THN}} + \frac{1}{2}\frac{\sigma^2_{\Delta(W/L)}}{(W/L)^2}\cdot V_{OV}^2$$

$$\sigma^2_{V_{os}} = \sigma^2_{V_{os_{1,2}}} + \sigma^2_{V_{os_{3,4}}} + \left(\frac{\Delta Q}{C_x}\right)^2$$

$C_{x,y}$

$$\sigma_{V_{os}} = \sqrt{(\quad)} = 90\ mV$$

Huge!

0.5μm Data

$\sigma_{\Delta V_{THN}} = 5mV$ ×

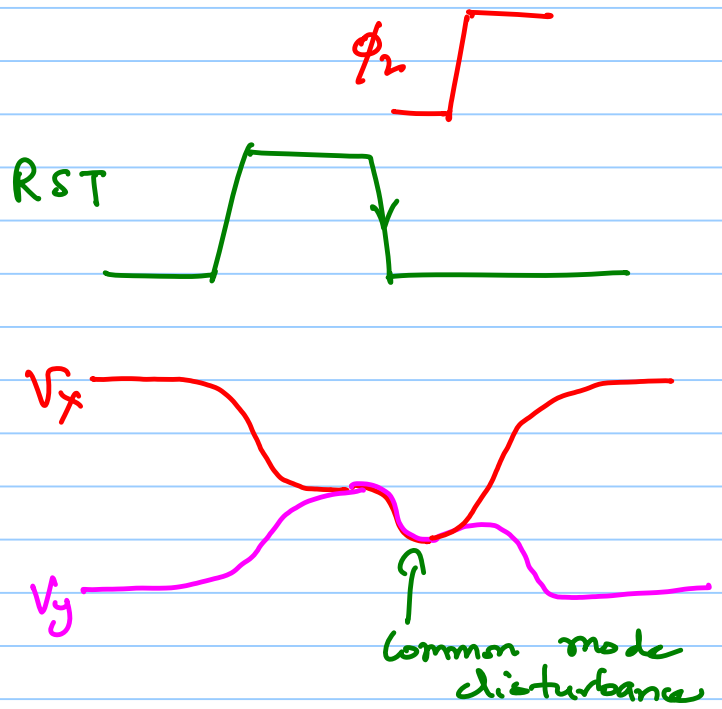
$\frac{\sigma_{\Delta(W/L)}}{(W/L)} = 0.1$ ✓

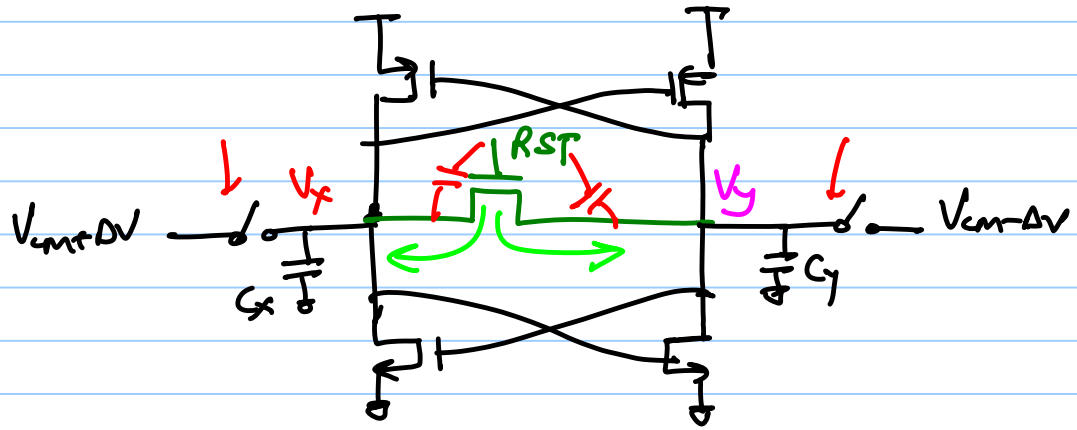
$V_{OV} = 1V$

$\Delta Q = 0.5\ fC$

$C_{x,y} = 100ff$

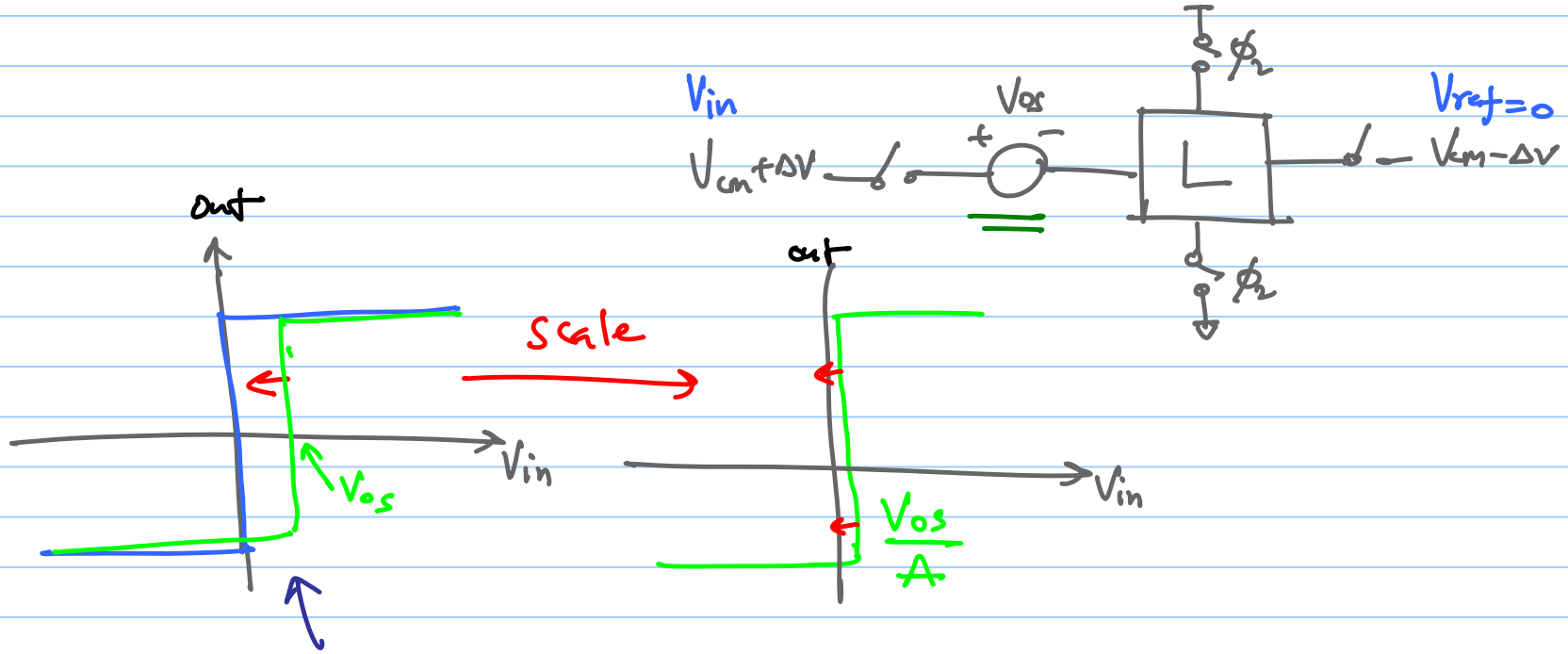
Dynamic offset in a Latch

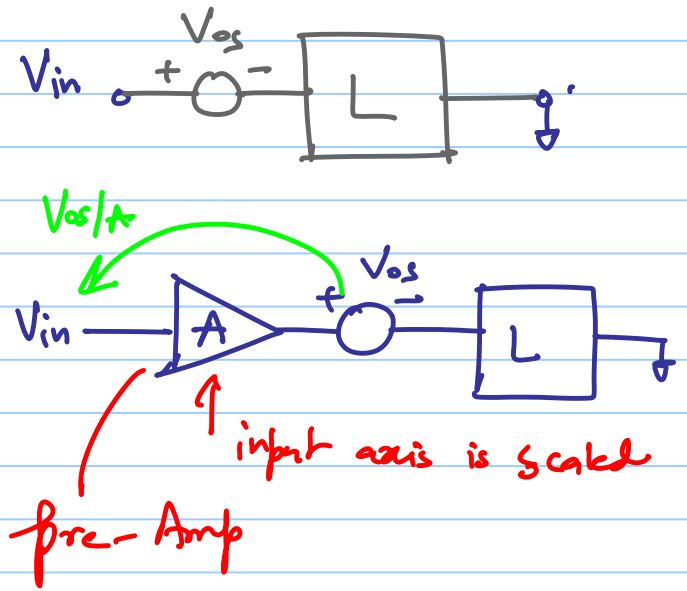




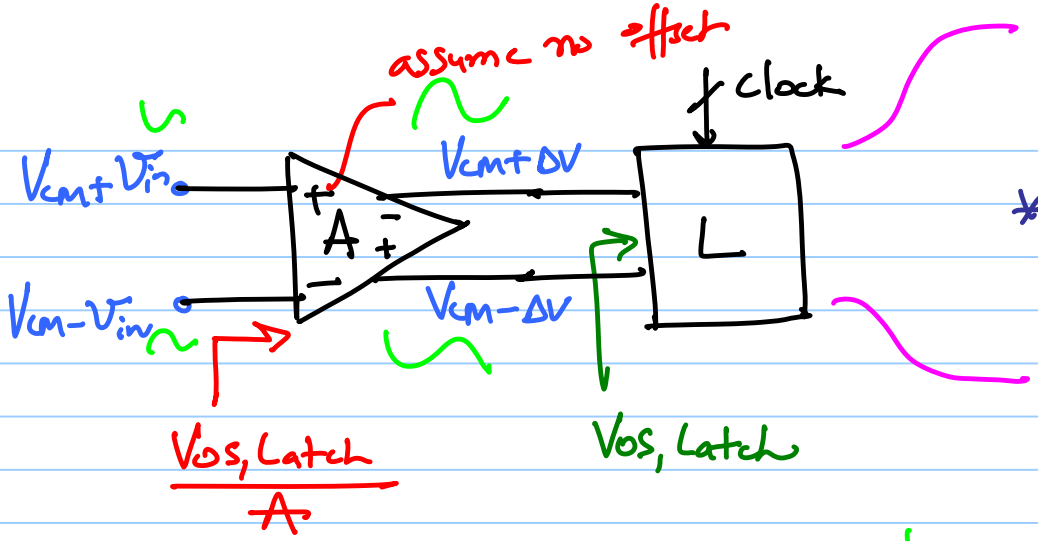
* Charge injection mismatch
* Clock feedthrough

* To use a latch with offset → Causes increased INL and DNL in the ADCs



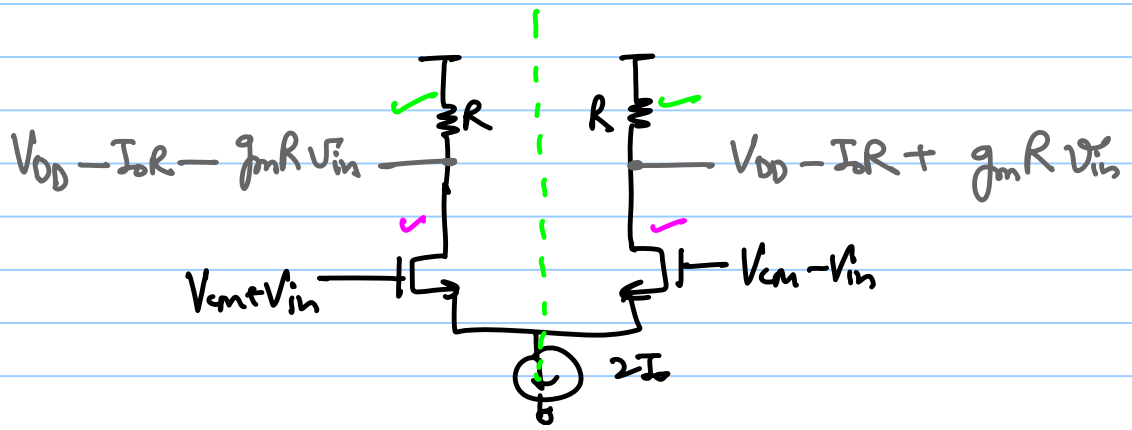


Scale the input axis by A, the threshold becomes $\frac{V_{os}}{A}$

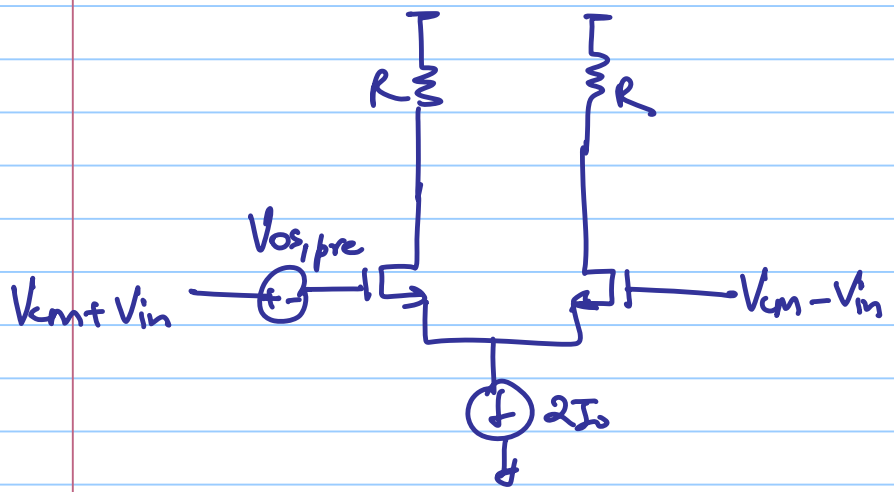


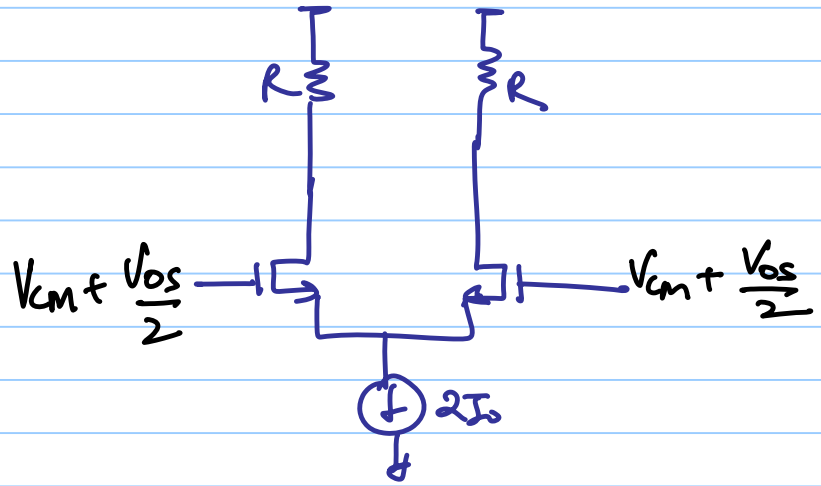
* pre-Amplier reduces the latch offset

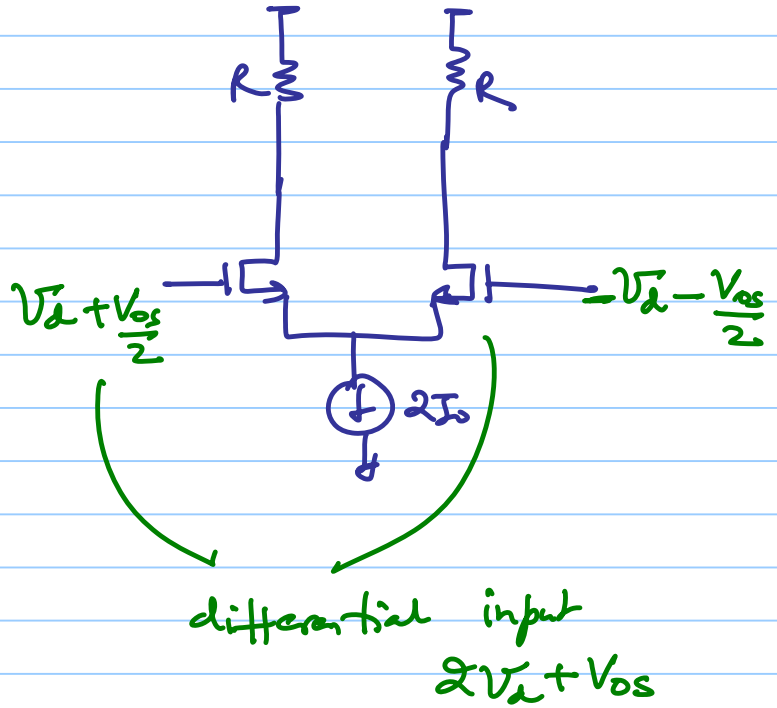
pre-amp :



Issue: Mismatch in the preamp:




R
R
$V_{cm} + \frac{V_{os}}{2}$
$V_{cm} + \frac{V_{os}}{2}$
$2I_o$


R
R
$V_d + \frac{V_{os}}{2}$
$-V_d - \frac{V_{os}}{2}$
$2I_o$
differential input
$2V_d + V_{os}$

random voltage quantities

$$V_{offset} = V_{os,preamp} + \frac{V_{os,Latch}}{A}$$

$$\sigma^2_{offset} = \sigma^2_{V_{os,preamp}} + \frac{\sigma^2_{V_{os,Latch}}}{A^2}$$

We use large A to reduce Latch offset

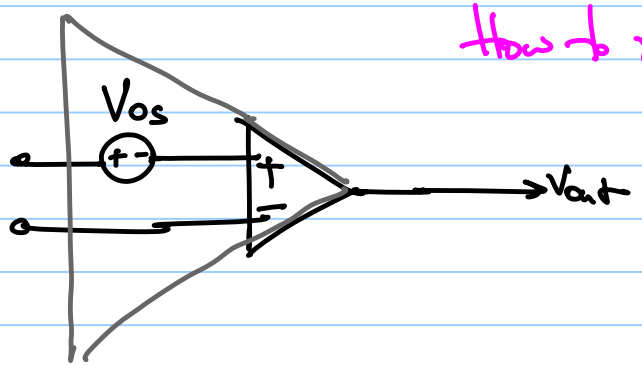
↳ reduce $\sigma_{V_{os,preamp}}$ → Large size of input devices

Preamp offset Cancellation

$$\sigma_{Vos} = \sqrt{\sigma_{os,preamp}^2 + \frac{\sigma_{Vos,Latch}^2}{A^2}}$$

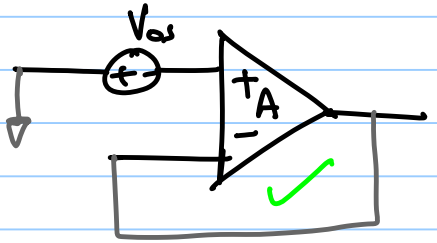
* Need to cancel $V_{os,\,pre\text{-}amp}$

How to measure V_{os}?



Assume
$A \to \infty$

V_{os}?



$V_{out} = -V_{os}$