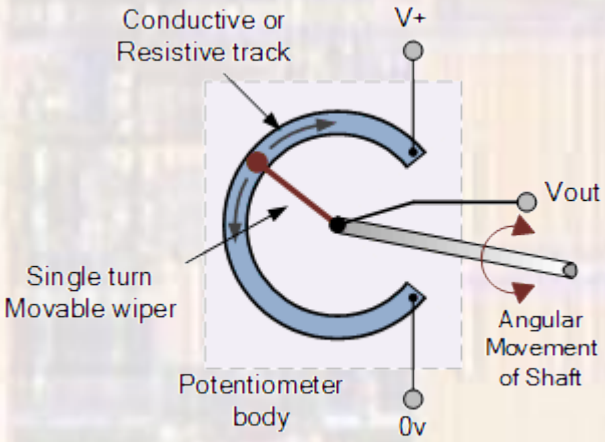
# Interfaces
# Inputs

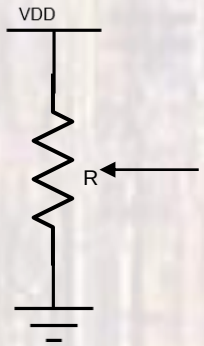
Last updated 5/2/22

# Interfaces - Inputs

- Potentiometer



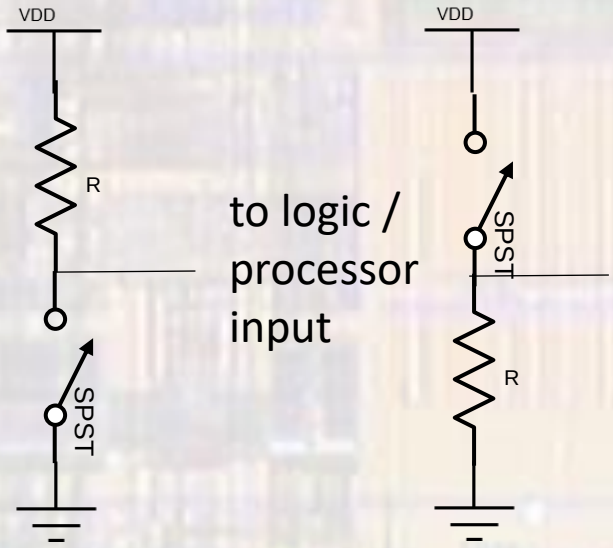

Voltage Divider

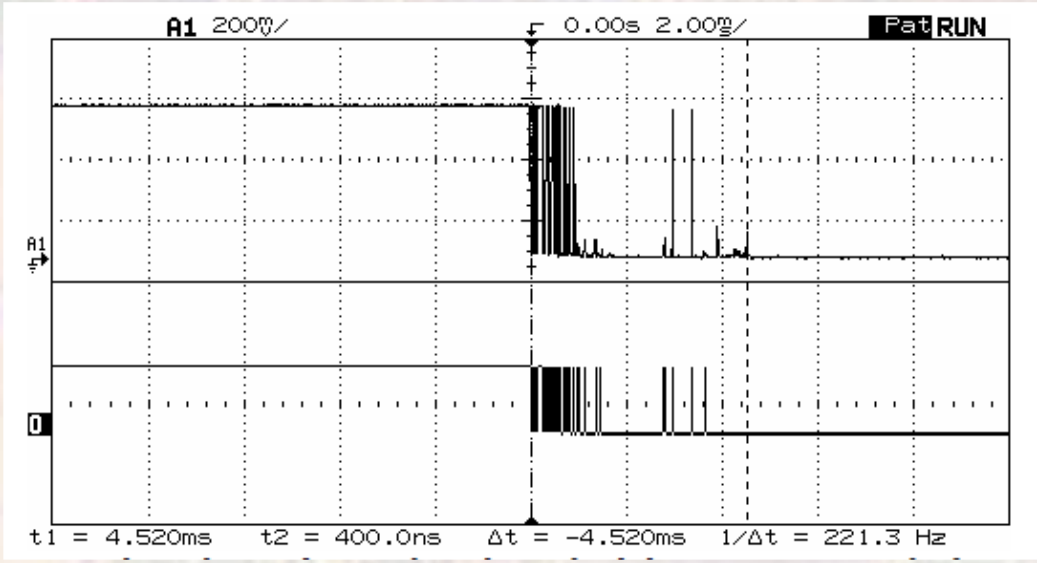



Reostat

# Interfaces - Inputs

- Simple Switch

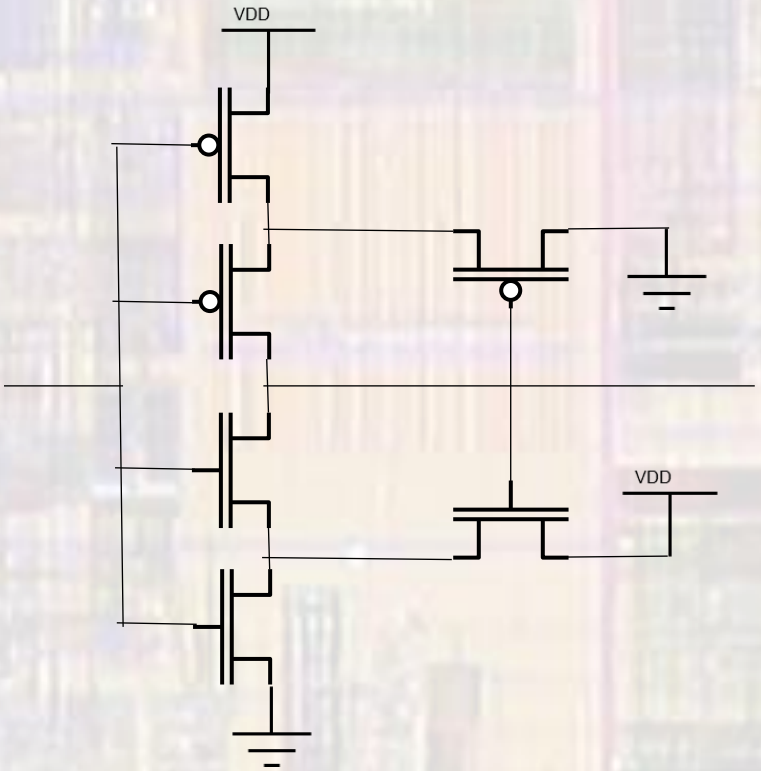


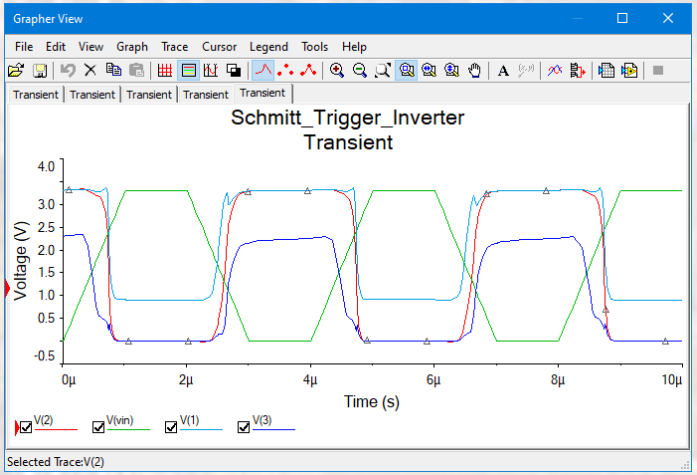




src: The Ganssle Group

# Interfaces - Inputs

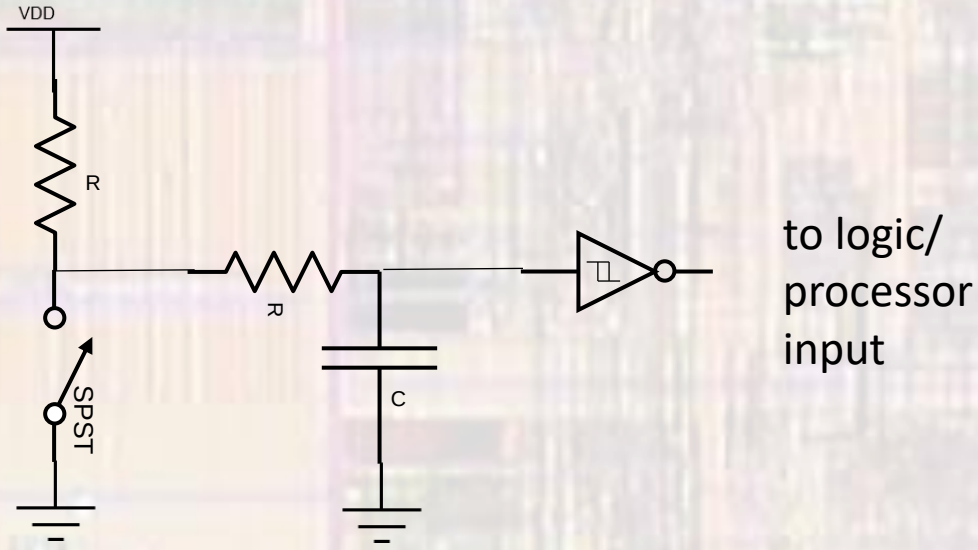
- Schmitt Trigger Inverter



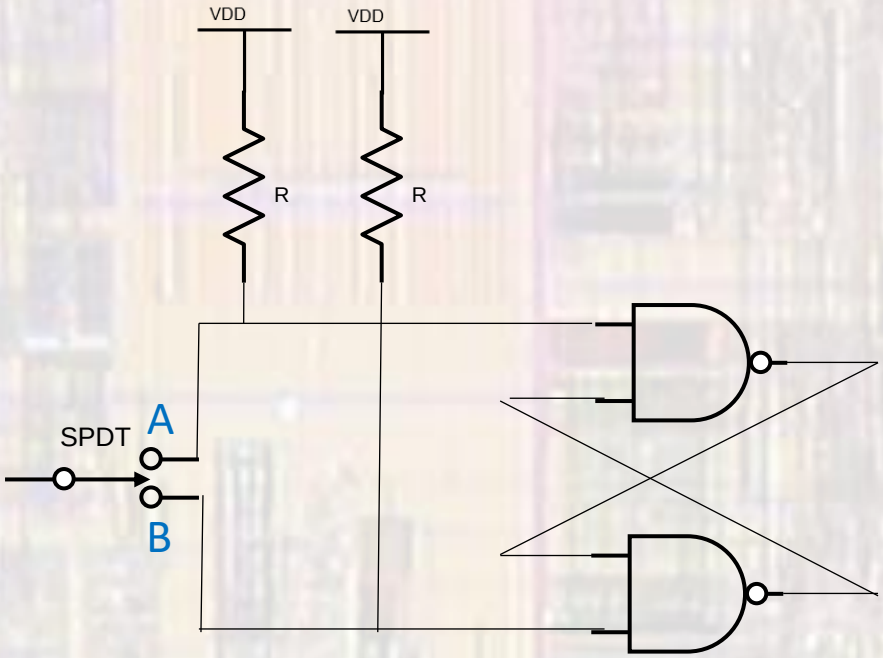
# Interfaces - Inputs

- Debounced Switch 1
  - Slows the transition (filters it)
  - Delays the switching time



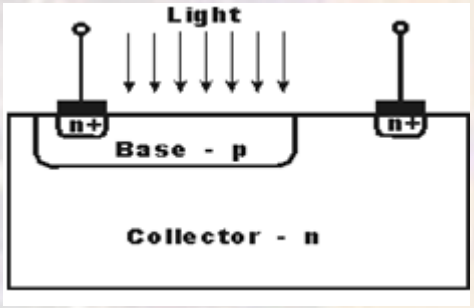
# Interfaces - Inputs

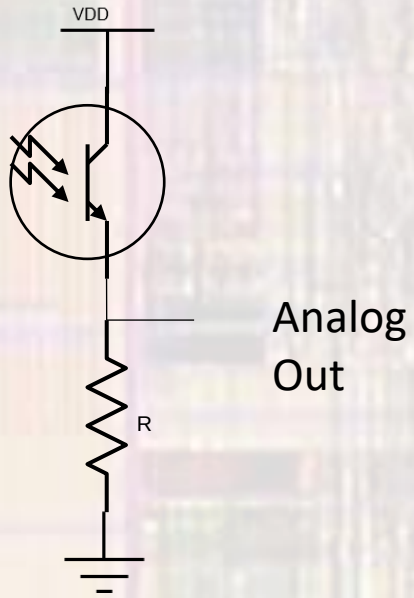
- Debounced Switch 2
  - SR latch
  - Requires an SPDT switch

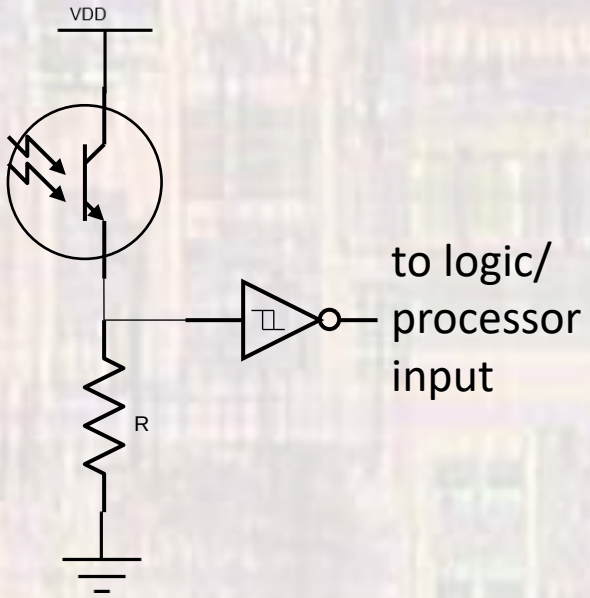


# Interfaces - Inputs

- Photo-Transistor
  - Converts light to current

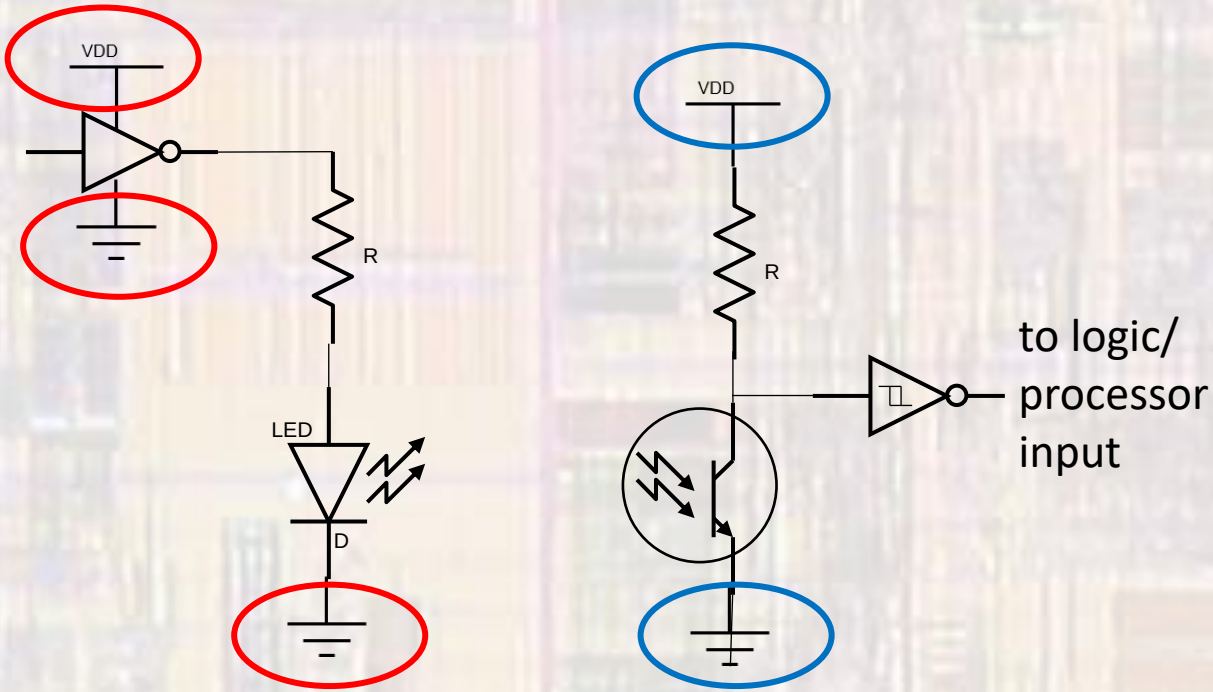


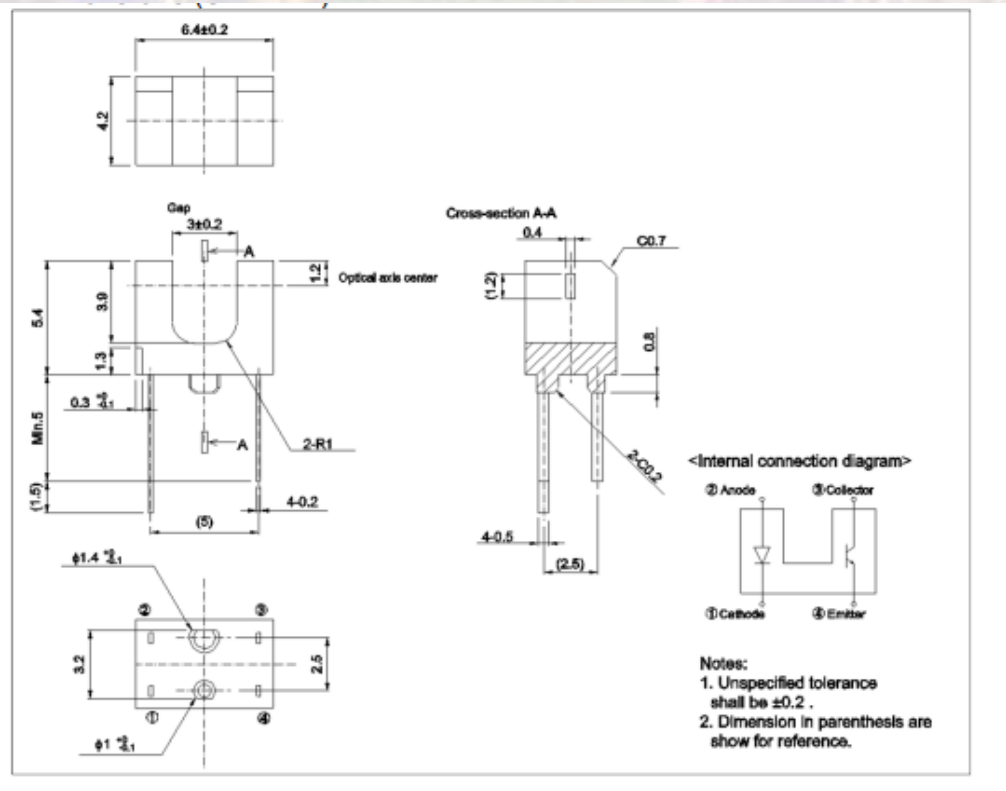
# Interfaces - Inputs

- Opto-coupler
  - Transmits a signal using light
  - Isolates Supplies



# Interfaces - Inputs

- Slotted Opto-coupler
  - Transmits a signal using light
  - Isolates Supplies

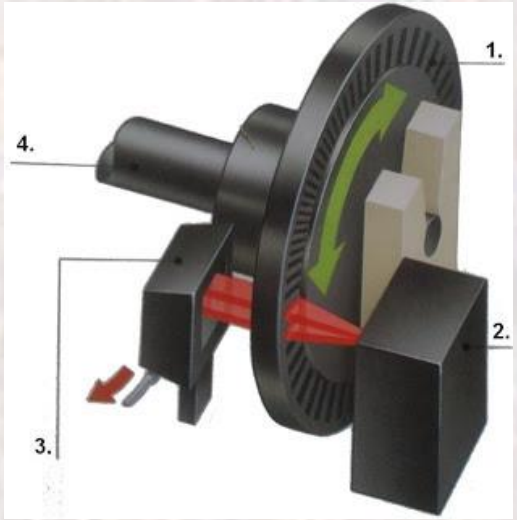


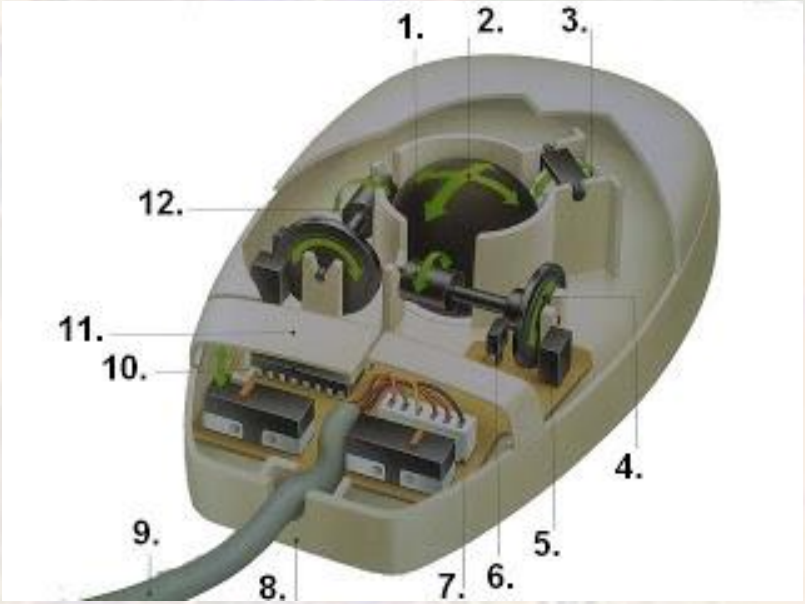


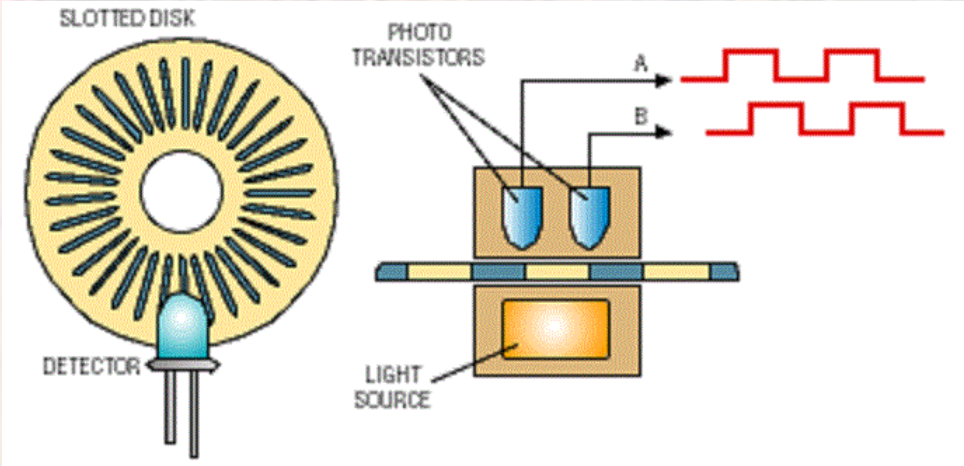
src: Rohm

# Interfaces - Inputs

- Rotary Encoder
  - Direction
  - Distance



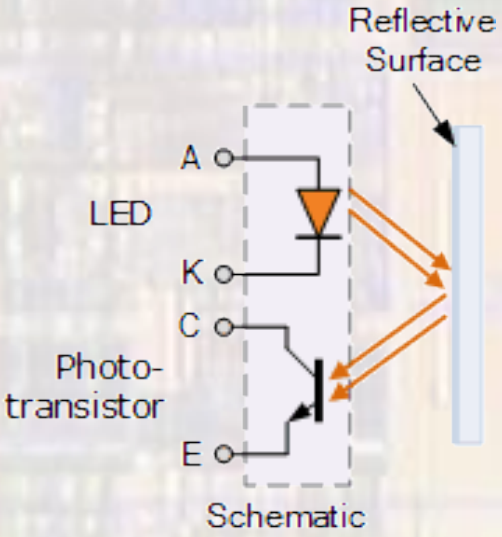



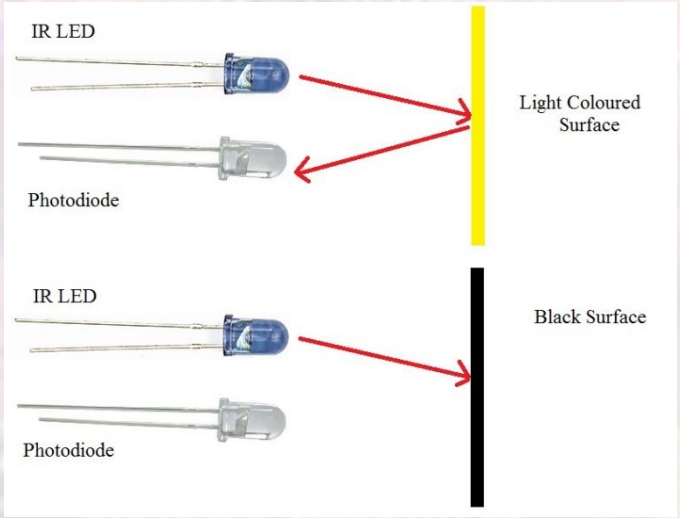



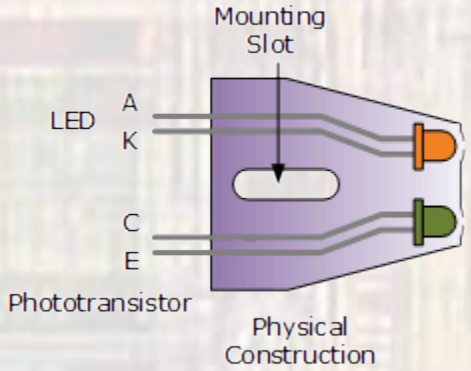

 

# Interfaces - Inputs

- Reflective Coupler
  - Line sensor

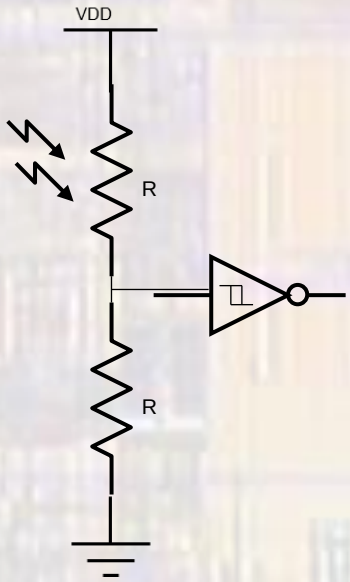


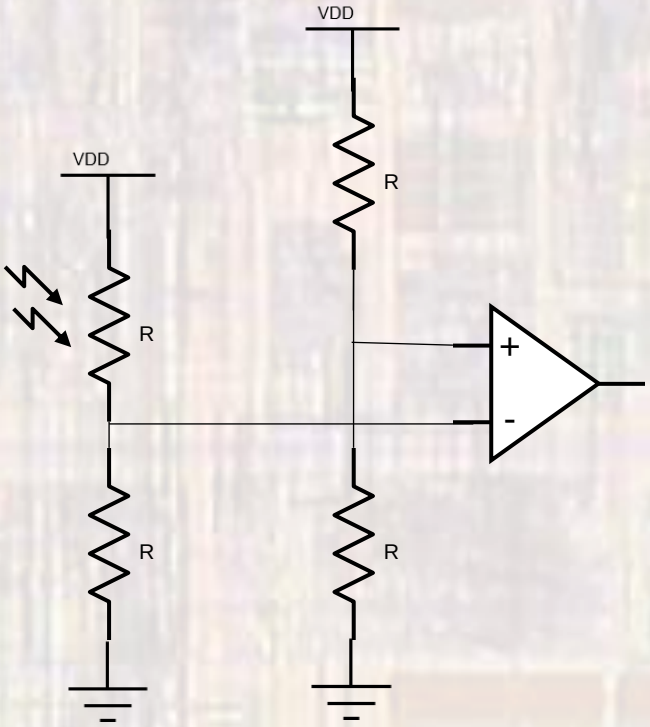



# Interfaces - Inputs

- Photo Resistor

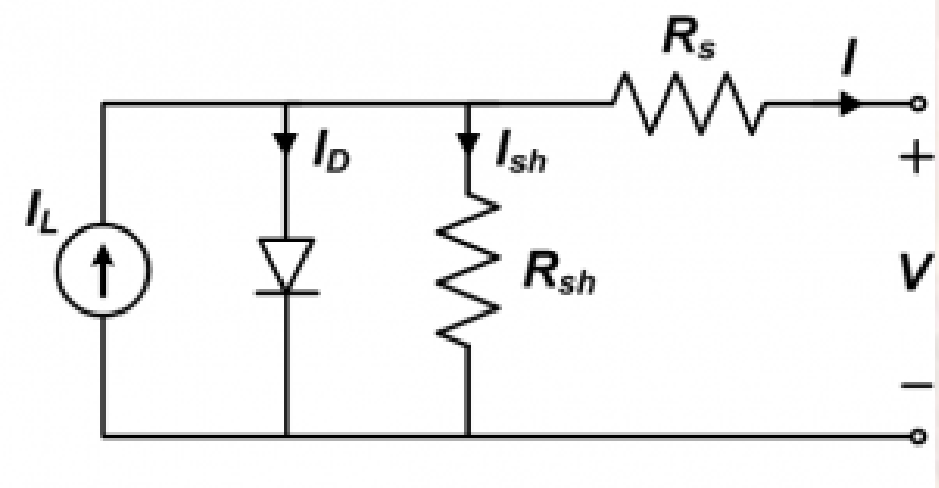



to logic/
processor
input



# Interfaces - Inputs

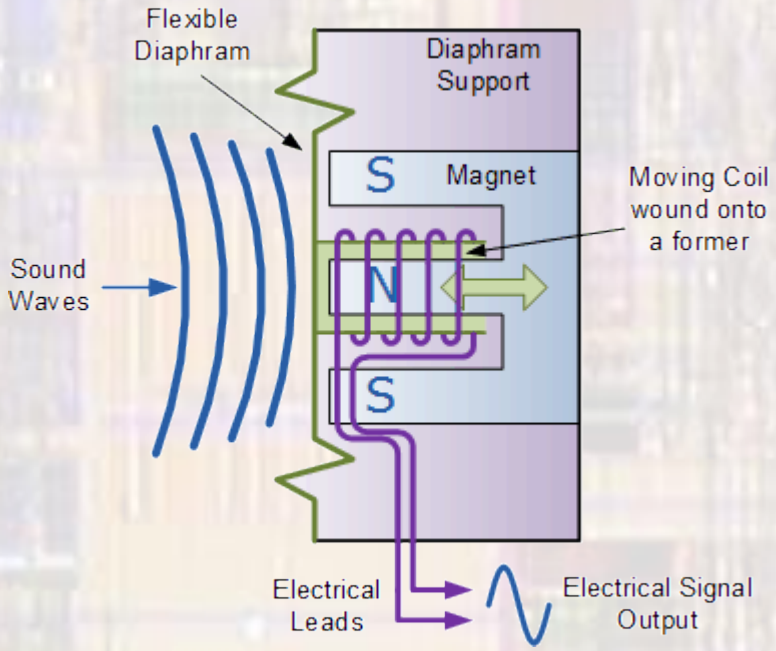
- Photovoltaic Cell (Solar Cell)
  - Generates a voltage that is the ln of the photo-current
  - Put cells in series to generate usable voltages



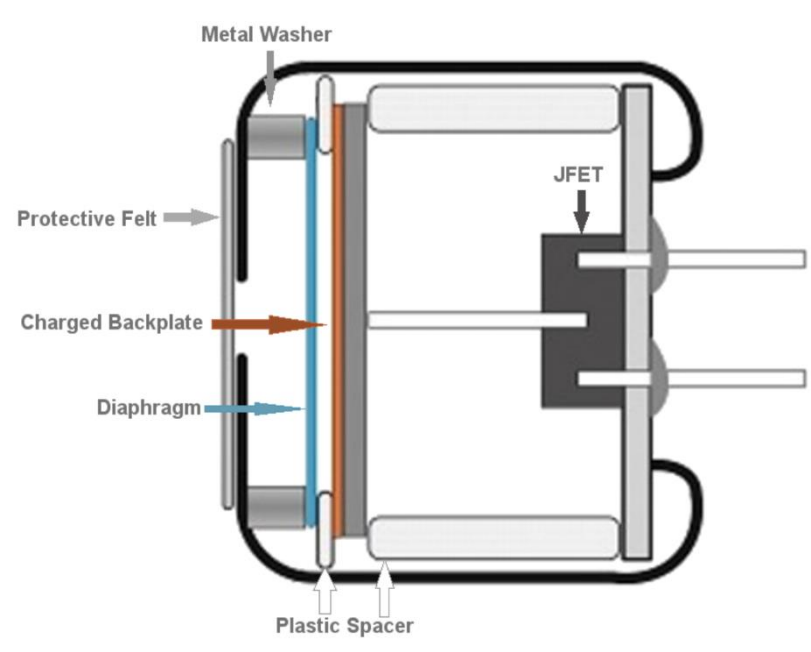
# Interfaces - Inputs

- Moving Coil Microphone

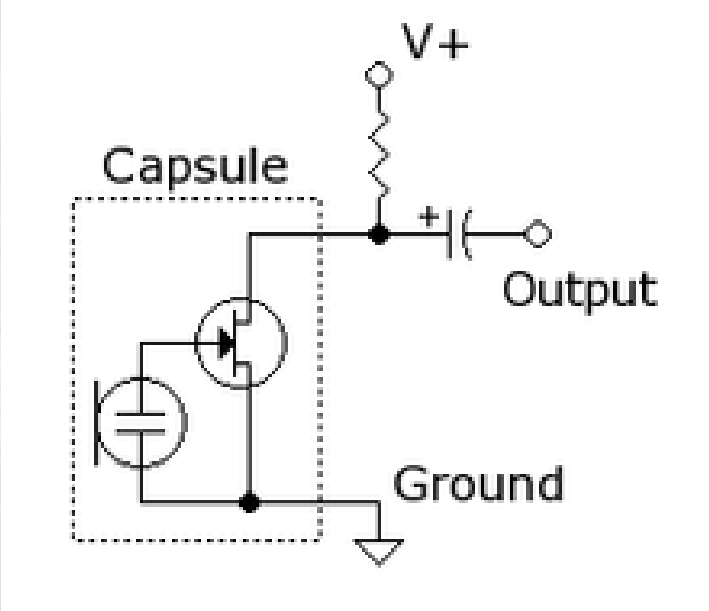


# Interfaces - Inputs

- Electret Microphone
  - Sound pressure moves the diaphragm → dC

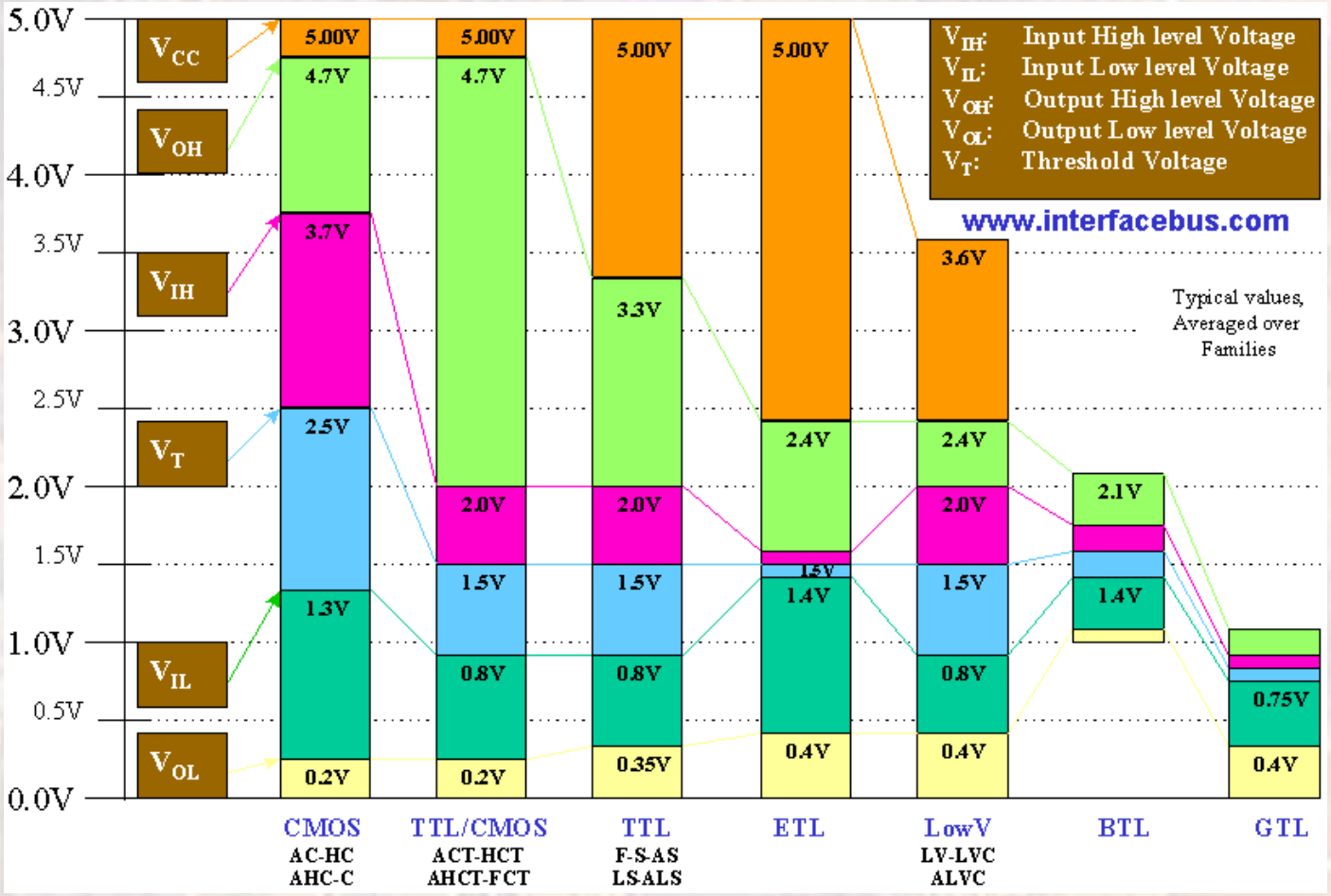



Fixed Q
Q = CV
V = Q/C
dV = QdC



# Interfaces - Inputs

- Logic Interfaces – Discrete



# Interfaces - Inputs

- Logic Interfaces – IC

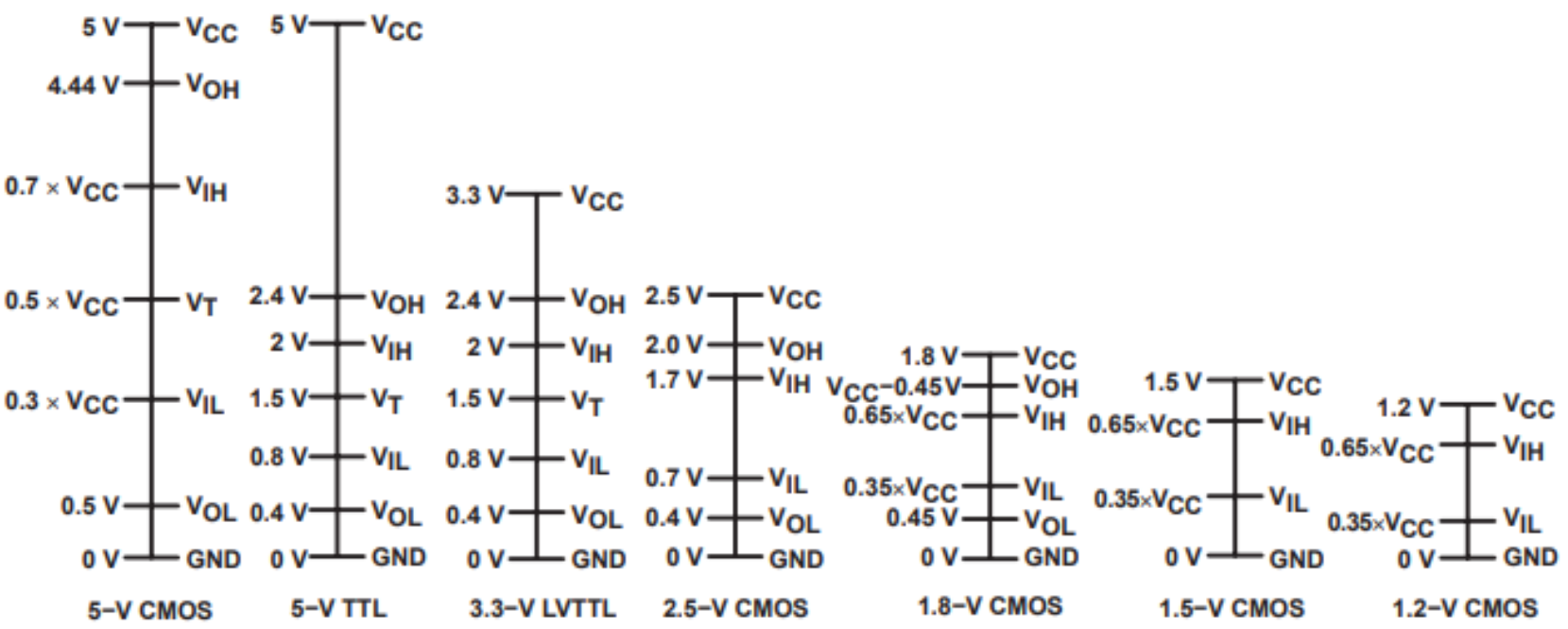
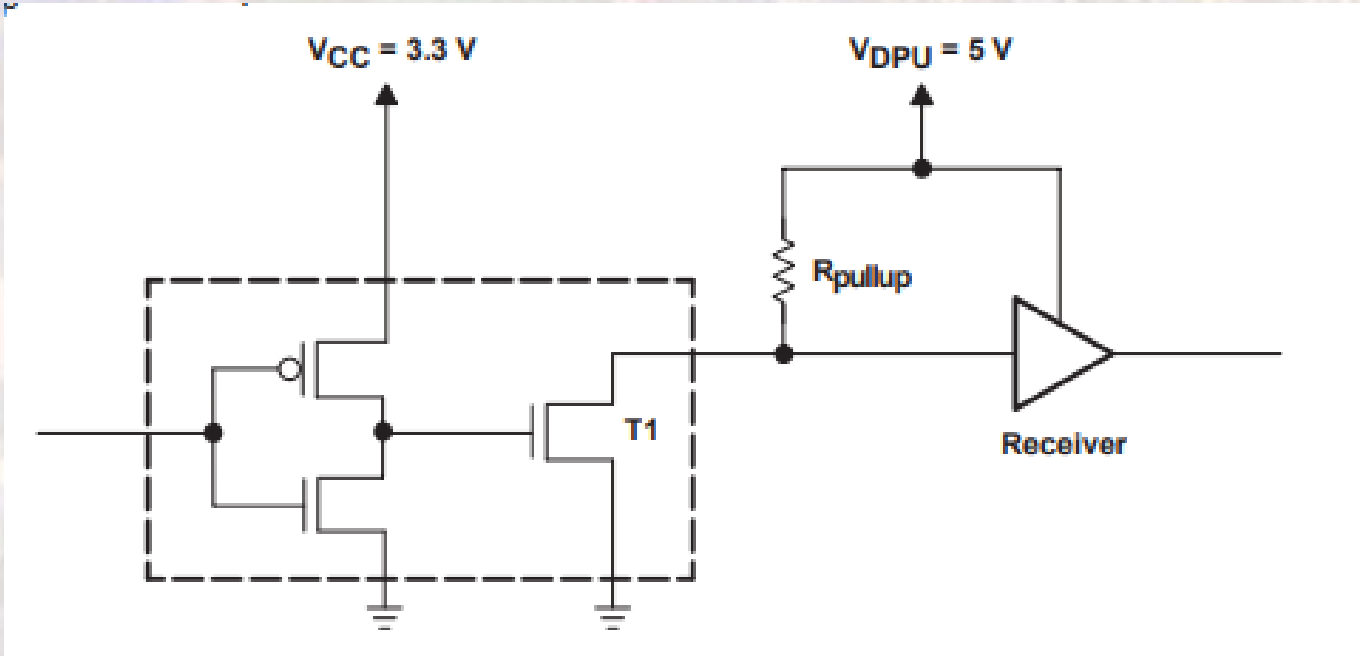



**Figure 2. Digital Switching Levels**

# Interfaces - Inputs

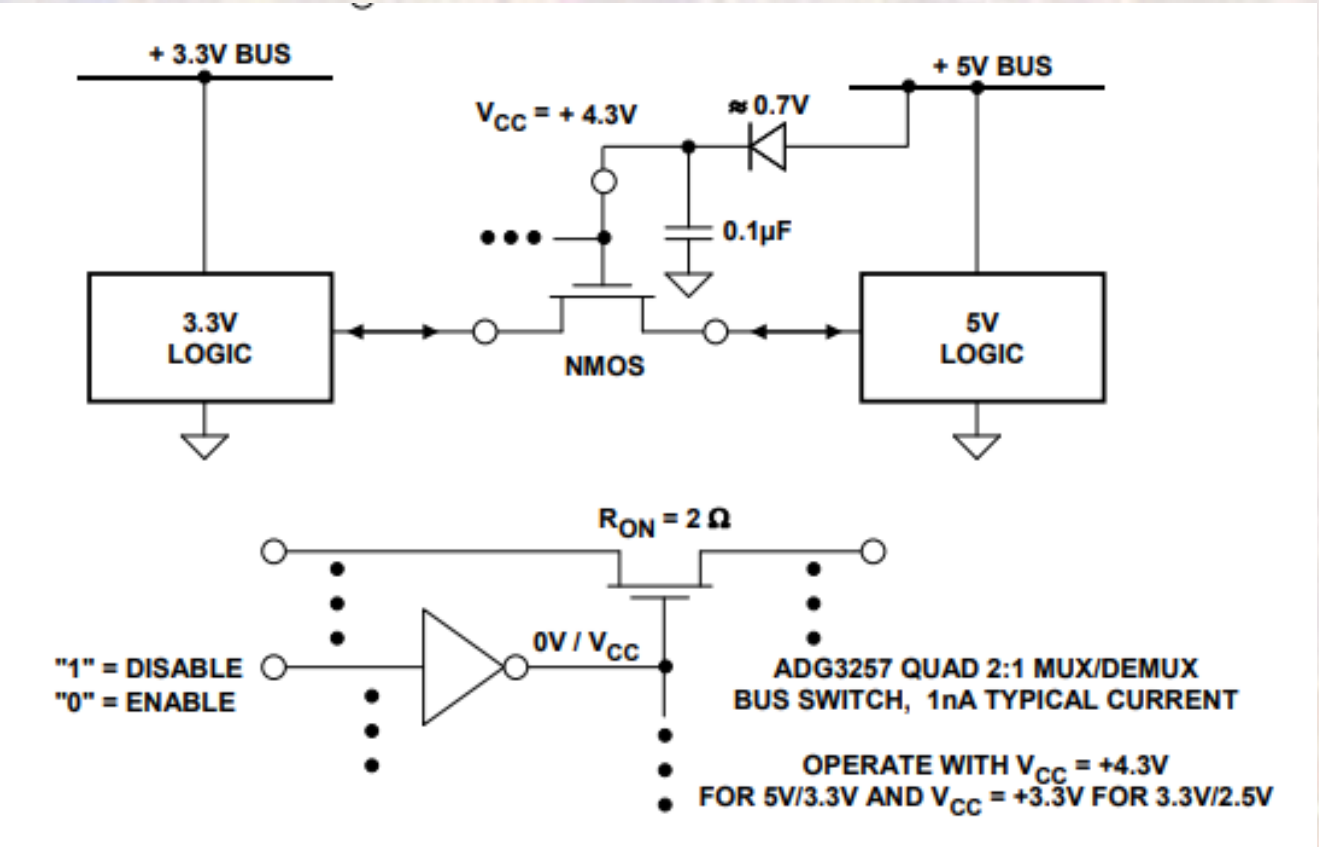
- Logic Interfaces
  - Open Drain



# Interfaces - Inputs

- Logic Interfaces
  - Open Drain



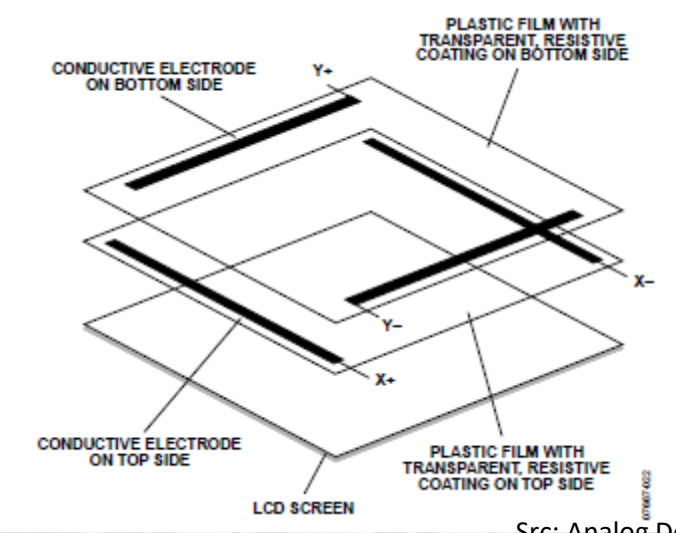

 

# Touch Screens

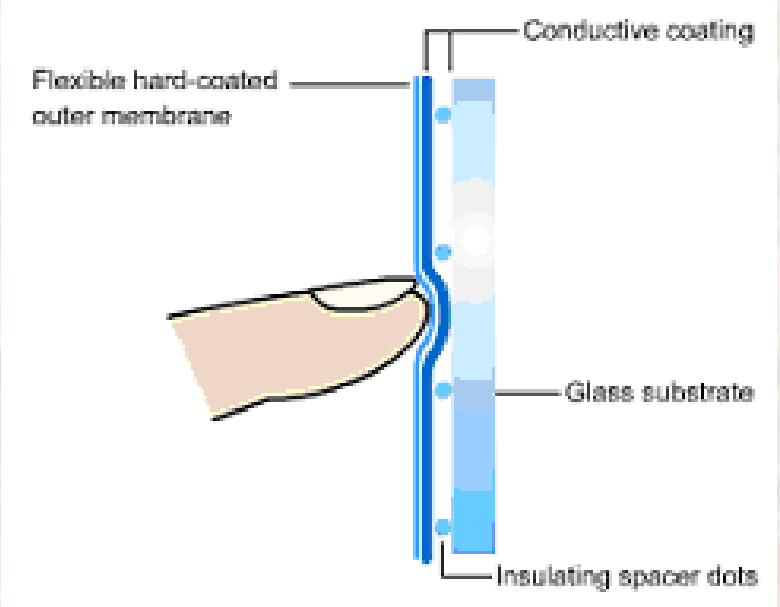
- Technologies
  - Resistive
  - Capacitive
  - Optical
  - Surface wave

# Touch Screens

- Resistive Touch – 4 wire
  - 2 layers of resistive material
  - 1 with connections at top/bottom
  - 1 with connections at sides
  - Separated by air/spacers



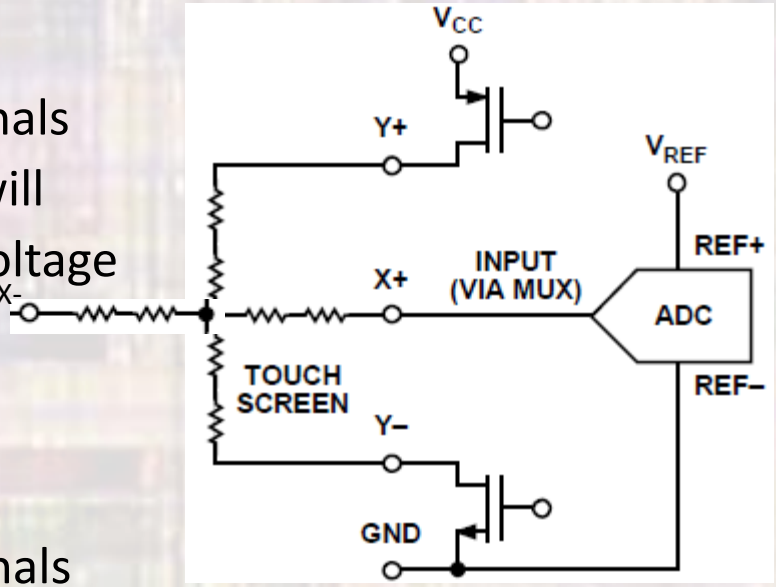

Src: Analog Devices




Src: ELO

# Touch Screens

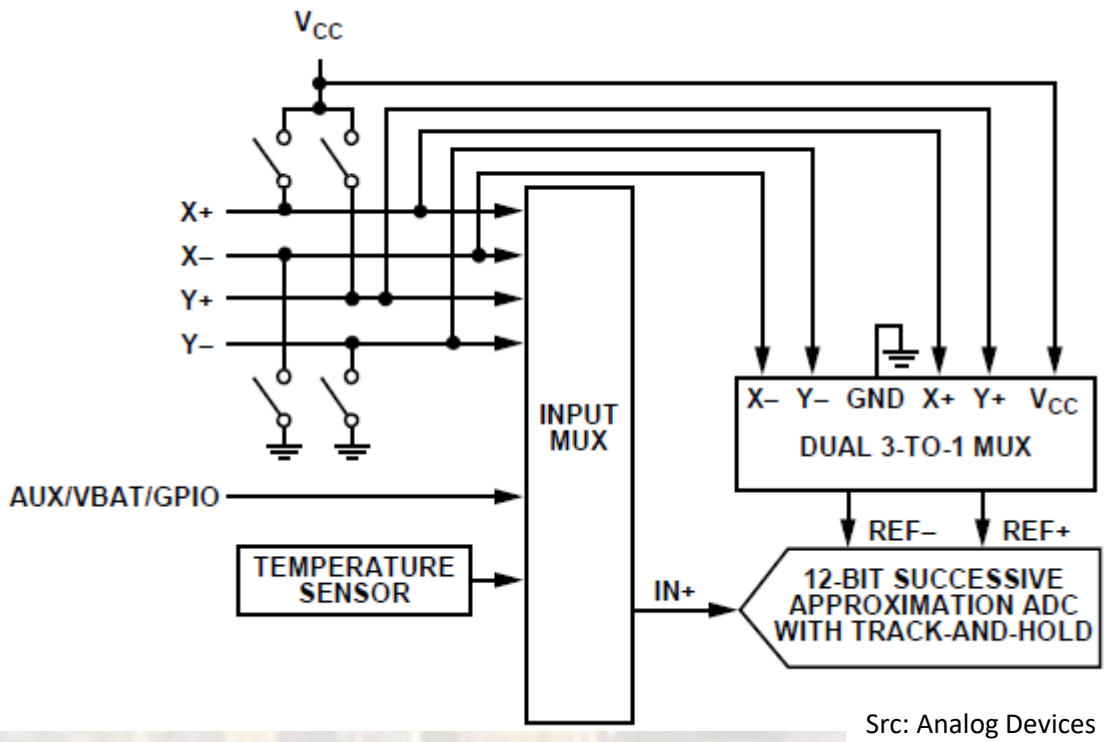
- Resistive Touch – 4 wire
  - Measure Y position
    - Place a voltage across Y terminals
    - Where touched, X+ terminal will measure relative voltage
  - Measure X position
    - Place a voltage across X terminals
    - Where touched, Y+ terminal will measure relative voltage




Src: Analog Devices

# Touch Screens

- Resistive Touch – 4 wire

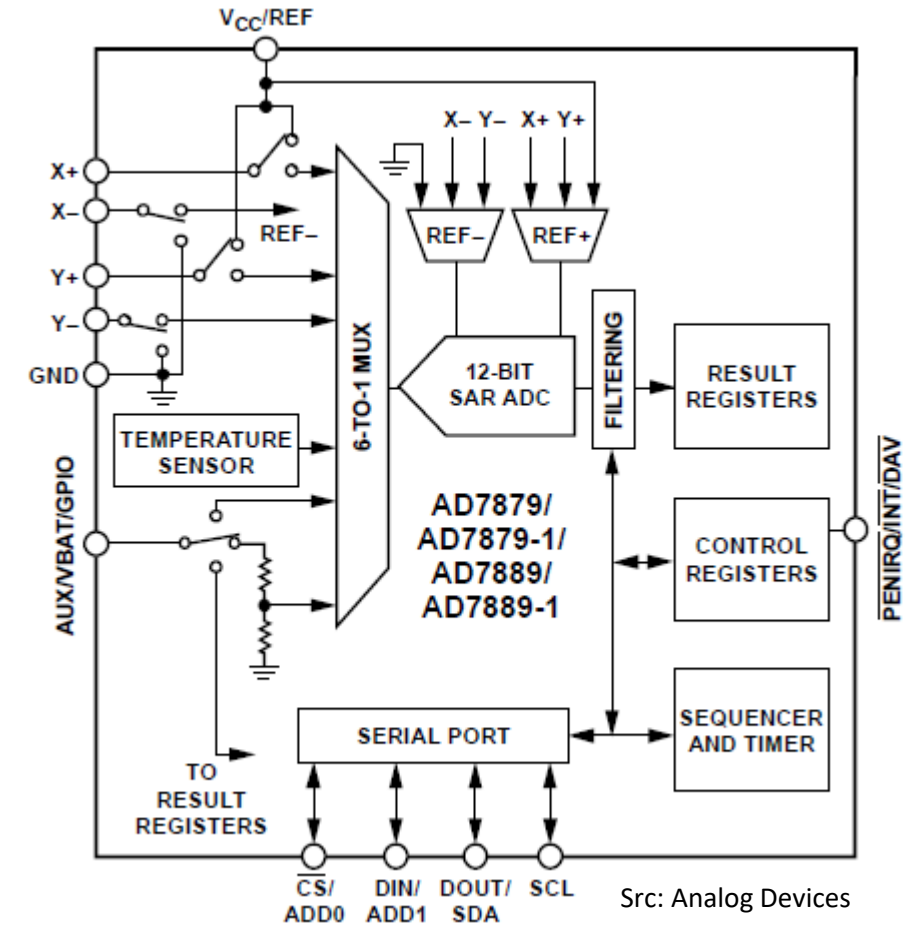



Src: Analog Devices

# Touch Screens

- Resistive Touch – 4 wire




Src: Analog Devices

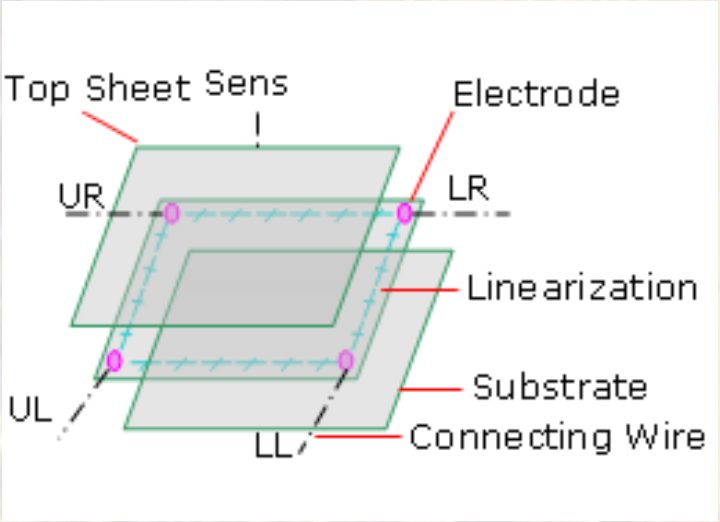
 

# Touch Screens

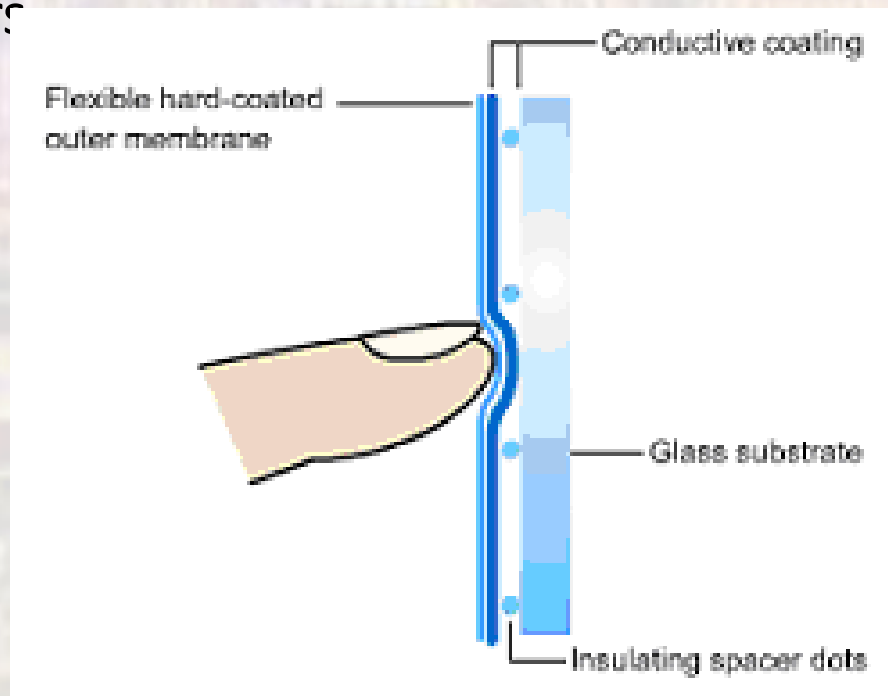
- Resistive Touch – 4 wire
  - Pro
    - Flexible screen material
    - Any material can be used for touch
    - Can be very accurate
  - Con
    - Surface easy to damage
    - Low endurance
    - Limited light transmission
    - SINGLE TOUCH

# Touch Screens

- Resistive Touch – 5 wire
  - 1 layer of resistive material
  - 1 with connections at 4 corners
  - 1 layer of conductive material
  - Separated by air/spacers




Src: ewinsonic

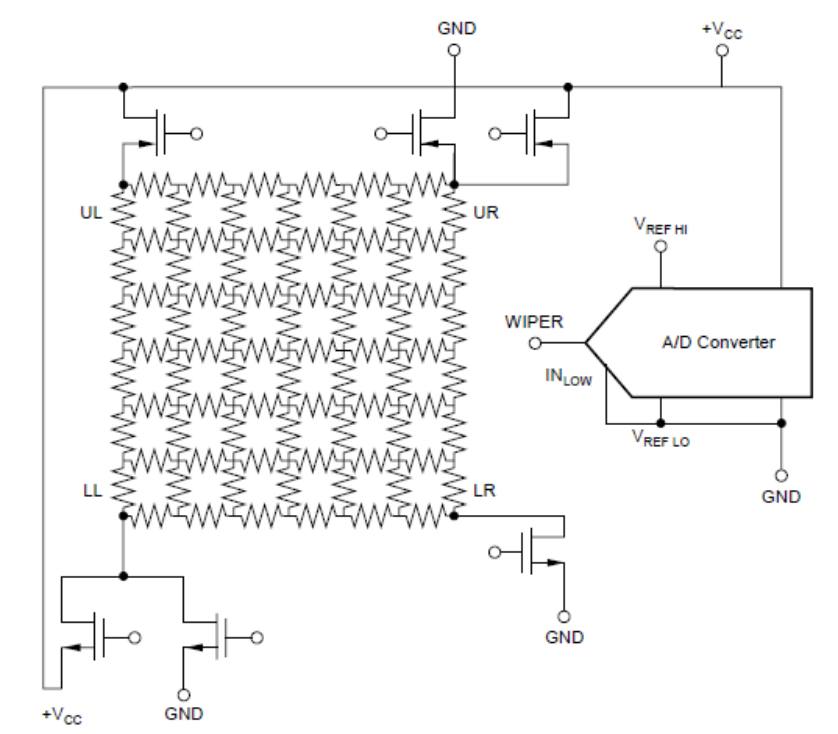



Src: ELO

# Touch Screens

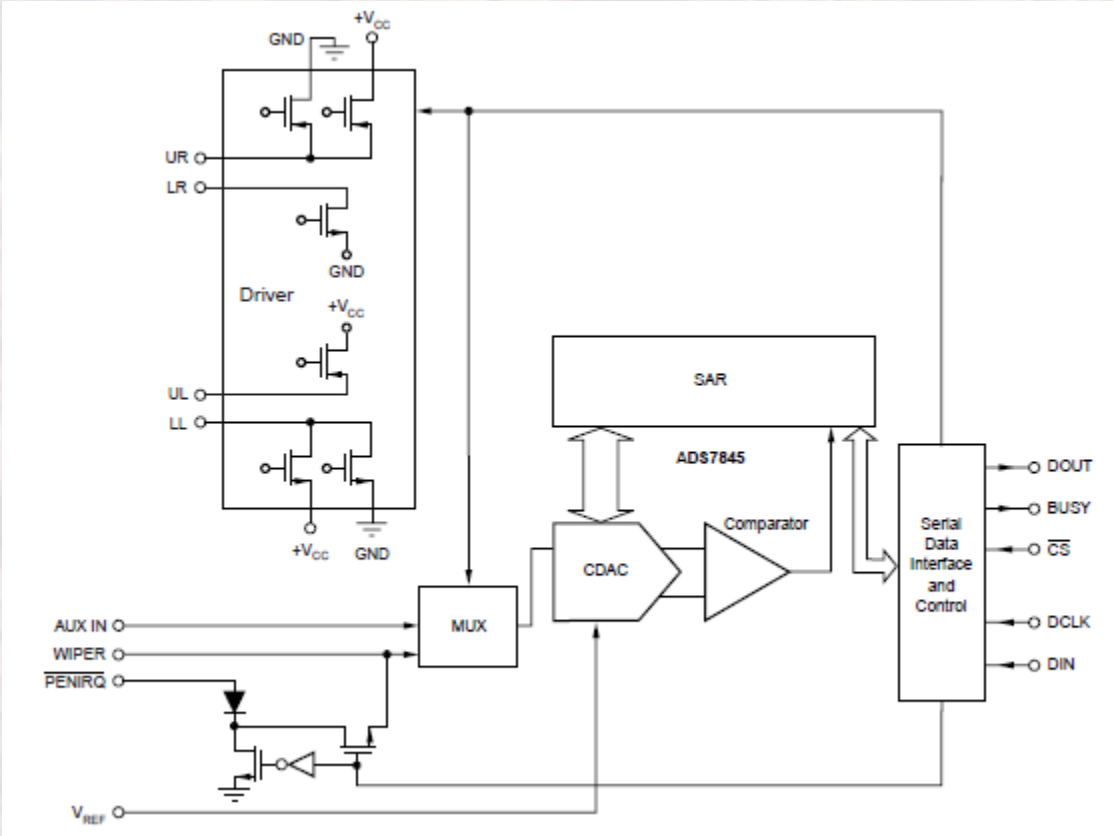
- Resistive Touch – 5 wire
  - Measure Y position
    - LR – gnd, UL - Vdd
    - LL – gnd, UR – Vdd
    - Where touched, wiper terminal will measure relative voltage
  - Measure X position
    - LR – gnd, UL - Vdd
    - LL – Vdd, UR – gnd
    - Where touched, wiper terminal will measure relative voltage




Src: TI

# Touch Screens

- Resistive Touch – 5 wire



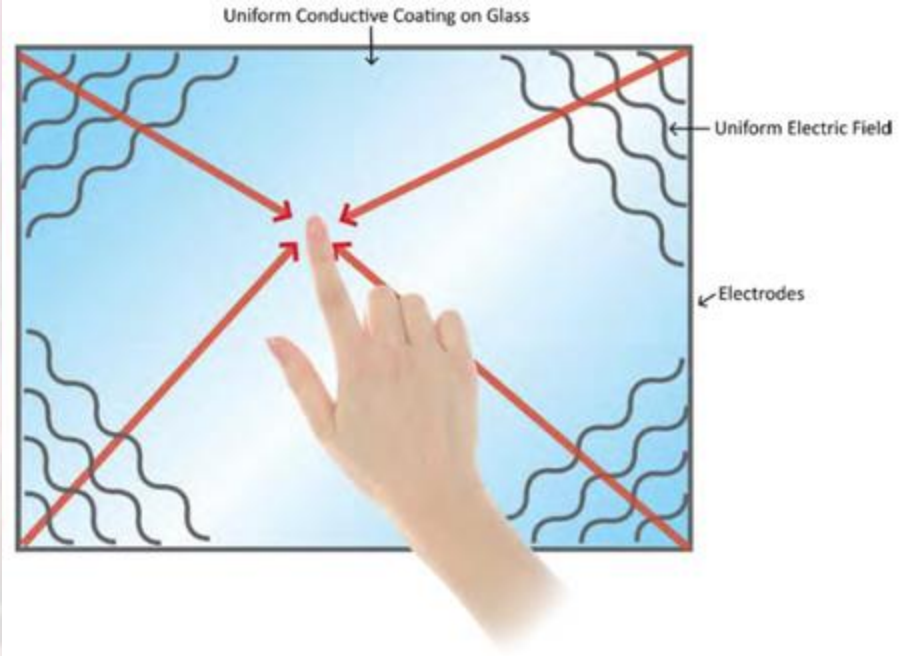

Src: TI

# Touch Screens

- Resistive Touch – 5 wire
  - Pro
    - Flexible screen material
    - Any material can be used for touch
    - Can be very accurate
  - Con
    - Surface easy to damage
    - Better but still limited endurance
      - Damage to the top layer does not impact performance
    - Better light transmission
    - SINGLE TOUCH

# Touch Screens

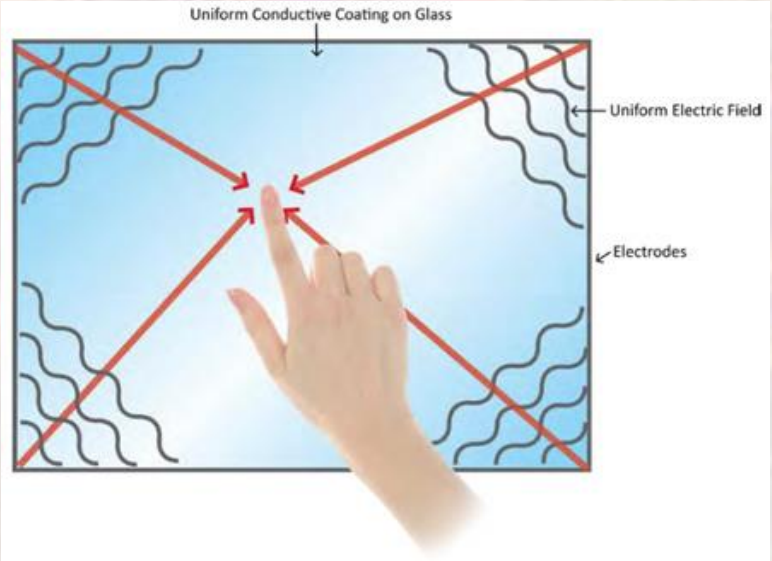
- Surface Capacitive




  - Uniform conductive material
    - On glass
  - Common ac voltage applied at all 4 corners → uniform electric field
  - When touched, finger modifies the field (creates a capacitor) → current from each corner
  - Calculate position based on relative current values – 1/r

# Touch Screens

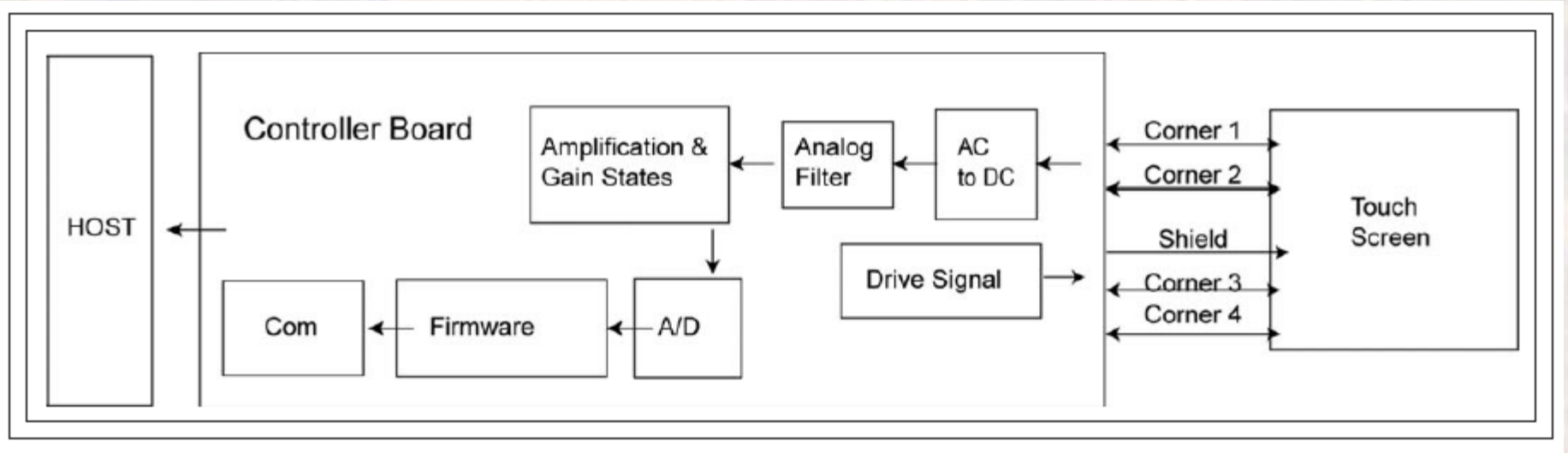
- Surface Capacitive
  - Setup a sine wave on all 4 corners
  - i = C dv/dt
  - When touched, finger modifies C
    → Δi
  - Calculate position based on relative current values – 1/r



# Touch Screens

- Surface Capacitive

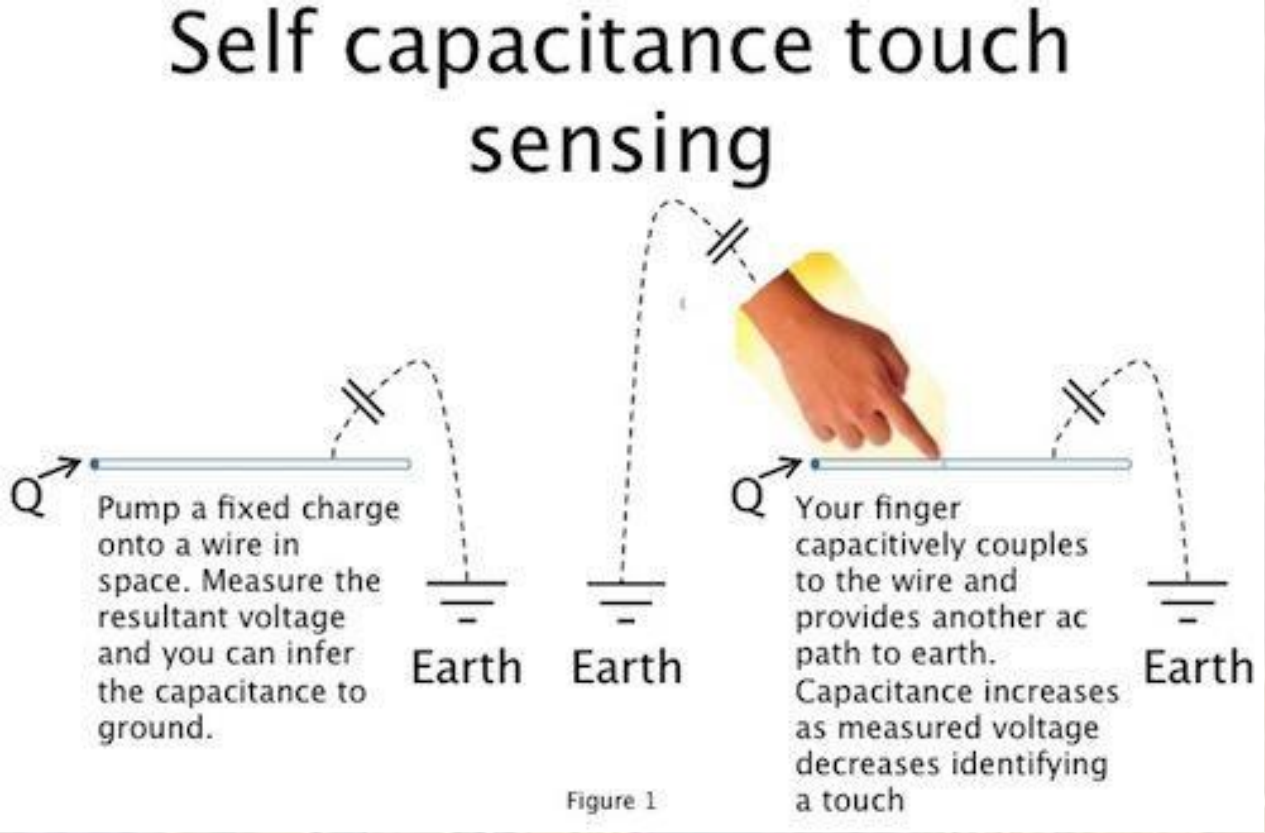



Src: Information Display

# Touch Screens

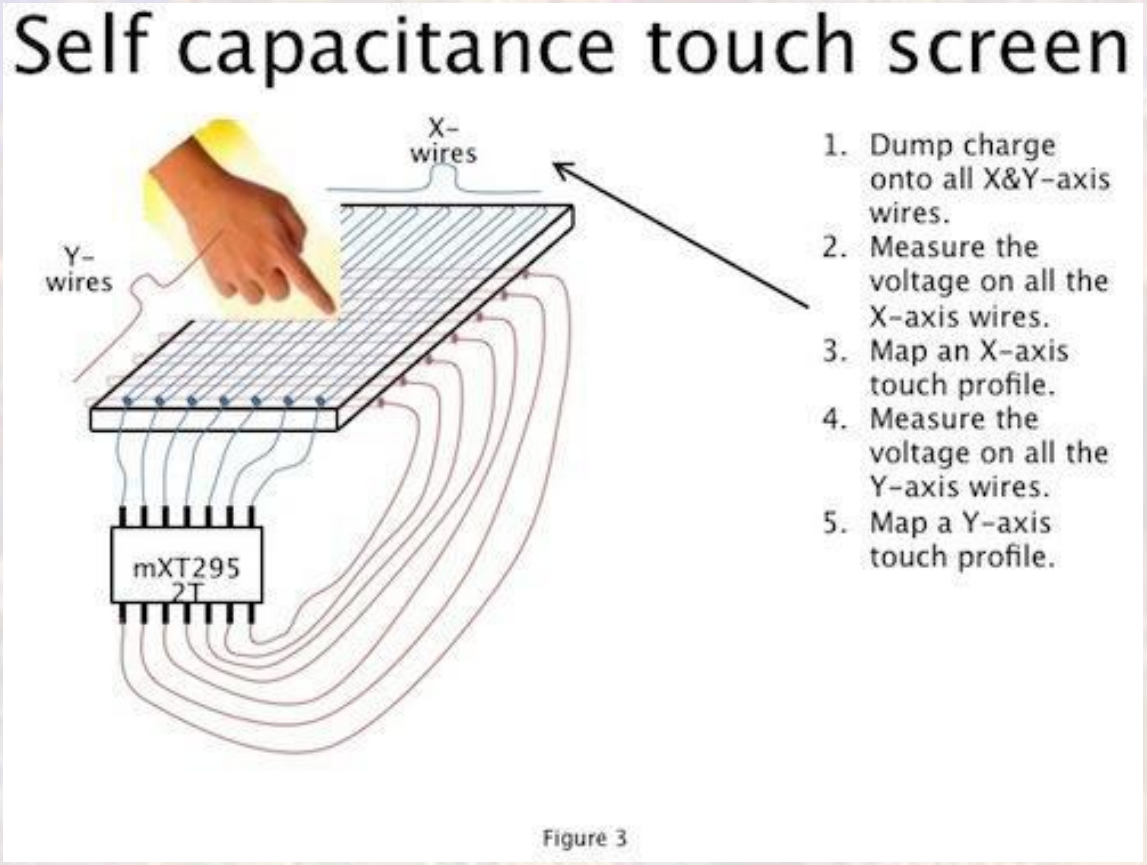
- Projected Capacitive – Self Capacitance




Src: Design News

# Touch Screens

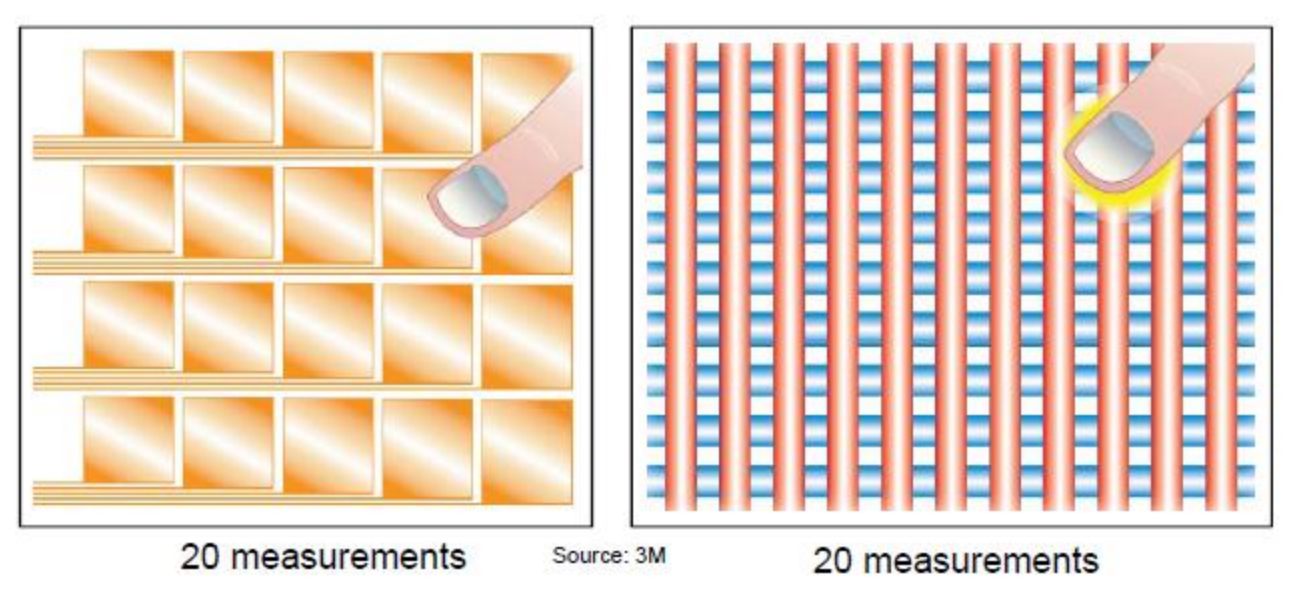
- Projected Capacitive – Self Capacitance




Src: Design News

# Touch Screens

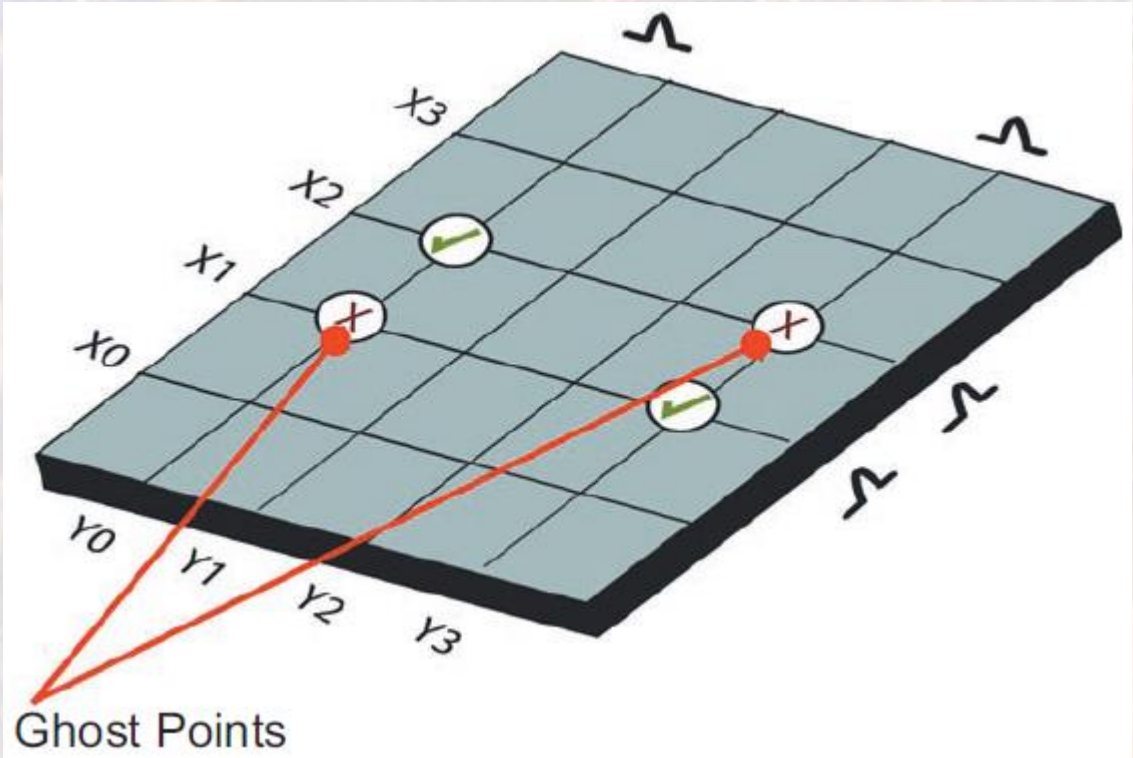
- Projected Capacitive – Self Capacitance



# Touch Screens

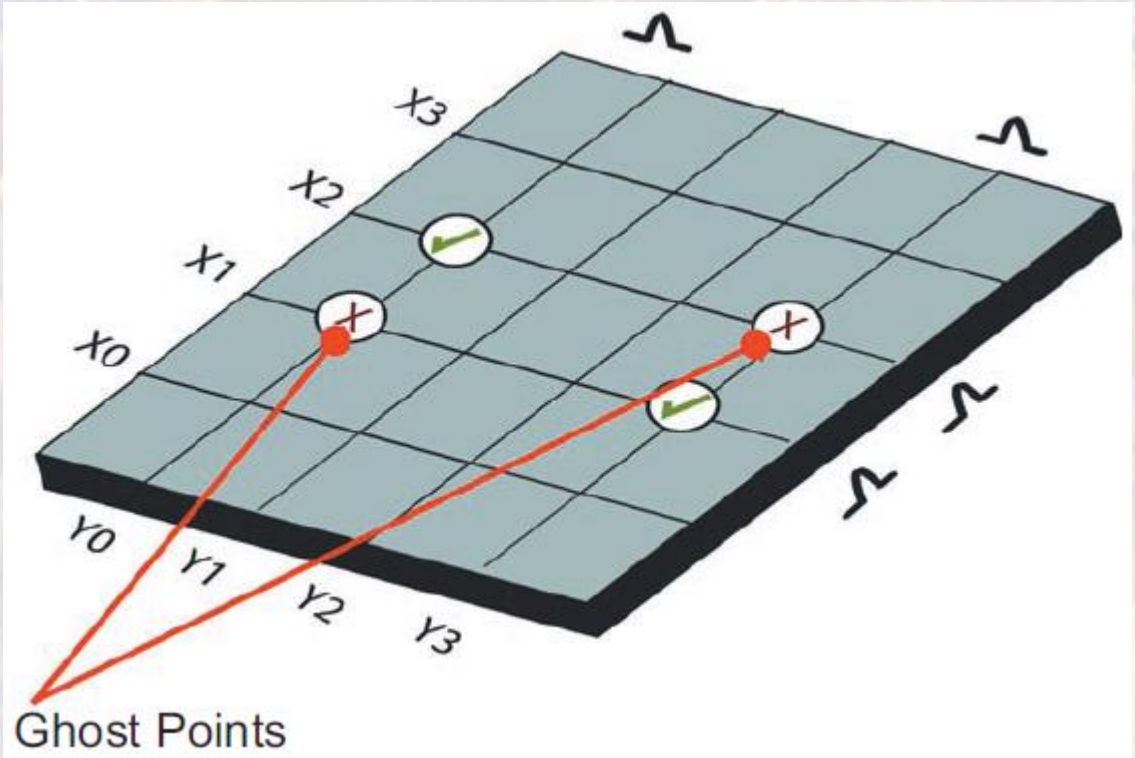
- Projected Capacitive – Self Capacitance
  - Single Touch only




Src: Stanford

# Touch Screens

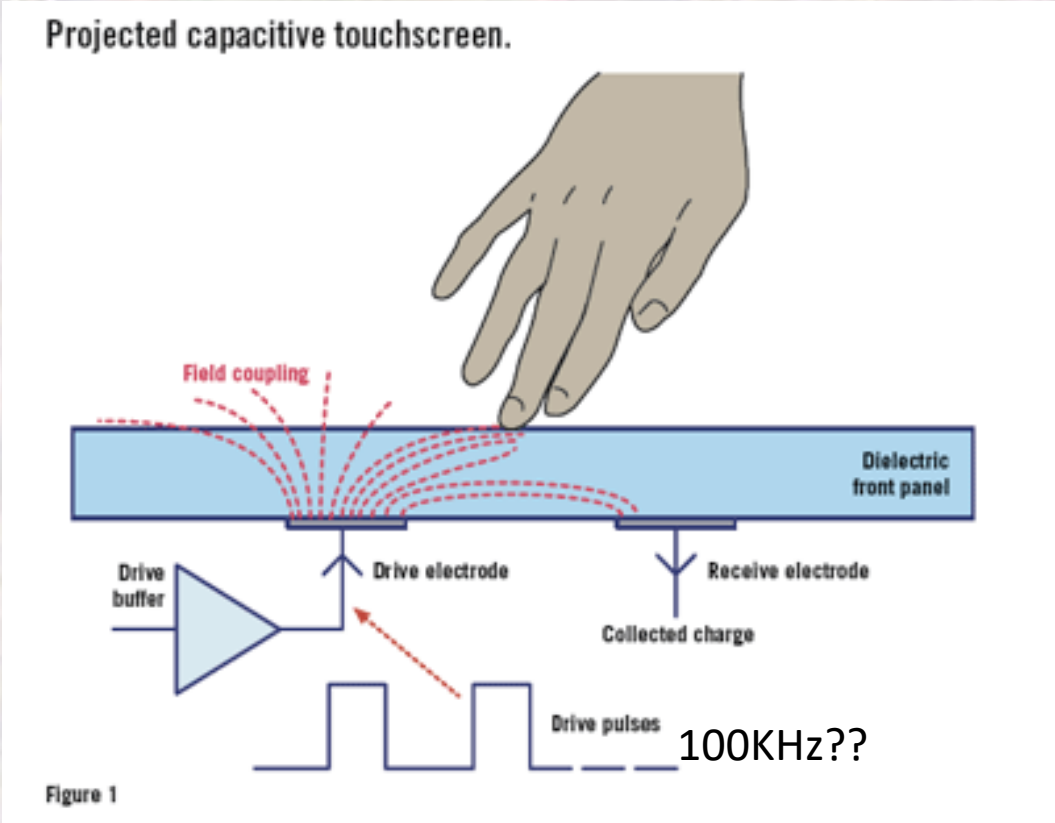
- Projected Capacitive – Self Capacitance
  - With SW can do 2 touch swipes (pinch, expand)

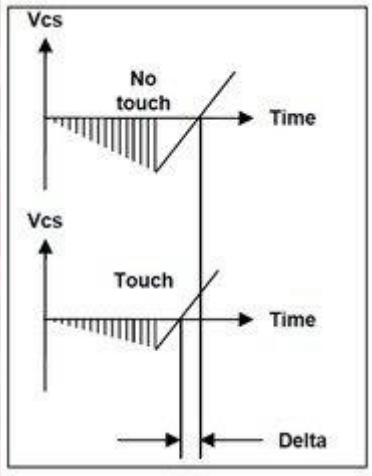



Src: Stanford

# Touch Screens

- Projected Capacitive – Mutual Capacitance
  - Reduce the apparent capacitance



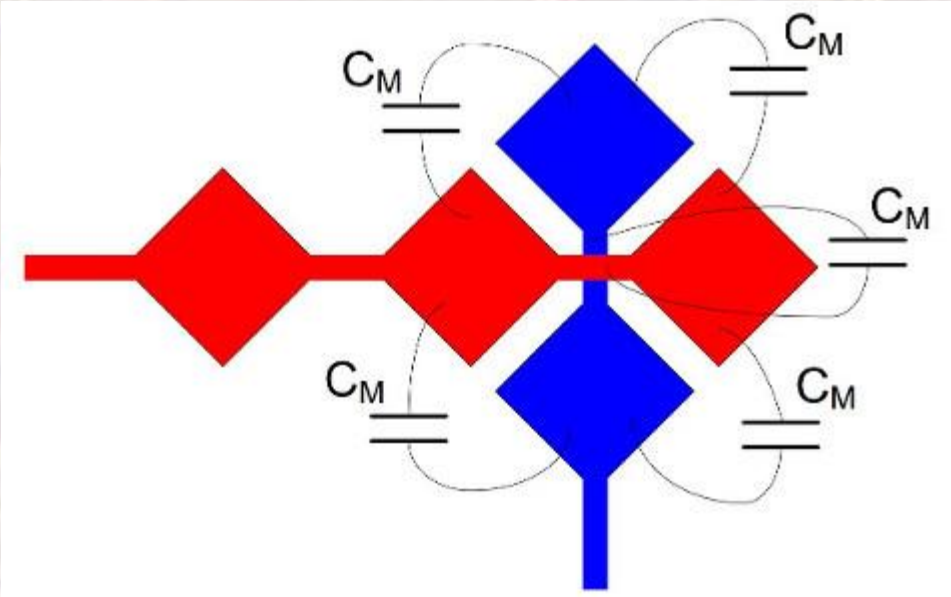




Src: MDPI

Src: Embedded Design

# Touch Screens

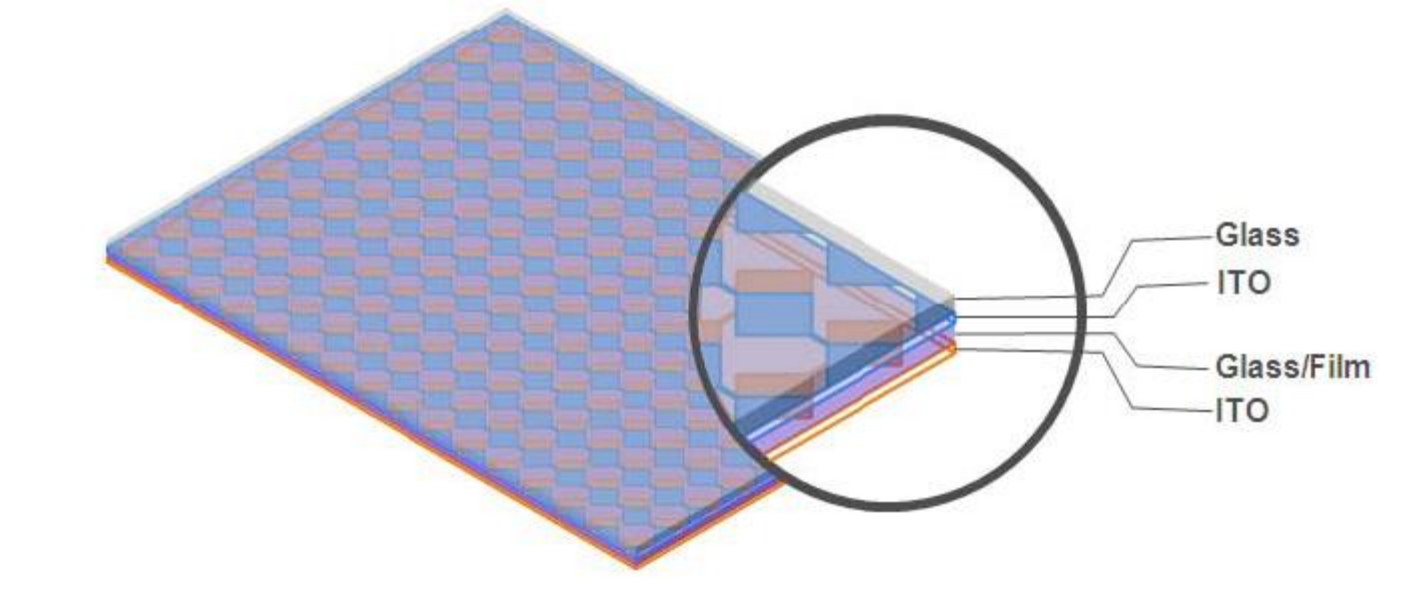
- Projected Capacitive – Mutual Capacitance
  - Single intersection – 2 layer ITO




Src Electronic Design

# Touch Screens

- Projected Capacitive – Mutual Capacitance
  - Matrix Structure



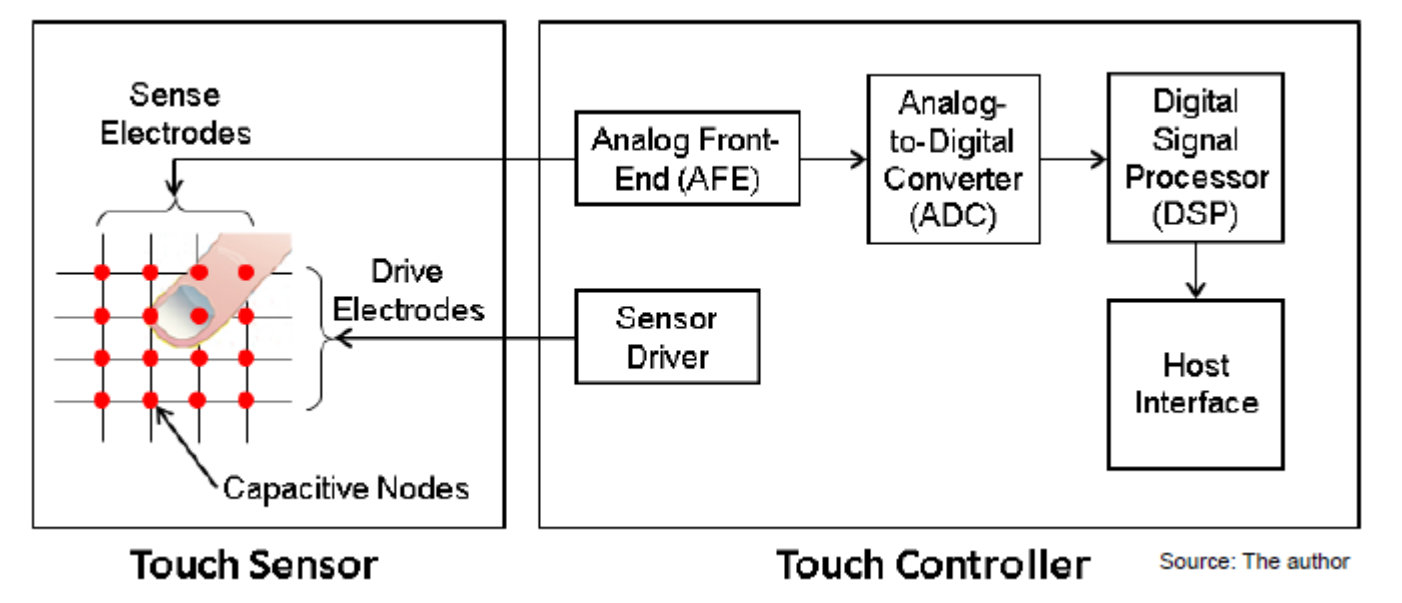

Src: Cypress

# Touch Screens

- Projected Capacitive – Mutual Capacitance
  - Matrix Structure
  - Drive 1 row – Scan each column
  - Measure capacitance
  - Provides for multiple touches as each row/column can be detected
  - Operate at a 20 – 200Hz full screen cycle rate

# Touch Screens

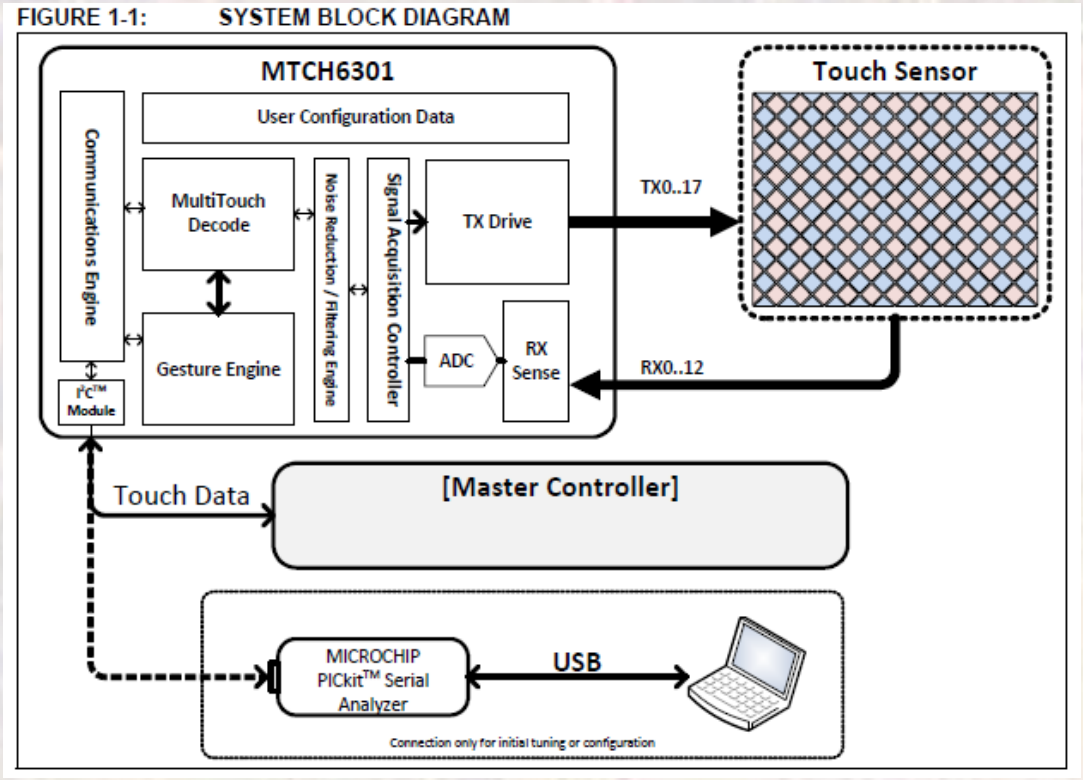
- Projected Capacitive – Mutual Capacitance
  - Controller




Src: Intel – Goeff Walker

# Touch Screens

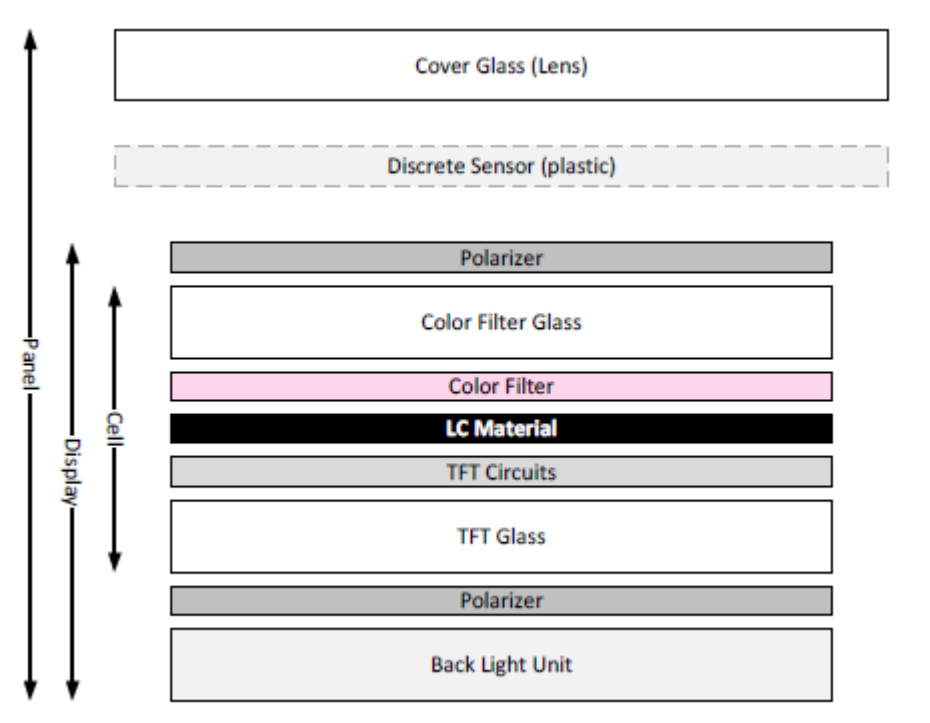
- Projected Capacitive – Mutual Capacitance
  - Controller



# Touch Screens

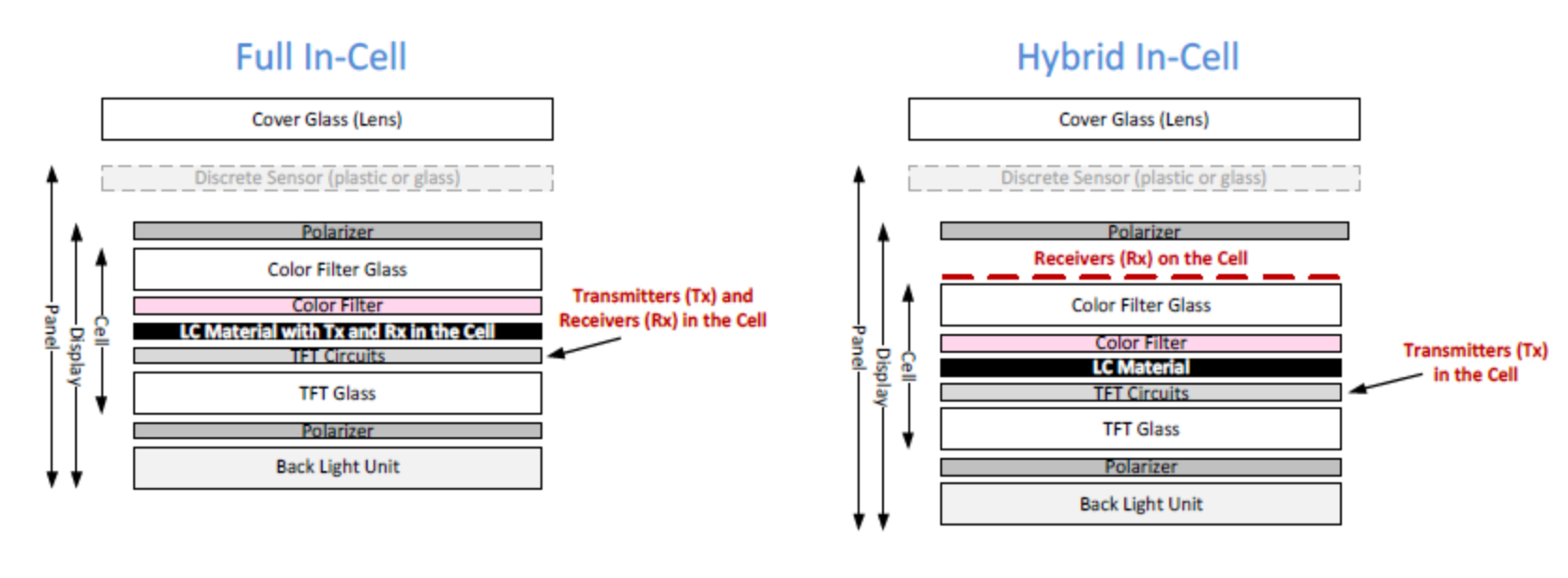
- Projected Capacitive – Mutual Capacitance
  - On Panel



# Touch Screens

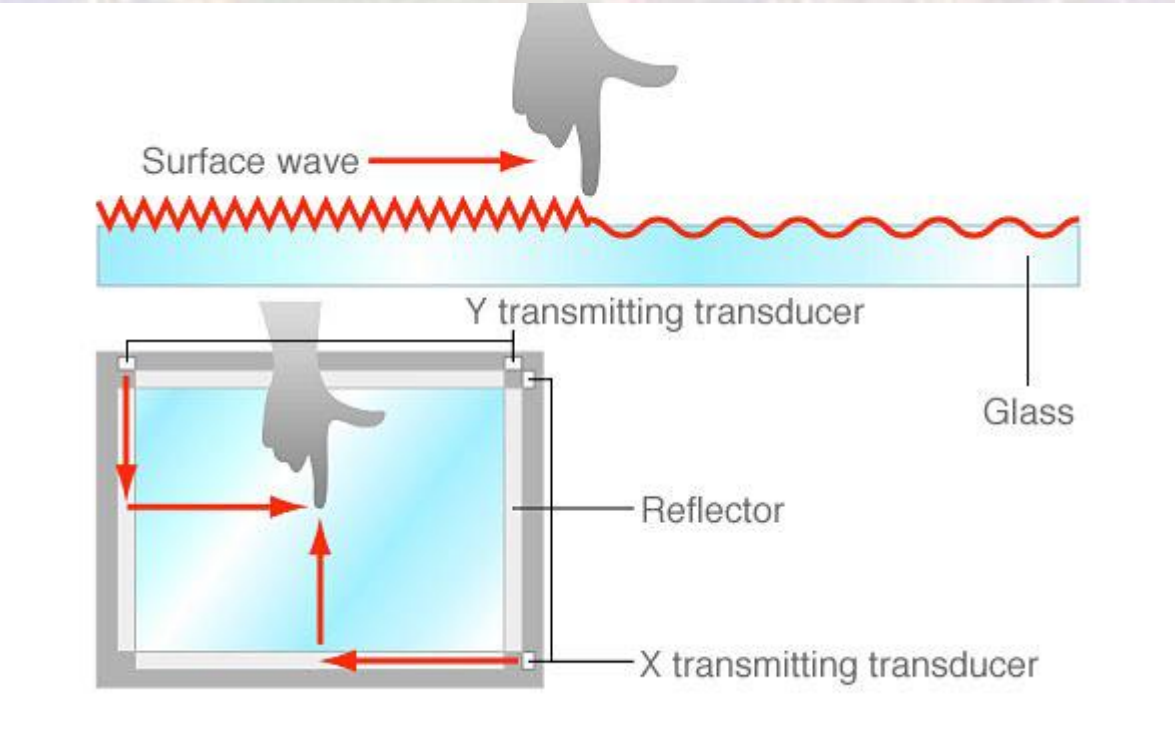
- Projected Capacitive – Mutual Capacitance
  - In Cell
    - Critical to design as a part of the display – noise, interference



# Touch Screens

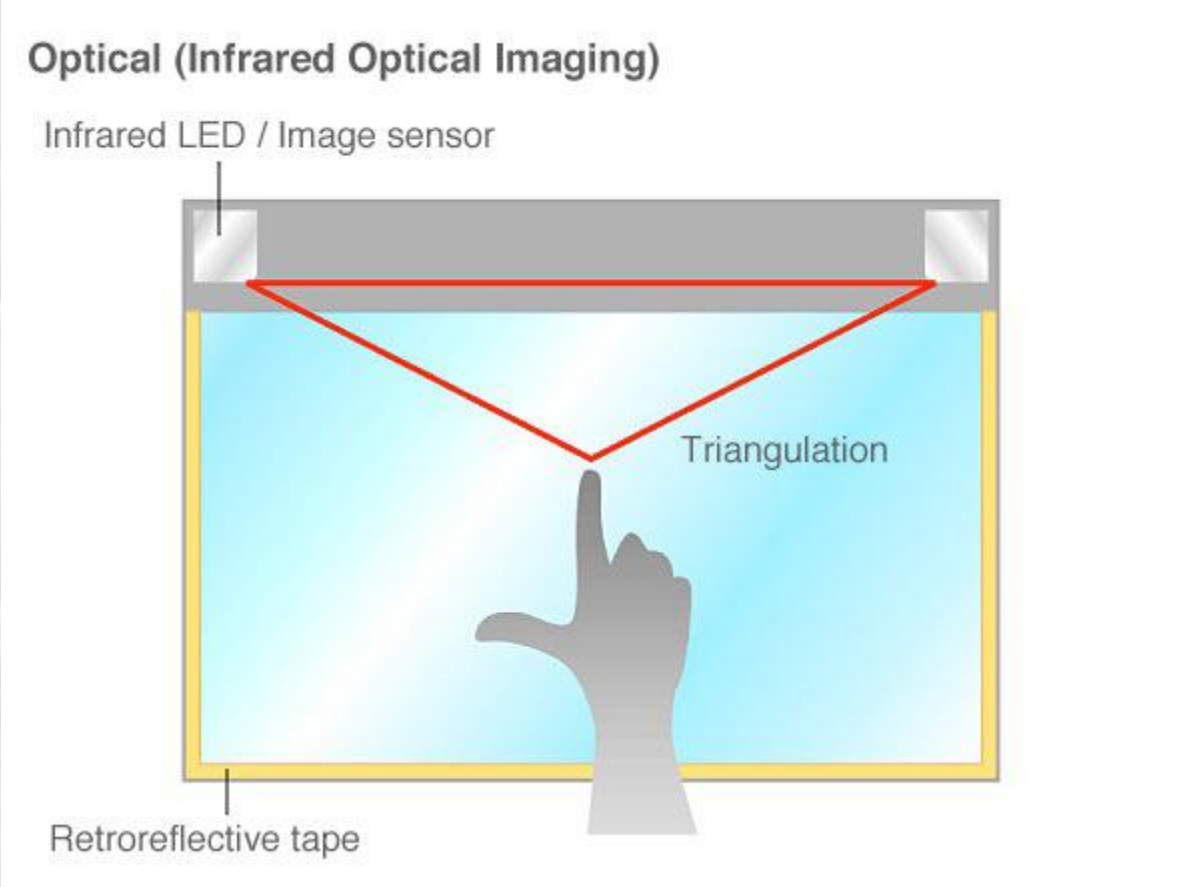
- Surface Acoustic Wave




Src: Touch Screen Basics

# Touch Screens

- Infrared




Src: Touch Screen Basics

# Touch Screens

- Sensor Comparison

| Method | Linearity | Accuracy | Size Scalability | Optical Clarity | Damage Resistant | Multitouch |
|---|---|---|---|---|---|---|
| Infrared | ★★★★★ | ★★★ | ★★★★★ | ★★★★★ | ★★★ | Yes (expensive) |
| Surface Acoustic Wave (SAW) | ★★★★ | ★★★★ | ★★ | ★★★ | ★★★★★ | No |
| Surface Capacitance | ★★ | ★★ | ★★ | ★★★★★ | ★★★★★ | No |
| Resistive | ★★★★ | ★★★★ | ★★★★ | ★★ | ★ | Yes (expensive) |
| Projected Capacitance | ★★★★★ | ★★★★ | ★★★ | ★★★★★ | ★★★★★ | Yes |

Src: Cypress