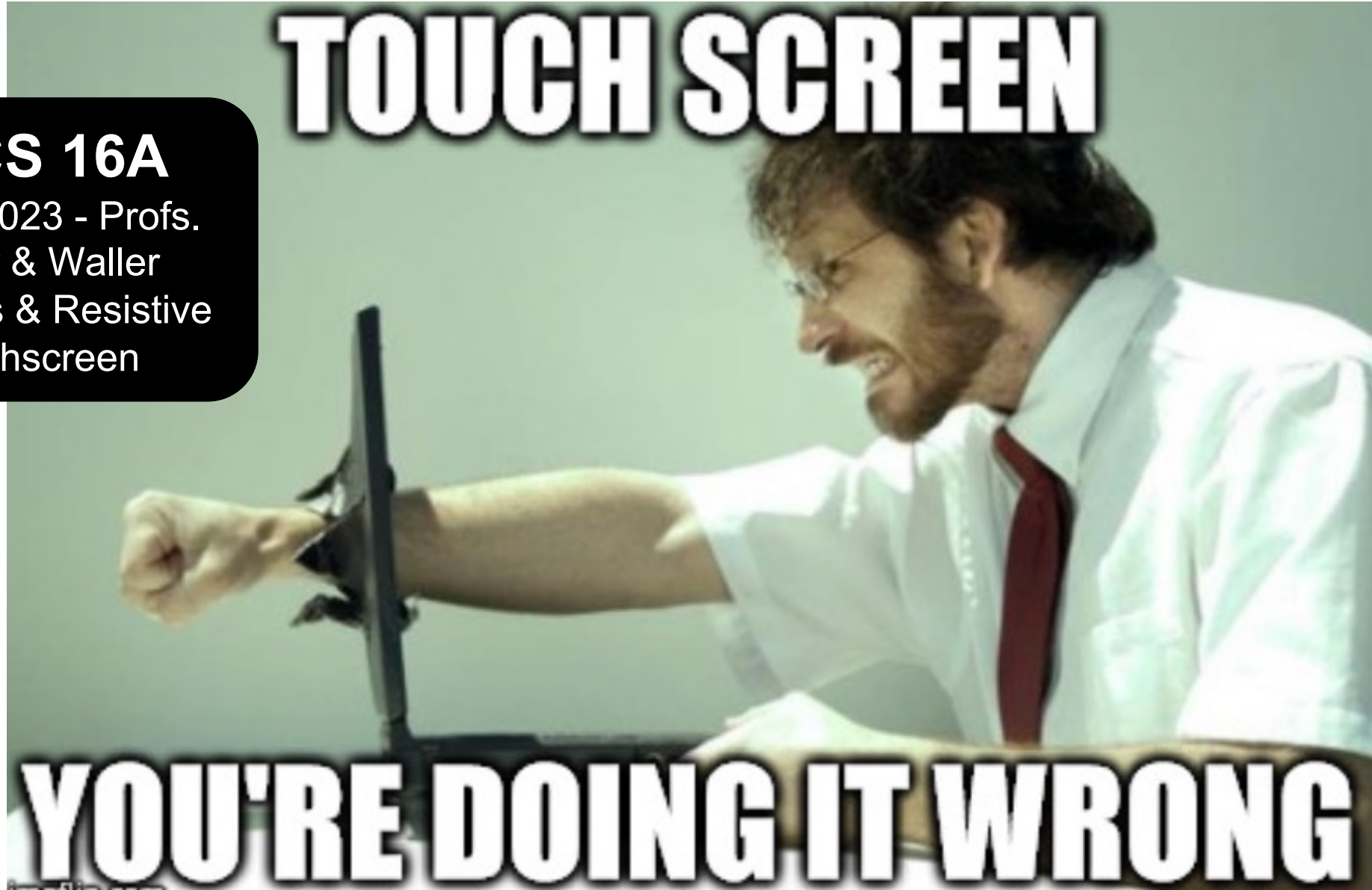
EECS 16A

Spring 2023 - Profs. Muller & Waller

Resistors & Resistive Touchscreen



Admin

Module 1 and midterm are complete!

Recap

large R
small R

*Power [Watts]: the rate at which energy is transferred

$$P = IV$$

large ↓ small

$V = IR$ ↗

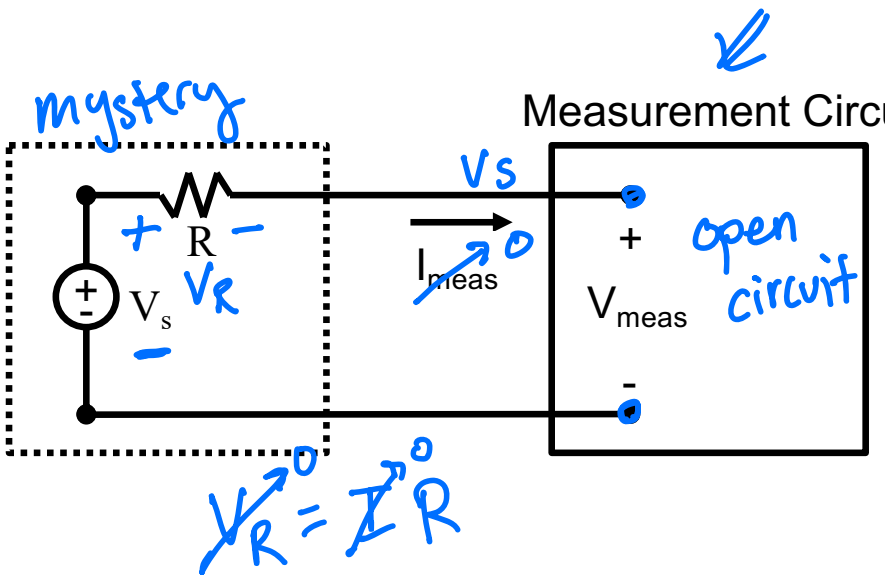
↝ heat

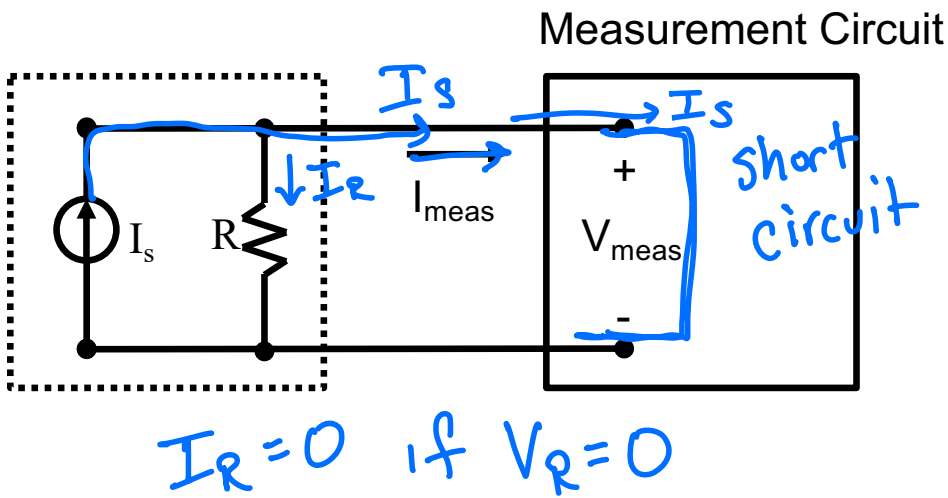
Power is dissipated in a resistor as heat

Supplies provide power to the circuit

constant

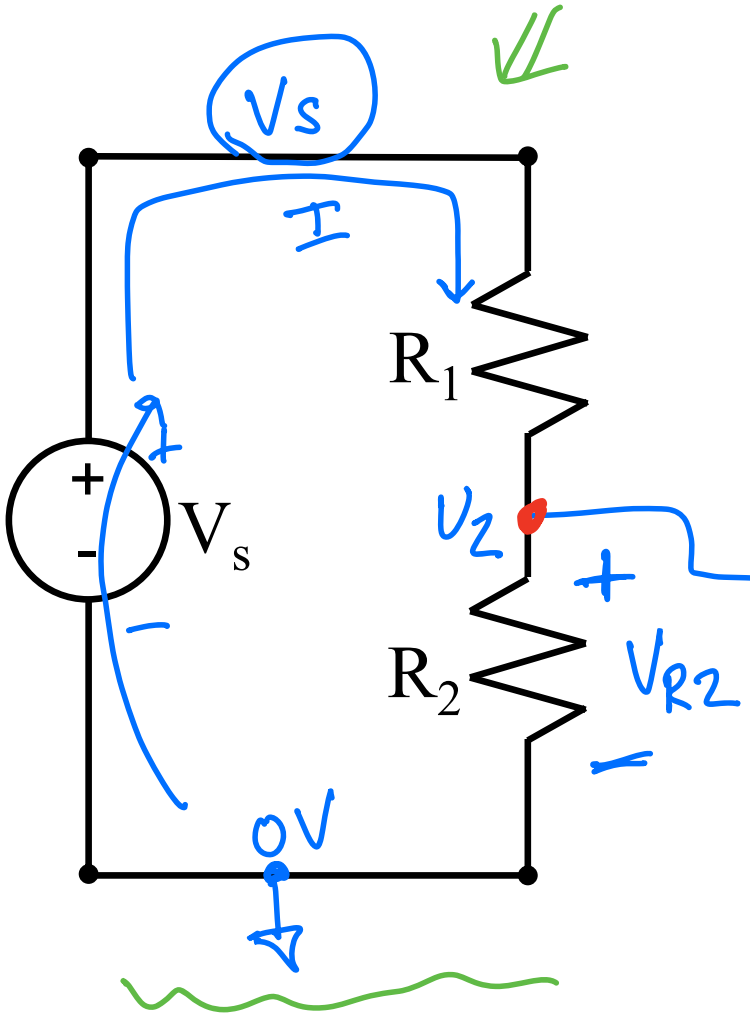
$P = V \cdot I$ ↑





Tool For Today's Lecture: The Voltage Divider

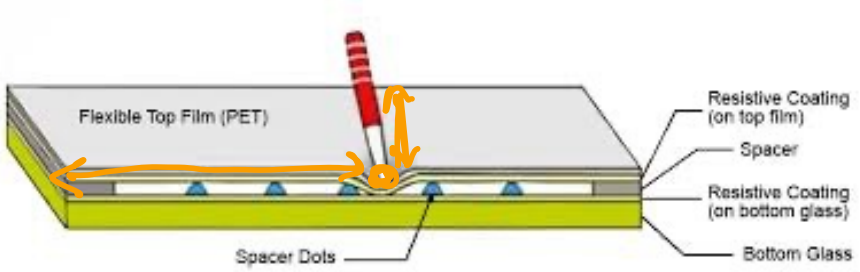
① the Voltage divider
② KVL / KCL
③ Ohm's Law



$$I = \frac{V_S}{R_1 + R_2}$$

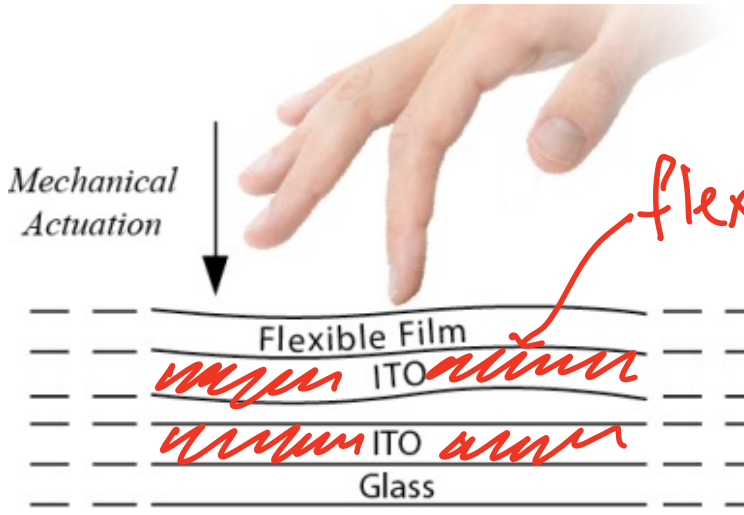
$$U_2 = \frac{V_S R_2}{R_1 + R_2} = V_S \left(\frac{R_2}{R_1 + R_2} \right)$$

Resistive Touch Screen



$$\text{Conductance} = \frac{1}{\text{Resistance}}$$

want $\downarrow R$ $\uparrow C$



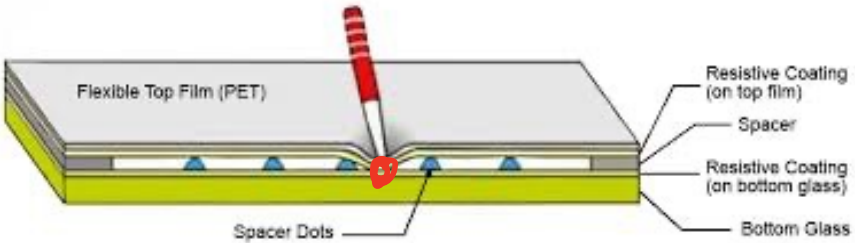
flexible conductor
↳ ITO
Indium Tin Oxide

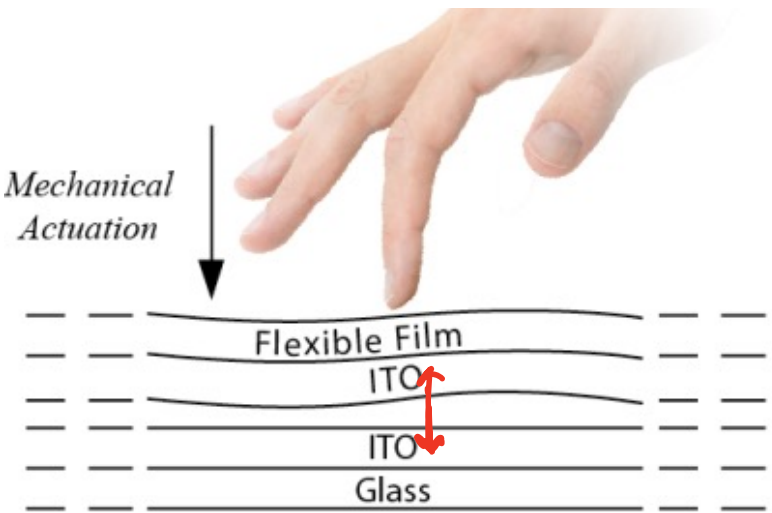
← flexible

↕

← Rigid base

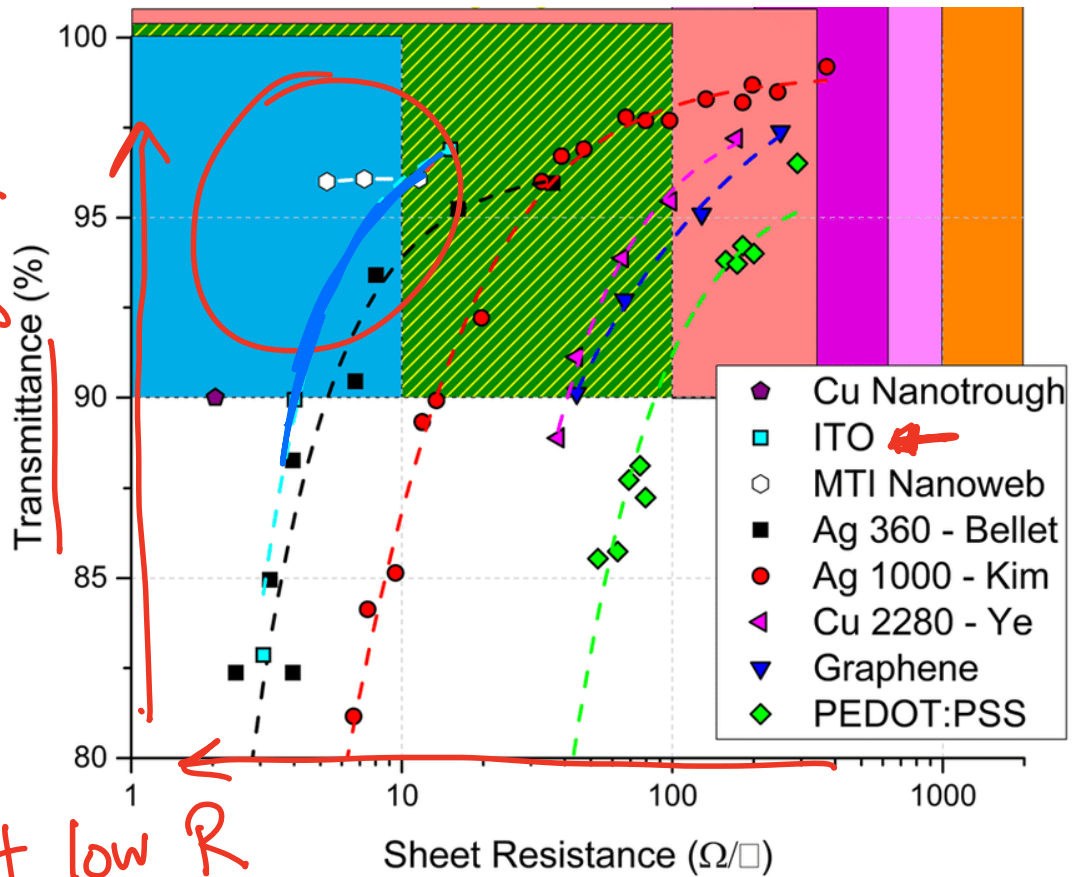
Resistive Touch Screen





$V = IR \uparrow$ $\downarrow P = V \cdot I \downarrow$

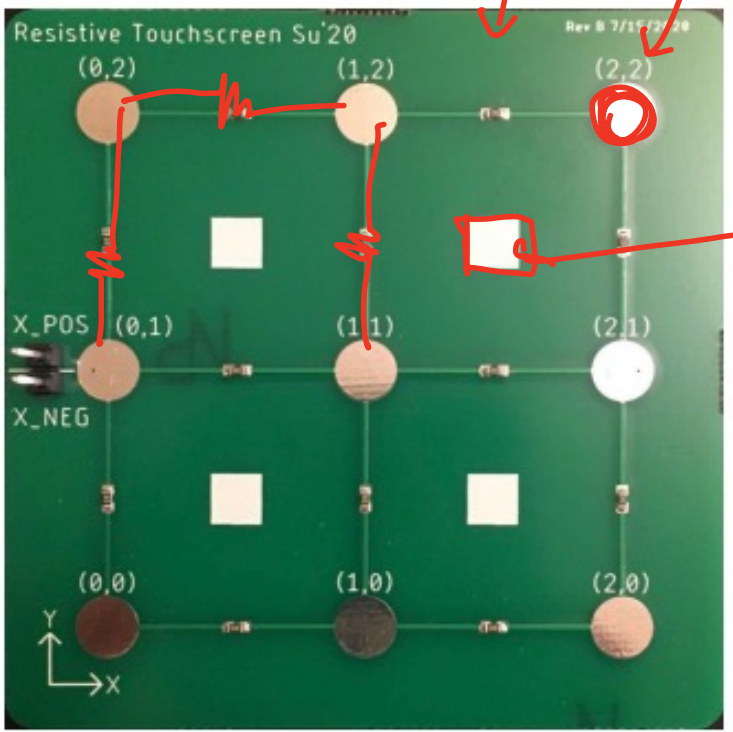
how much light passes through



want low R

https://doi.org/10.1038/s41598-019-47777-2

Resistive Touch Screen

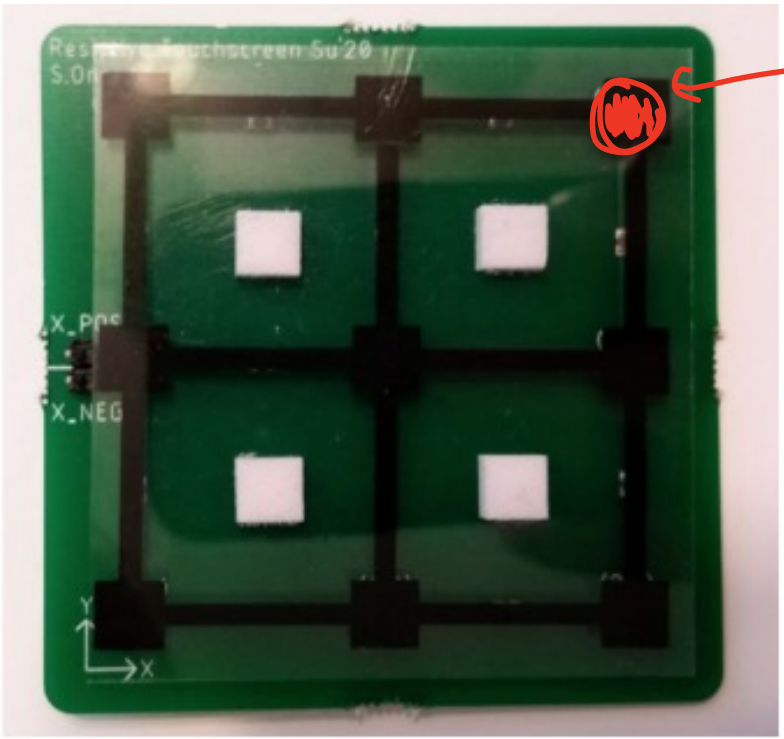


Rigid

touchpoint

spacer

Top Layer: Flexible Resistive Layer

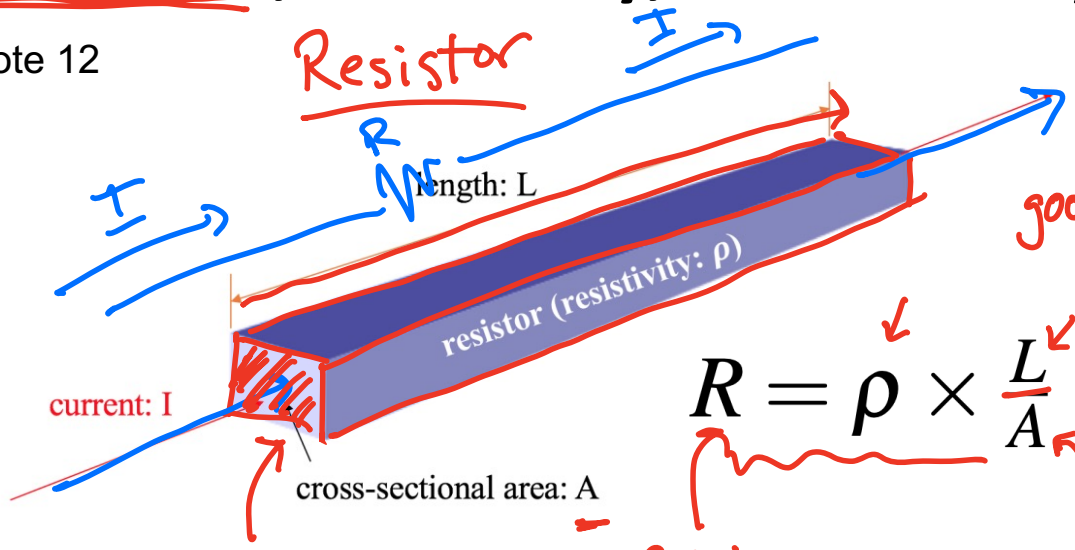


flex

Bottom Layer: Resistive Layer

Resistance, Resistivity, Conductivity – Properties of Materials

Note 12



$$R = \rho \times \frac{L}{A}$$

Resistance

$\frac{L}{A}$: geometric parameters → properties of wire/elem (R)

Wide wires → low R

longer wires → more E is lost

good conductor

Material	Electrical characteristics	
	Electrical Resistivity (Ω x cm)	Electrical Conductivity (Ω^{-1} x cm^{-1})
Cu	0.034×10^{-5}	29×10^{5}
Fe	32.54×10^{-5}	0.031×10^{5}
Ag	0.36×10^{-5}	2.8×10^{5}
Al	0.03×10^{-5}	33.3×10^{5}
Ni	0.046×10^{-5}	21.7×10^{5}
Cu-Fe	33.37×10^{-5}	0.030×10^{5}
Cu-Ag	2.71×10^{-5}	0.37×10^{5}
Al-Ni	0.564×10^{-5}	1.77×10^{5}

Resistivity (ρ) [Ω-cm]
→ property of the material

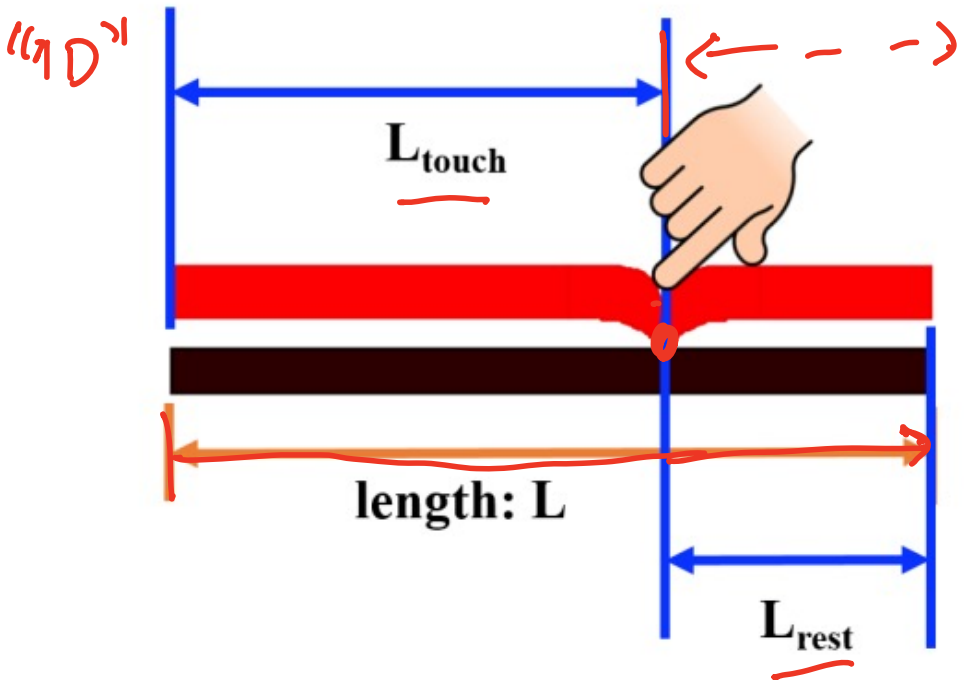
Conductivity (σ) $[\Omega\text{-cm}]^{-1}$

$$\sigma = \frac{1}{\rho}$$

– property of material

Resistive Touch Screen

Problem: Find the location of touch

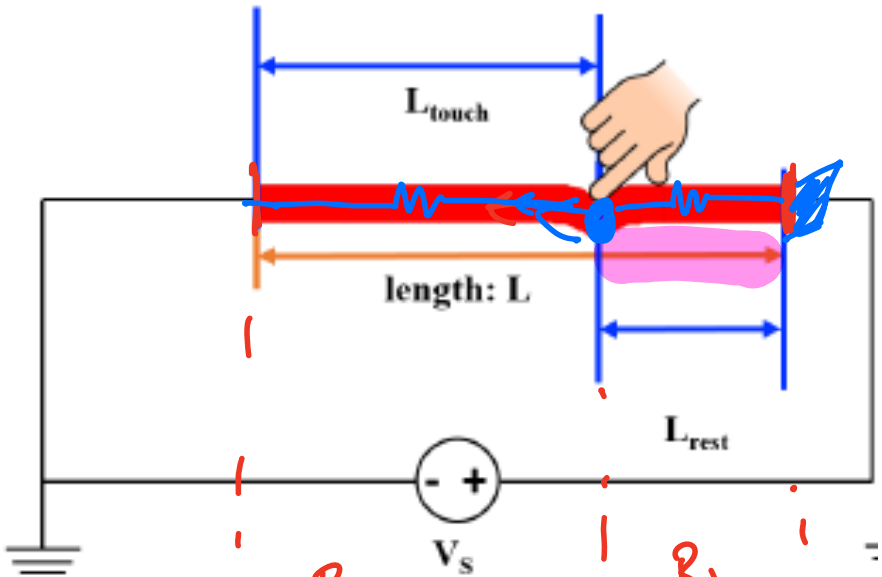


Go from mechanical to electrical quantity

Want to measure $\frac{L_{touch}}{L}$

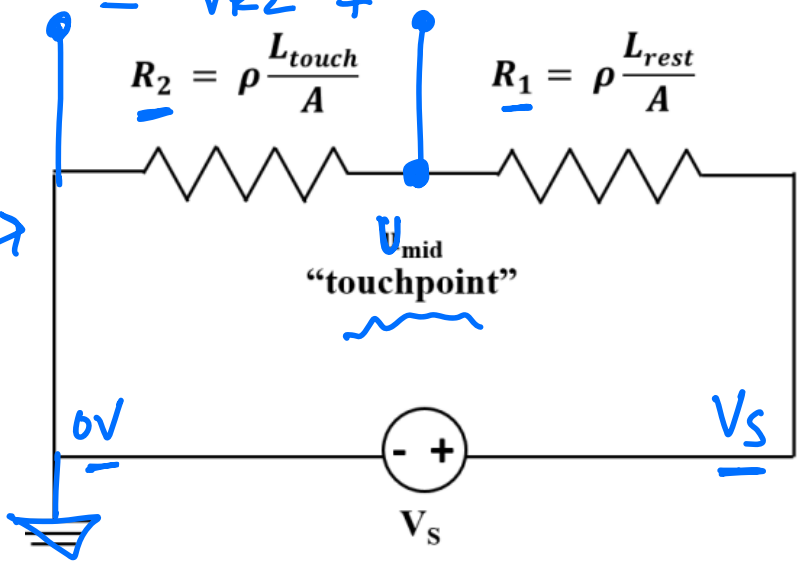
L_{touch} is unknown

Resistive Touch Screen – First model



$R_2 = \rho \frac{L_{touch}}{A}$ $R_1 = \rho \frac{L_{rest}}{A}$

Voltage Divider



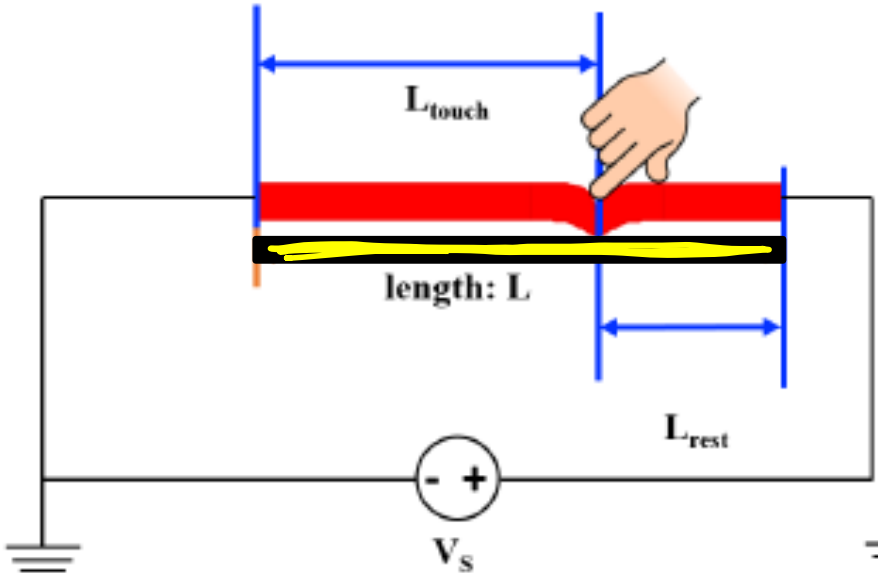
Note 12

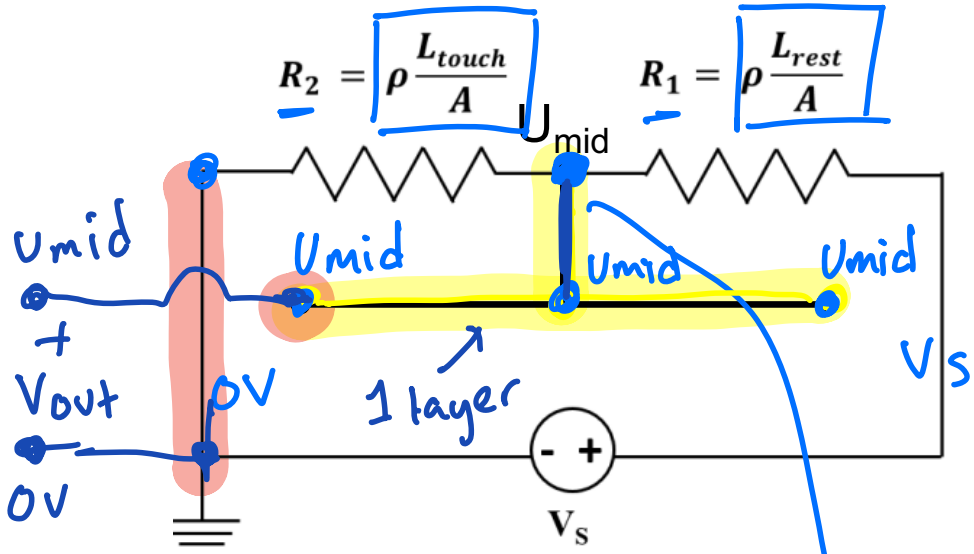
$U_{mid} = V_s$

$V_{R2} = U_{mid} - 0$

$\Rightarrow \boxed{U_{mid} = V_s \frac{R_2}{R_1 + R_2}}$ *

Resistive Touch Screen – More realistic model

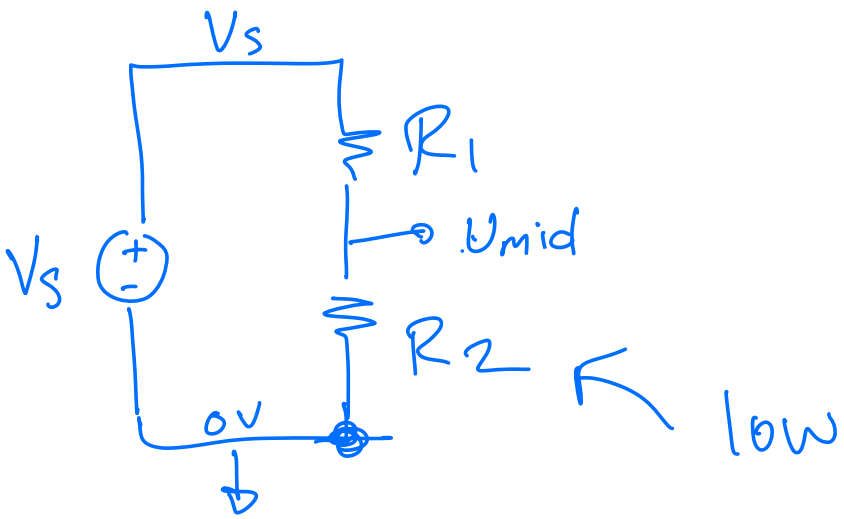


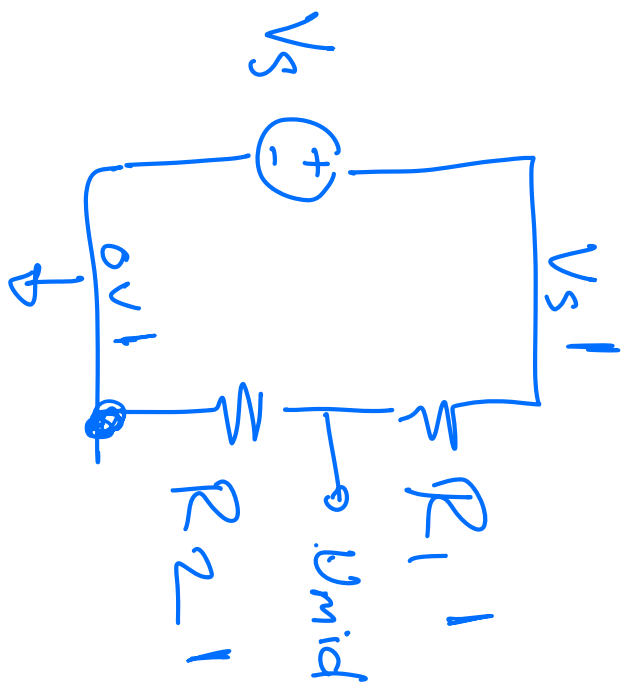


$$V_{mid} = V_S \left(\frac{R_2}{R_1 + R_2} \right)$$

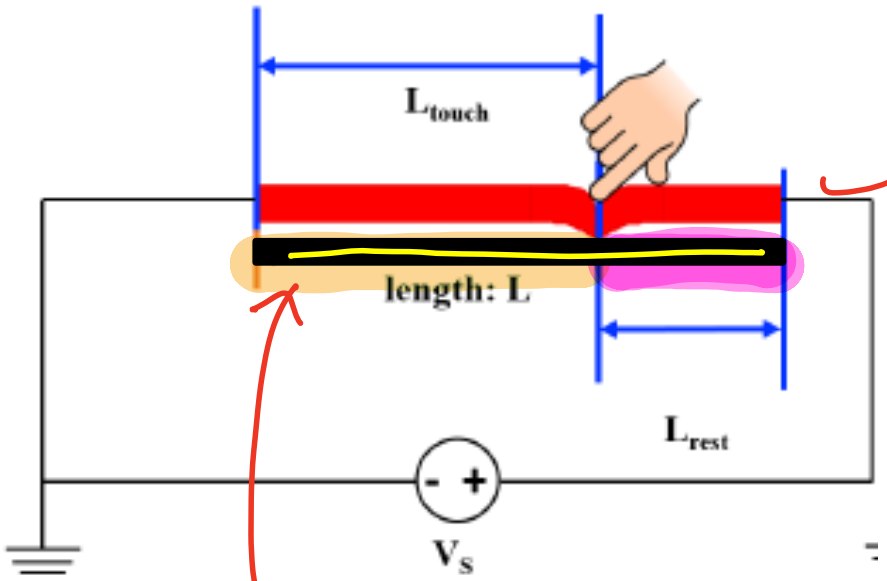
$$V_{out} = U_{mid} \text{ (open circuit)}$$

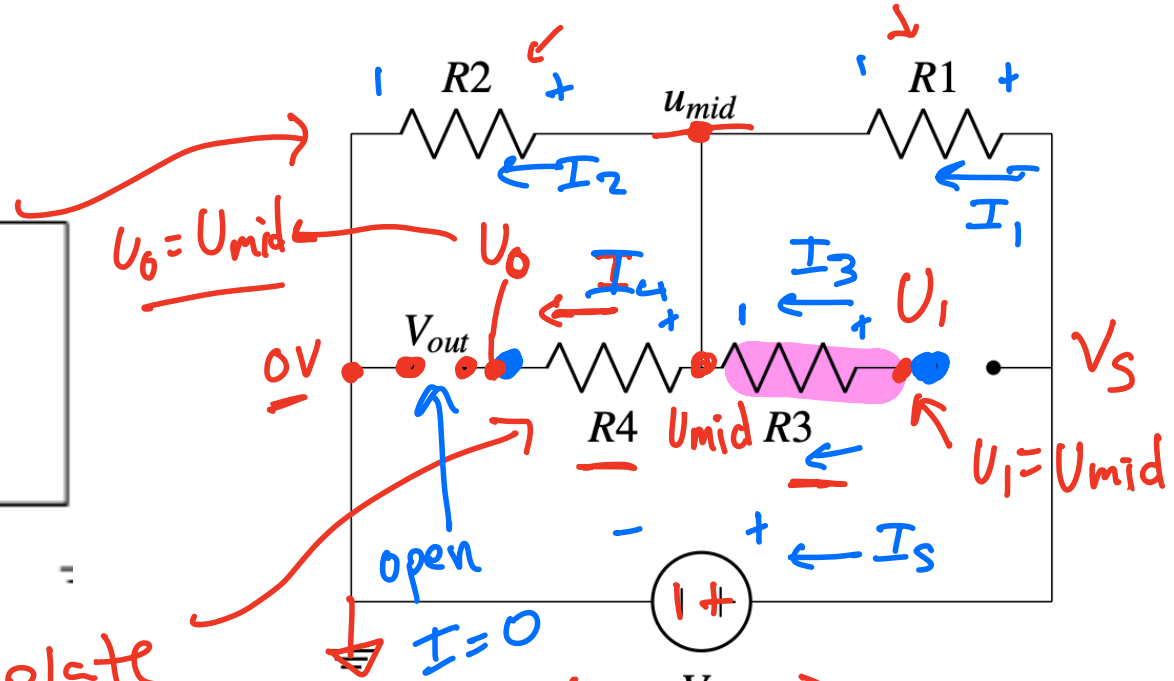
$$* U_{mid} = V_S \left(\frac{\rho L_{touch}/A}{\rho L_{rest}/A + \rho L_{touch}/A} \right) = V_S \left(\frac{L_{touch}}{L_{rest} + L_{touch}} \right) = \frac{V_S L_{touch}}{L}$$


Vs
R1
Vmid
Vs
R2
0V
low


Vs
0V
Vs
R2
Vmid
R1

Resistive Touch Screen – Most realistic model





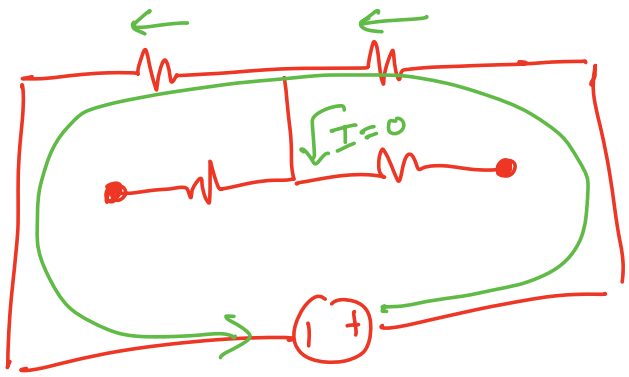
represents bottom plate

KCL: $I_4 = 0$

$I_3 = 0$

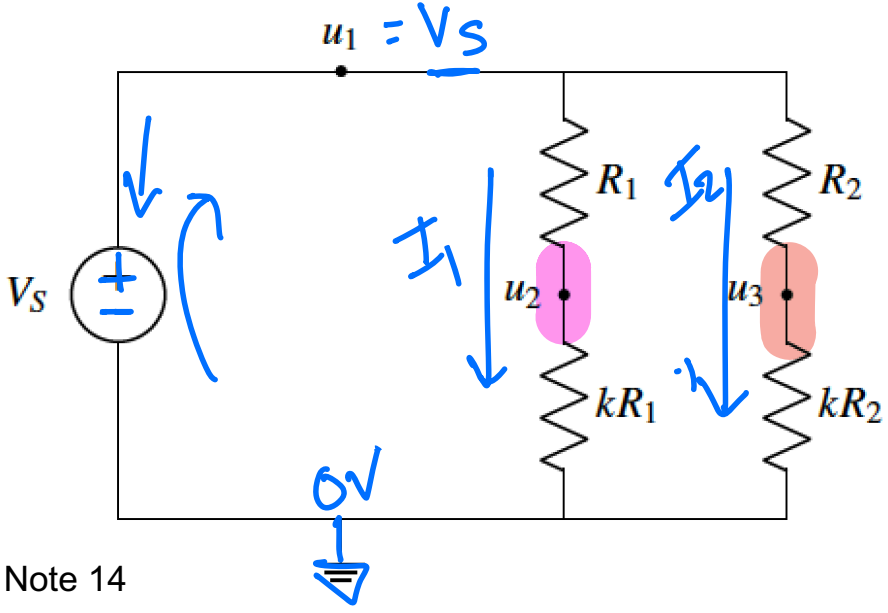
$V_{out} = V_{mid}$

$I = 0$ → 0V


I=0

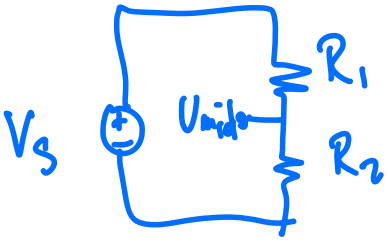
An Interesting Circuit *

What are U_2 ? U_3 ?



Note 14

*tool box



$$U_{mid} = V_S \left(\frac{R_2}{R_1 + R_2} \right)$$