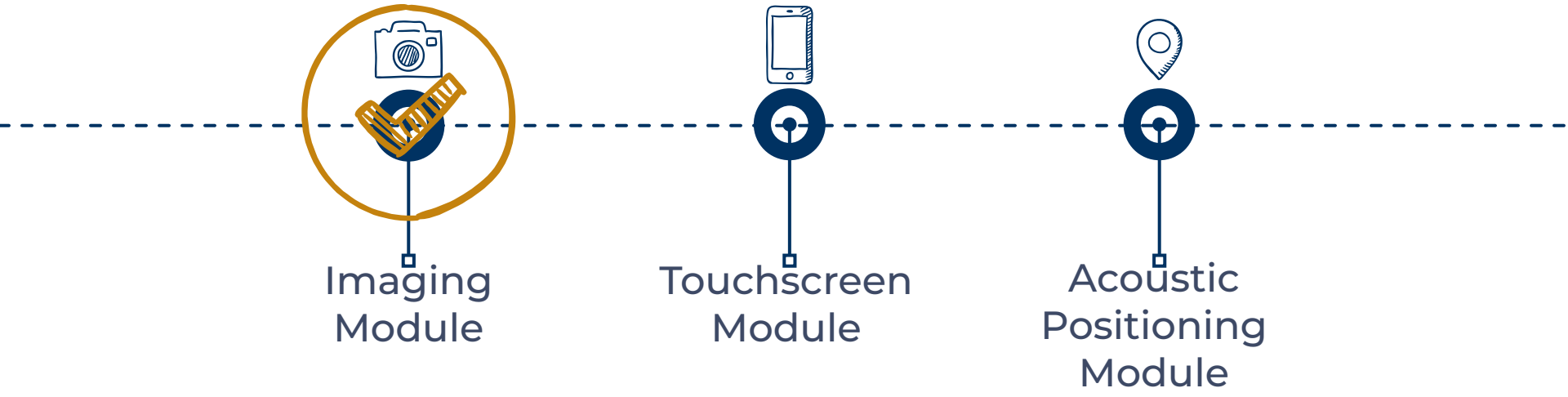
EECS 16A Touchscreen 2

Insert your names here

Semester Outline



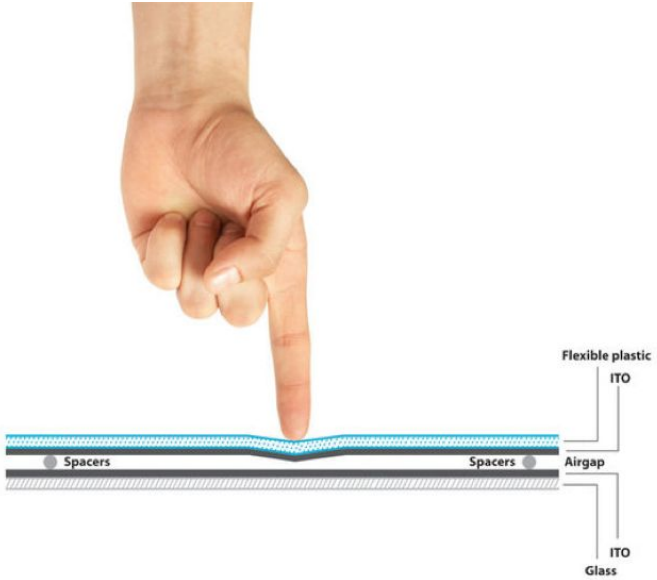
Resistive Touchscreen

- Investigate a resistive touchscreen
  - Something that actually was used for a long time!
  - Top: Flexible resistive layer
  - Bottom: Our resistor circuit layer.
- 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 ™



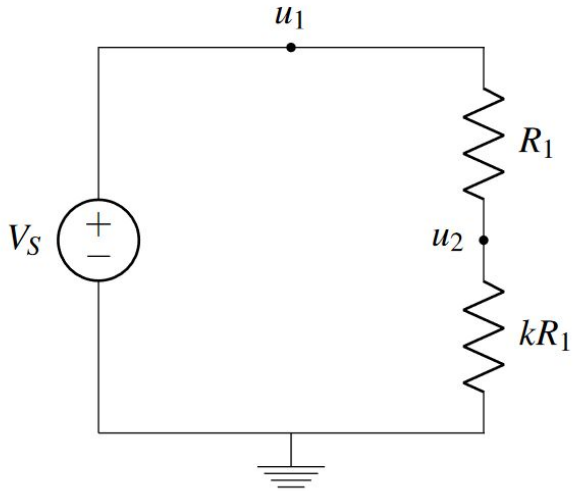
Resistive touchscreen

Tools for Today:

- Power Supply (Always set a current limit of 0.1 A!)
- Multimeter - measuring device
- Soldering iron and PCBs!
- Voltage dividers
  - How we will detect location
- Falstad
  - Circuit simulation, has virtual Power Supplies and Multimeters

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)

- **What's the voltage at the top?**

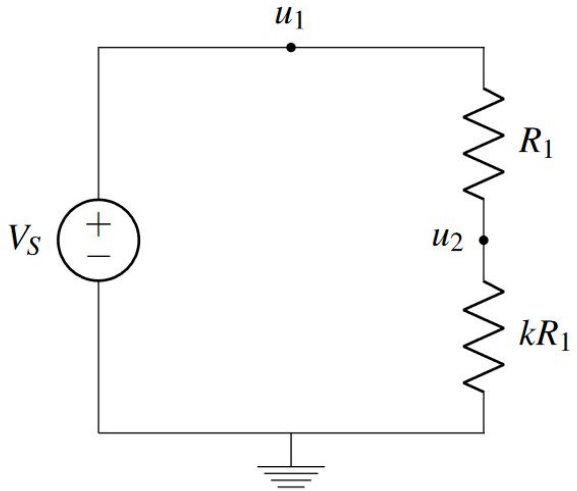
Vs

- **What's the voltage at the bottom?**

0

- Voltage at u2?

Voltage divider!



Touchscreen Theory (Note 13/14)

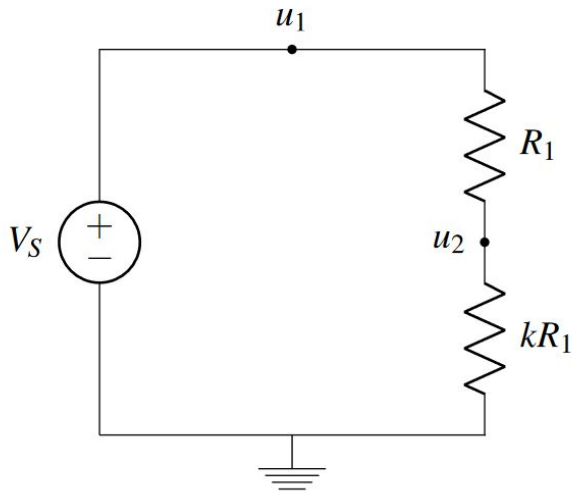
- Voltage divider:

$$u_2 = V_s * \frac{kR_1}{kR_1 + R_1}$$

$$u_2 = V_s * \frac{R_1(k)}{R_1(k+1)}$$

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

Independent of the value of R!

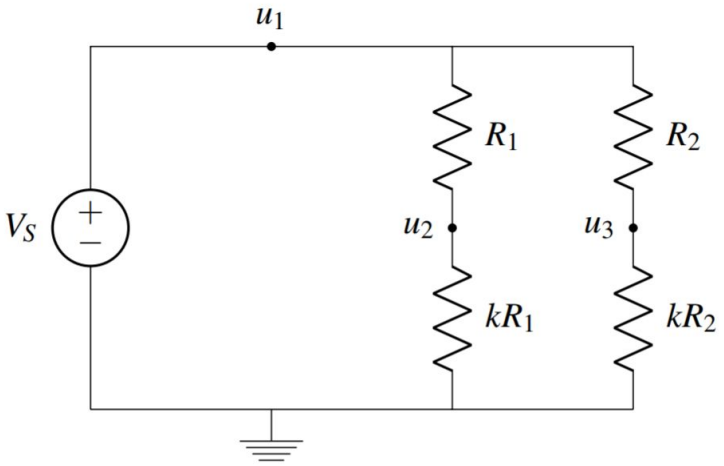


Building it up

- What are the voltages at u2 and u3?

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

$$u_3 = V_s * \frac{k}{k+1}$$



- **What's the voltage difference?**

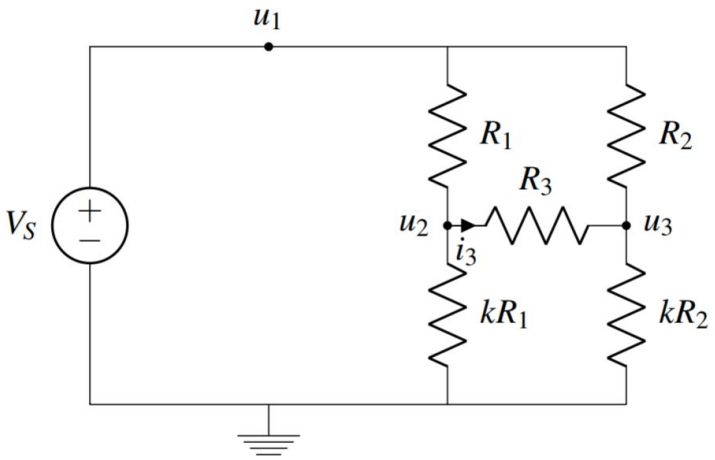
The Rs cancel out! All that matters is the proportion between the top and bottom resistors.
In fact, **u3 and u2 are at the *SAME* VOLTAGE**

Building it up

- We know that u2-u3=0
- **How much current goes through R3?**

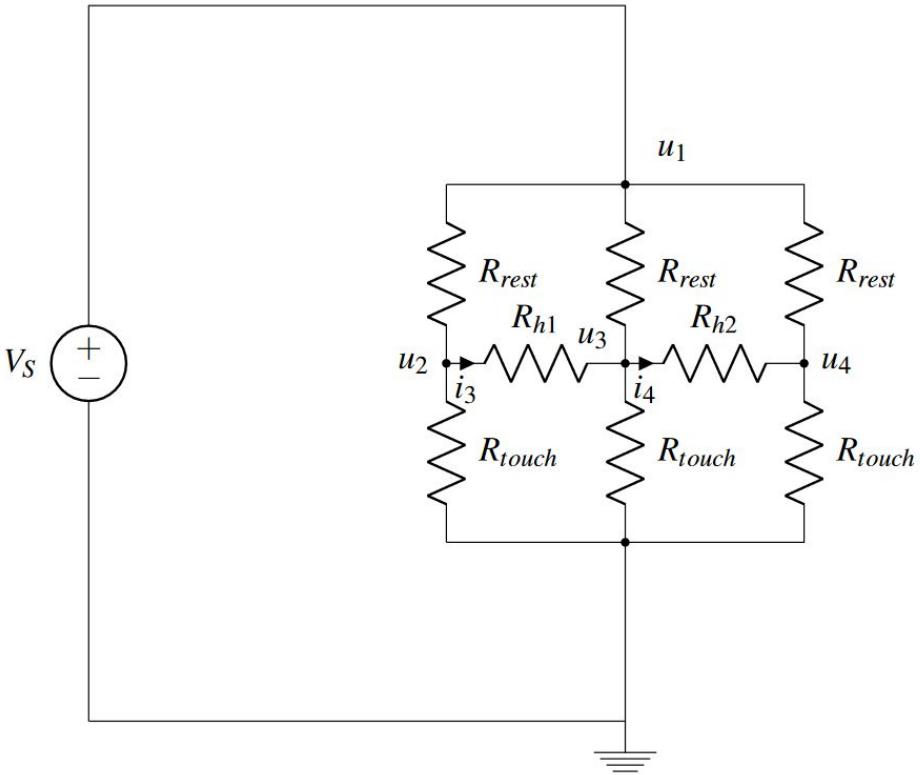
$$u_2 = V_s * \frac{k}{k+1}$$

$$u_3 = V_s * \frac{k}{k+1}$$



Building it up

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



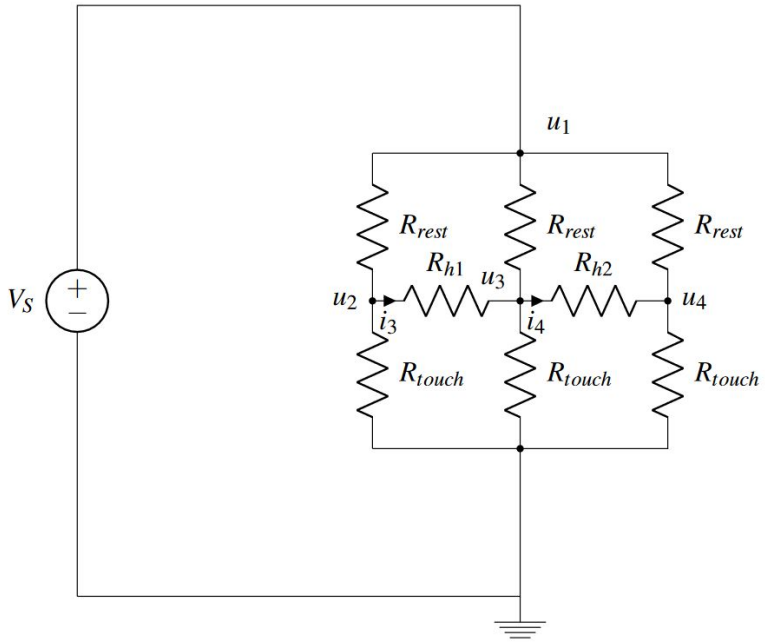
Poll Time!

What is the voltage at u4?

- 0V
- Same as u2
- None of the above

How much current is flowing through Rh2?

- 0A
- Non-zero current



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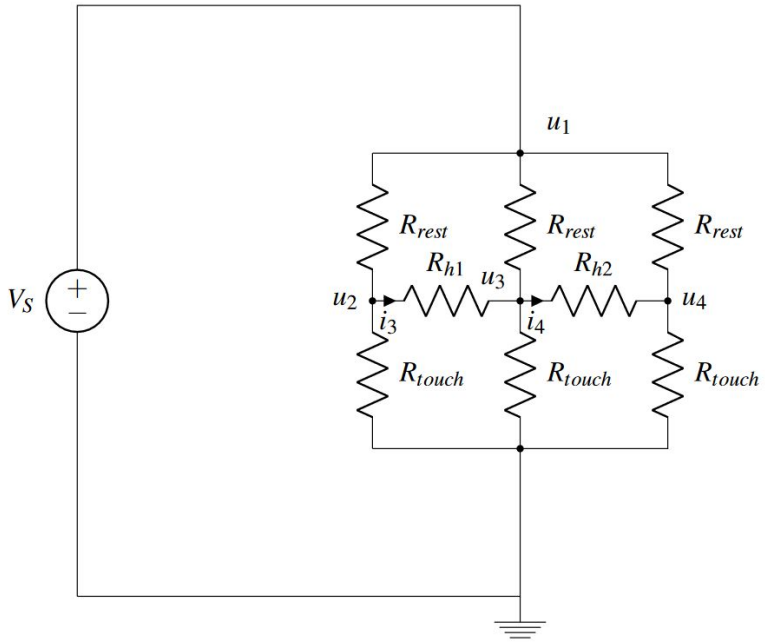
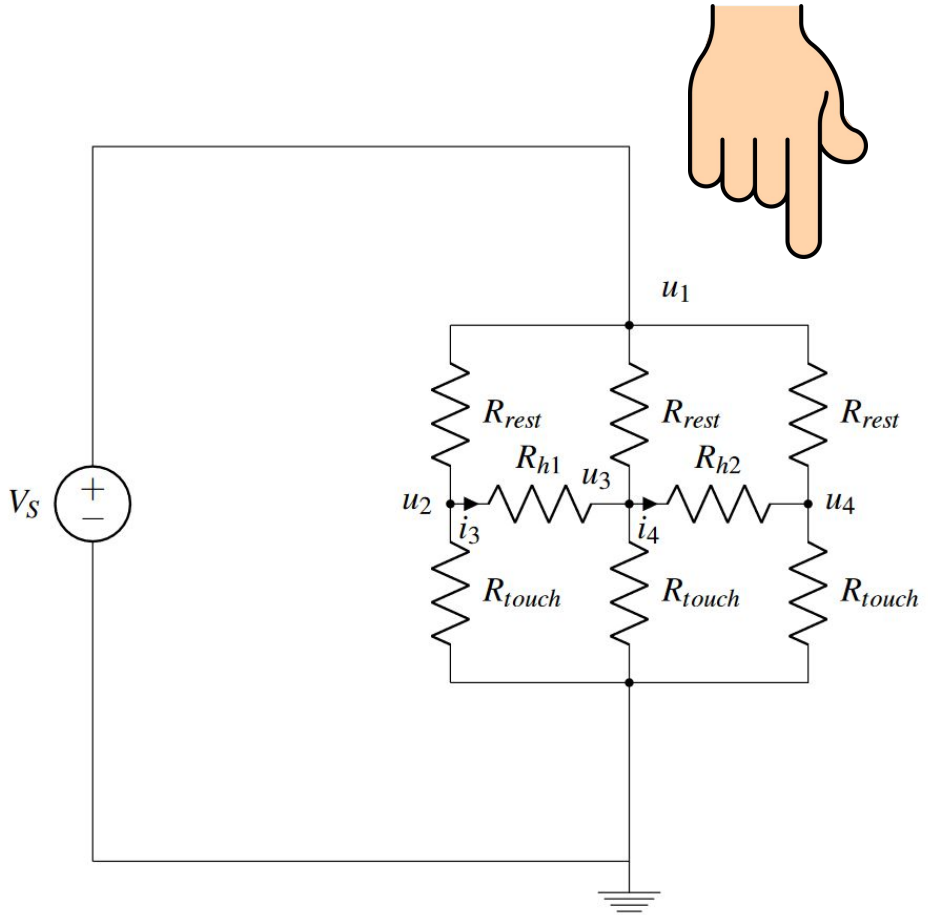
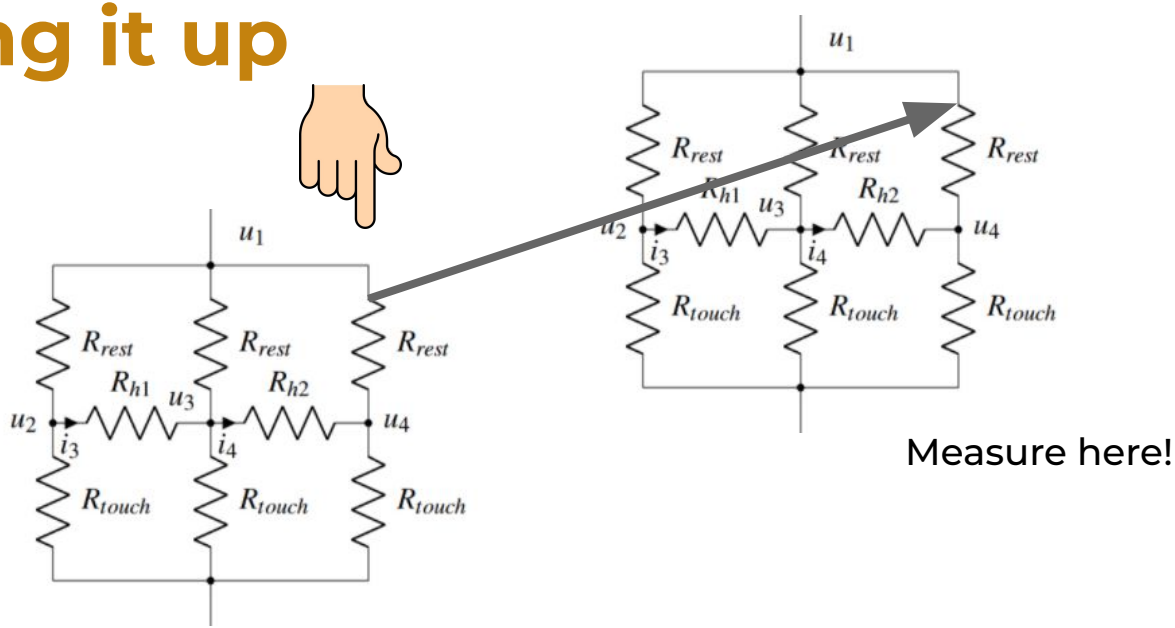


Building it up

- But how do we measure the voltage?
- Our finger can press down on a point, but we need the voltage measurement!



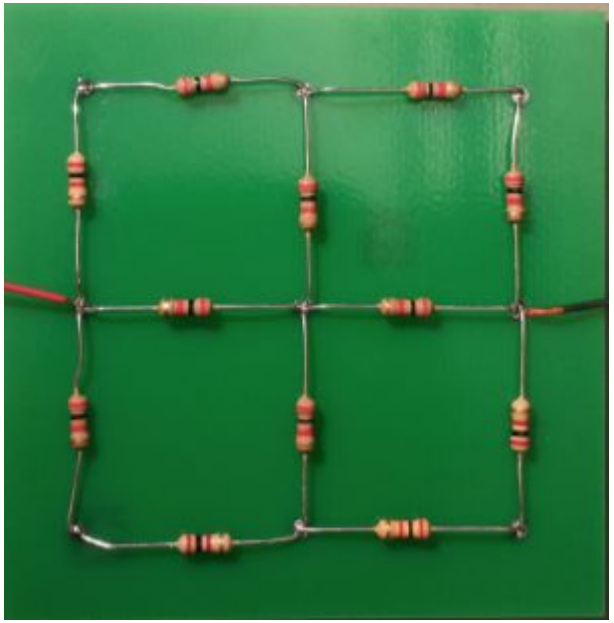
Building it up



- We can add another (ungrounded) mesh!
- If we connect the meshes at the point we touch, we get the voltage all over the added (ungrounded) mesh!
- Why specifically a mesh? We'll see in a bit.

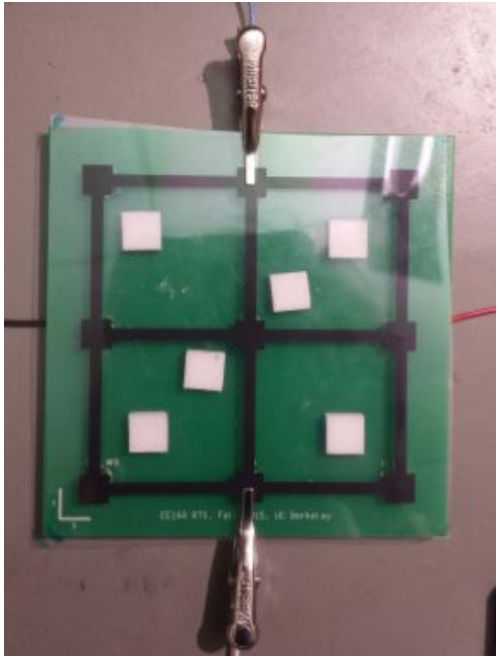
Resistive Touchscreen - 2 Layers

Bottom Layer: Resistive Layer



Resistive Touchscreen - 2 Layers

Top Layer: Flexible Resistive Layer

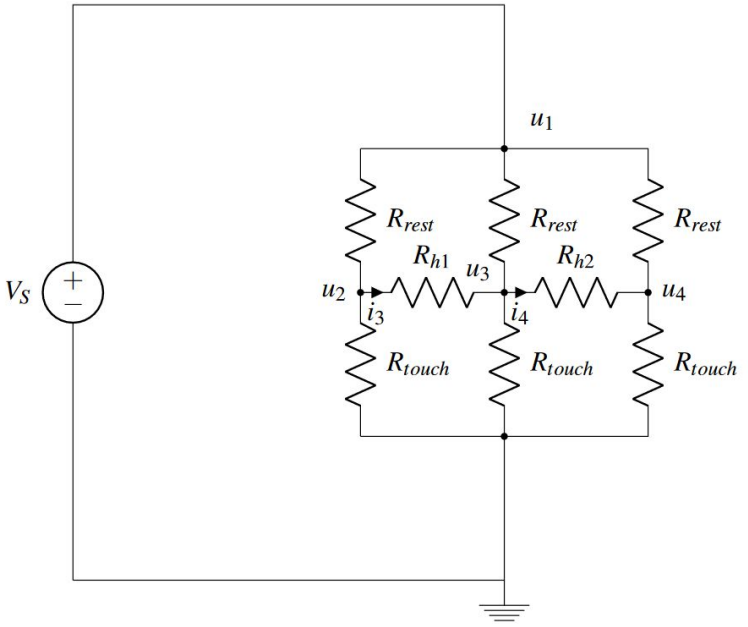


What’s the difference?

- 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

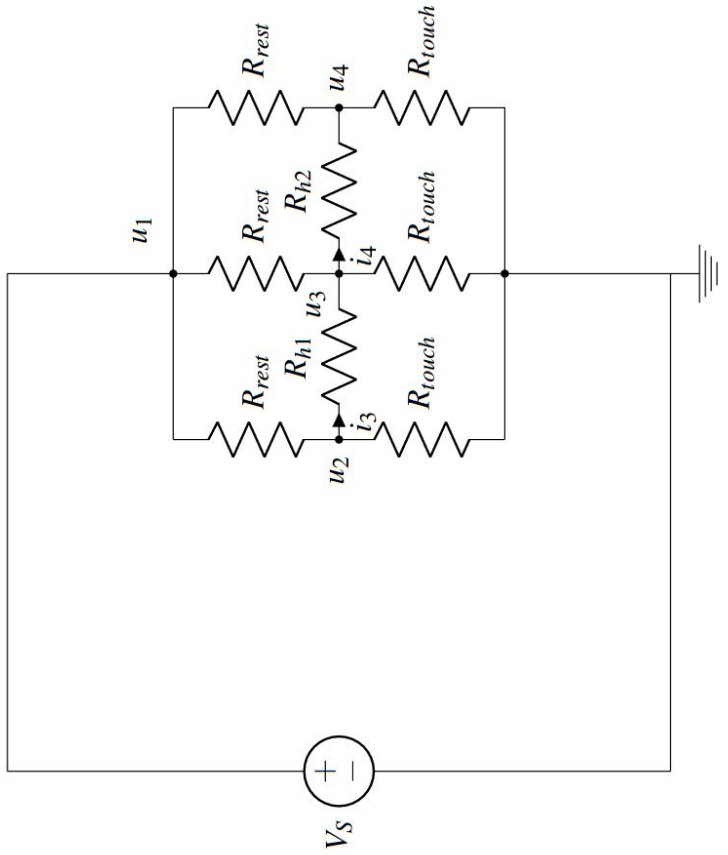
- Measure some voltages, compute location based on value
- **Can you find any two horizontal locations that would output the same voltage?**
- **What about vertical?**



Computing a Location

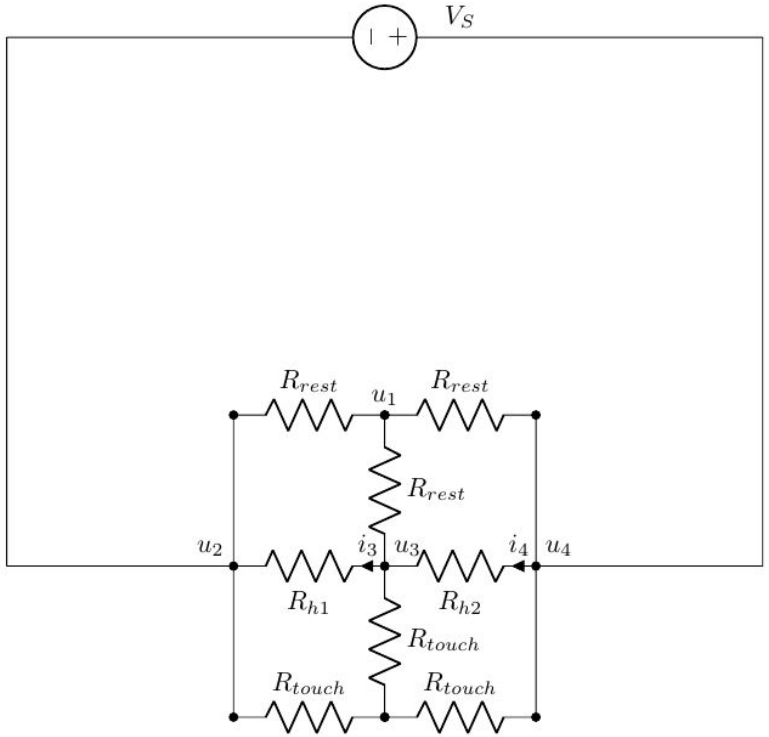
- We can only determine vertical position
- So, what about this other orientation?

What if we turned it sideways?

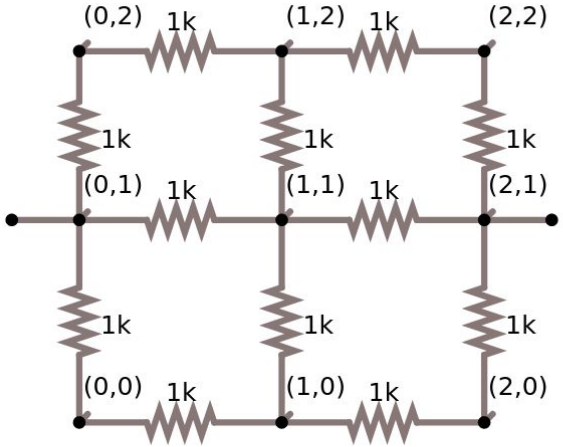


Computing a Location

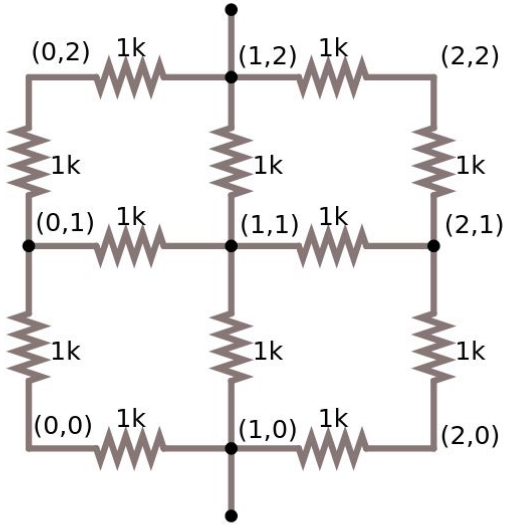
- Let's turn it sideways
  - Apply voltage so we power the horizontal direction
  - **Now, we can find vertical locations that would output the same voltage**
  - **But we cannot find horizontal locations that would output the same voltage**
- This lets us determine horizontal location



Computing a location



Bottom mesh

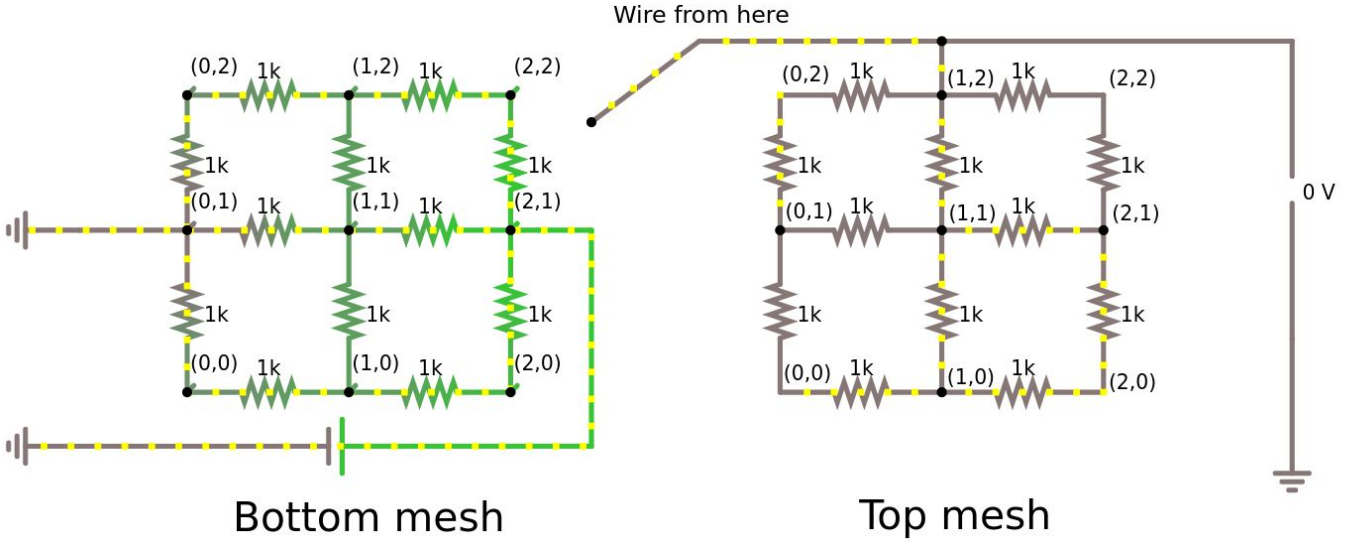


Top mesh

- Additional resistors? Combine as equivalent resistors in series!

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 notebook

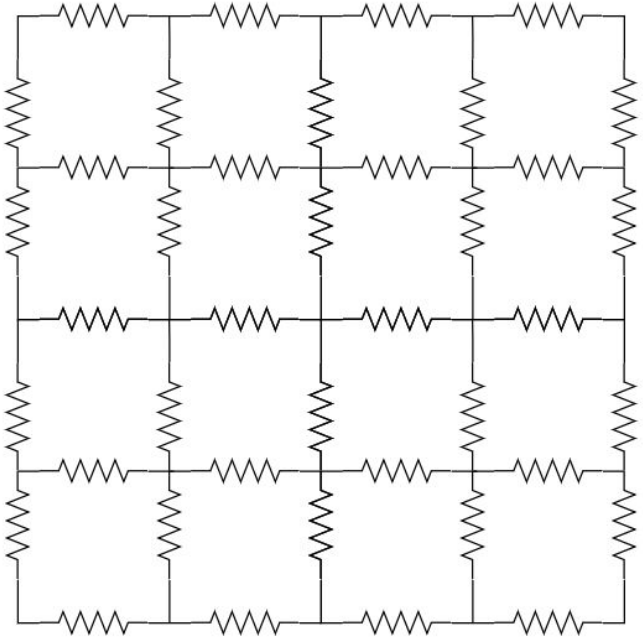


Taking the Limit

- 9 touch points is kinda... meh
- **How do we get more?**

Taking the Limit

- Add more resistors!

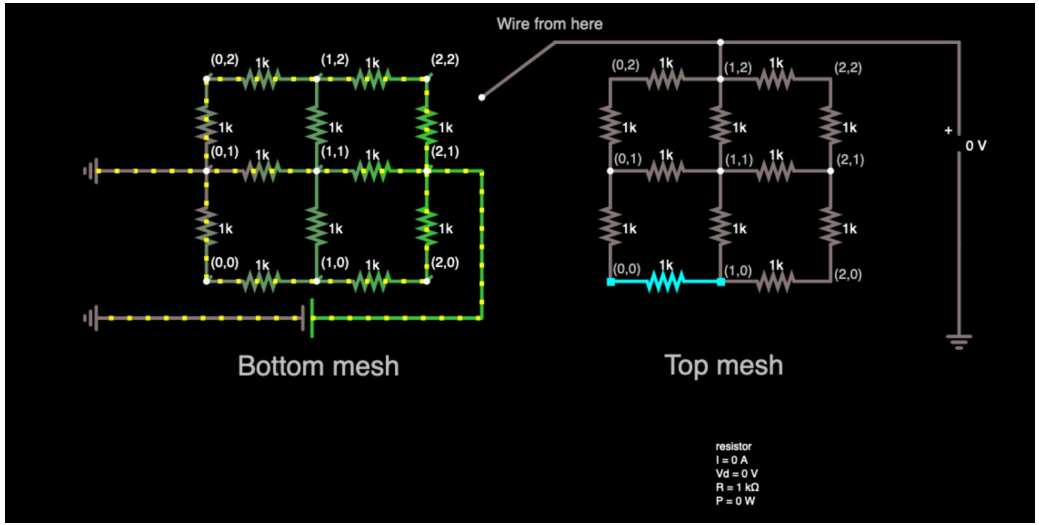


Taking the Limit

- 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 note 12, note 13, note 14

Simulating Touchscreens

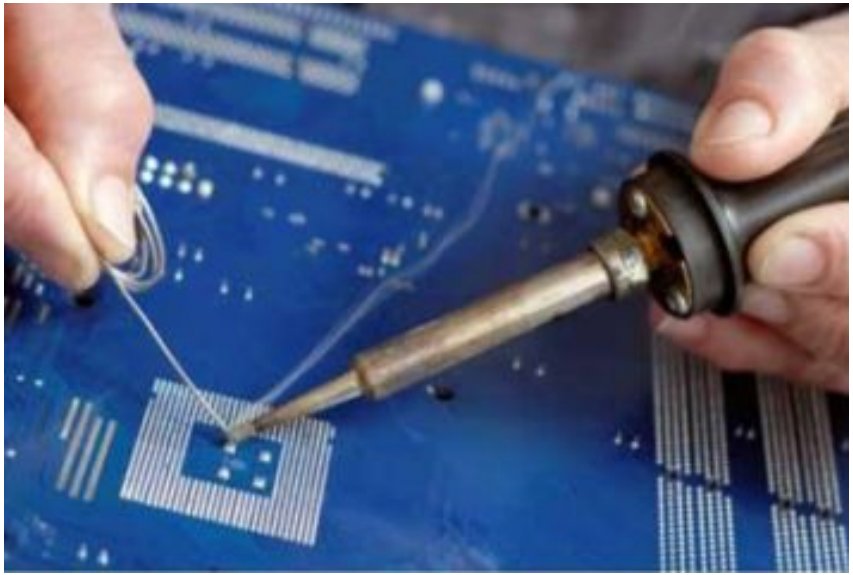
- Falstad simulator (Link)
  - Will be used in this lab to simulate resistive dividers in upper and bottom plates



Building the Mesh

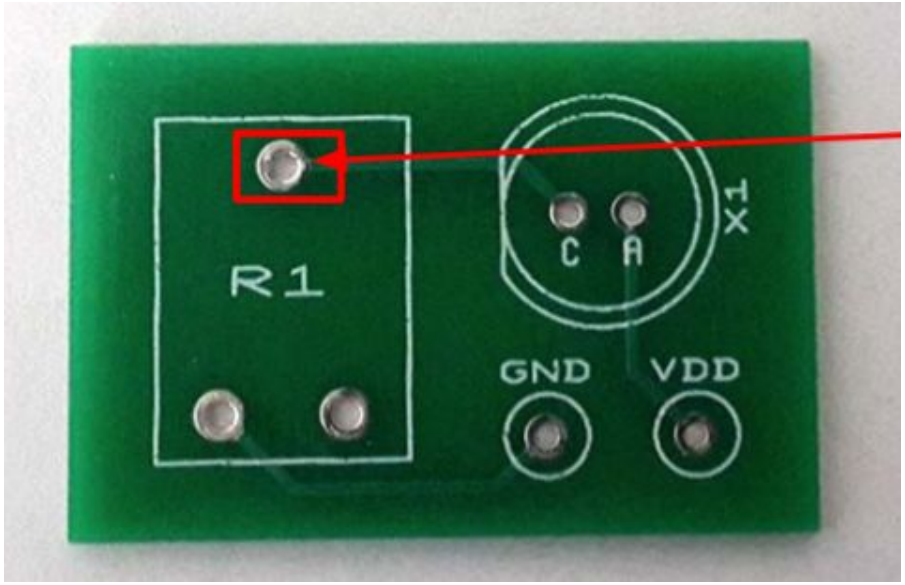
- Today’s lab will have you build your own 3x3 resistive touchscreen almost from scratch!
- You’ll need to learn how to solder in order to build your mesh
  - Be safe, let us know if you are unsure or if you get hurt
  - First aid at the TA desk

Soldering



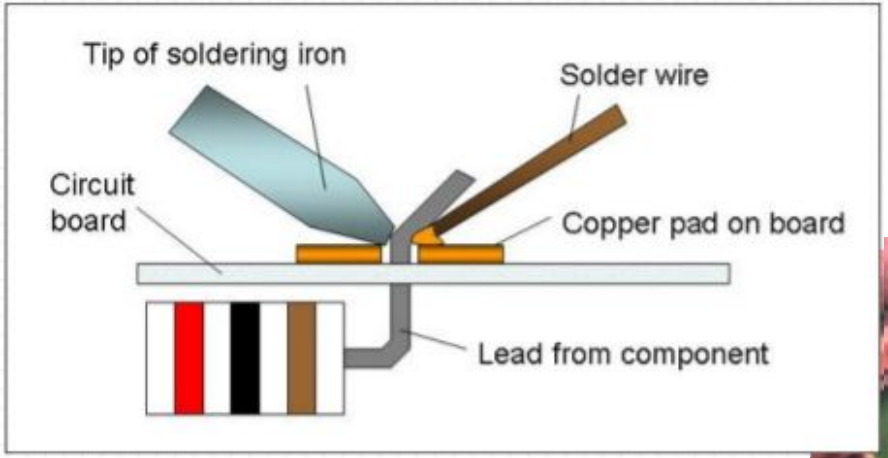
- Like hot glue for circuits
- Ensures there’s a physical connection for all your components

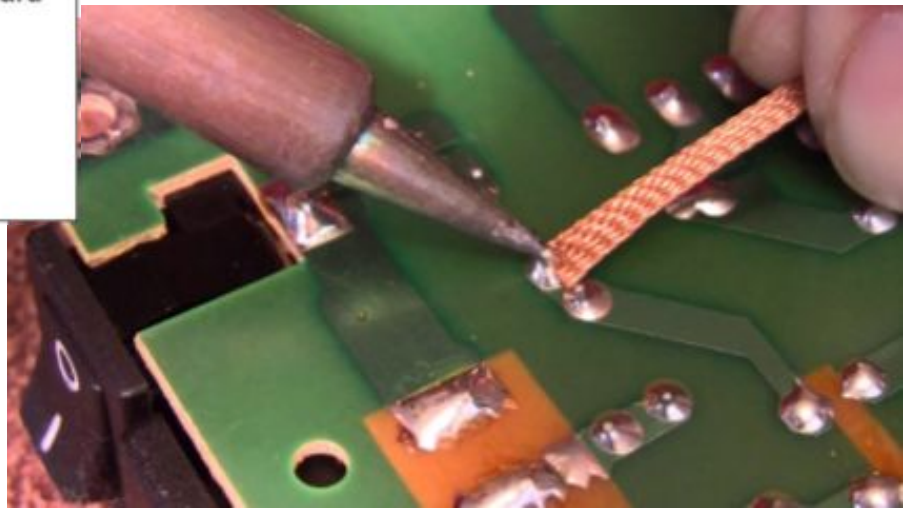
PCB (Printed Circuit Board)



Pad (Copper plate)

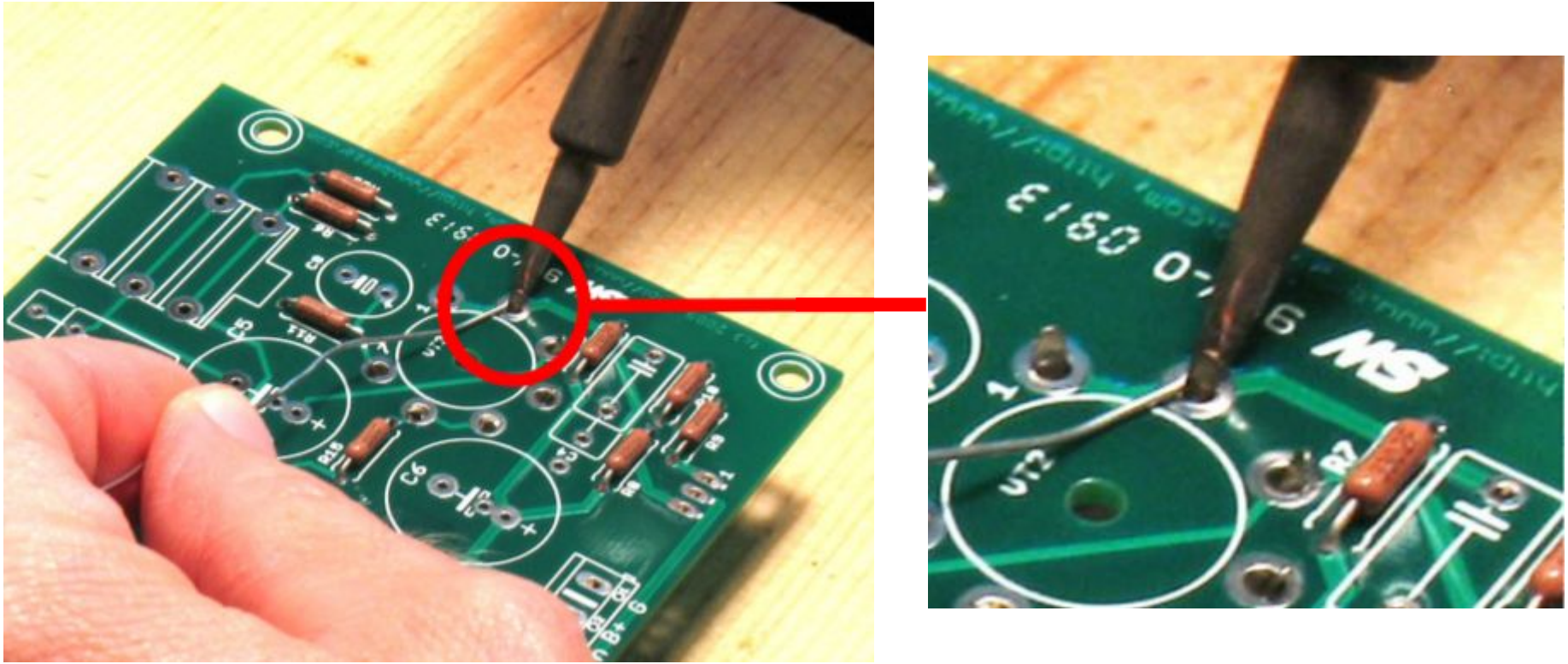
Soldering (Cont.)



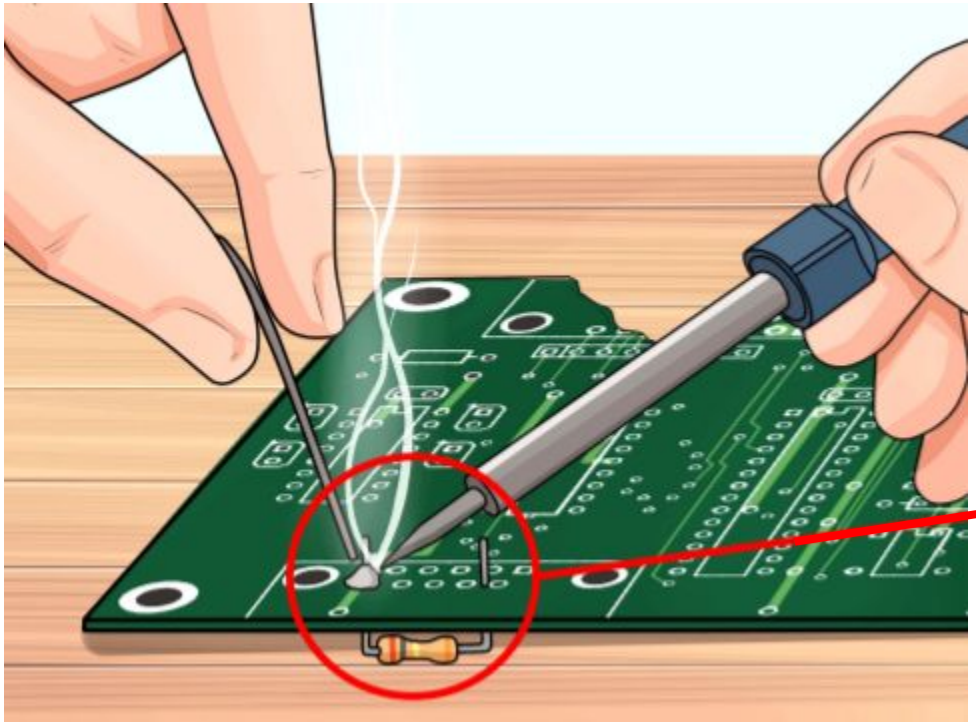


Only solder metal to metal!

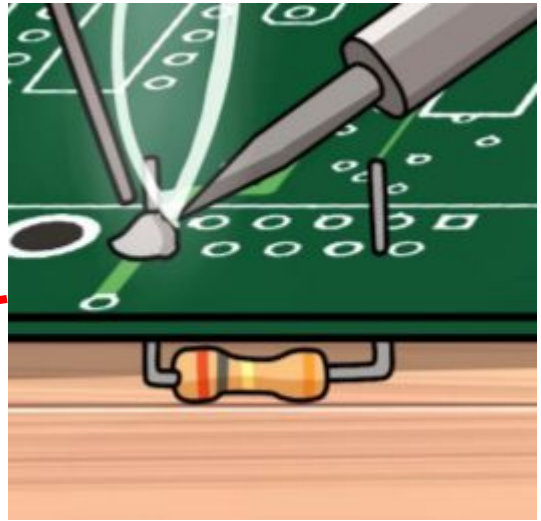
Soldering (Cont.)



Soldering (Cont.)



Component should be flush to the board...why?



Soldering DON’TS

- **Never** eat in lab, but especially not today
- Don’t solder jumper wires!
  - Use breadboarding wires from TA desk
- Don’t solder plastic and other non-metals
  - Strip your wires! Wire strippers are at your station
- Don’t use too much solder
  - But also not too little

Soldering DO'S

- Wet the sponge and clean the tip when you start
- Use the clamp: components should be stable before you start soldering
  - Push components **ALL THE WAY IN**
- **Safety first**; don't burn yourself
  - If you do, let us know immediately!
- Ask if you're unsure about what you're doing
- Clean up after yourself, turn off all equipment

Soldering Grip

Soldering Intro Quiz Check

- Before you're allowed to begin soldering, have all members of your group show a TA/ASE your quiz score
  - Each individual must take their own quiz
  - You must be able to explain any incorrect answers

Pac-Man!

- Thanks to the efforts of your wonderful lab development staff, you'll be able to play pac-man using your touchscreen at the end of the lab!
- **Please don't close the pac-man window – doing so will cause your kernel to crash**. Instead, just lose the game and it'll close automatically.

Lab Feedback

- Tell us about your concerns/ideas using the link at the end of the notebook!
- Let us know what worked, what didn't, and any particular areas you'd like to change
- Also, let us know if you have an idea for a new section of the lab!
- **The form is completely anonymous!**

Pointers

- **Be careful** when soldering your resistive touch screen!
- **Don’t solder jumper wires** – strip breadboarding wires using the wire stripper at the lab station
- Make sure components are all flush with the PCBs before soldering
- Cut the soldered joints of the resistors to be **VERY SHORT** using the **Precision Cutters** at the **TA Desk**
  - **Twist** component leads together before soldering
- Water squirters, precision cutters, solder rolls **STAY** on the TA Desk – only a few inches of solder required
- Turn off your soldering iron before checkoff!
- Watch instructional videos in the notebook for guidance
- **If you don’t finish, save your iPython notebook & email it to yourself!**

https://tinyurl.com/touch2-sp23

http://tinyurl.com/training-sp23