

EECS 16A Designing Information Devices and Systems I

Summer 2023 Pre-Lab Reading Touch 2

1 Touch 1 Review

In the last lab, you built an LED fader circuit. If you recall, this was a circuit that changed the brightness of the LED based on the overall resistance in the circuit. This variable resistance was given by a new kind of circuit element, a potentiometer. The key concept we used to determine the voltage across the LED was the **voltage divider**. We will make use of voltage dividers as we build our first touchscreen of the semester - the resistive touchscreen!

2 Touch 2 Preview

The resistive touchscreen is a type of touchscreen that was commonly used before newer/modern capacitive touchscreens became popular. Even today, some are still around. It consists of two different layers - a flexible resistive layer on the top and a resistor circuit layer on the bottom. A physical touch results in physical contact between the top and bottom layers. This contact allows us to determine unique positions of touch on different parts of the screen. Thus, examples of resistive touchscreens are those where a considerable physical touch is required from the user. Think old Nokias, Nintendo DS & Gameboy, etc. In this lab, you will build both layers of the touchscreen as well as write simple code to detect different (unique) touch-points on your screen.

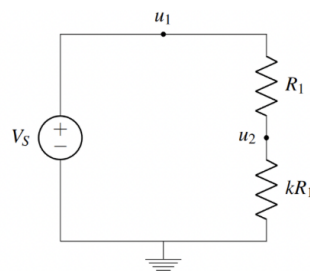
2.1 Touchscreen Theory (Note 13/14)

Here's a version of the voltage divider you might have seen a few times over the last week. Note that the two resistors have resistances R_1 and kR_1 respectively. There is a step-by-step derivation of the voltage at node u_2 using the voltage divider equation.

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

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

$$u_2 = V_s * \frac{k}{k+1} \quad \text{Independent of the value of } R!$$



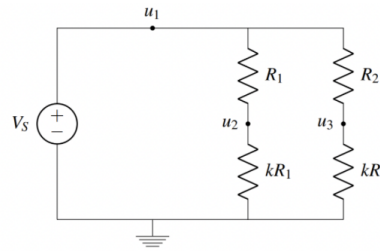
Thus, we can see that the voltage between two resistors whose resistances are multiples of each other is independent of the actual resistances. It only depends on the scaling factor k .

What happens if we add another voltage divider to the above circuit? It's surprisingly straightforward! With the help of KVL, we can inspect each loop independently and apply the voltage divider equation twice:

What are the voltages at u_2 and u_3 ?

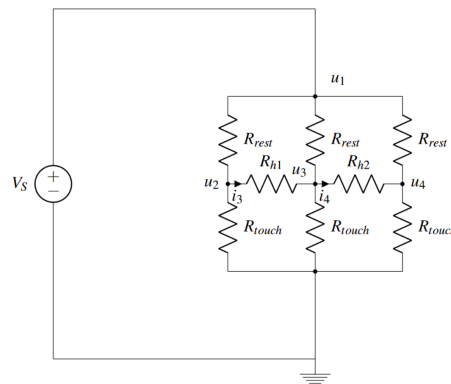
$$u_2 = V_s * \frac{k}{k+1}$$

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

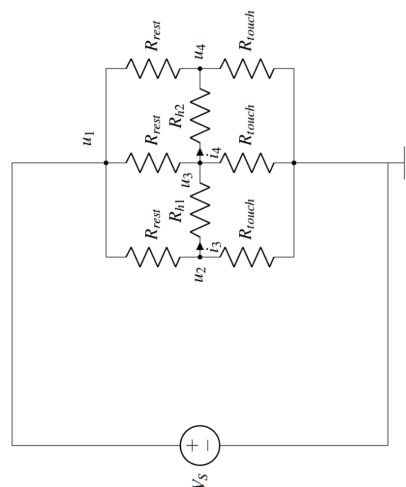


Please refer to **Note 14** if you are confused about these derivations. Now, say we connected another resistor R_3 between nodes u_2 and u_3 . What would the current be through that resistor? Think about the potential difference across that resistor; *i.e.*, $V_{u_2} - V_{u_3}$.

Let's now go one step further and add more nodes (touch points) to the circuit. This is a simplified version of **one layer** of the touchscreen you will be building in lab. Note that $V_{u_2} = V_{u_3} = V_{u_4}$ and $V_{u_1} \neq V_{u_2} \neq GND$



All we need to do now is to measure the voltages at different points in this circuit to determine what point is being touched. However, we are not quite done with building our touchscreen. We saw earlier that the voltages differ in the vertical direction but not in the horizontal direction. This means that we can only find unique points in the vertical direction. How do we uniquely determine pairs of points along both axes? What if we flip the orientation of the touchscreen by 90° ?



Now, we have variation across vertical and horizontal directions which allows us to uniquely determine **pairs** of points using our voltage measurements. We will take you through the exact process during lab!

2.2 Soldering!

You will be soldering for the first time in this lab! Soldering is a process used for joining metallic parts to form an electrical (or mechanical) bond. It uses a low melting point metal alloy (called solder). The solder is melted and applied to the desired parts to be joined. This might be the first time that many of you will be soldering. Do not worry, we will walk you through all the steps required to successfully solder your circuit. Please pay attention to the DOs and DON'Ts we outline during the lab presentations!