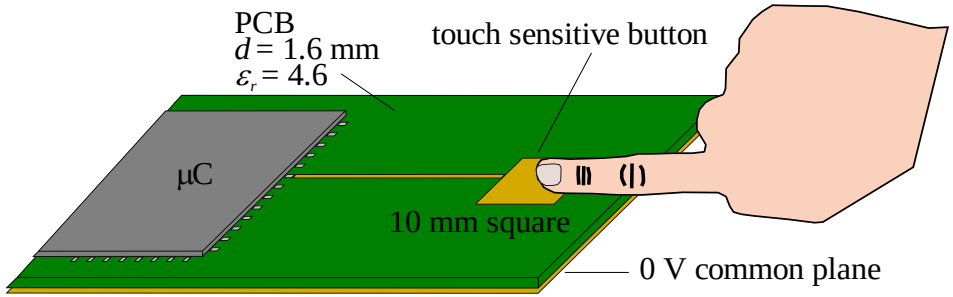
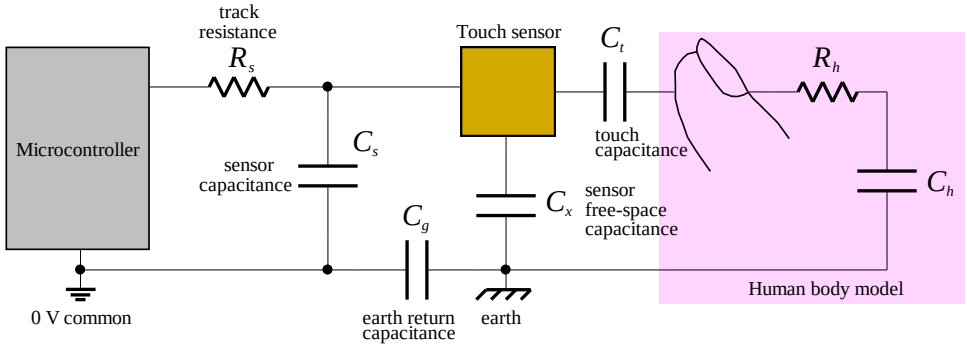
7 Capacitive Touch Sensor Analysis

A *Personal Solar Torch* has a square capacitive touch sensor, 10 mm on each side, as shown below:



An electrical model of the system is shown below:



Self-capacitance touch sensors use a single sensor electrode to measure the apparent capacitance between the electrode and the 0 V common of the touch sensor circuit.

Note: $\varepsilon_0 = 8.85419\ \text{pFm}^{-1}$.

The Human Body Model (HBM) has the following typical values: $R_h = 1.5\,\text{k}\Omega$, $C_h = 100\ \text{pF}$.

C_t may be modelled as a parallel plate capacitor. A user's fingertip placed onto a solid surface may be approximated as a disc with a diameter of 8 mm. Capacitor plates are the touch sensor electrode and the user fingertip. The dielectric is "solder mask" material, thickness 0.1 mm, with $\varepsilon_r = 3.7$.

$C_g = 20\ \text{pF}$ is the capacitance of the coupling between the PST 0 V common and earth. $C_x = 10\ \text{fF}$ is the capacitance of the coupling between the sensor and earth.

(a) Determine whether the resistors are important in the analysis.

(b) Show that in series capacitors, the dominant effect is that of the smallest capacitor.

(c) Determine the no-touch capacitance as sensed by the microcontroller (µC).

(d) Determine the touch capacitance as sensed by the µC.