

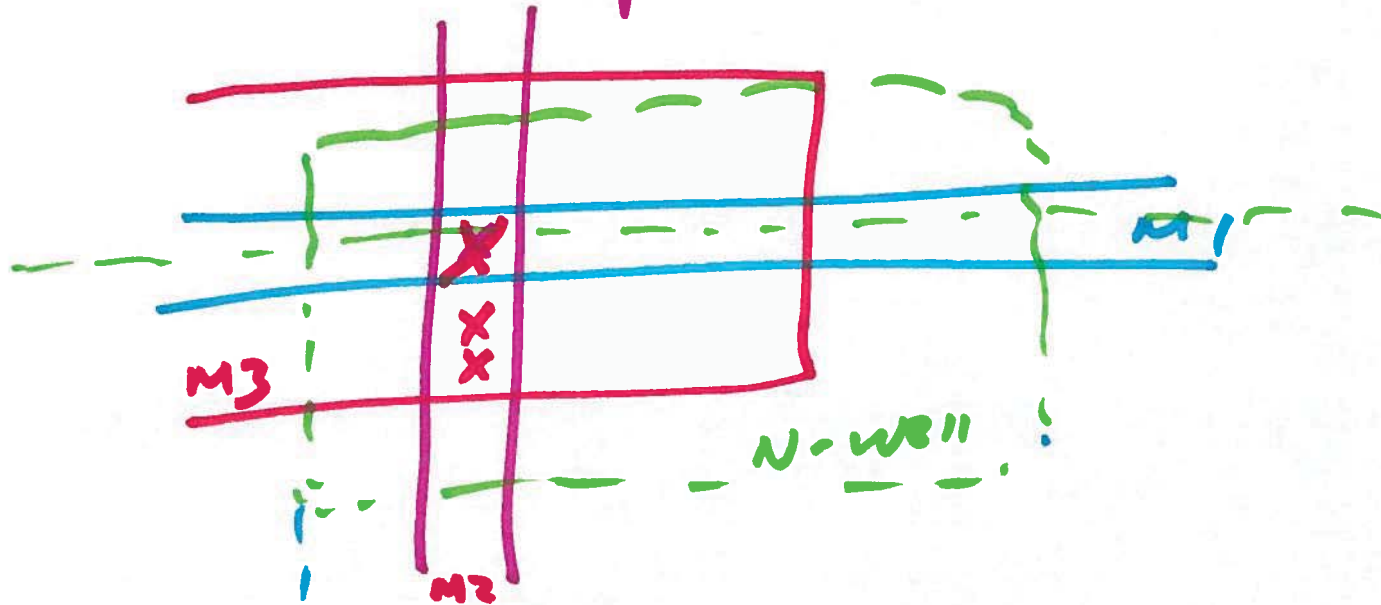
EE421/ELG621

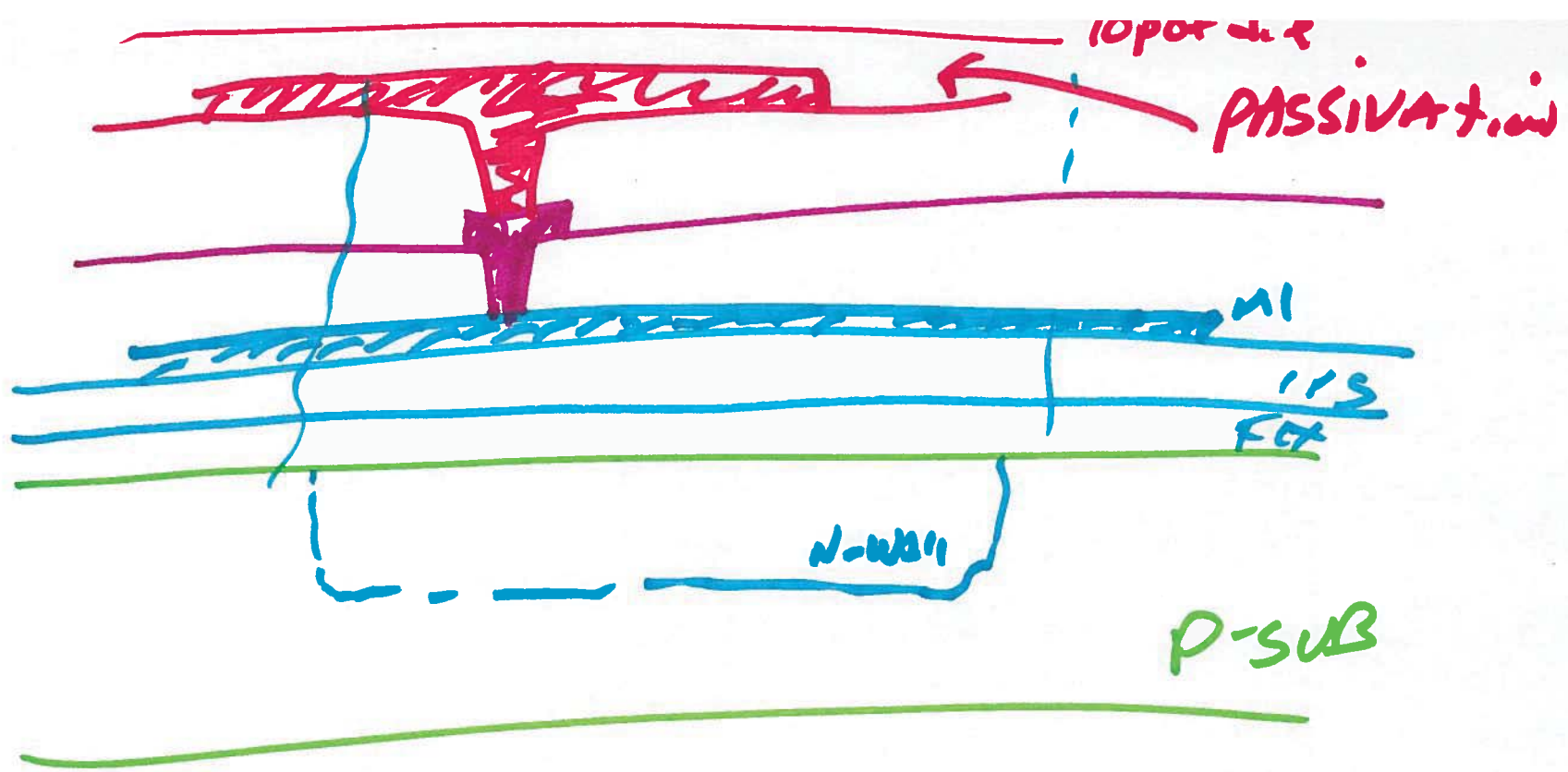
EE 421/ELG621

Lecture 6

Sept. 18, 2017

N-well
Metal 1
VIA
Metal 2
VIA 2
Metal 3
OVGL (glass)
PAD





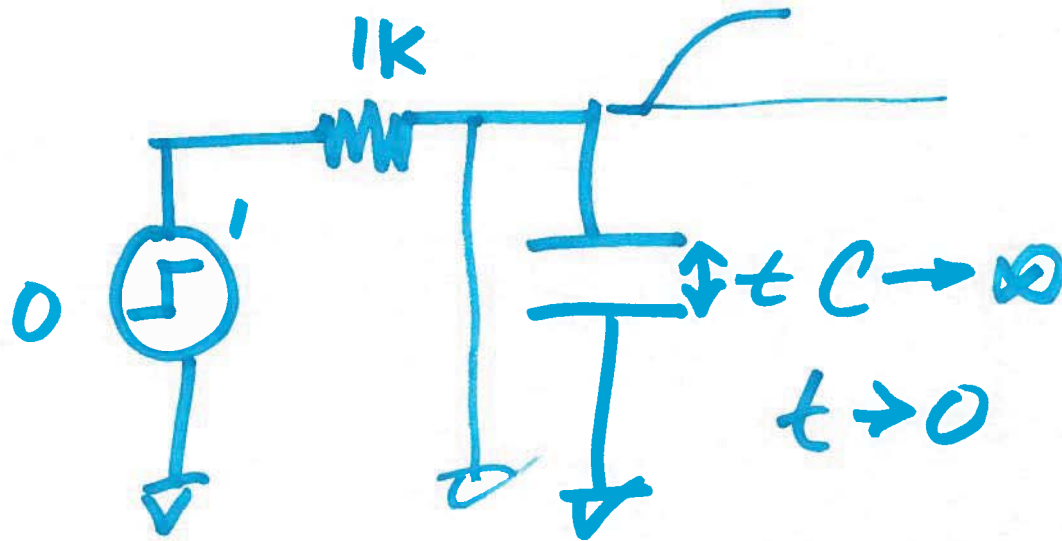
2)

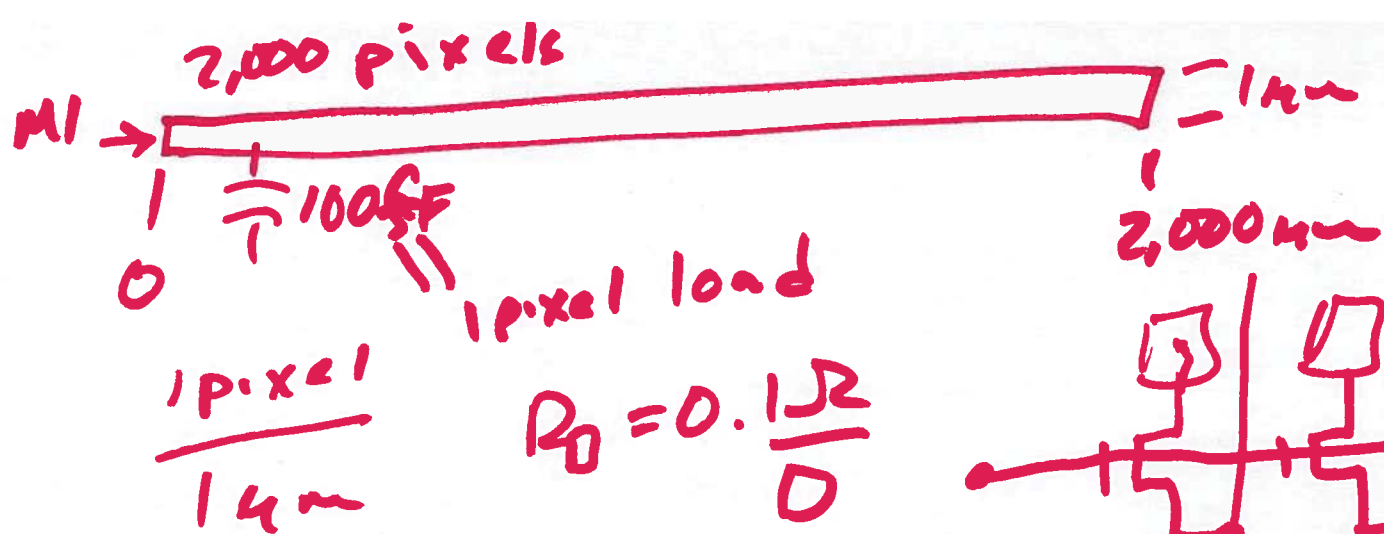
RC - delay

$$R_D = 0.1 \Omega/\square$$

$$C = \frac{A \cdot \epsilon}{t}$$

$$CV = Q$$





How many squares? $2,000$

$$Q = 2,000$$

$$t_d = 0.35 \cdot 0.1 \Omega \cdot 2,000$$

$$\cdot 100 \text{ fF} \cdot 2,000$$

$$0.35 \cdot 200 \cdot 200 \text{ fF}$$

$$70 \cdot 200 \text{ fF}$$

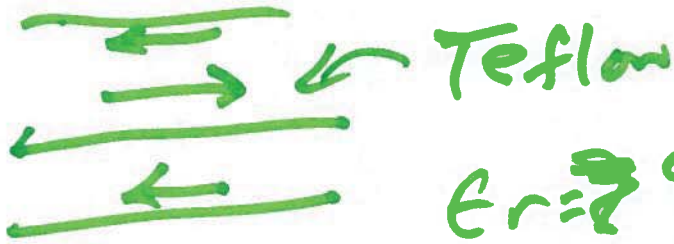
$$= \underline{\underline{14 \text{ ns}}}$$



delay time

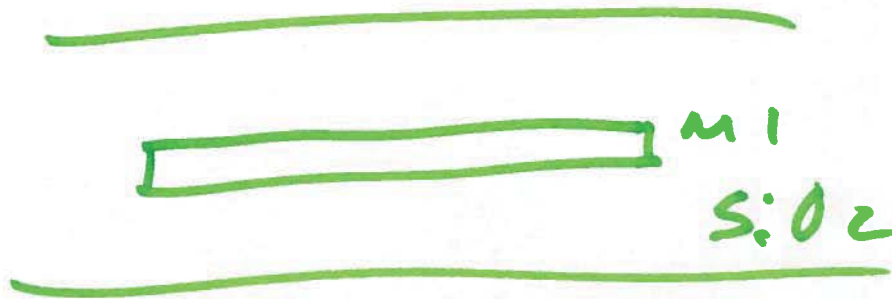
$$3 \times 10^8 \text{ cm/s}$$

IN A VACUUM



$$\epsilon_r = 9$$

$$\text{speed} = \frac{3 \cdot 10^8 \text{ cm/s}}{\sqrt{9}}$$



5)



$I_{peak} = 20p \cdot \frac{5V}{1ns} = 100nA$
 $2,000nA \quad R = 0.1 \Omega$
 $2,000$

Power supply noise

Ground bounce

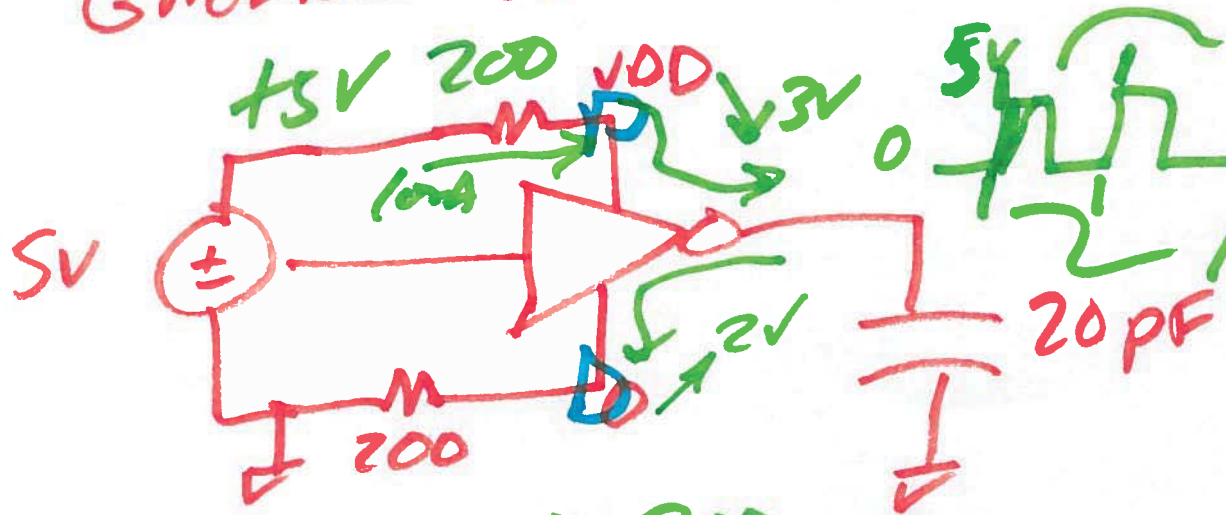
$CV = Q$

$Q = 100pC$

$I_{avg} = \frac{100pC}{10ns}$
 $= 10nA$

$100MHz = f_{clk}$

$T_{clk} = \frac{1}{f_{clk}}$
 $= 10ns$



$10nA \cdot 200$
 $= 2V$



b)

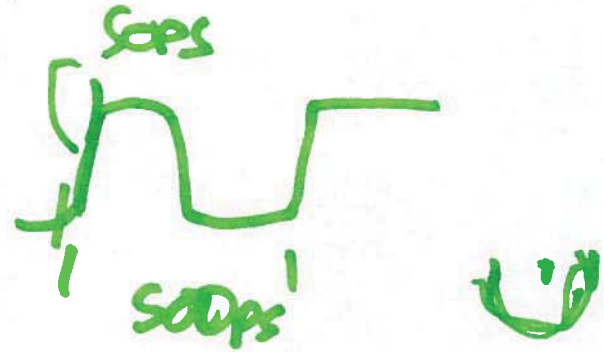
DDR4

$$f_{clk} = 26\text{Hz} \quad , \quad T_{clk} = 50\text{ps}$$

$$Cv = Q$$

$$C = 20\text{pF}$$

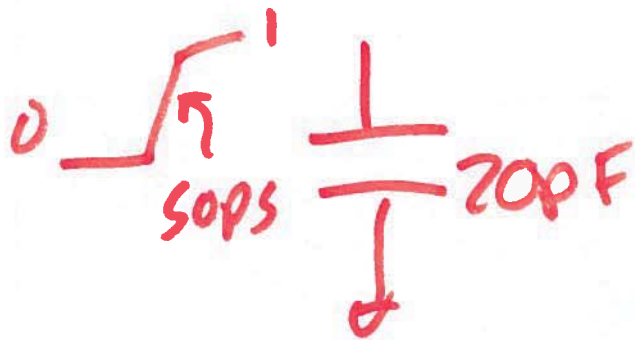
$$V_{DD} = 1\text{V}$$



$$I_{avg} = \frac{20\text{pF}}{50\text{ps}} = 400\text{nA}$$

TRANSMISSION LINES

$$P_{avg} = V_{DD} \cdot I_{avg} = 4\text{mW}$$



$$I = C \frac{dv}{dt}$$

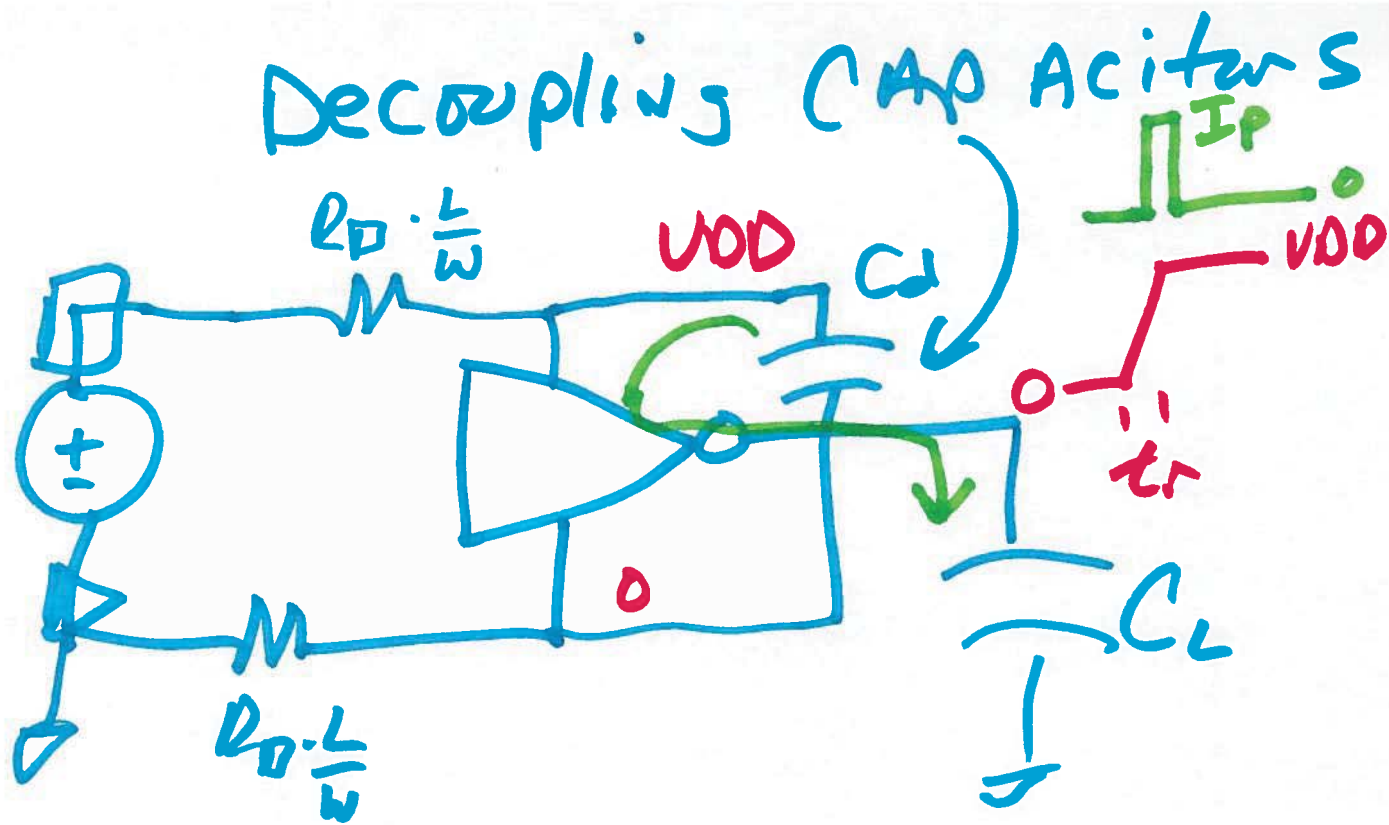
$$= 20\text{pF} \cdot \frac{1\text{V}}{50\text{ps}} = 400\text{nA}$$

$$= 400\text{nA}$$

$$= 0.4\text{A}$$

→

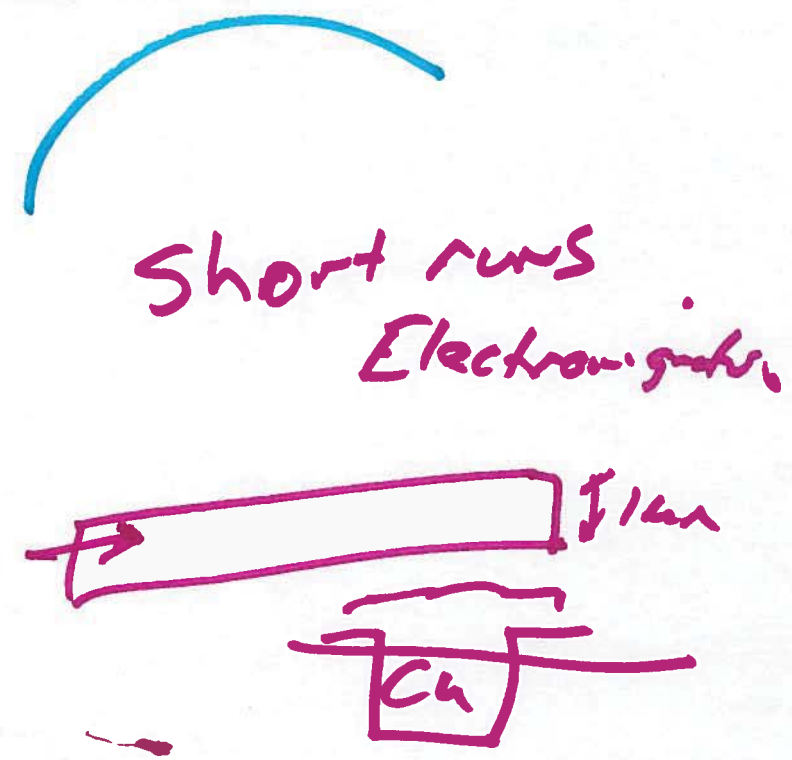
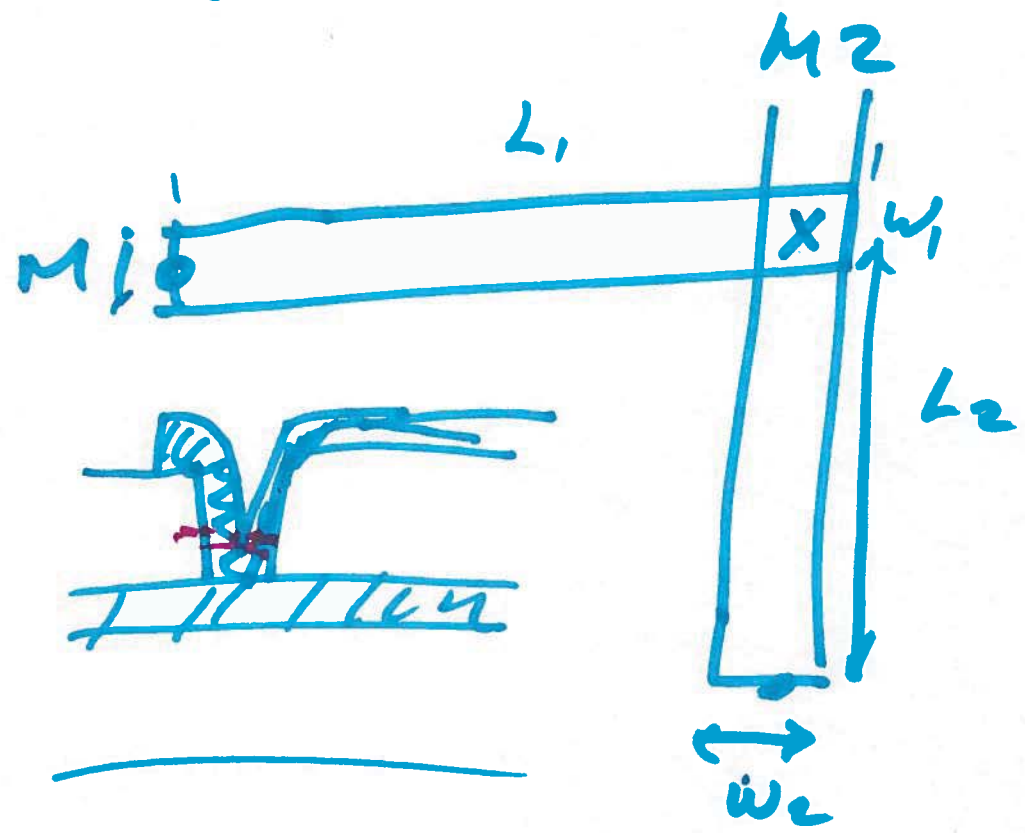
Decoupling CAP Acitars



$$I_P = C_L \cdot \frac{VDD}{t_r} = C \frac{dv}{dt}$$

$$I_P = C_d \cdot \frac{\Delta VDD}{t_r}$$

Wire resistance



Electromigration $J_{EM} = \frac{1 \text{ mA}}{4 \mu\text{m}}$

Long runs \rightarrow resistance