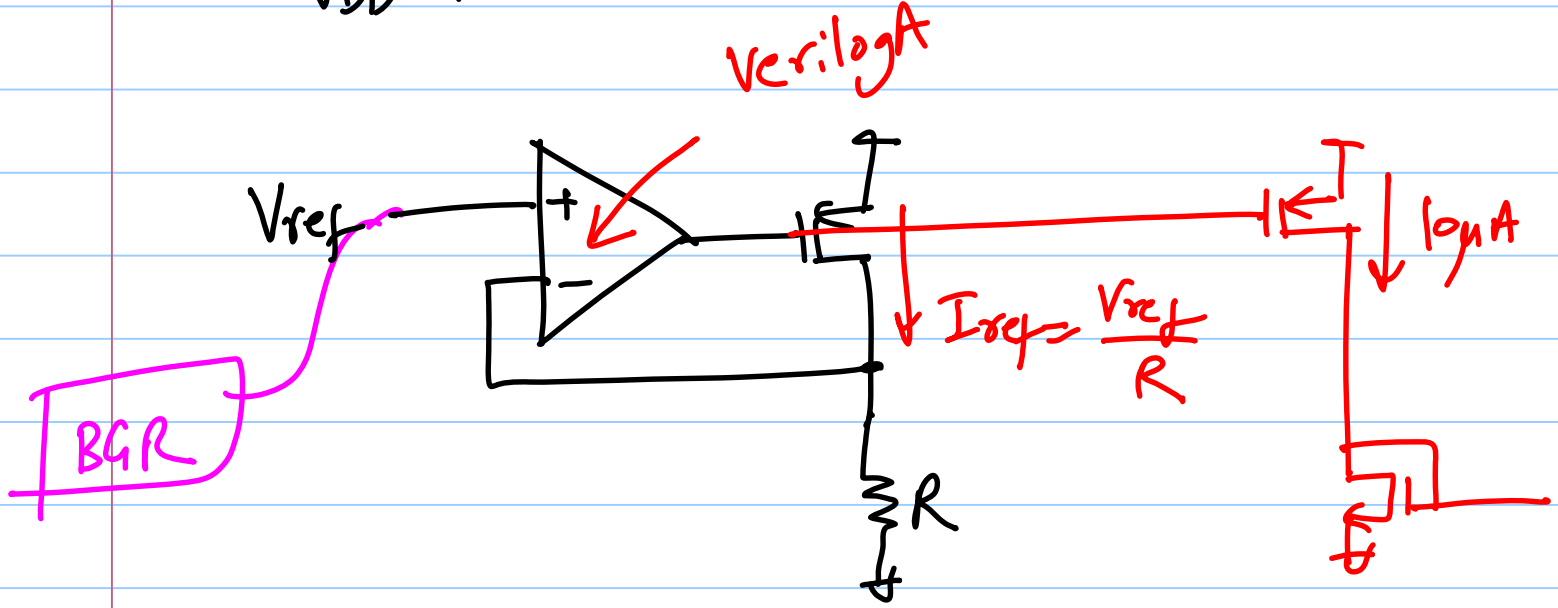
ECE 614 – Lecture 15

Note Title 10/14/2014

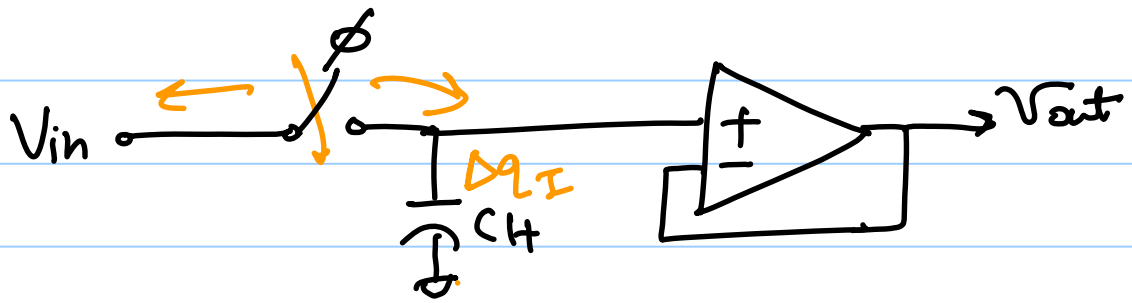
"10μA"

V_{DD}-R bias

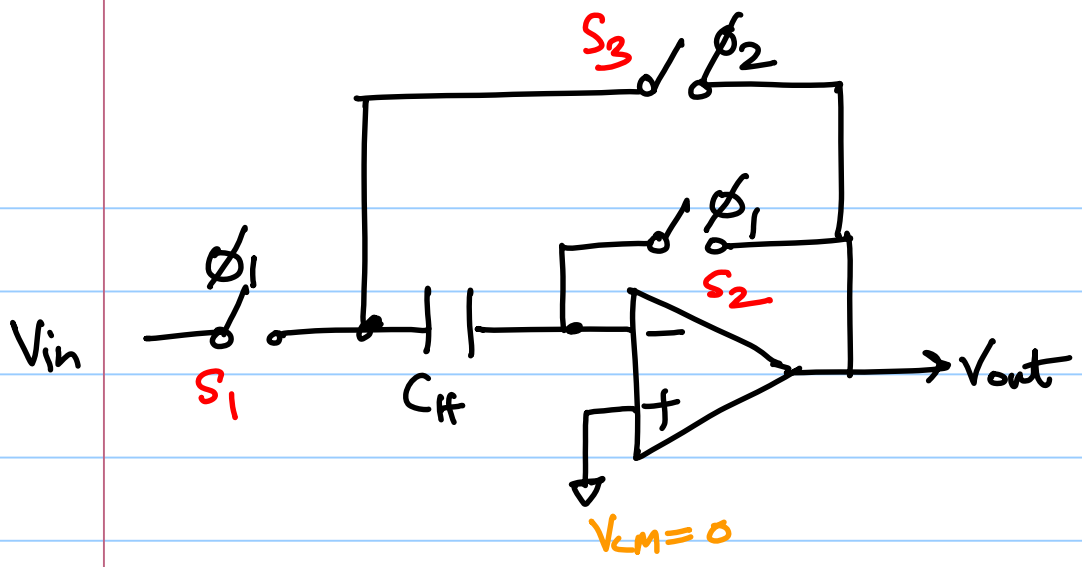


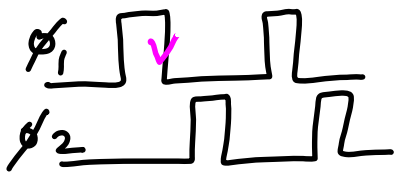
Unity-Gain Sampler (S/H), Buffer

S/H Buffer



charge injection limits accuracy.

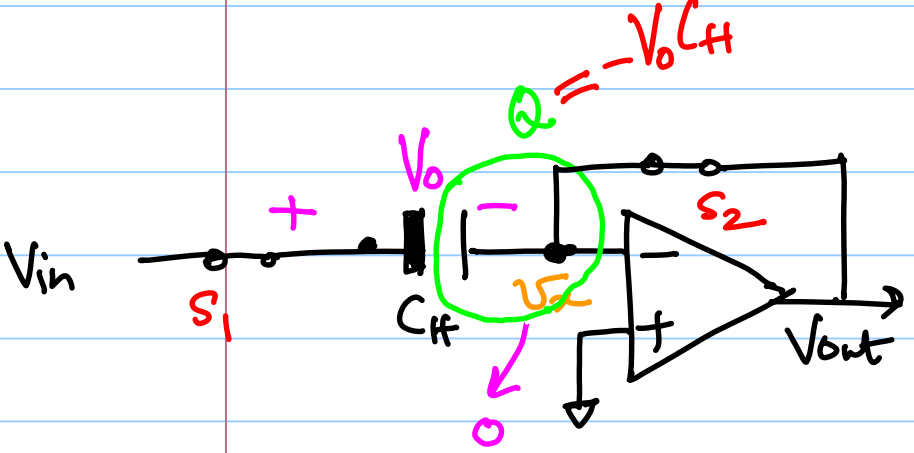




N.O. clocks

Assume Ideal opamp

Sampling mode ($\phi_1 = 1$)

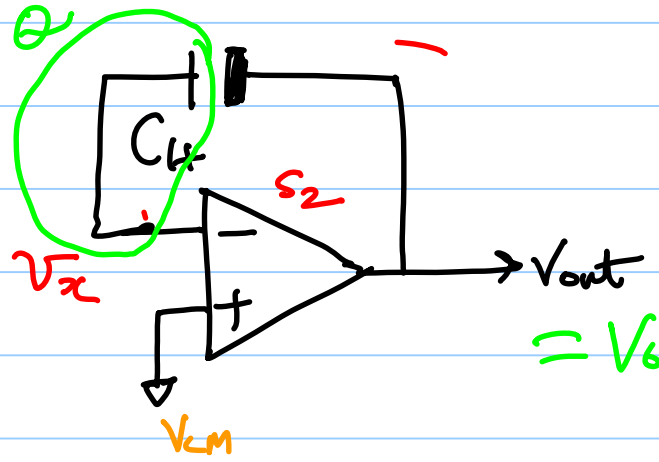


$v_x = 0$

Voltage across C_H tracks V_{in}

$\phi_2 = 1$ (Butting mode)

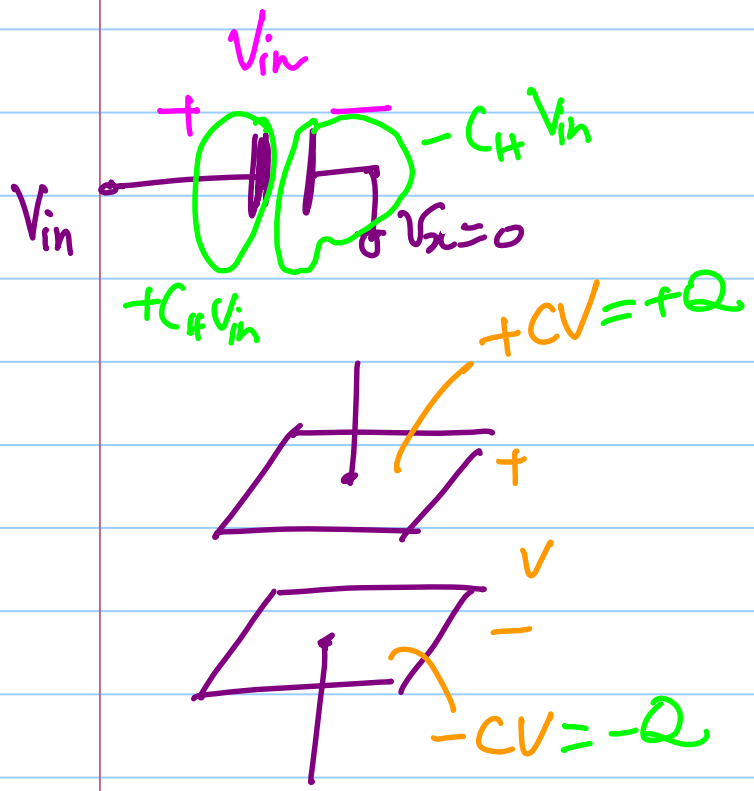
$-C_H V_{out} = Q$



Vin

↳ When $t=t_0$, ϕ_1 ↓

$V_{in}=V_0$ is stored on C_H

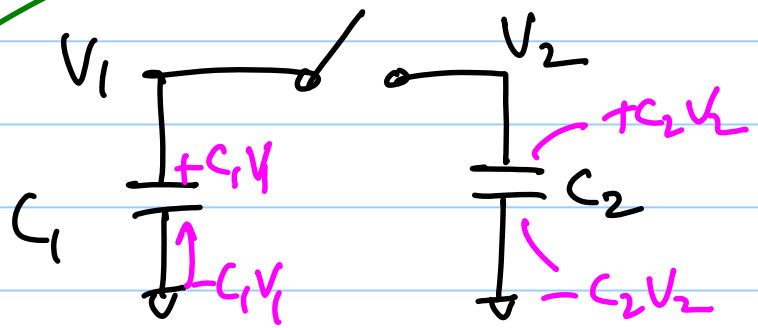


due to Conservation of charge at the surface connected to V_x

$$-C_H V_{out} = -C_H V_0$$

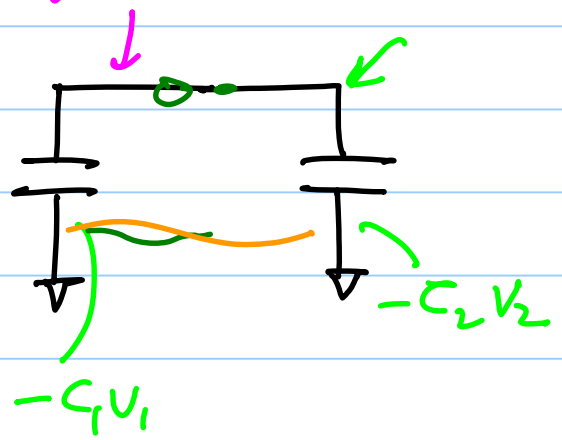
$$V_{out} \Rightarrow V_0$$

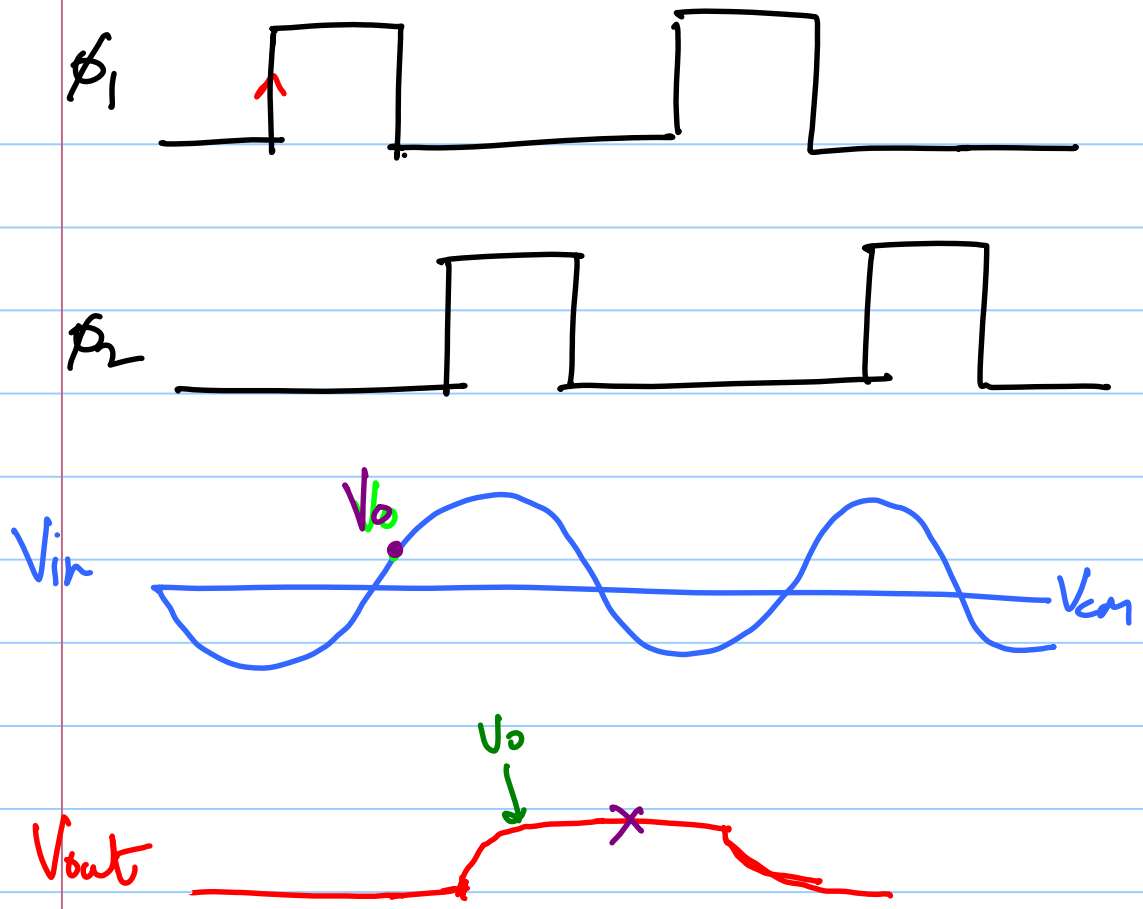
Aside



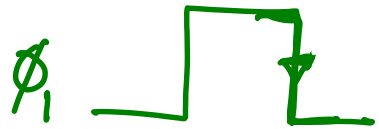
$$V_f = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$$

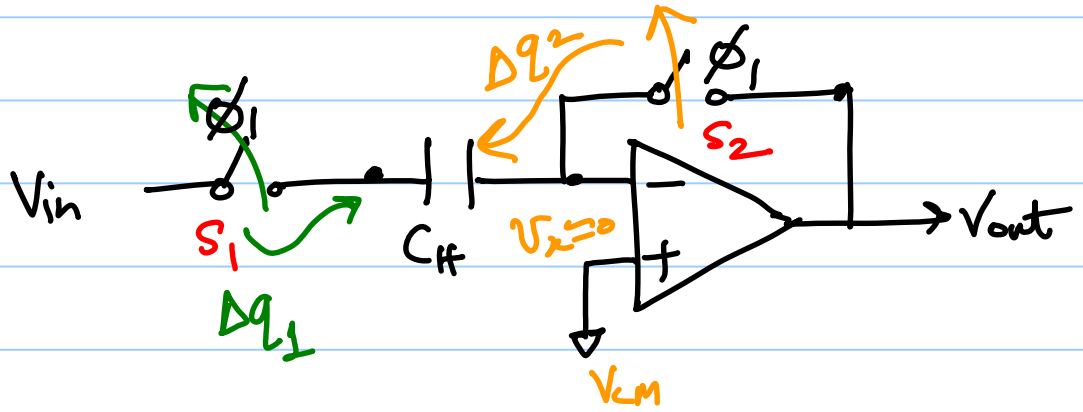
$$Q = C_1V_1 + C_2V_2$$




ϕ_1
ϕ_2
V_{in}
V_o
V_{cm}
V_o
V_{out}

Slow-Mo Recap





$$\Delta q_1 = WLC_{ox}(V_{CLK} - V_{in} - V_{THN})$$

* Charge injection from S_1 to C_{ff} is still a problem

$$\Delta q_2 = WLC_{ox}(V_{CLK} - V_{THN})$$

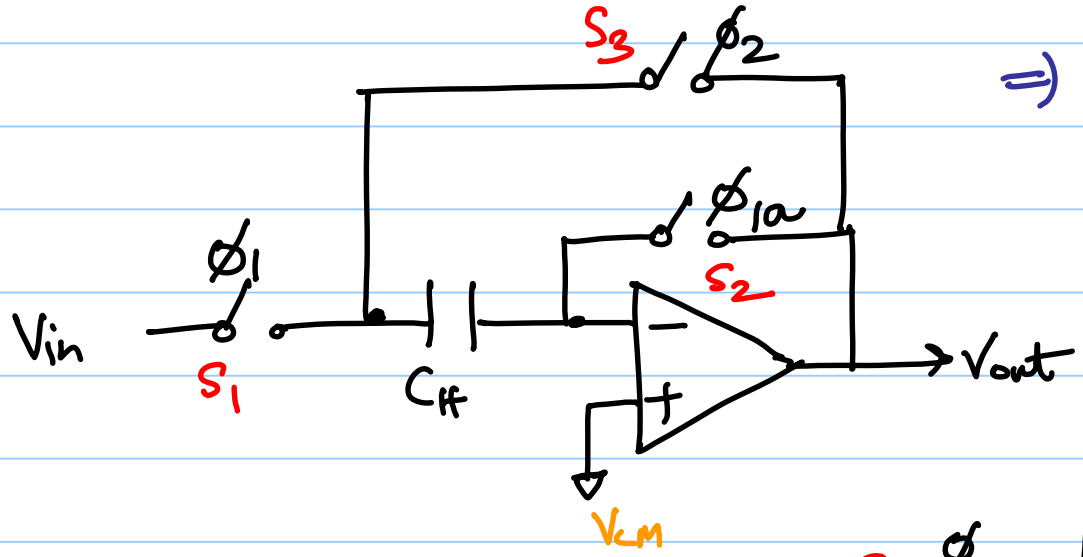
↳ constant charge injected

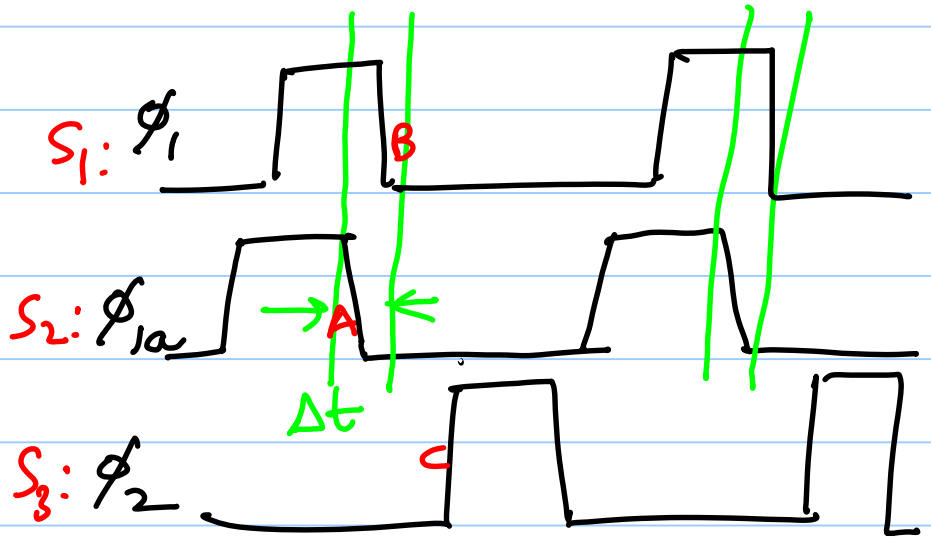
↳ can be removed by differential operation

Trick: Delayed sampling clock

ϕ_{1a} is advanced phase of ϕ_1

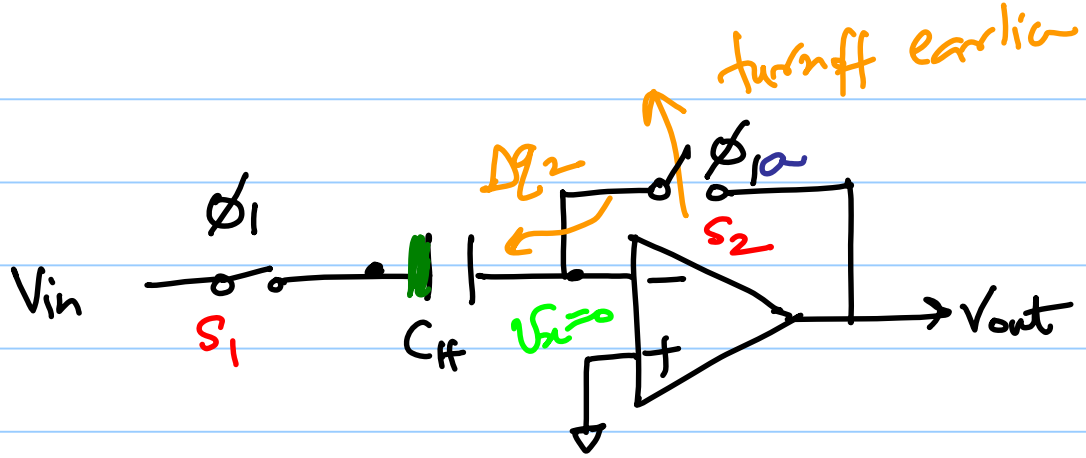
$\Rightarrow$ Turn off S_2 earlier than S_1



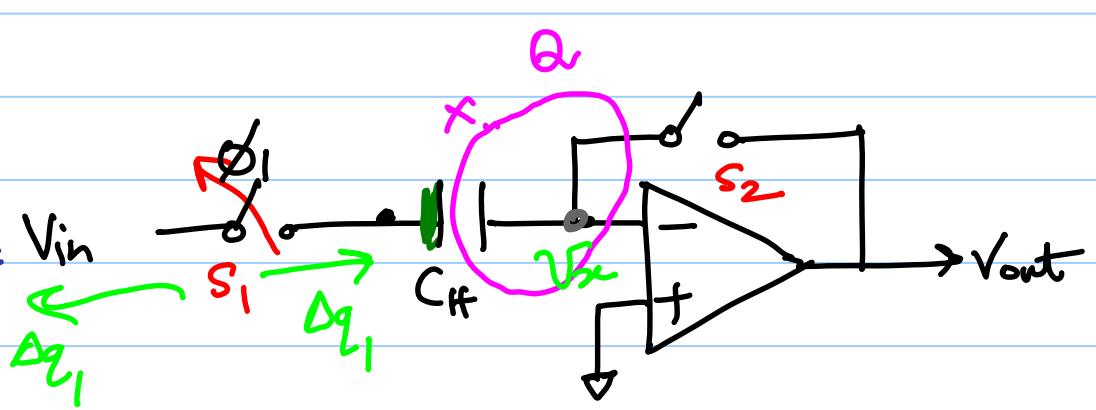


ϕ_{1a} falls earlier than ϕ_1

(A)



(B)



ΔQ_1 is injected from S_1 into one of the plates of C_{ff}.

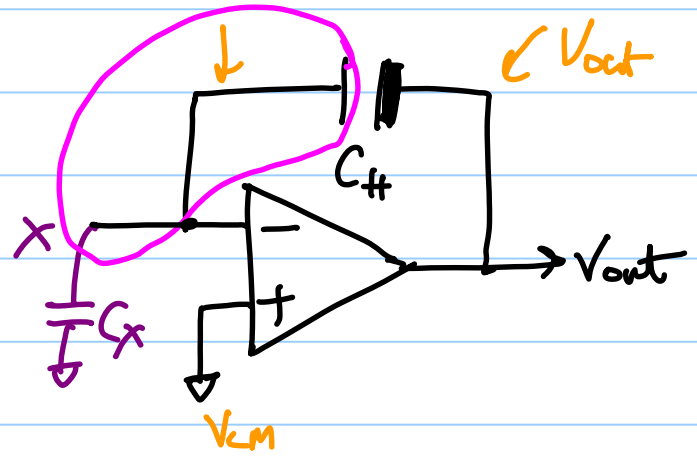
Simplify life

After $\phi_{1a}\downarrow$ i.e. S_2 turned off, total charge at X cannot change as no path exists for electrons to flow in or out of this node

$\Rightarrow$ Conservation of charge at surface X

(c) S_3 ↑

$Q = -(V_{out} - V_x) C_{ff}$



total charge on X is conservation

$Q = -C_x V_x = -(V_{out} - V_x) C_{ff} \rightarrow (1)$

when $V_0 = 0$,

$V_x = \frac{-V_{out}}{A_{v_1}} \rightarrow (2)$

(1) + (2)

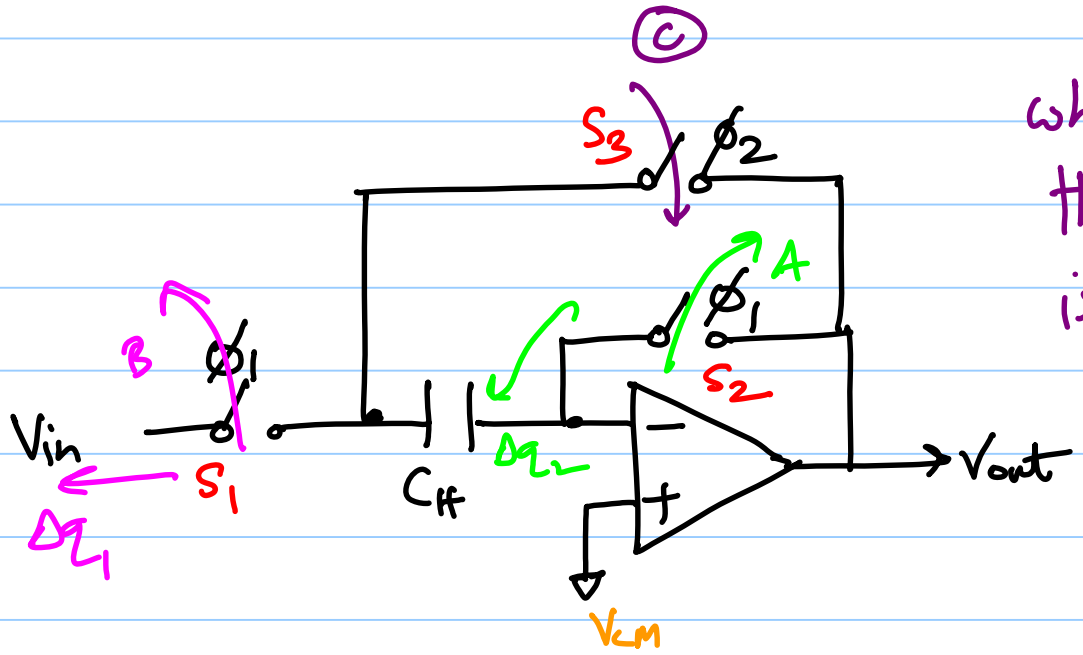
$-(C_x + C_{ff}) \frac{V_{out}}{A_{v_1}} - V_{out} C_{ff} = 0$

$\Rightarrow V_{out} = 0$

↳ result is independent of ΔQ_1, parasitic Cap value, A_v (opamp gain)

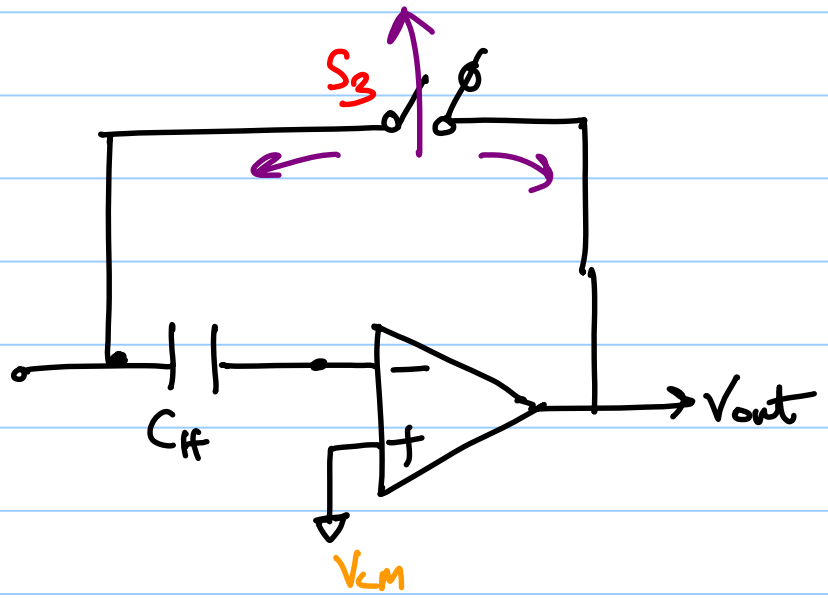
Do this for $V_{in} > 0$

Qualitatively, all the ΔQ_1 is absorbed into the source (V_{in})

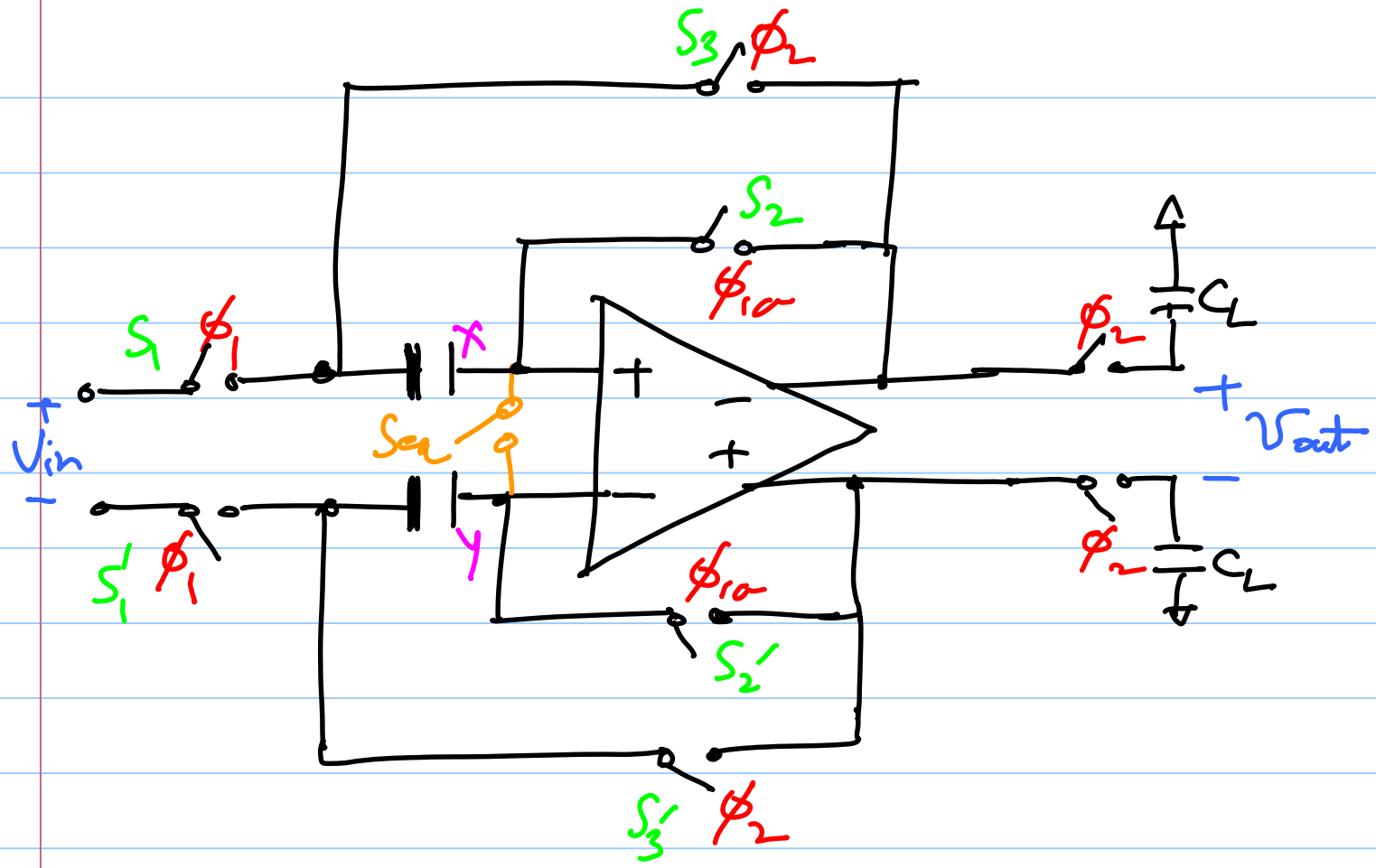


when S_3 is turned on, the inversion layer charge is supplied by the opamp (not C_{ff})

①



charge injected by S_3 is unimportant



mismatch between S_2 & S_2' $\Rightarrow$ $\Delta q_2 - \Delta q_2' \neq 0$

S_{eq} $\Rightarrow$ turns off slightly after S_2 & S_2' but before S_1 & S_1' $\Rightarrow$ equalizes the charge at nodes x & y