

EECS 16A Designing Information Devices and Systems I Discussion 9A  
 Spring 2023

1. Capacitive Touchscreen

Consider the 2-dimensional capacitive touchscreen in Figure 1. Node  $F$  (green) represents the contact area of the finger with the top insulator. The finger contact area has horizontal width  $w_2$  and depth (into the page)  $d_1$ . The ‘top’ metal at node  $E_1$  (red) has width  $w_1$  and depth  $d_1$ . The ‘bottom’ metal at node  $E_2$  (grey) has width  $w$  and depth  $d_2$ , where  $w$  is much larger than  $w_1$  and  $w_2$ . The vertical distance between the top metal (red) and bottom plate (grey) is  $t_1$ , and the vertical distance between the finger (green) and the bottom plate (grey) is  $t_2$ .

Table 1: Touchscreen Dimension Values

$d_1$	$d_2$	$w_1$	$w_2$	$t_1$	$t_2$
10mm	1mm	1mm	2mm	2mm	4mm

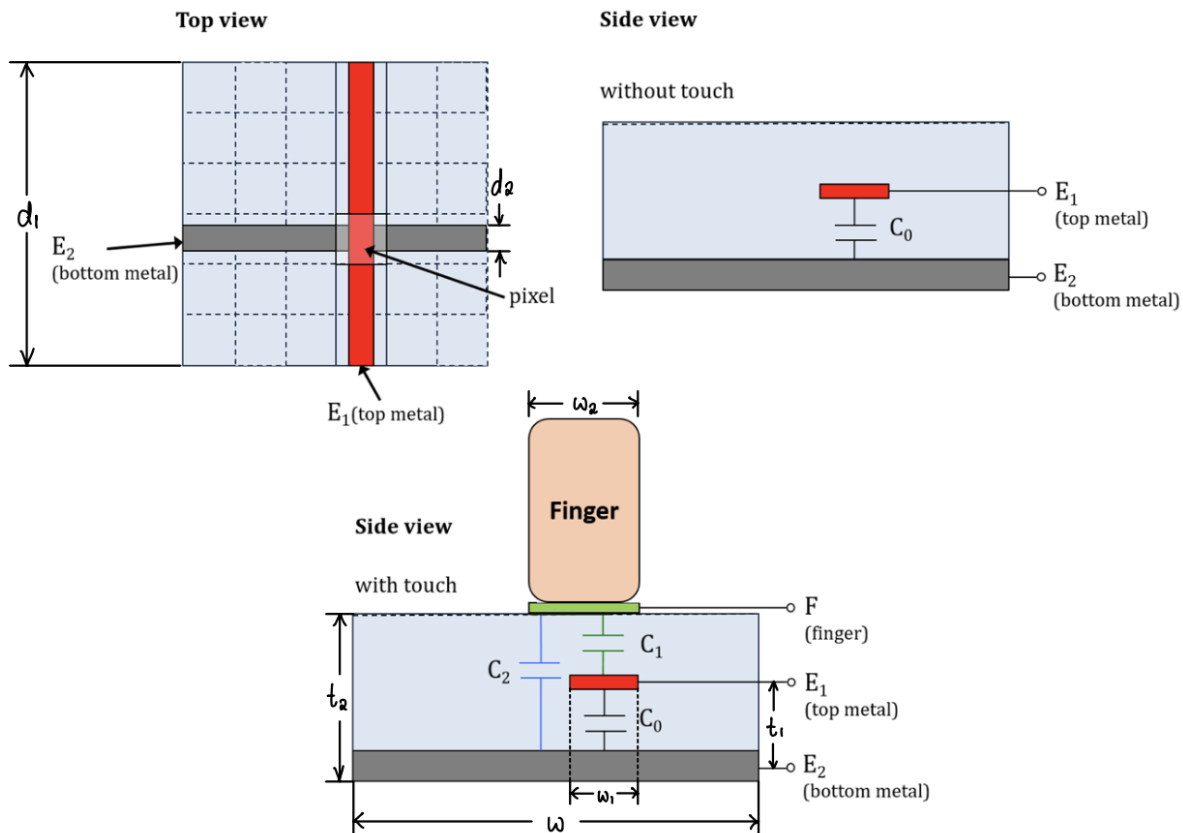


Figure 1: Model of capacitive touchscreen.

- (a) Draw the equivalent circuit of the touchscreen that contains the nodes  $F$ ,  $E_1$ , and  $E_2$  when: (i) there is no finger present; and (ii) when there is a finger present. Express the capacitance values in terms of  $C_0$ ,  $C_1$ , and  $C_2$ .

*Hint: Note that node  $F$  represents the finger. When there is no touch node,  $F$  would be non-existent.*

- (b) What are the values of  $C_0$ ,  $C_1$ , and  $C_2$ ? Assume the insulating material has a permittivity of  $\epsilon = 4.43 \cdot 10^{-11}$  F/m and the thickness of the metal layers is small compared to  $t_1$  (so you can ignore the thickness of the metal layers). Also assume that the right edge of the top metal (red area) in the diagram is aligned with the right edge of the finger (green area) in the diagram. Convert your calculated values to femto-Farads (*femto* =  $f = 10^{-15}$ ).

(c) What is the effective capacitance between the two metal plates (nodes  $E_1$  and  $E_2$ ) when a finger is present?