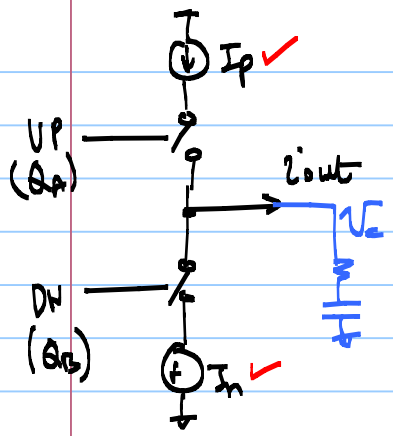
ECE 518 – Lecture 17

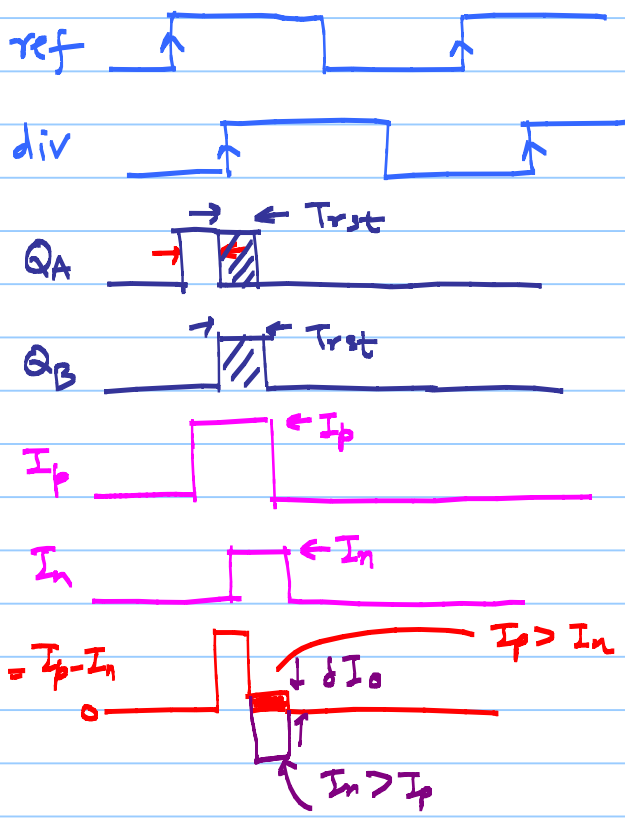
Note Title 3/19/2013

① PFD/CP dead zone

② UP/DN skew

③ I_p, I_n (CP current mismatch)





T_{rst} ↑ Reset pulse width

$I_p \neq I_n$

$I_p > I_n$

* Current flowing into the loop filter due to the mismatch in the (I_{cp}) current

$$\delta I_{cp} = I_p - I_n$$

flows for time $\Rightarrow T_{rst} > 0$

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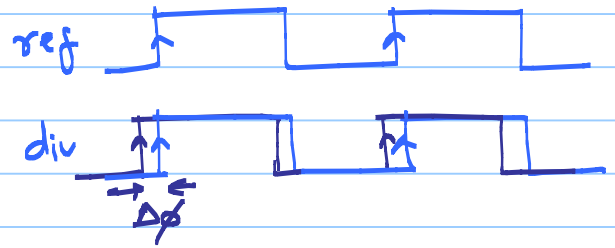
* In the steady state

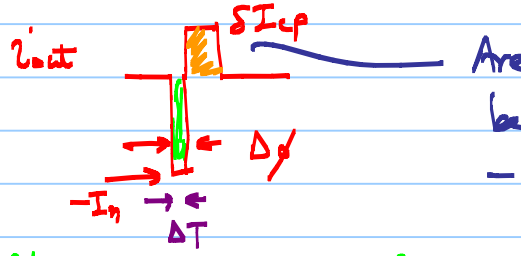


$$\Delta Q = T_{rst}(I_p - I_n) = \Delta T \cdot I_n$$

$$\Rightarrow \quad \Delta T = T_{rst}\left(\frac{\delta I_{cp}}{I_{cp}}\right)$$

$$\rightarrow \Delta\phi = \left(\frac{\Delta T}{T_{ref}}\right) \cdot 2\pi \quad \text{radians}$$

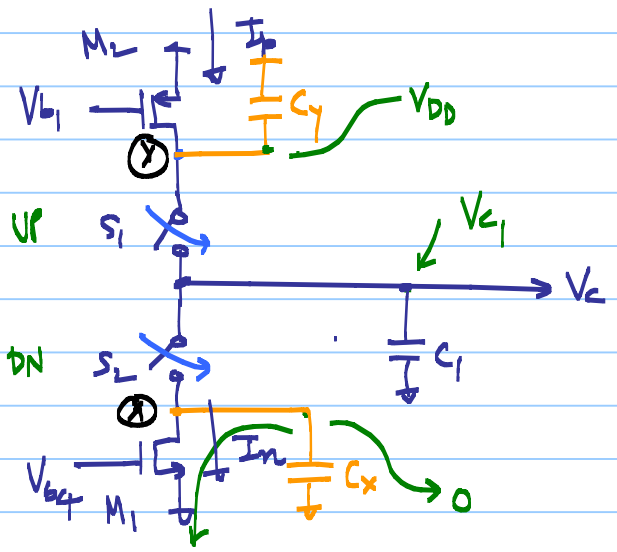
$$\Delta\phi = 2\pi \cdot \left(\frac{T_{rst}}{T_{ref}}\right) \cdot \left(\frac{\delta I_{cp}}{I_{cp}}\right) > 0 \Rightarrow \text{reference feed through}$$

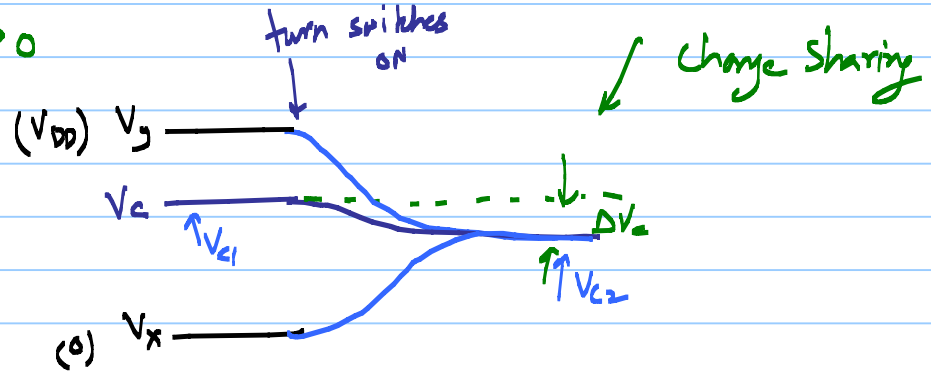


Areas are forced to be equal by the -ve feedback loop

④ Charge Sharing

* Initially S_1 & S_2 are off
  - X → discharged to ground
  - Y → charged to V_{DD}
* Now, the switches are turned on





* When the switches S_1 & S_2 turn ON

V_x rises, & V_y falls

and eventually $V_x = V_y = V_c$

$\Rightarrow$ charge sharing occurs b/w

C_x, C_y & C_1

$$V_{c_1,\,final} = \frac{C_x V_x + C_y V_y + C_1 V_c}{C_x + C_y + C_1}$$

(V_x: 0, V_y: V_{DD}, V_c: V_{c_1})

$$= \frac{C_y \cdot V_{DD} + C_1 V_{c_1}}{C_x + C_y + C_1} \neq V_{c_1}$$

* Due to charge sharing

$\Rightarrow$ V_c "jumps" $\Rightarrow$ VCO phase error $\Rightarrow$ output jitter

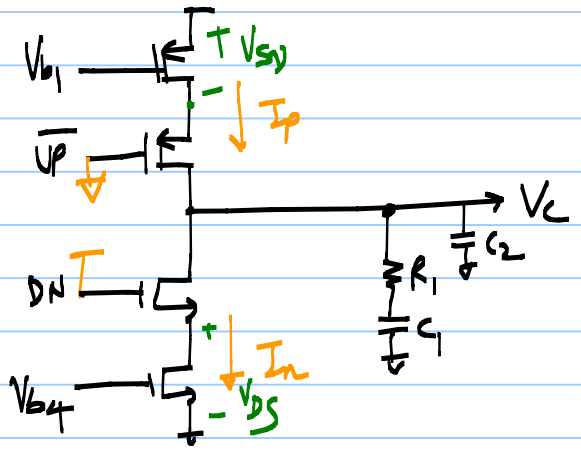
* This amount of disturbance depends upon the steady state value of V_c

⇒ desired f_{out}

⇒ disturbance / jitter in the output depends upon $f_{out} = N \cdot f_{ref}$

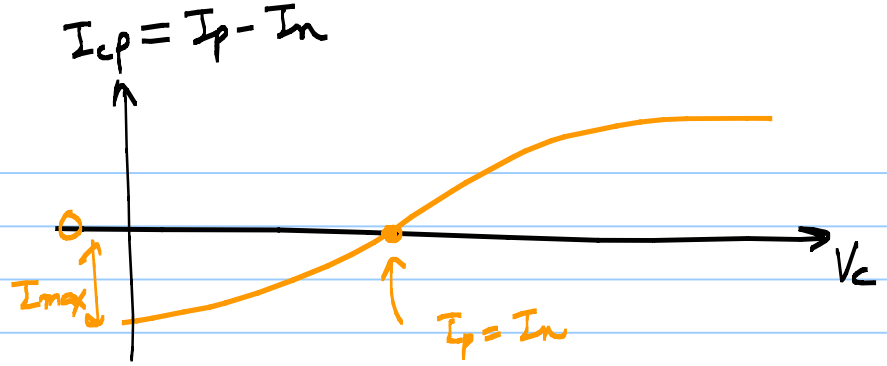
" Big problem! "

(5) Channel length Modulation



* different output voltages will lead to different V_{DS} & V_{SD} for the current sources

⇒ mismatch between I_p & I_n



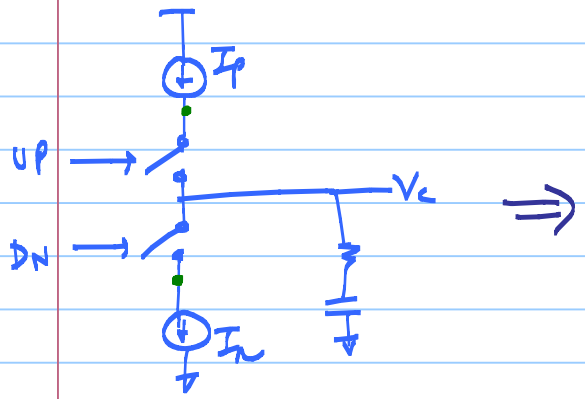
$$\frac{I_{max}}{I_0} \simeq 30 - 48\%.$$

& mismatch depends upon $\rightarrow V_c$

$\Rightarrow$ Jitter

① Charge injection and clock feedthrough

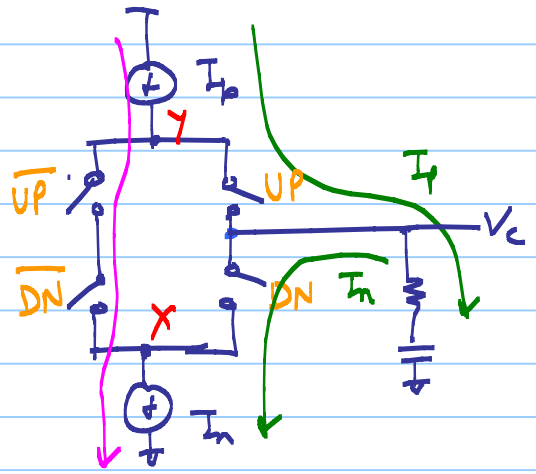
Charge pump with improved matching



current sources shut off and turned on

$\Rightarrow$

UP=DN=0

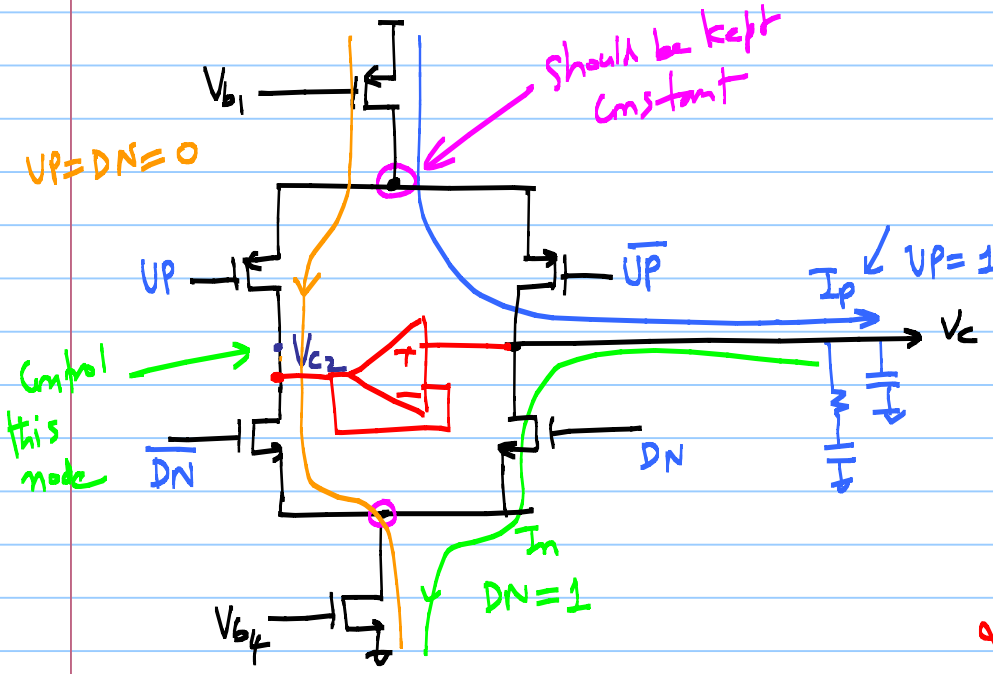


UP=DN=1

* Charge sharing solution $\Rightarrow$ keep the current sources turned on and simply steer the currents.

*

* Need to keep the V_{DS} ($\sim V_{SD}$) of the current sources constant.



* To keep the V_{SD} & V_{GS} of the current sources constant

V_{C2} must mirror V_C

(in project, use ideal opamp)

reduced transient current mismatch

Professional CP Design: