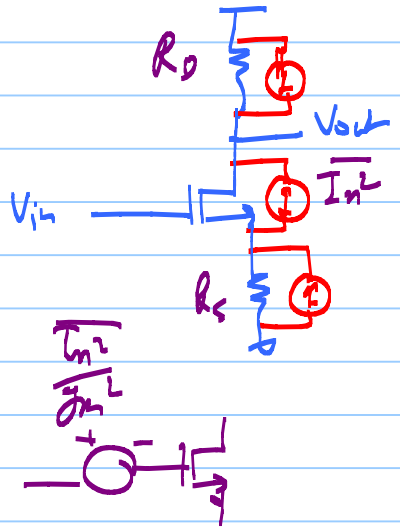
ECE 614 — Lecture 15

Note Title 10/23/2012



$$\overline{V_{n,out}^2} =$$

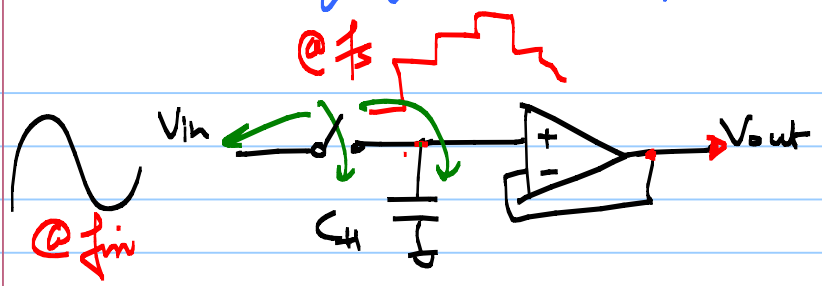
$$V_n = V_{n_1} + V_{n_2}$$

$$\overline{V_n^2} = \left(V_{n_1} + V_{n_2}\right)^2$$

$$= \overline{V_{n_1}^2} + \overline{V_{n_2}^2} + 2E(V_{n_1} V_{n_2})$$

$E(V_{n_1} V_{n_2}) = 0$ uncorrelated

Unity-gain Sampler (S/H)

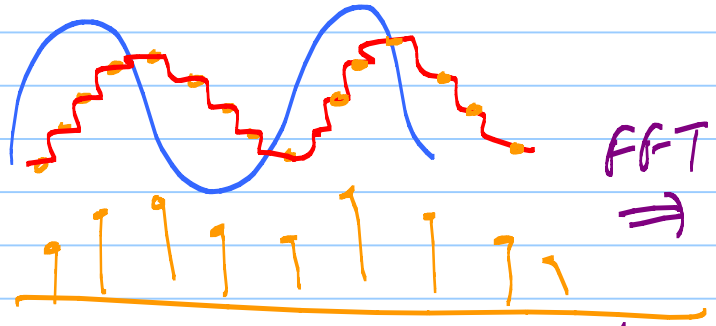


HD ← one-tone test

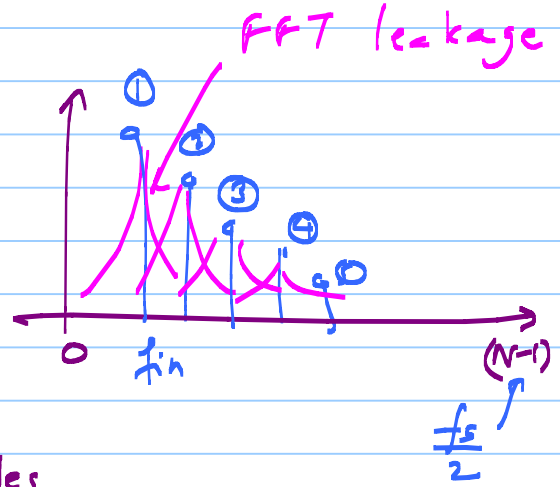
IM ← two-tone test

A

input dependent CI



FFT ⇒



"N" samples

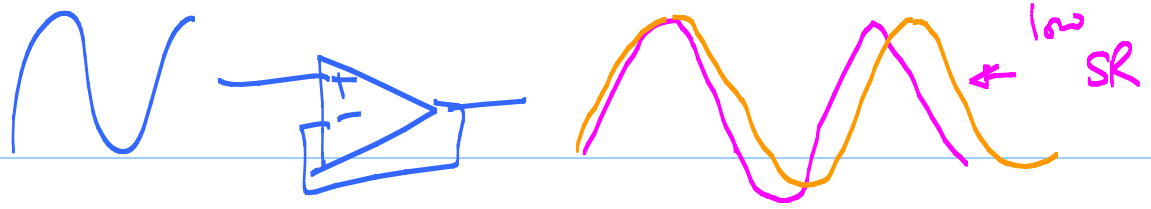
$\frac{f_{in}}{f_s} = \frac{k}{2} = \frac{1}{128}$ ~~$\frac{1001}{128}$~~

mutually prime

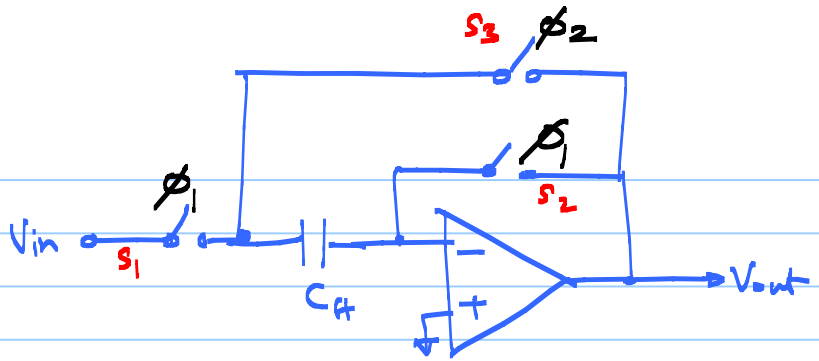
* Coherent sampling

"Dynamic Characterization"

$= \frac{32}{128} = \frac{1}{4}$

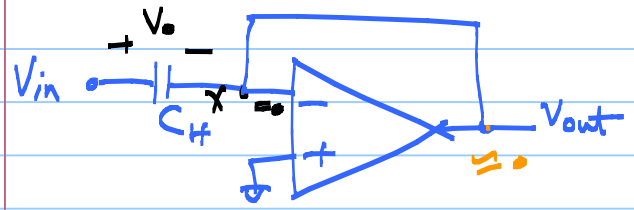


distortion due to slewing



$\underline{\phi_1}$ Sampling mode

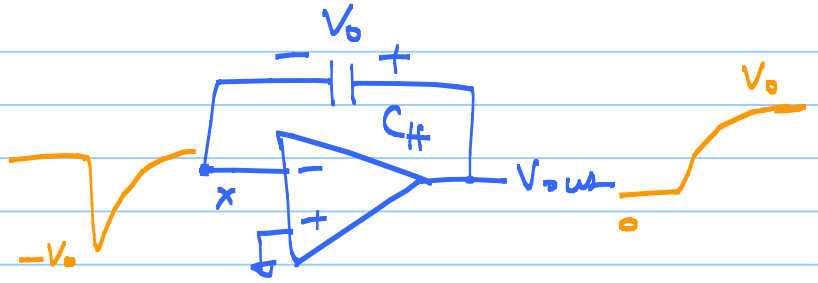
$\underline{\phi_2}$ Amplification / Hold mode



$V_{out} = V_x = 0$

Voltage across C_H tracks V_{in}

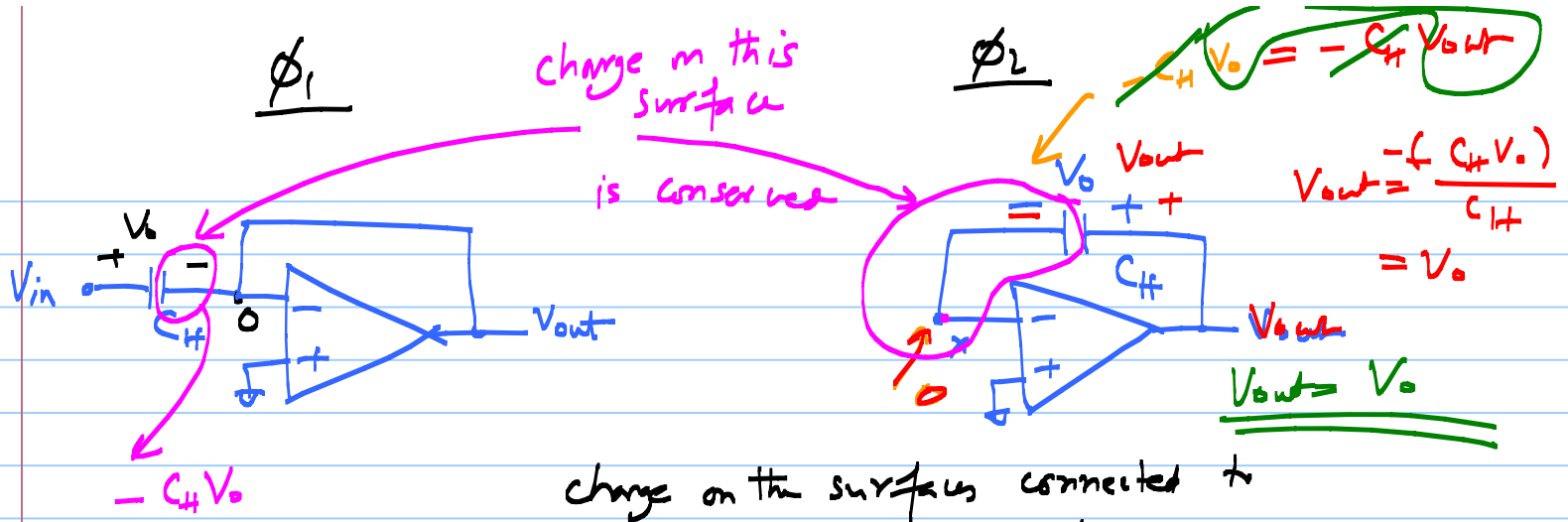
@ $t = t_0$ $\phi_1 \rightarrow$, $V_{in} = V_o$ is stored in C_H



$V_x =$

V_{out} rises to $= V_o$

* This value is frozen and proceeded to subsequent stage



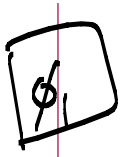
$-C_H V_o = -C_H V_{out}$

$V_{out} = \frac{-(C_H V_o)}{C_H}$

$= V_o$

charge on the surfaces connected to the virtual ground (V_x) is conserved

↳ No DC path

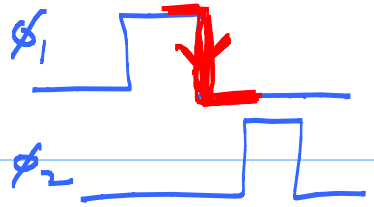


Slow-motion: $\Delta q_2 = WL C_{ox}(V_{CLK} - V_x - V_{THN_2})$

$V_x \to 0$

V_{THN_2}

Constant — Charge injection



Δq_1

$WL C_{ox}(V_{CLK} - V_{in} - V_{THN_1})$

$\uparrow (\sqrt{V_{in}})$

effect ← Δq_2 ⇒ Constant C.I.

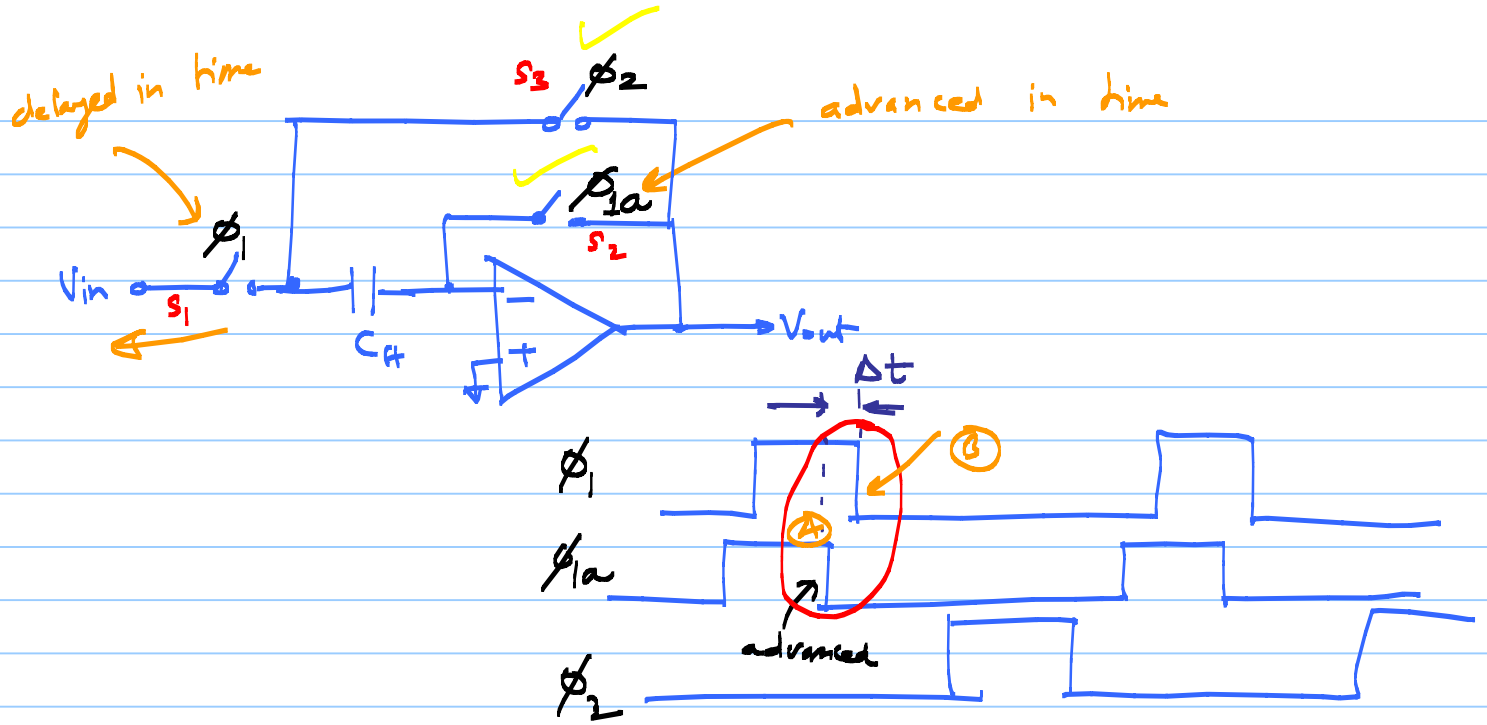
⇒ input dependent CI

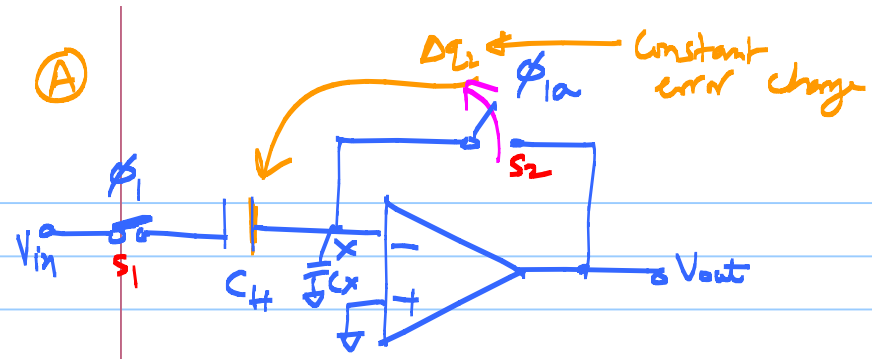
Δq_1

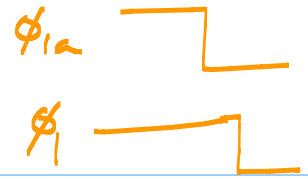
NL

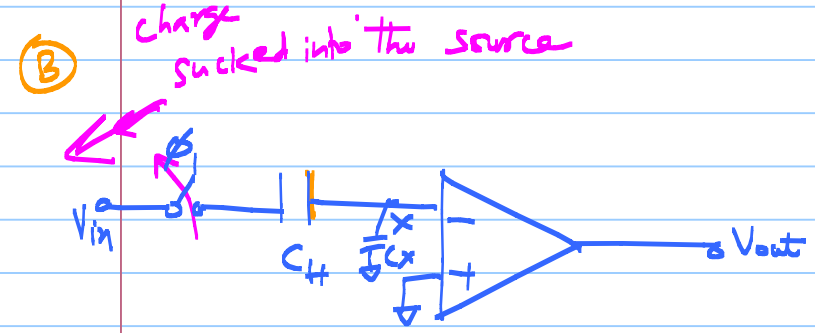
Can we get rid of this?

Trick: Delayed sampling clock



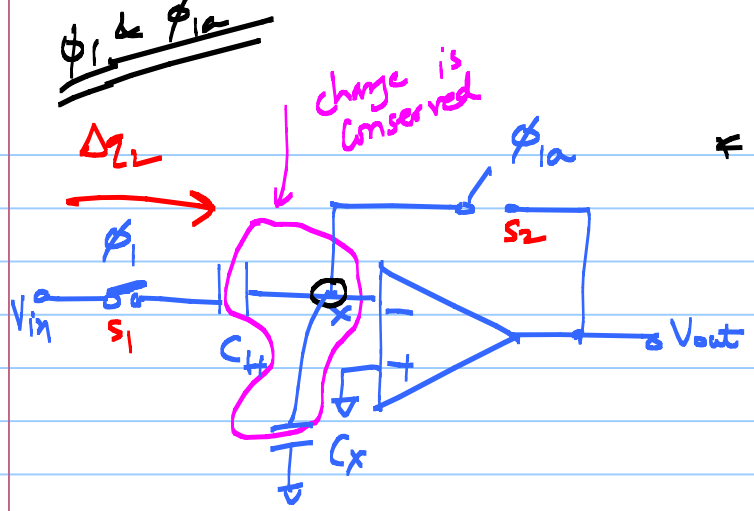






* avoids input-dependent charge injection

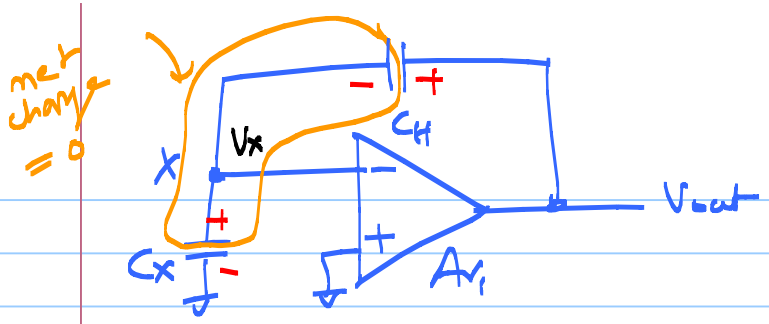
ϕ_1 & ϕ_{1a}



Example $V_{in}=0$

* After S_2 is off.

* Before S_1 turns off,
  total charge in right plate of C_H
  + top plate of $C_x = 0$



Total charge @ node $x = 0$

$$\Rightarrow \quad C_x V_x - (V_{out} - V_x) C_H = 0 \longrightarrow (1)$$

$$\& \quad V_x = -\frac{V_{out}}{A_{v_1}} \longrightarrow (2)$$

$\Rightarrow (1) \& (2) \Rightarrow$

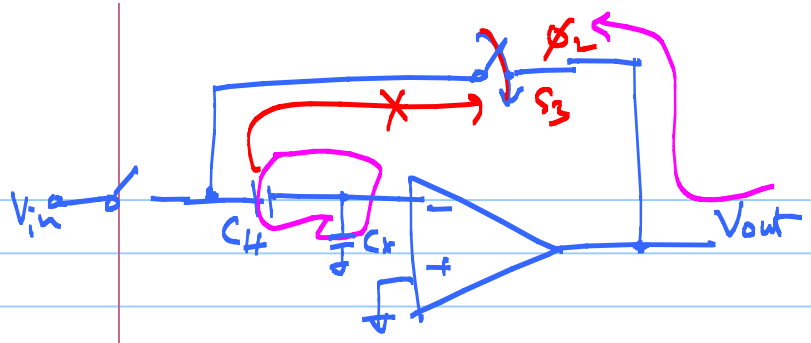
$$-(C_x + C_H)\frac{V_{out}}{A_{v_1}} - V_{out} C_H = 0$$

$$V_{out}\left(\ ?\ \right) = 0$$

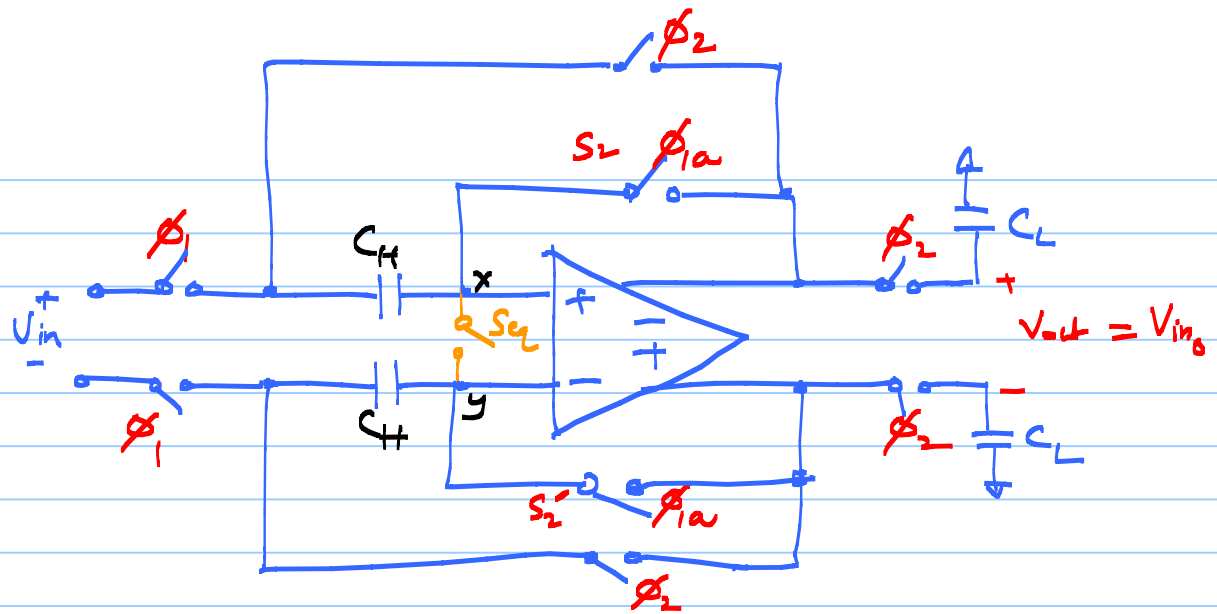
$$\Rightarrow V_{out} = 0$$

$\Rightarrow$ charge injection Δq_{2_2} (by S_1) introduces no error as "S_2" is turned off first.

$\boxed{V_{out} = V_0}$ ← indep. of Δq_{2_2}, C_x, A_{v_1}

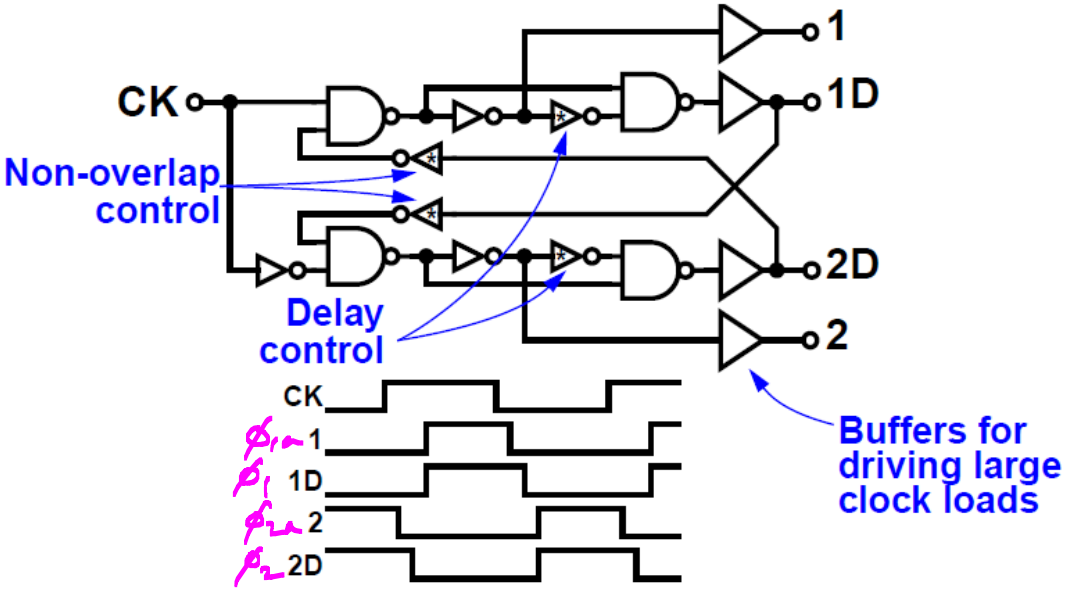


* when, ϕ_2 goes high
the inversion layer charge for S_3
is completely supplied by Vout
(opamp)



* NL due to the input dependent charge injection is mitigated
* any fixed charge injected at x & y is a CM-disturbance
* In reality S_2 & S_2' exhibit finite charge injection mismatch
  - Add another switch S_{eq}
    - turns off slightly after S_2 & S_2'
      - but before S_1 & S_1'

Professional Clock Generator



- To maximize the time available for settling, make the early and late phases start at the same time