Touchscreen Interfacing

ECE 3710

reading:

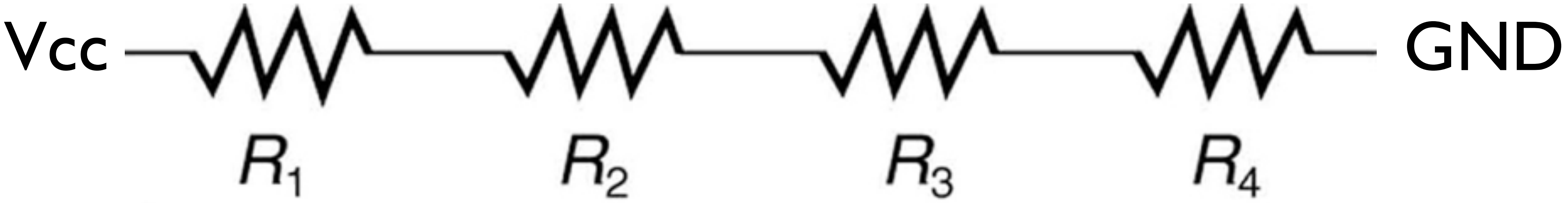
1. Documents on resistive touchscreens under lecture supplements; XPT2046 Datasheet (digital interface, penirq output, per-conversion)
2. V1.Ch10.1--4, V2.Ch8.4.1--2

How do you tell when you're out of invisible ink?

- Steven Wright

resistive touchscreens

assuming:

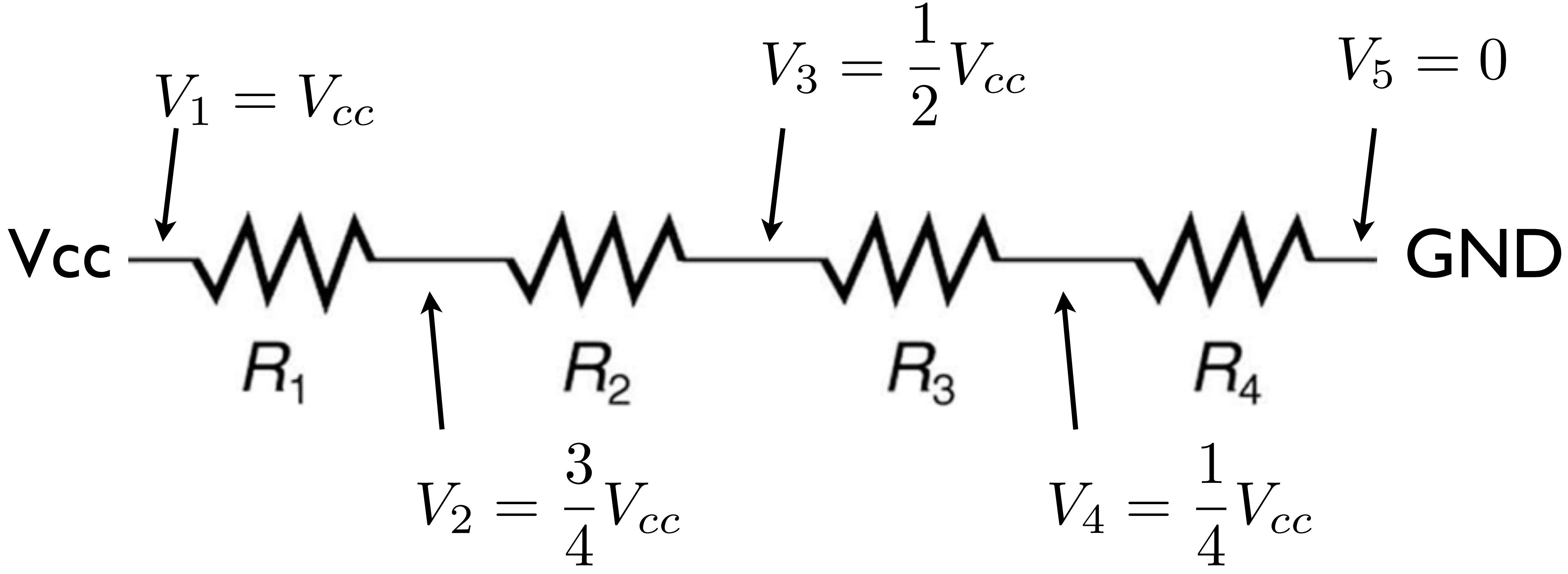


if given V_x:
can we deduce where on resistive
chain the measurement is made?

$$R_1 = R_2 = R_3 = R_4$$

resistive touchscreens

assuming:



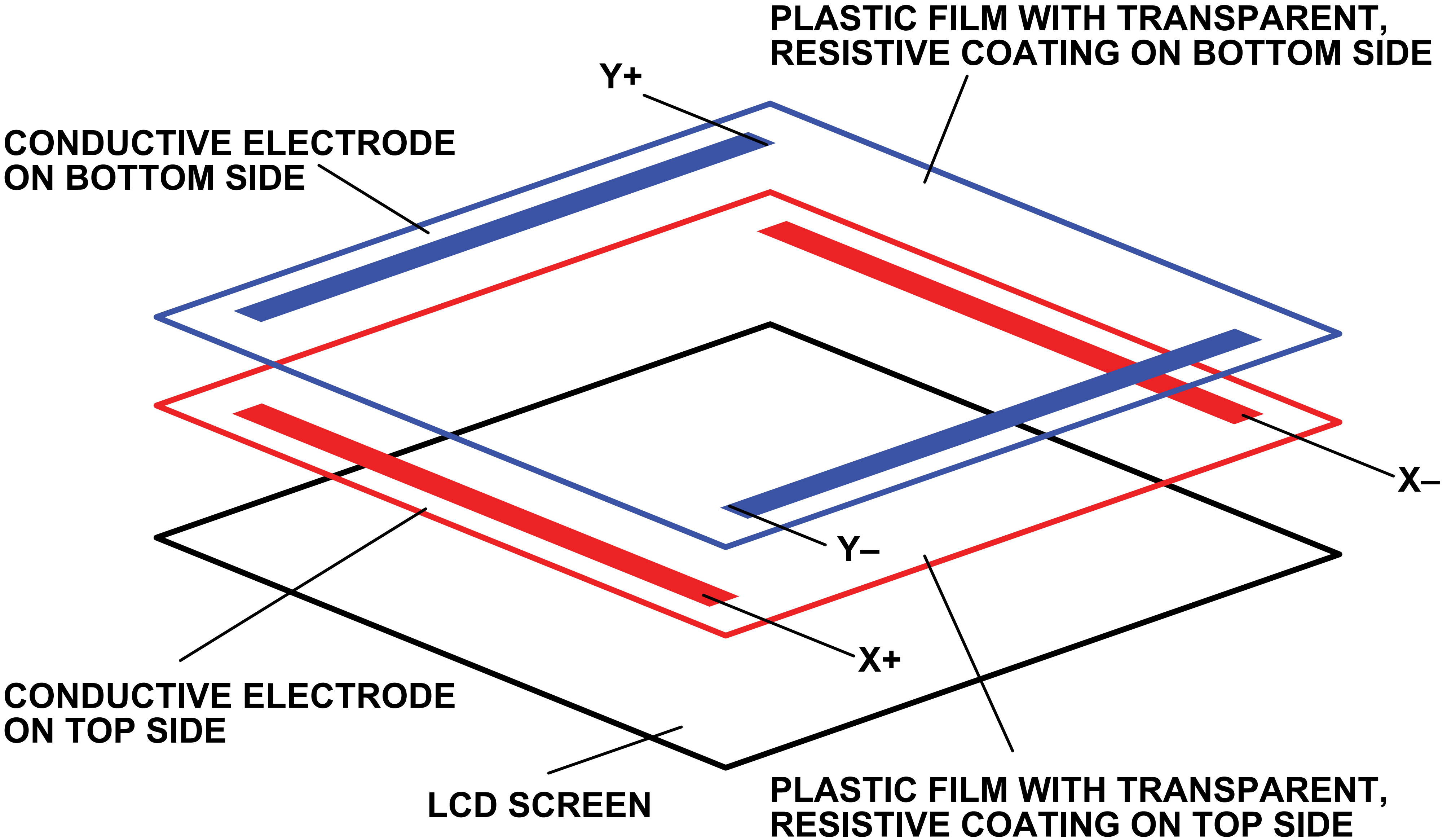
$V_1 = V_{cc}$
$V_3 = \frac{1}{2} V_{cc}$
$V_5 = 0$
Vcc
GND
R_1
R_2
R_3
R_4
$V_2 = \frac{3}{4} V_{cc}$
$V_4 = \frac{1}{4} V_{cc}$

if given V_x:
we can deduce where on resistive
chain the measurement is made

$$R_1 = R_2 = R_3 = R_4$$

resistive touchscreens

if we embed resistors
in a screen overlay:

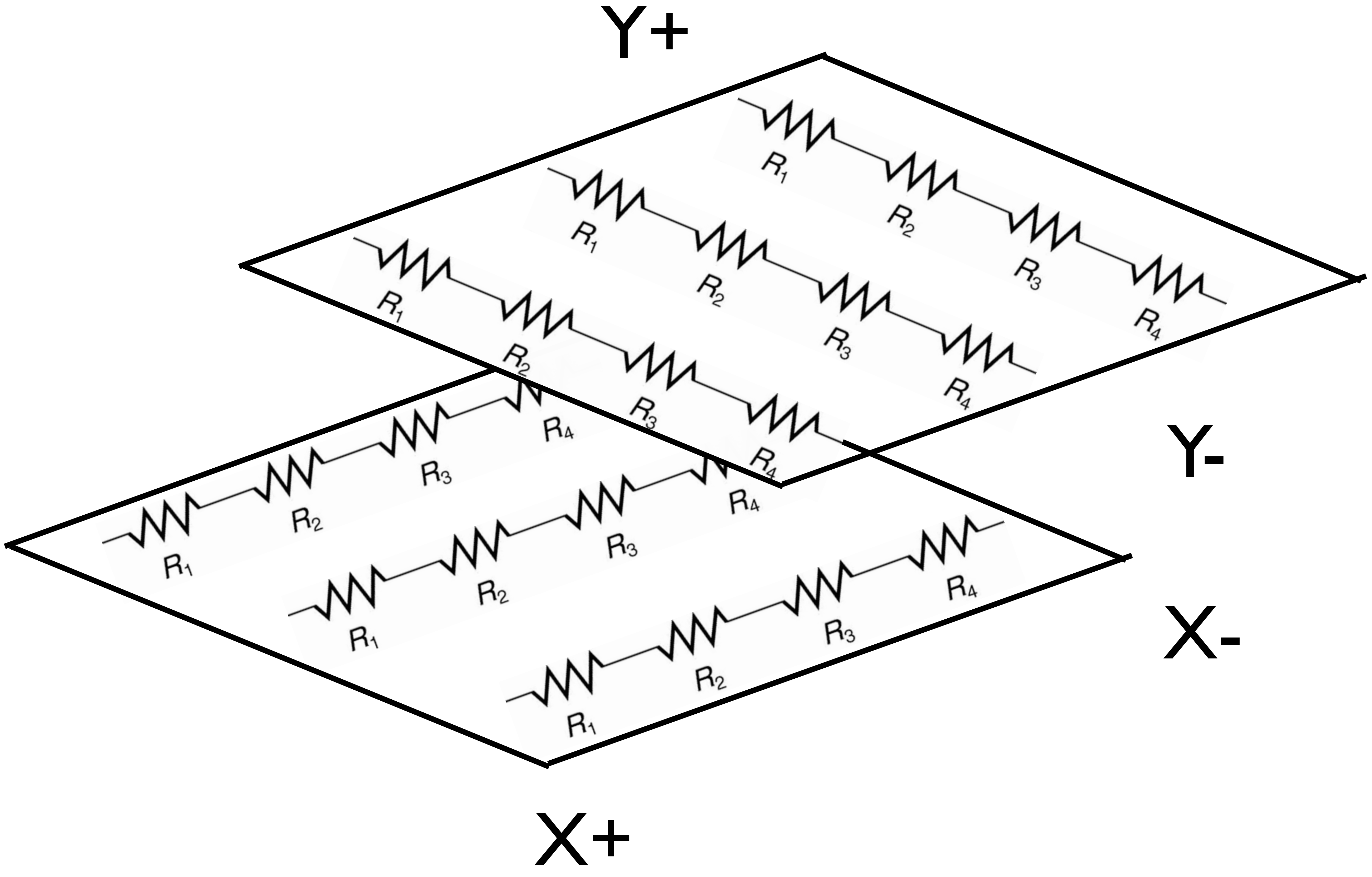

PLASTIC FILM WITH TRANSPARENT, RESISTIVE COATING ON BOTTOM SIDE
Y+
CONDUCTIVE ELECTRODE ON BOTTOM SIDE
X–
Y–
X+
CONDUCTIVE ELECTRODE ON TOP SIDE
LCD SCREEN
PLASTIC FILM WITH TRANSPARENT, RESISTIVE COATING ON TOP SIDE

resistive coating: resistance per unit length

resistive touchscreens

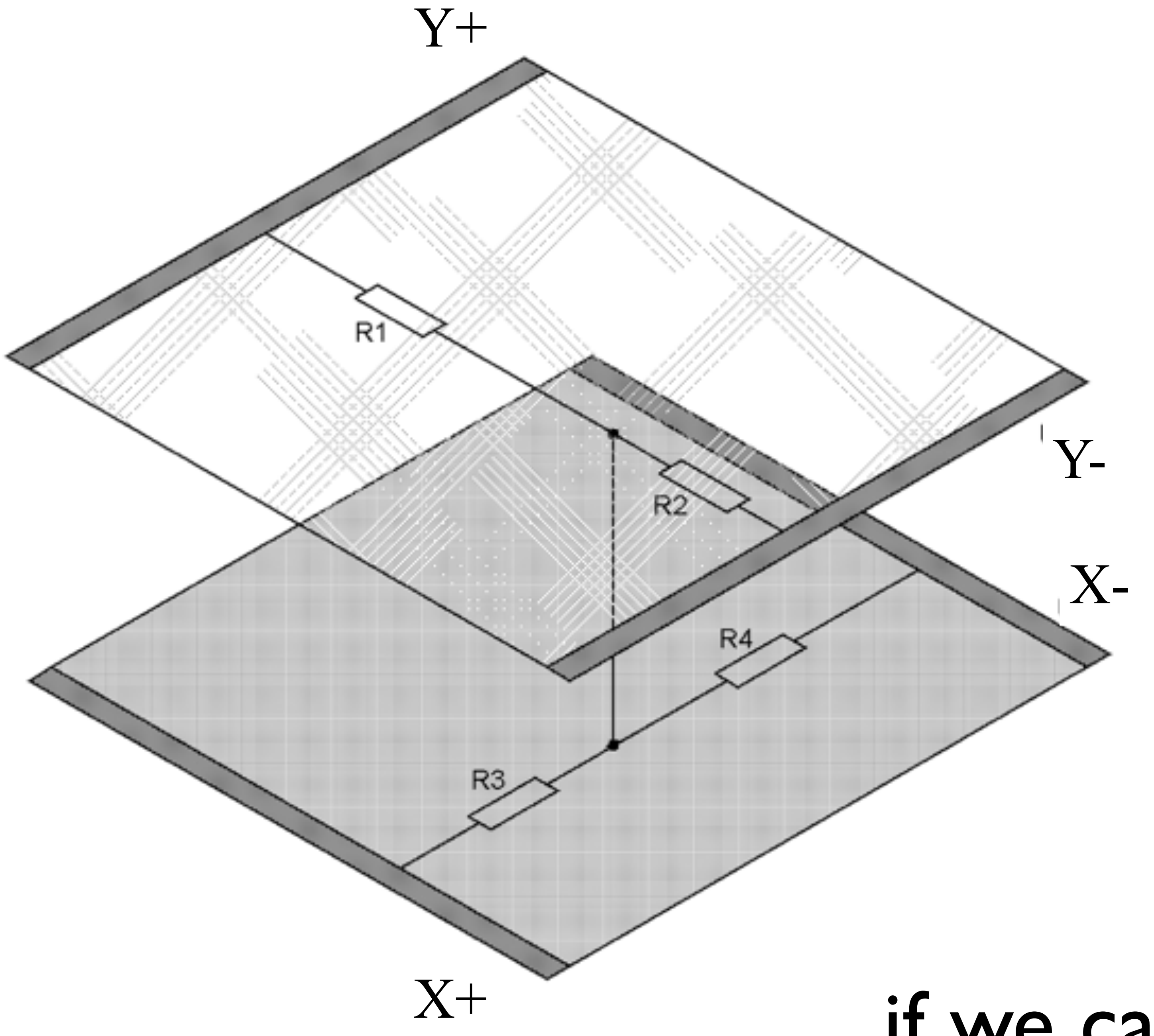
resistive coating:

resistance per unit length



resistive touchscreens

when the screen is touched:



given:

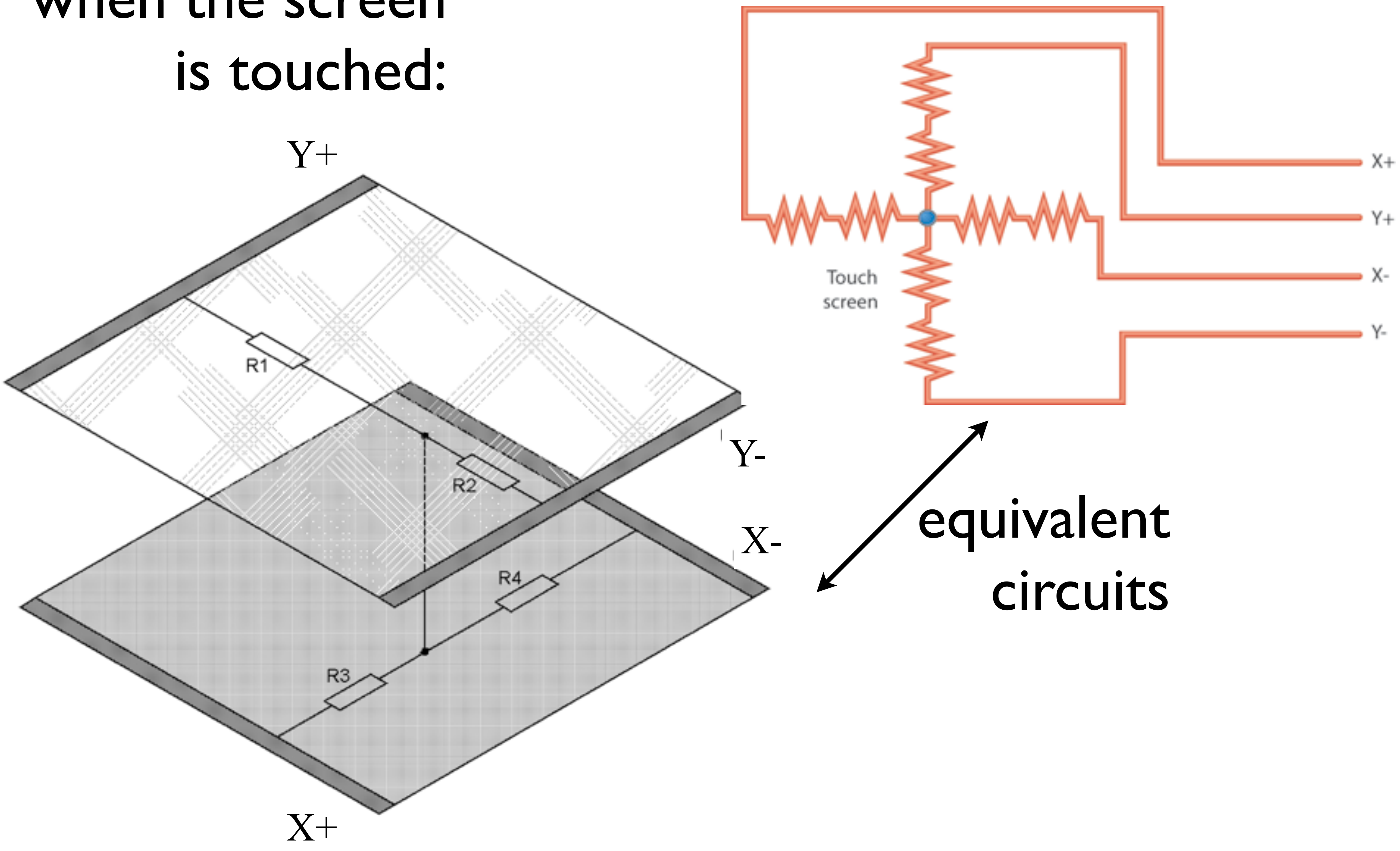
1. Y+ = Vcc & Y- = GND
2. V = voltage at point of contact
3. smaller V means closer to Y- edge; larger V means closer to Y+ edge

↓

can determine position if we can measure voltage at point

resistive touchscreens

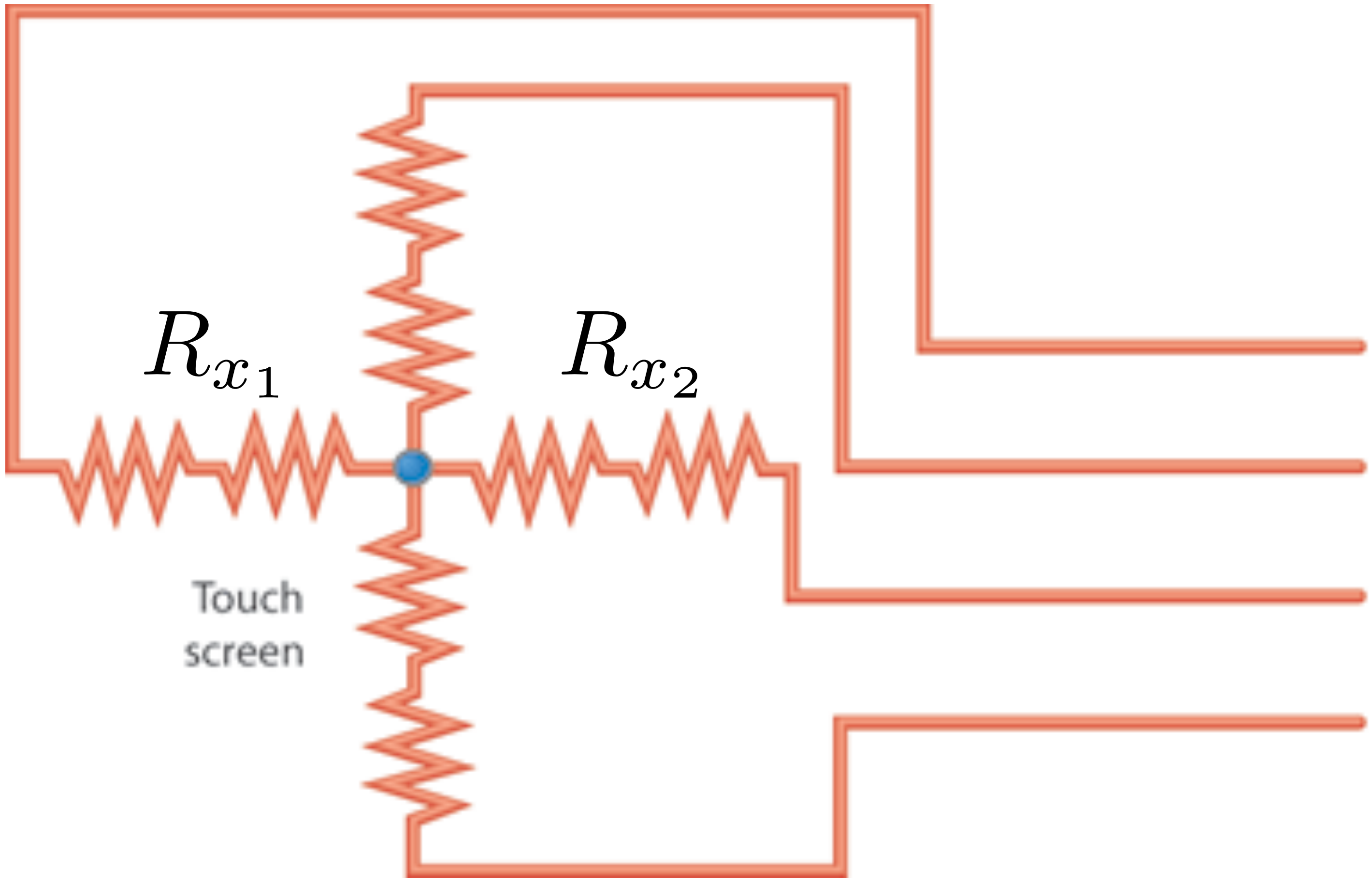
when the screen is touched:



equivalent circuits

resistive touchscreens

to determine x coordinate:



X+ = Vcc

Y+ = $V_{cc}\left(\dfrac{R_{x_2}}{R_{x_1}+R_{x_2}}\right)$

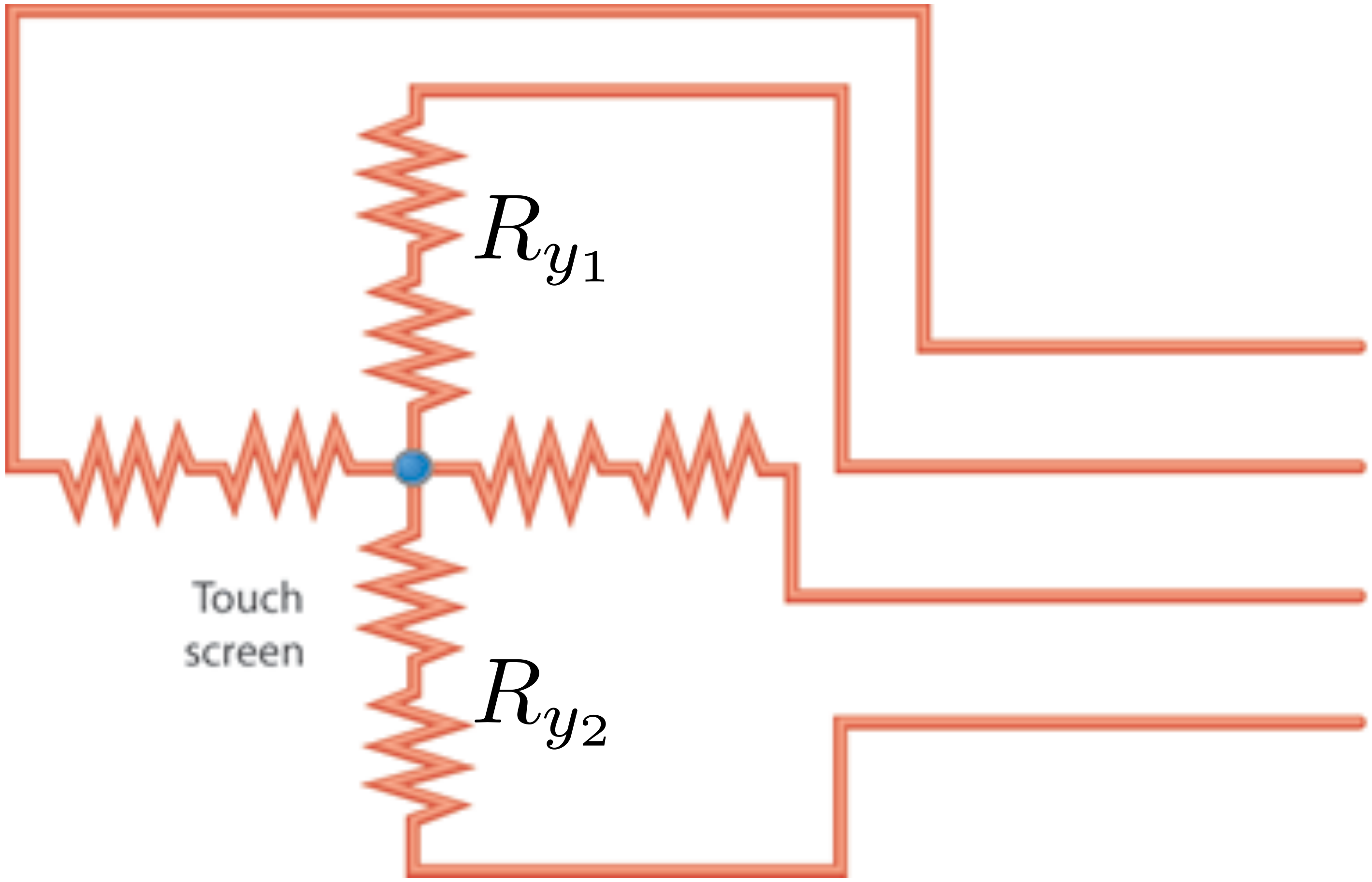
X- = GND

Y- = floating

need x,y coords:
two measurements

resistive touchscreens

to determine y coordinate:



X+ = $V_{cc}\left(\frac{R_{y_2}}{R_{y_1}+R_{y_2}}\right)$

Y+ = Vcc

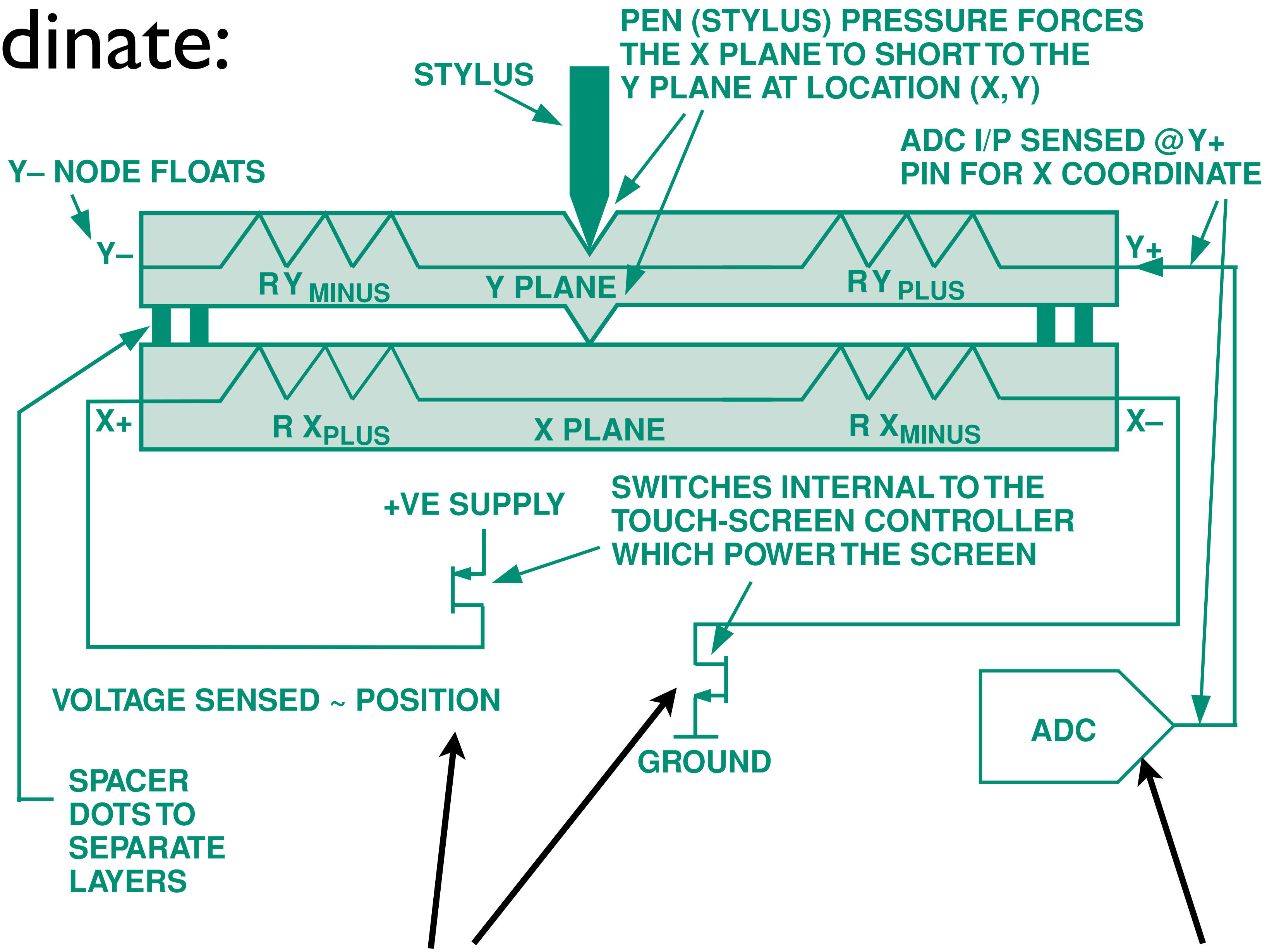
X- = floating

Y- = GND

need x,y coords:
two measurements

resistive touchscreens

to determine x coordinate:



STYLUS
PEN (STYLUS) PRESSURE FORCES THE X PLANE TO SHORT TO THE Y PLANE AT LOCATION (X,Y)
ADC I/P SENSED @ Y+ PIN FOR X COORDINATE
Y– NODE FLOATS
Y–
R Y MINUS
Y PLANE
R Y PLUS
Y+
X+
R X PLUS
X PLANE
R X MINUS
X–
+VE SUPPLY
SWITCHES INTERNAL TO THE TOUCH-SCREEN CONTROLLER WHICH POWER THE SCREEN
VOLTAGE SENSED ~ POSITION
GROUND
ADC
SPACER DOTS TO SEPARATE LAYERS

touchscreen controller controls these switches

measures voltage; converts to proportional binary number you, on theory operation:

Q: how do we actually use this?

generic touchscreen controller

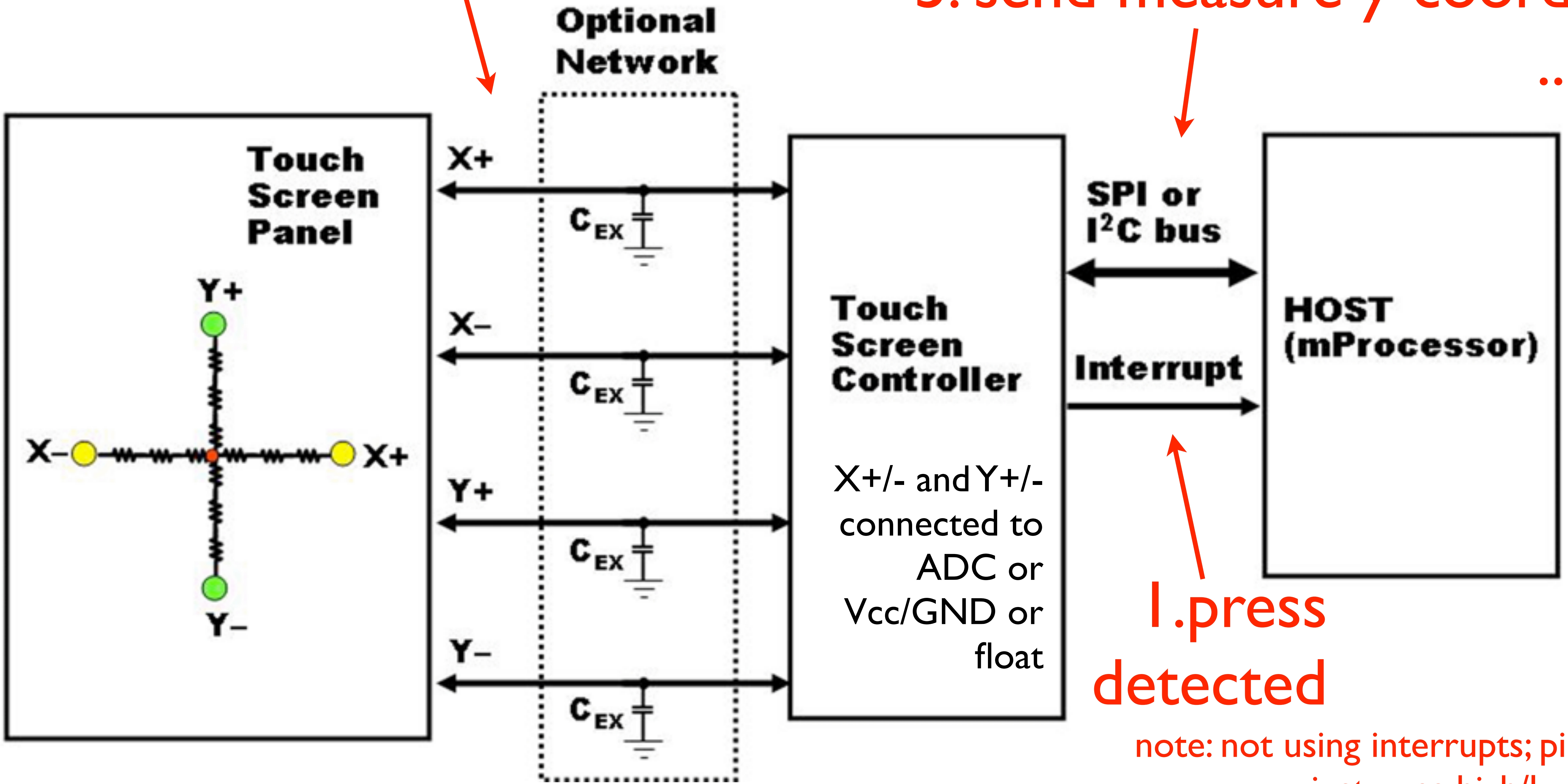
3. connect Y+ to ADC; Y- is floating; X+ to VCC; X- to GND

2. send measure x-coord command

4. receive x-coord

5. send measure y-coord

...



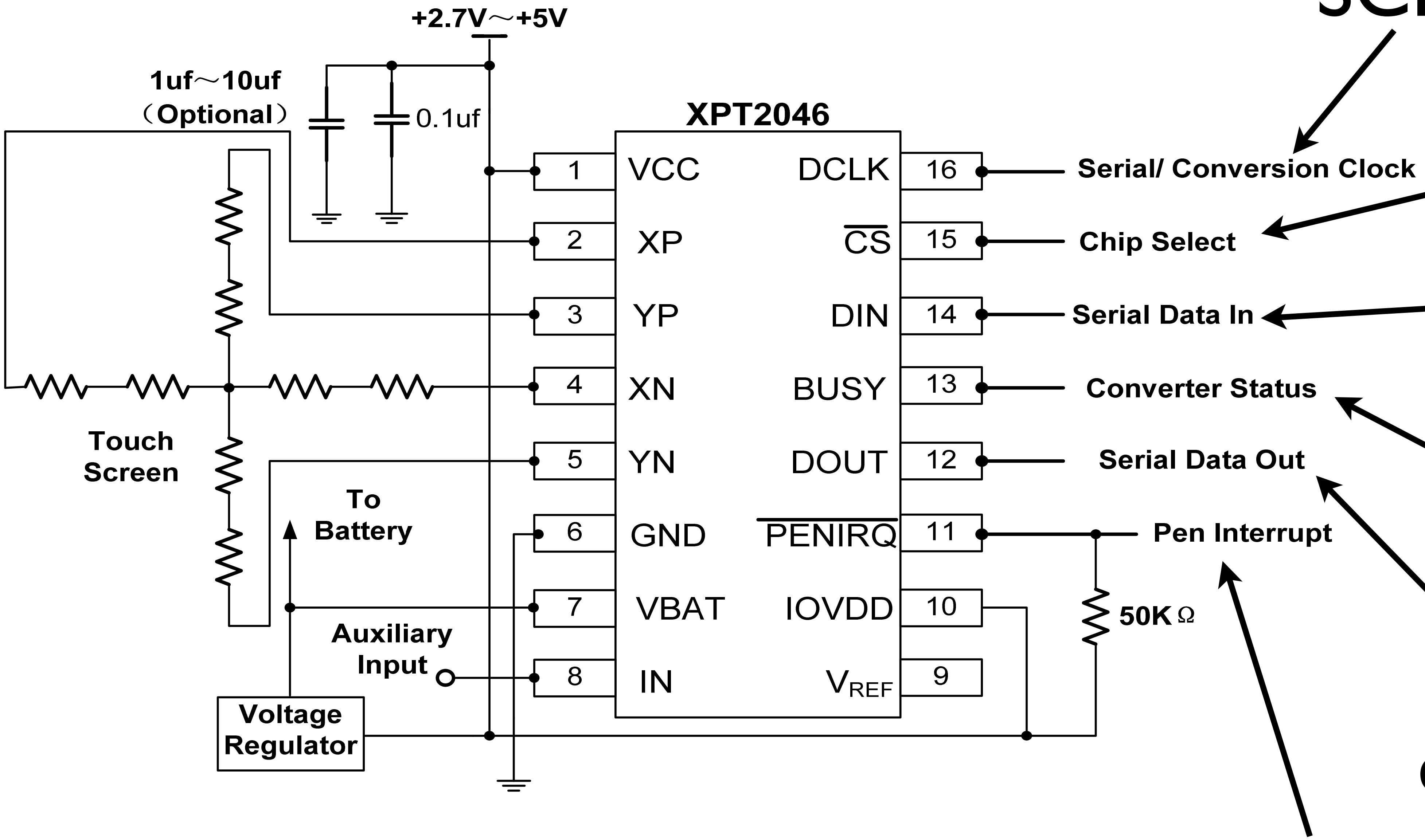
X+/- and Y+/- connected to ADC or Vcc/GND or float

1. press detected

note: not using interrupts; pin just goes high/low

XPT2046 touchscreen

interface via SPI



SCLK

enable I/O

data latched on rising edge

high during conversion

data shifted on falling edge

low while touch is detected

note: refer to schematic to find pins on LCD board

p13 & p9

XPT2046 touchscreen

one command

pressure
temperature

very simple:

1. tx: get x,y, or z/t (control byte)
2. rx: requested coord

note: the control byte also contains configuration options

XPT2046 touchscreen: control byte

what is sent to touchscreen controller

coordinate:
x: 101
y: 001

conversion resolution:
1: 8-bits
0:12-bits

BIT7(MSB)	BIT 6	BIT 5	BIT 4	BIT 3	BIT2	BIT 1	BIT 0(LSB)
S	A2	A1	A0	MODE	SER/$\overline{DFR}$	PD1	PD0

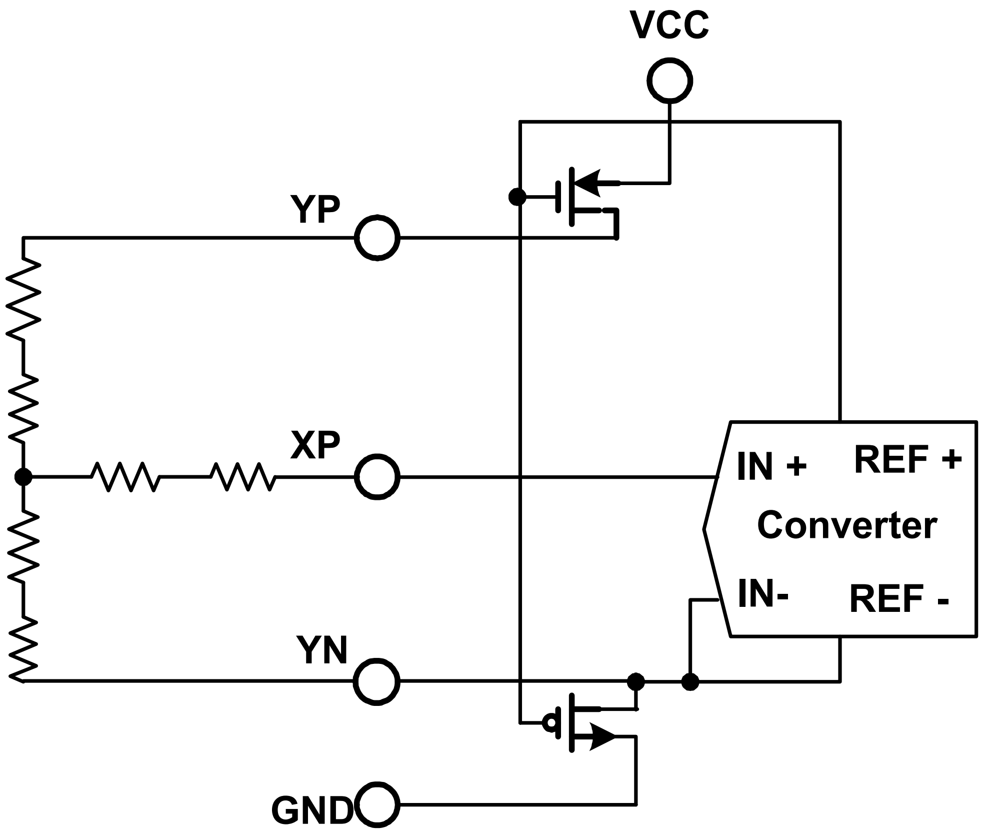
always 1

conversion reference type:
1: single
0:differential

power/interrupt pin:
0 0: unit off between conversions but / PENIRQ active

XPT2046 touchscreen: `A[2:0]`

(get y)



X+ input to ADC

=> measure y coord

of course,
depends on orientation

A2	A1	A0	+REF	−REF	YN	XP	YP	Y-POSITION	X-POSITION	Z_1-POSITION	Z_2-POSITION	DRIVERS
0	0	1	YP	YN		+IN		M				YP, YN
0	1	1	YP	XN		+IN				M		YP,
1	0	0	YP	XN	+IN						M	YP,
1	0	1	XP	XN			+IN		M			XP,

XPT2046 touchscreen: control byte

CB[6:4] depend on if you want x or y

recommended configuration (CB[3:0]):

1. differential reference
2. 12-bit conversion
3. power-down between conversions

recommended functions:

1. `getX()`
2. `getY()`

1. issue appropriate control byte
2. get response

need routines for SPI TX/RX

this is the tricky bit

XPT2046 touchscreen: SPI

(12 bit)

recommended
config

24 clock cycles to get single coord:

1. TX control byte (clocks 1--8)
2. RX coord (clocks 9--24)

coord: [0C[11:0]000]

preceded by 0

followed by 000

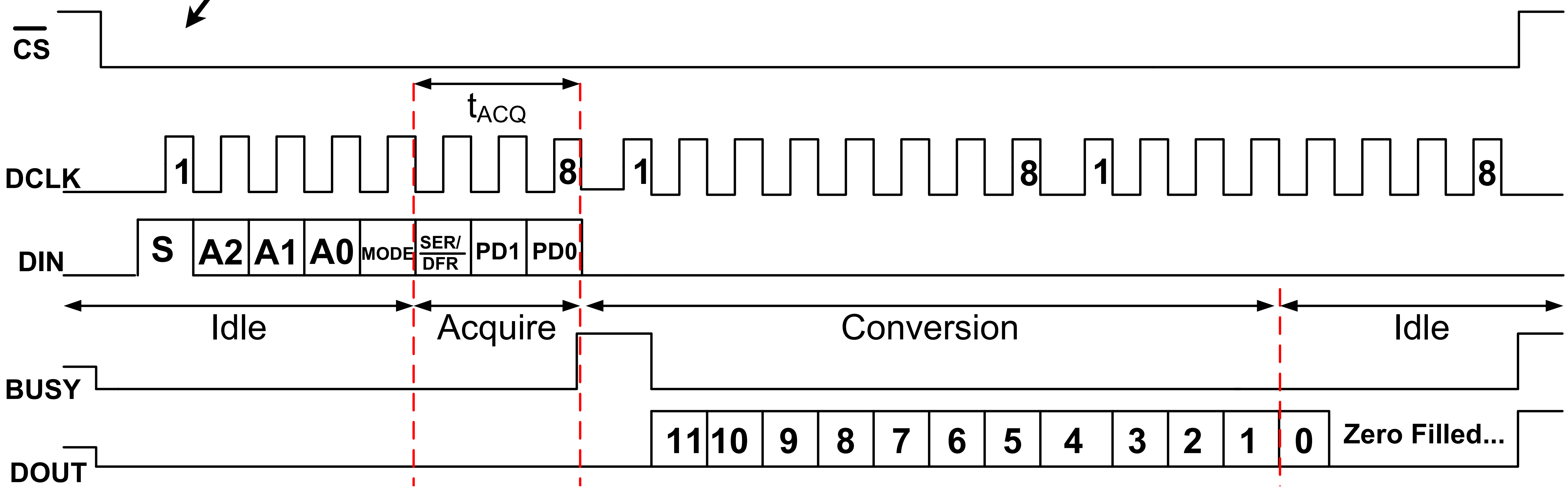
p21 & fig 12, p23

XPT2046 touchscreen: SPI

use FSS of SPI

(module does CS automatically)

note: not all of these pins are
connected on your board



touchscreen RX on rising → uC change data on falling

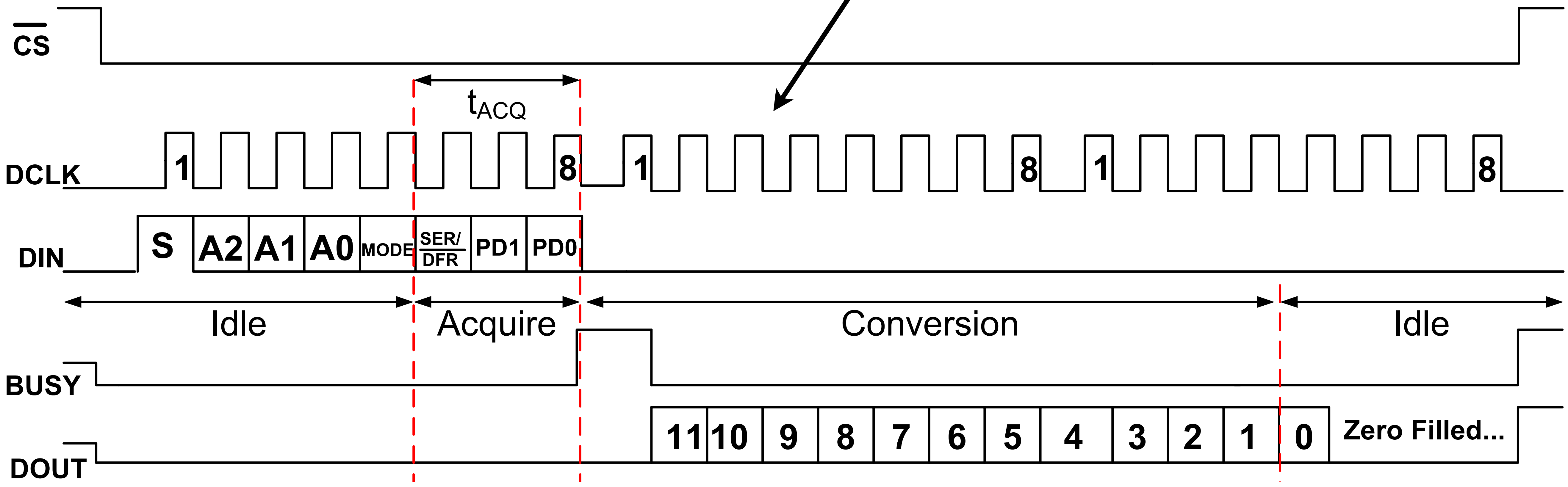
touchscreen change data on falling → uC RX on rising

fig 12, p23

XPT2046 touchscreen: SPI

(format: Freescale)

clock only generated when master TX



1. TX CB (8-bits)
2. TX 0s (16-bits)

→ three writes; extract coord from last two bytes

recommended: Microwire

to receive coordinate

(assuming one byte frames w/Freescale)

use RX queue in SPI module:

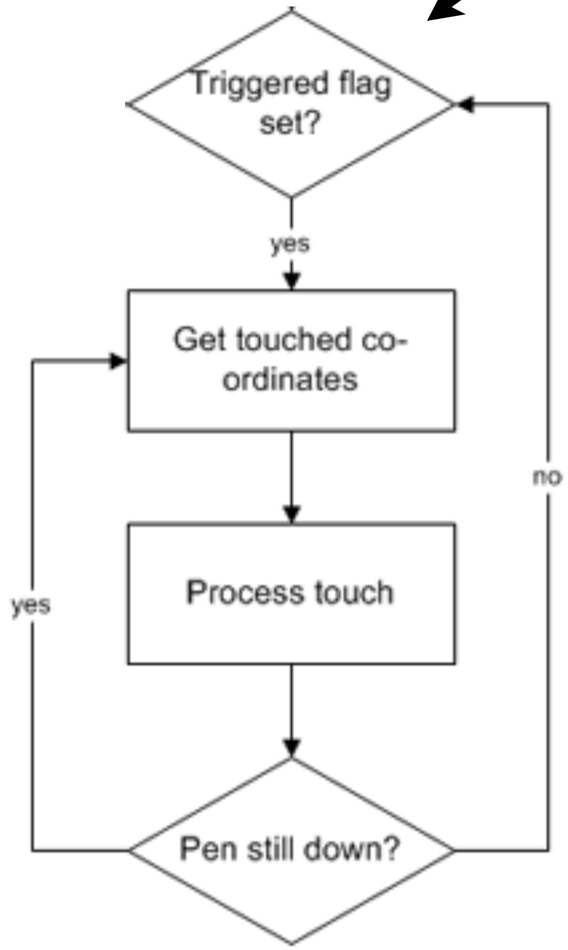
1. init conversion
2. wait
3. read DR
   (NULL)
4. read DR
   (A11--A5)
5. read DR
   (A4--A0)
6. concatenate

remember: can only RX when TXing
something b/c master generates clock

XPT2046 touchscreen: approach

polling/interrupt
/PENIRQ

basic approach:
(triggered flag is /PENIRQ)



1. don't have to update until screen is released
(in general: bad idea)

2. data is noisy: average or take median of coords while pressed

advice:

create project just for TS and then integrate with LCD code

(debugging *much* easier)