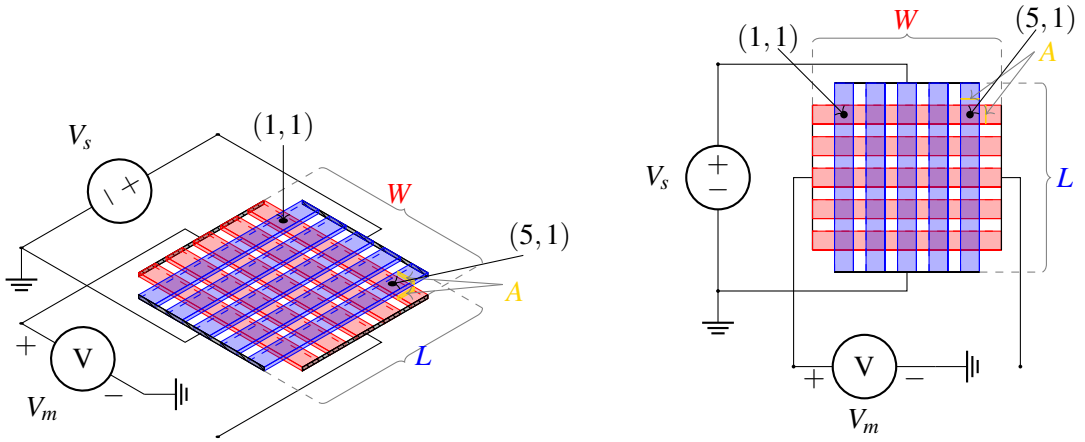
EECS 16A Spring 2023 — Designing Information Devices and Systems I — Discussion 7B

1. Resist the Touch

Investigate the $N \times N$ resistive touchscreen with vertical length L and horizontal width W shown in Figure 1. The touchscreen is constructed in two layers: a flexible conductive top layer comprised of N vertically oriented strips with even spacing $\frac{W}{N+1}$; and a rigid conductive bottom layer comprised of horizontally oriented strips with even spacing $\frac{L}{N+1}$.

The vertical and horizontal strips form a grid of detectable touch points. The upper left touch point in Figure 1(b) is position $(1,1)$, and the upper right touch point is $(N,1)$. All strips in top and bottom layers have equal resistivity, ρ, and cross-sectional area, A.

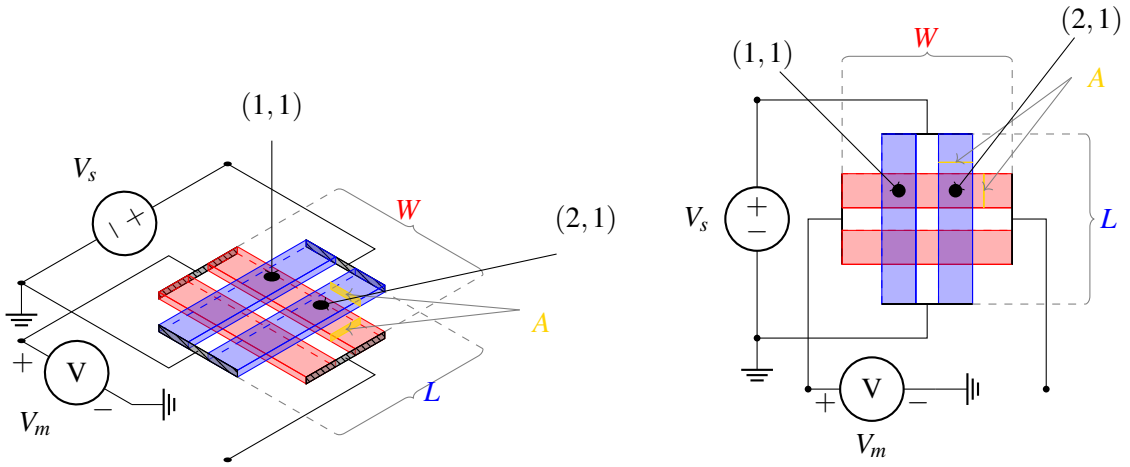


(a) 5×5 2-D Resistive Touch Screen Oblique View

(b) 5×5 2-D Resistive Touch Screen Top View

Figure 1: $N \times N$ Resistive Touch Screen, $N = 5$

(a) Find the resistance R_y for a single vertical blue strip and R_x for a single horizontal red strip as a function of the screen dimensions W and L, the strip resistivity ρ, and the cross-sectional area A.



(a) 2×2 2-D Resistive Touch Screen Oblique View

(b) 2×2 2-D Resistive Touch Screen Top View

Figure 2: 2×2 Resistive Touch Screen

(b) Consider a 2×2 example for the touchscreen circuit, as shown in Figure 2.

Assume a voltage source V_s is connected from the top to bottom terminals of all the vertical (blue) strips, and a voltmeter V_m is connected from the left terminal of all horizontal (red) strips to the negative terminal of the voltage source.

If $V_s = 3\,\text{V}$, $R_x = 2000\,\Omega$, and $R_y = 2000\,\Omega$, draw the equivalent circuit for when the point $(2,2)$ is pressed and solve for the measured voltage, V_m, with respect to ground.

(c) Suppose a touch occurs at coordinates (i, j) for an arbitrary $N \times N$ touchscreen, and the voltage source and meter are connected as in the diagrams. Find an expression for V_m as a function of V_s, N, i, and j.