Sit with the same partner as last week, make sure you have brought the touchscreen you built
Last week: Soldering and Breadboarding

- Building the base of the resistive touchscreen
- Resistors in parallel and in series
- Debugging techniques
- Voltage divider intuition
This week: Resistive touchscreen

- Investigate a resistive touchscreen
  - Something that actually was used for a long time!
- Use voltage as a signal to determine position of touch
  - How?
Resistive touchscreen

- Physical touch results in physical contact between top and bottom layers
- Voltage dividers allow us to compute touch location

EX: Nokia N900, Nokia N97 Mini, LG Optimus, LG GW620, Nintendo DS™
Tools for today:

- Power Supply
  - Always set a current limit! (0.1 A)
- Multimeter - measuring device
- Launchpad - measuring device
- Voltage dividers
  - How we will detect location
Touchscreen theory (Note 13/14)

- What’s the voltage at the top?
- What’s the voltage at the bottom?
- Voltage at u2?
**Touchscreen theory (Note 13/14)**

- **Voltage divider:**

\[ u_2 = V_s \cdot \frac{kR_1}{kR_1 + R_1} \]

\[ u_2 = V_s \cdot \frac{R_1(k)}{R_1(k + 1)} \]

\[ u_2 = V_s \cdot \frac{k}{k + 1} \]

Independent of the value of \( R \)!
Building it up

- What are the voltages at $u_2$ and $u_3$?

$$u_2 = V_s \times \frac{k}{k + 1}$$
$$u_3 = V_s \times \frac{k}{k + 1}$$

- What’s the voltage difference?

The Rs cancel out! All the matters is the proportion between the top and bottom resistors.
In fact, $u_3$ and $u_2$ are at the SAME VOLTAGE
Building it up

- We know that $u_2 - u_3 = 0$
- How much current goes through $R_3$?

$$u_2 = V_s \cdot \frac{k}{k + 1}$$

$$u_3 = V_s \cdot \frac{k}{k + 1}$$
Building it up

- Add one more resistor divider...
- We get our touchscreen!
Resistive touchscreen - 2 layers

Bottom Layer: Resistive Layer
Resistive touchscreen - 2 layers

Top Layer:
Flexible Resistive Layer
What’s the difference?

- Nothing
  - The ink is a bunch of resistors
    - The resistor values don’t matter because we showed only the proportions matter for this circuit
  - Their circuit diagrams are the same
- One is flexible so we can actually move it to make contact
- We use two so that we can measure with one and apply voltage to the other without changing our circuit
Computing a location

- Measure some voltages, compute location based on value
- Can you find any two horizontal locations that would output the same voltage?
- What about vertical?
Computing a location

- We can only determine vertical position.
- What about the other orientation?
- What if we turned it sideways?

What if we turned it sideways?
Computing a location

- Let’s turn it sideways
  - Apply voltage so we power the horizontal direction
  - Find “vertical” location in horizontal orientation
- This gives horizontal location
Computing a location

- If we take two readings, one in each dimension can uniquely determine our location in 2D
- More on this in the lab
Taking the limit

- 9 touch points is kinda... meh
- How do we get more?
Taking the limit

- Add more resistors!
Taking the limit

● But what if I don’t want to increase the size of the circuit
  ○ Add more, but make the resistors smaller!
● What happens as the resistors approach infinitely small sizes?
  ○ Isn’t that just a resistive sheet?
  ○ This is how all resistive touchscreens work
  ○ Review lecture note12, note13
Notes

- Make sure **ink side** of the plastic film is **facing down** towards the resistors (rounder side of the film)
- There are coordinates on the PCB (**use them**)
- Foam blocks and film are on the TA desk
- Make sure you close serial monitor before running the ipython code
- Read **carefully** for which coordinates you should be connecting the multimeter and the power supply to
  - One wire will be free & 3 wires will be in use