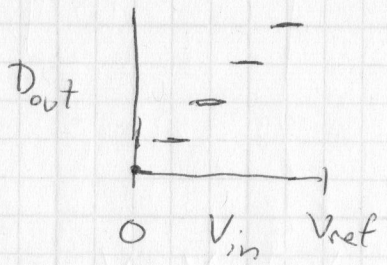
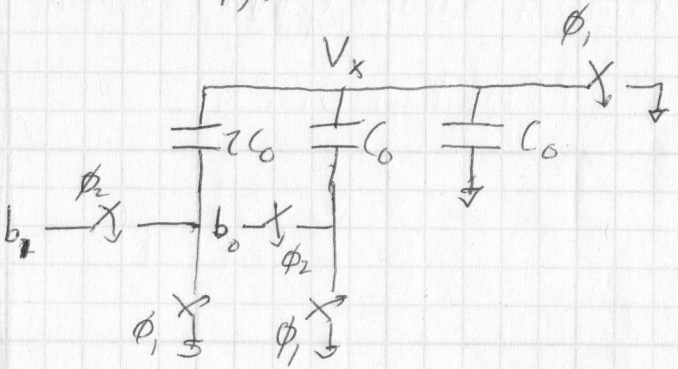
Recap #1 - meet the team

ADCs




Switched cap, take 2



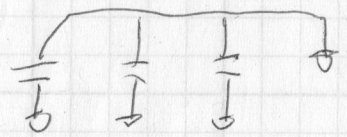

$B = [b_1 b_0]$ = 00 0 where logic 0 ⇒ 0 V

01 1

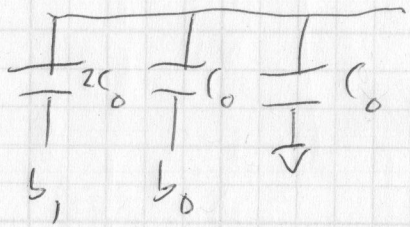
10 2 logic 1 ⇒ $V_{ref}$ = 1 V

11 3

$\phi_1$



$\phi_2$

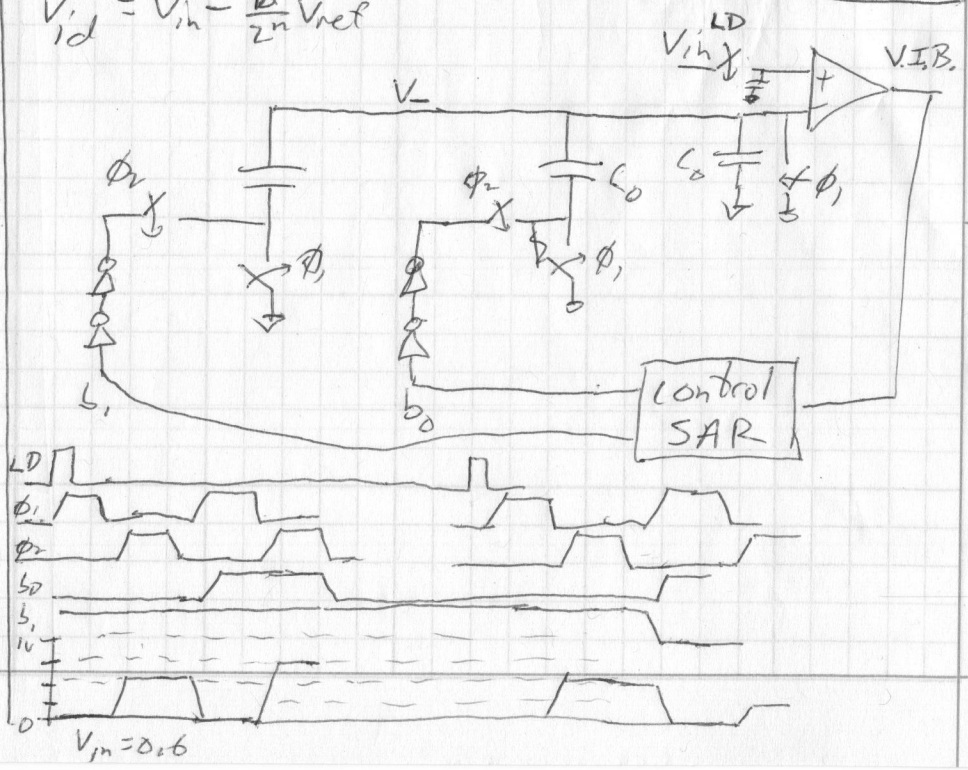



$$V_x = \frac{B C_0}{4 C_0} V_{ref}$$

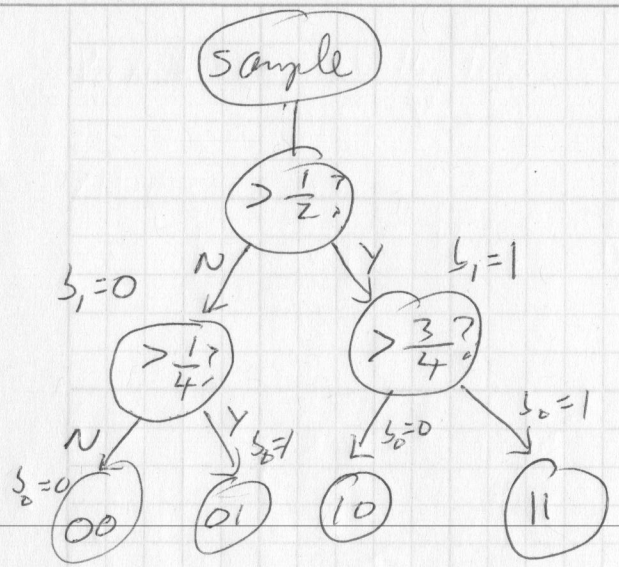
$$= \frac{B}{4} V_{ref}$$

$$= \left\{0, \frac{1}{4}, \frac{1}{2}, \frac{3}{4}\right\}(1V)$$

$$V_{id} = V_{in} - \frac{B}{2^n} V_{ref}$$




140/240A 17 SP W13 L3

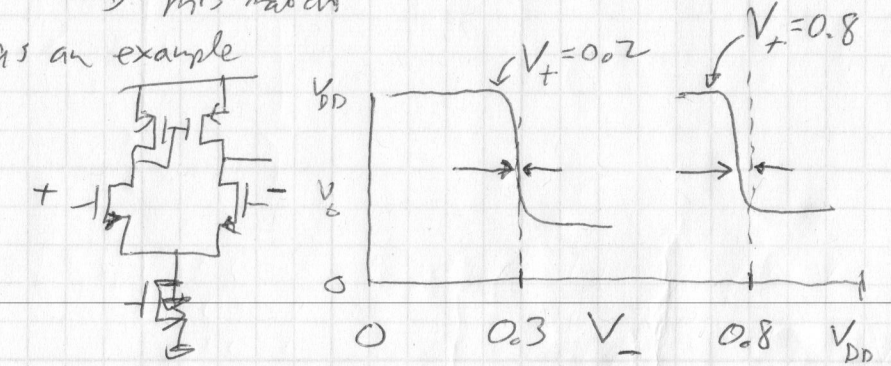



Problem: comparing at all possible output values

$\Rightarrow V_{cm}$ varies from 0 to $V_{ref}$

$\Rightarrow$ mismatch

as an example



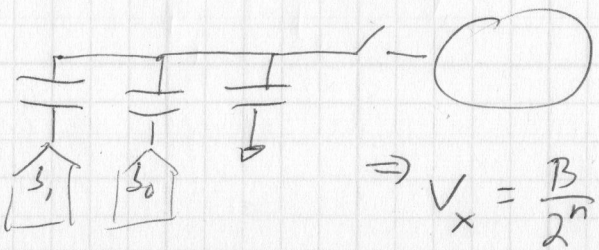

Change in input offset with Cm

now add in Temp & Process variation —

Keep input offset < 1mV over $0 \rightarrow V_{ref}$

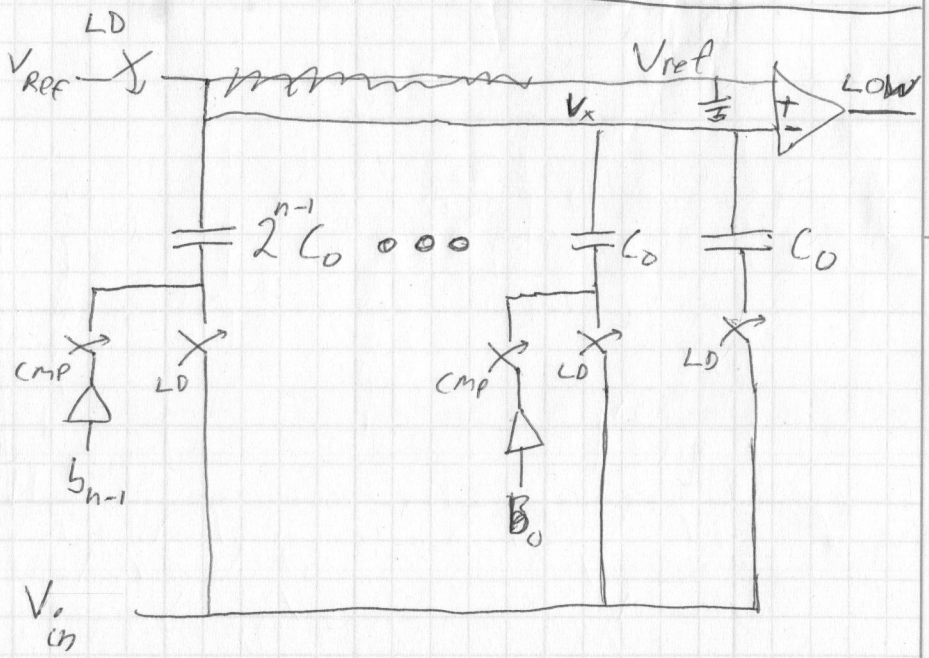
hard. So... be clever, compare all 1 voltage only. for us, it's $V_{ref}$. How?

1st, recall:

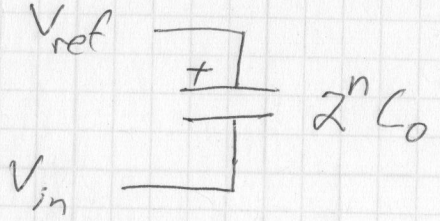



$$\Rightarrow V_x = \frac{B}{2^n} V_{ref} + V_z$$

we will make $V_z = V_{ref} - V_{in}$



During LD



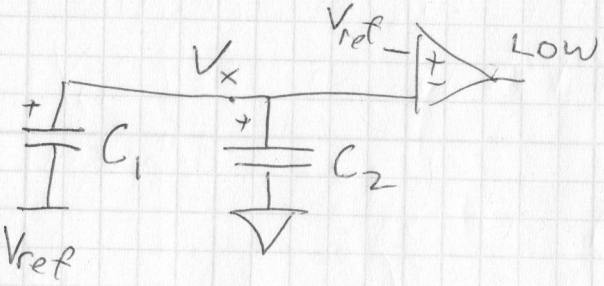

$$Q_{x,LD} = (V_{ref} - V_{in})\, 2^n C_0$$

When LD goes low $Q_x$ is fixed

consider 1pA from 1pf for 10μs ⇒ 10μV

huge leakage — about right — 100K $\frac{s}{s}$

During cmp




$C_1 = BC_0 \quad C_2 = (2^n - B)C_0$

$$Q_{x,cmp} = (V_x - V_{ref})C_1 + V_x C_2$$

$$= V_x(C_1 + C_2) - V_{ref} C_1 \quad \text{which must equal}$$

$$= Q_{x,LD}$$

$$Q_{x,LD} = (V_{ref} - V_{in})\, 2^n C_0 = Q_{x,cmp} = V_x\, 2^n C_0 - V_{ref} B C_0$$

$$V_{ref} - V_{in} = V_x - V_{ref}\frac{B}{2^n}$$

$$V_x = V_{ref} + V_{ref}\frac{B}{2^n} - V_{in}$$

$$V_{id} = V_+ - V_- = V_{ref} - V_x = V_{in} - \frac{B}{2^n} V_{ref}$$

Debugging - check the bias point

~~verify~~ verify hand calcs match sim

- run DC sweeps

verify hand calcs vs. sim

DO NOT HACK!