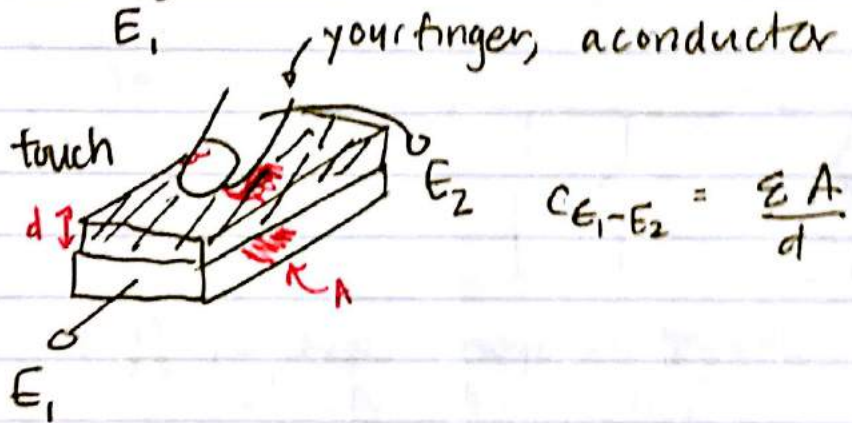
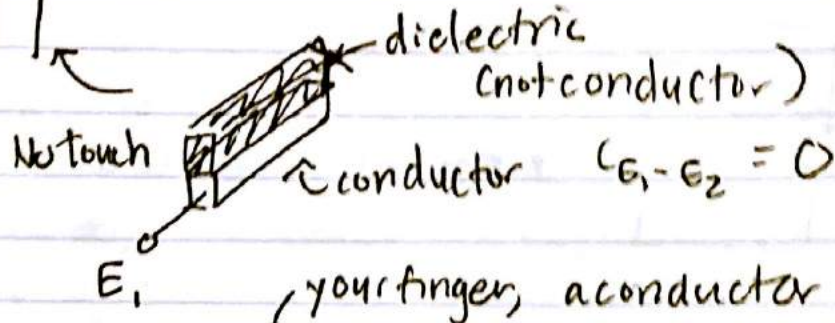
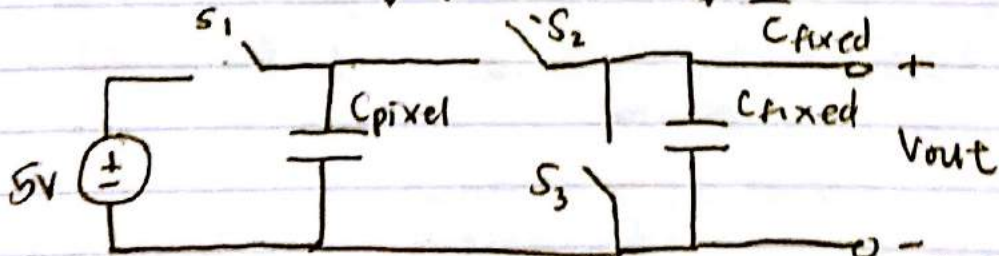
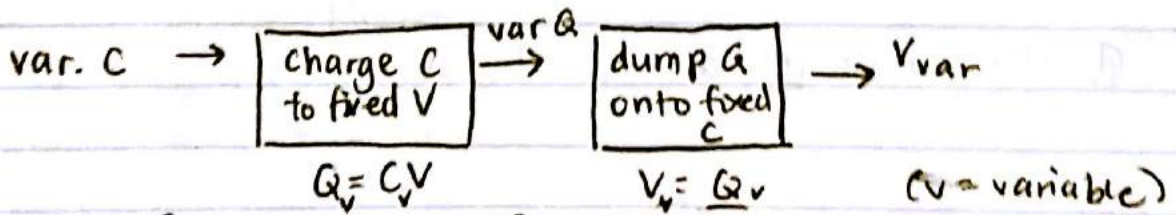


1D Touchscreen w/ Capacitors

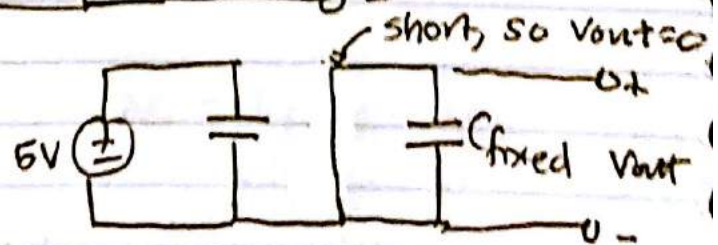


How to measure C?

Block diagram:



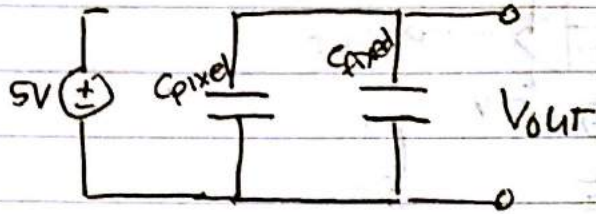
- Phase 1:
- S_1 : ON (closed)
 - S_2 : OFF (open)
 - S_3 : ON (closed)



$Q_{\text{fixed}} = 0C$

$Q_{\text{pixel}} = 5C_{\text{pixel}}$

Phase 2: $S_1: OFF$
 $S_2: ON$
 $S_3: OFF$

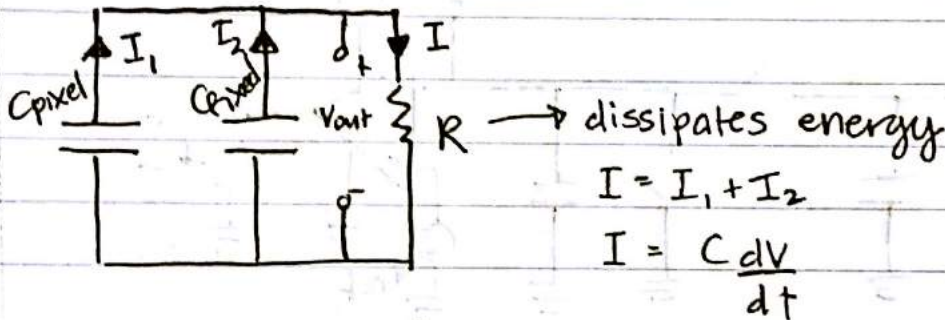


$$Q_{pixel} = C_{pixel} V_{out}$$

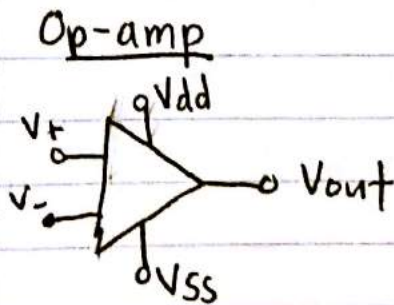
$$Q_{fixed} = C_{fixed} V_{out}$$

$$5 C_{pixel} = C_{pixel} V_{out} + C_{fixed} V_{out}$$

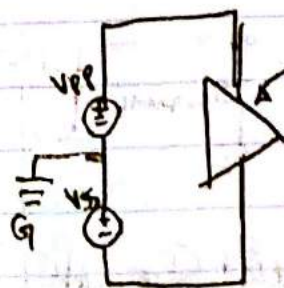
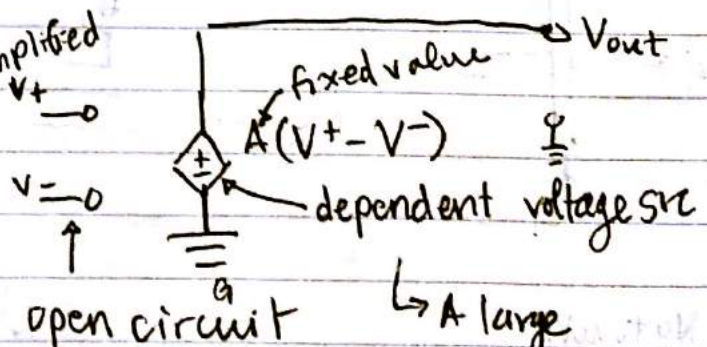
$$V_{out} = \frac{5 C_{pixel}}{C_{pixel} + C_{fixed}}$$



- New Goals:
- ① Take V_{out} and force it to be 5V if touch, 0V if no touch.
 - ② Make sure component present an open (no R !)

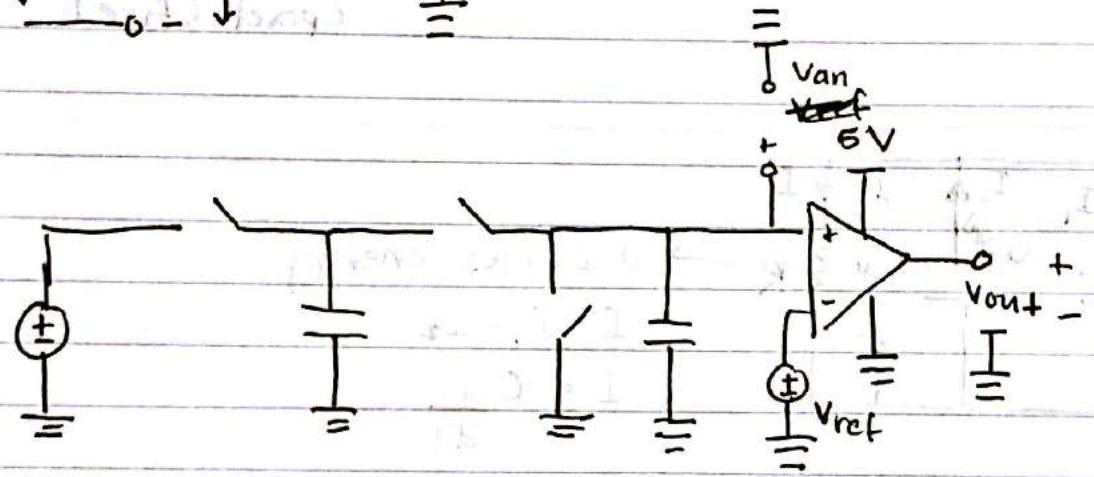
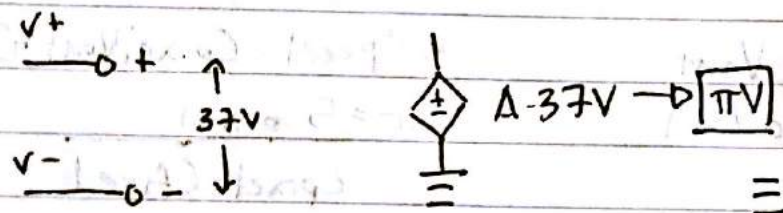
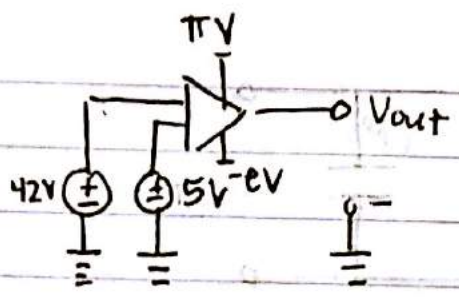


can be simplified \Rightarrow



opamps have to be connected to power sources

$\hookrightarrow A$ large (really ∞)
 but $V_{out} < V_{DD}$
 behavior is linear until you hit V_{DD}/V_{SS}



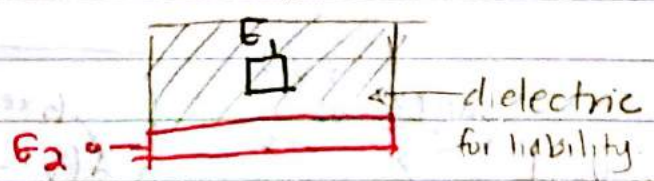
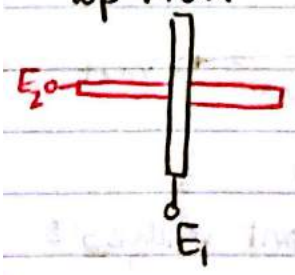
$$V_{an} = \frac{5V \cdot C_{pixel}}{C_{pixel} + C_{final}}$$

Choose V_{ref} , C_{fixed} s.t. $V_{an} > V_{ref}$ when touch
 $V_{an} < V_{ref}$ when not touch

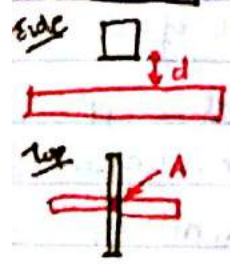
Let's do 2D!

Top View

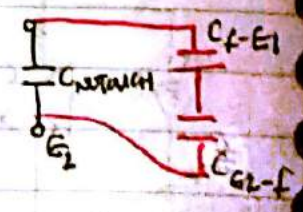
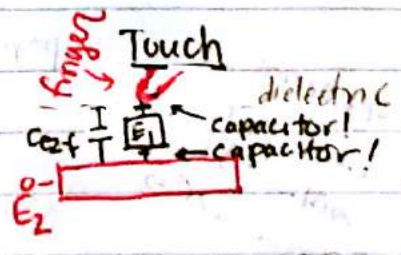
Side View



Notouch



$$C_{notouch} = \frac{\epsilon A}{d}$$



$$C_{\epsilon-\epsilon_2} = C_{notouch} + (C_{\epsilon-E1} || C_{\epsilon-E2})$$