1 Overview

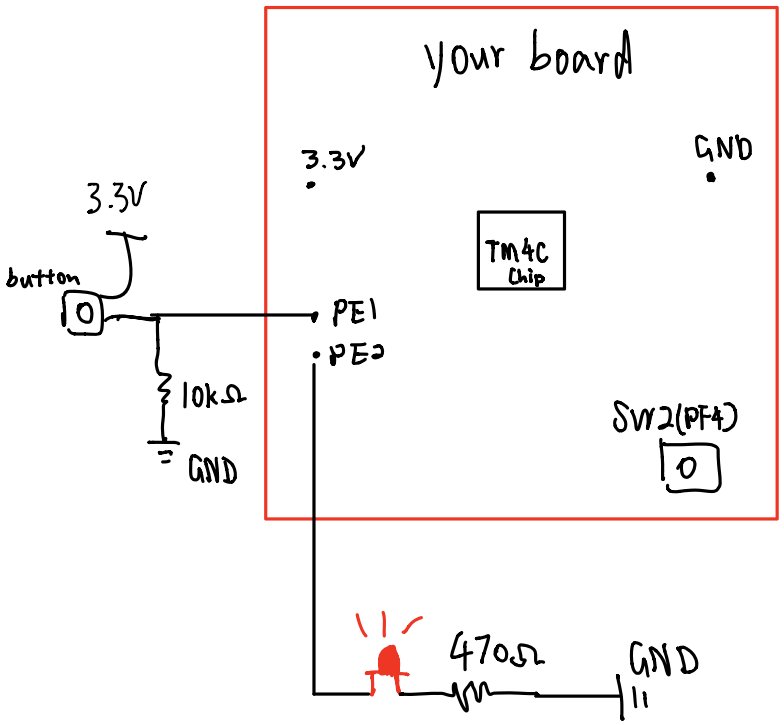
2 main topics

- Software
  - overall logic
  - Duty Cycle / Delay Implementation
  - Switch logic
- hardware
  - circuit
  - Texas_display
  - measurement

3 things to notice

4 Questions

Overview



- LED blink twice a second with different duty cycle

- if pressed & released PE1, duty cycle increase 20%
  - 10% → 30% → 50% → 70% → 90% → 10%

- if hold down PF4 (on board), breath instead.
  - changing duty cycle continously at high frequency

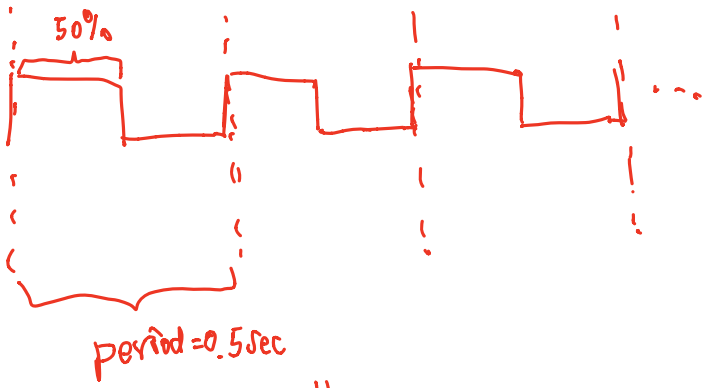
* demo here

main topics:

- Software

what is duty cycle & period:

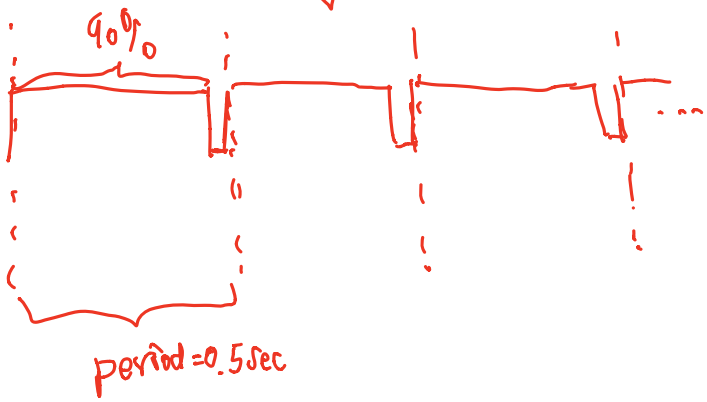
50% duty: at 2Hz



$T_{high} = 50\% \cdot 500ms = 250ms$

$T_{Low} = 50\% \cdot 500ms = 250ms$

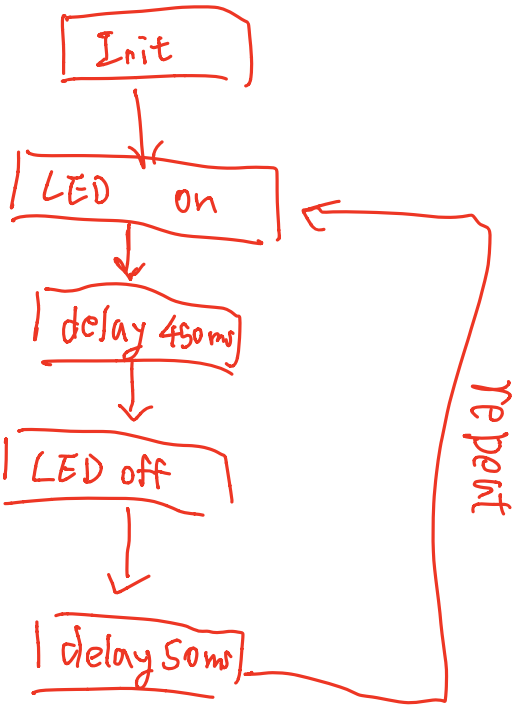
90% duty at 2Hz



$T_{high} = 90\% \cdot 500ms = 450ms$

$T_{Low} = 10\% \cdot 500ms = 50ms$

So to Implement



- you already know how to turn Led on/off

- but how to do delay ?

  - by Looping !!

```
    LDR  R0, = 1000
loop
    SUBS R0 , R0, #1
    BNE  loop
```

- so then SUB & BNE will run 1000 times in this example.

- how long does each instruction take?

```
      LDR R0, = N
loop  SUBS R0, R0, #1   ← 1 cycle
      BNE  loop         ← 2 to 4 cycle. (let say it is 3)
```

so then

$1 + 3 = 4$ cycle per iteration

how long per cycle?

$$\frac{1}{80\text{MHz}} = 12.5\text{ns}$$ ← very small number!!

how long does one iteration take?

$$4 * \frac{1}{80,000,000}$$

how many iteration to cover 1ms?

$$.001\text{sec} \div \left(4 * \frac{1}{80,000,000}\right)$$

$$= 80\,000 \div 4$$

so then to delay 1ms:

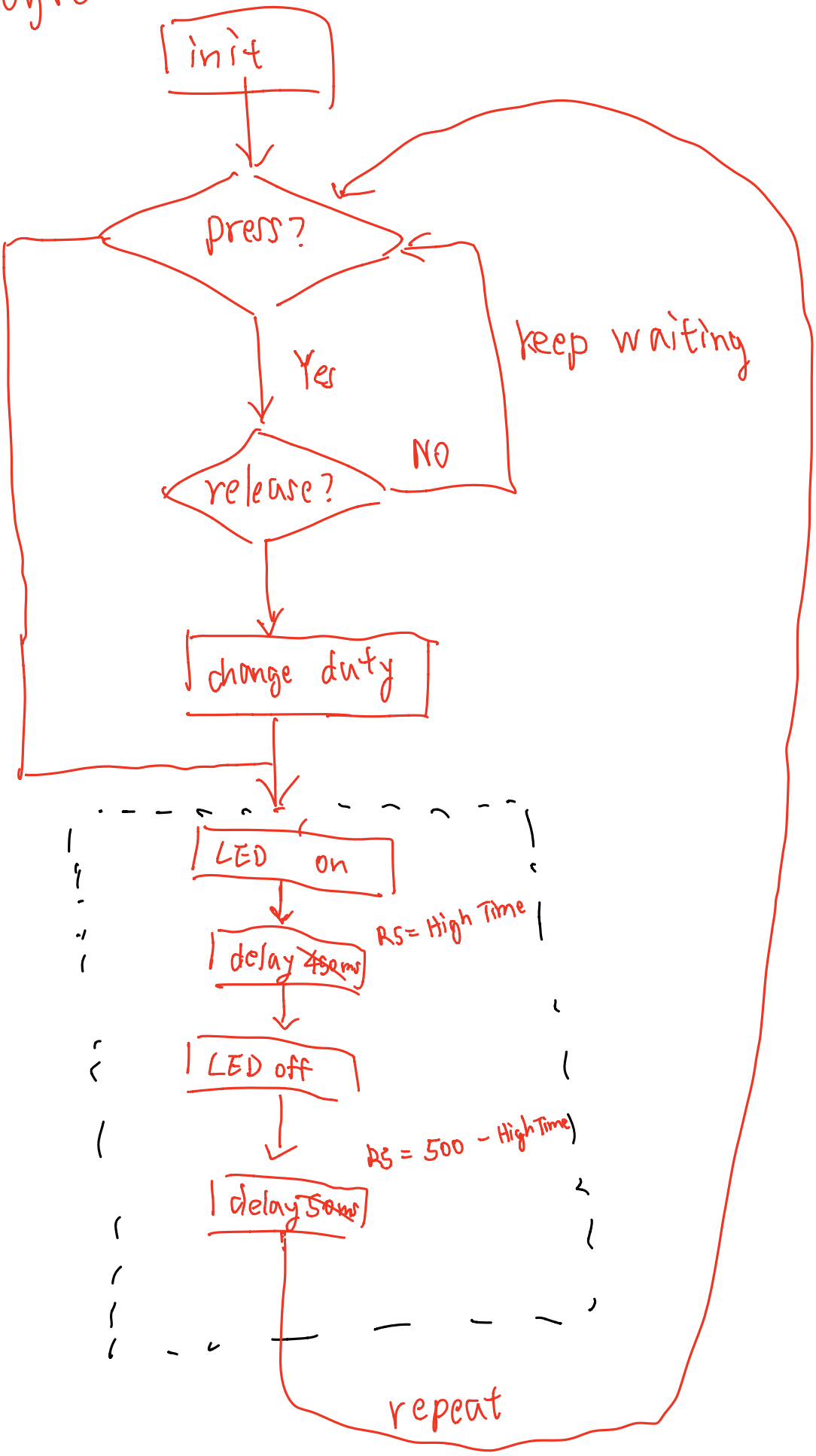
```
      LDR R0, =80000/4
loop  SUBS R0, R0, #1
      BNE  loop
```

how to delay 450ms then?

just add another layer of Loop!

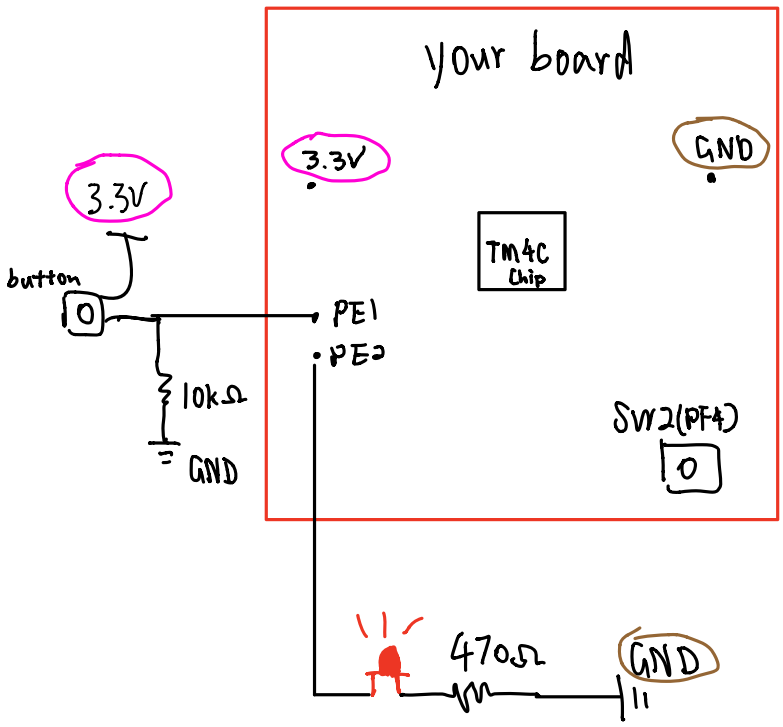
```
        LDR R1, =450
Loop1ms
        LDR R0, =80000/4
loop1ms
        SUBS R0, R0, #1
        BNE loop1ms

        SUBS R1, R1, #1
        BNE Loop1ms
```

- Switch Logic



Hardware

- Check out canvas → file → Lab lecture → Switch & LED wiring.pdf



Texas_display

- connect PD3 to place you want to measure (PE2 in this case)

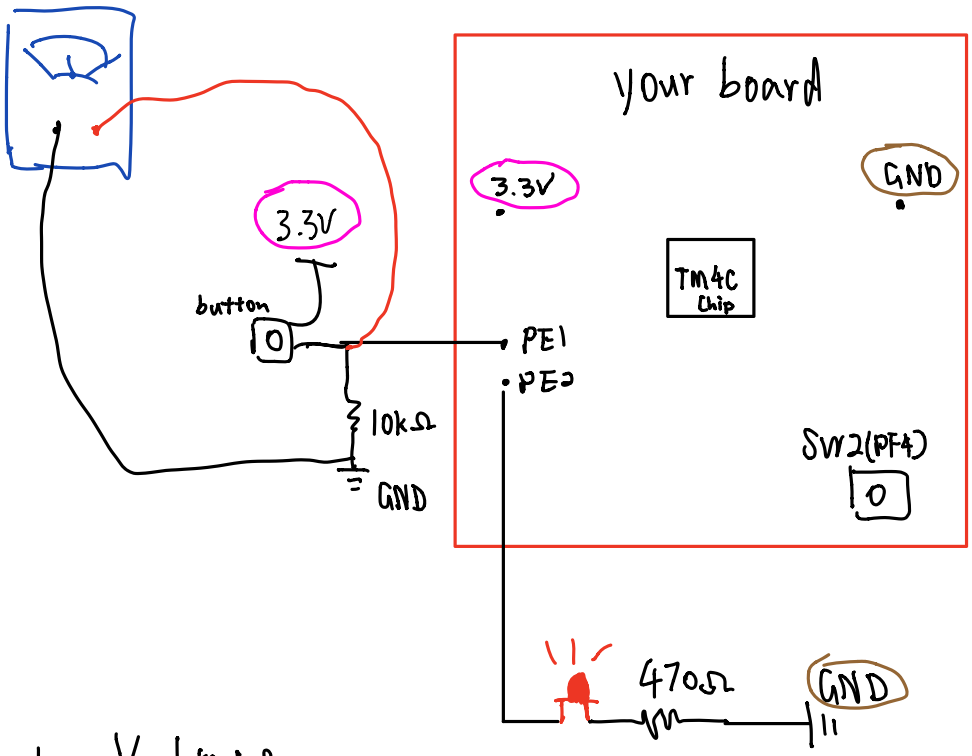
- click texas_display in EE319K lab folder
  - then click COM → Open Port
  - then click View → Oscilloscope
  - then keep hitting F6 key until X axis show 1600ms
  - see if you frequency & high Time is right

* demo in Zoom here

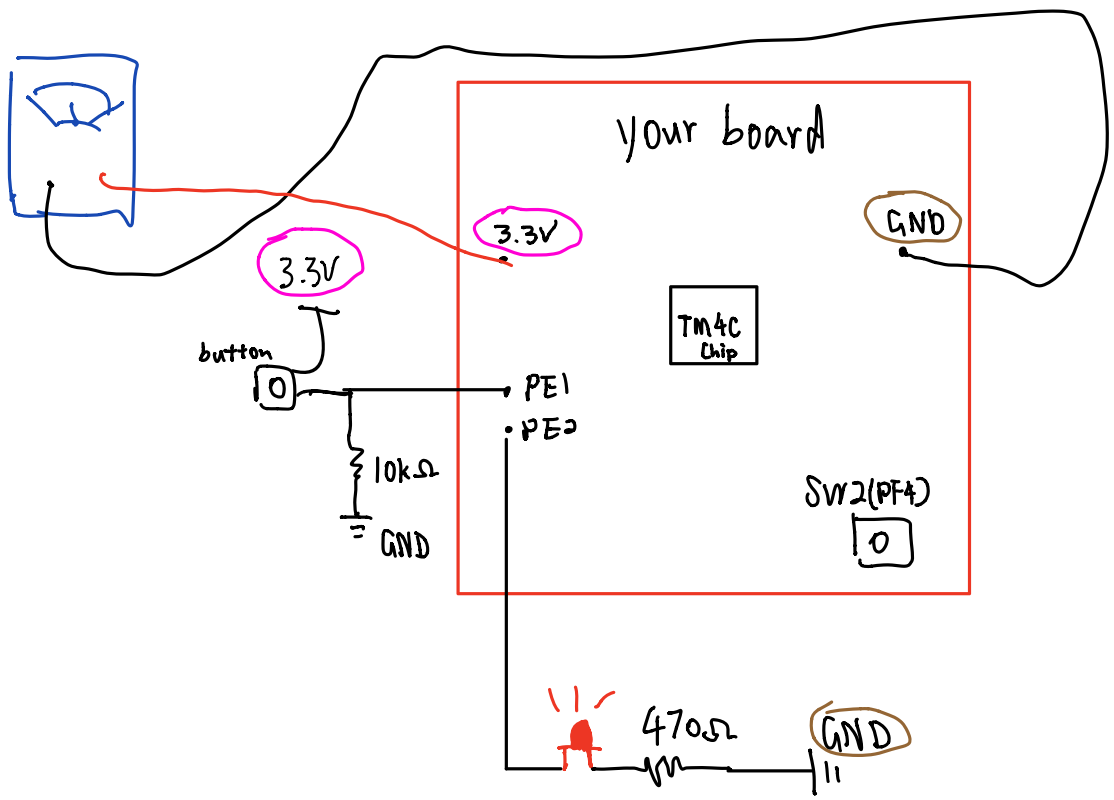
Measurement

Switch data

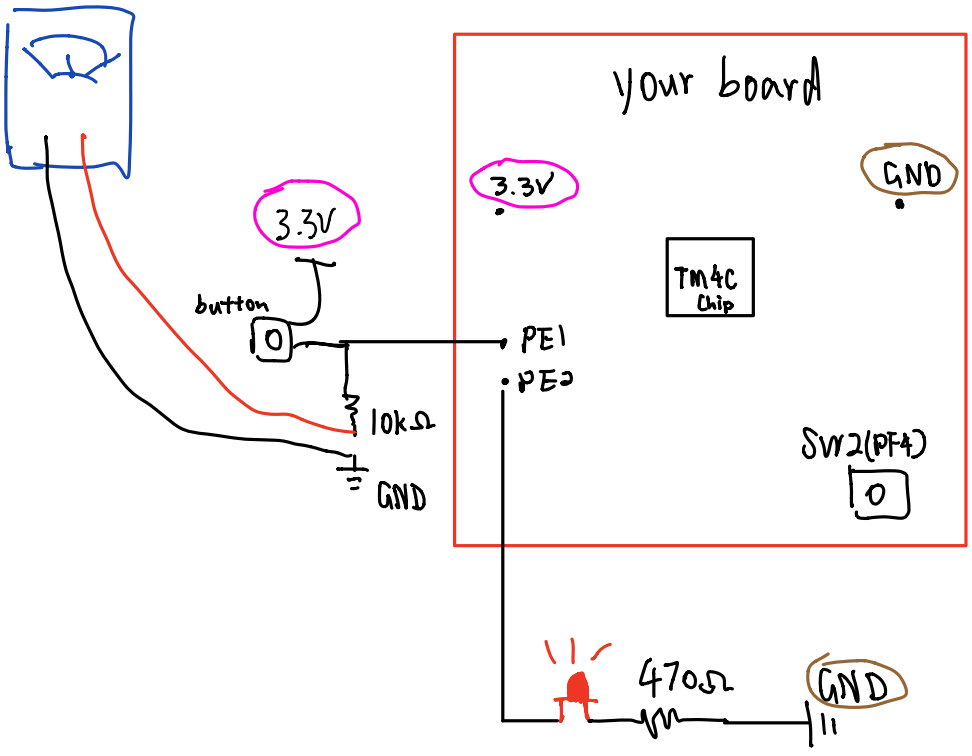
Input Voltage



Supply Voltage

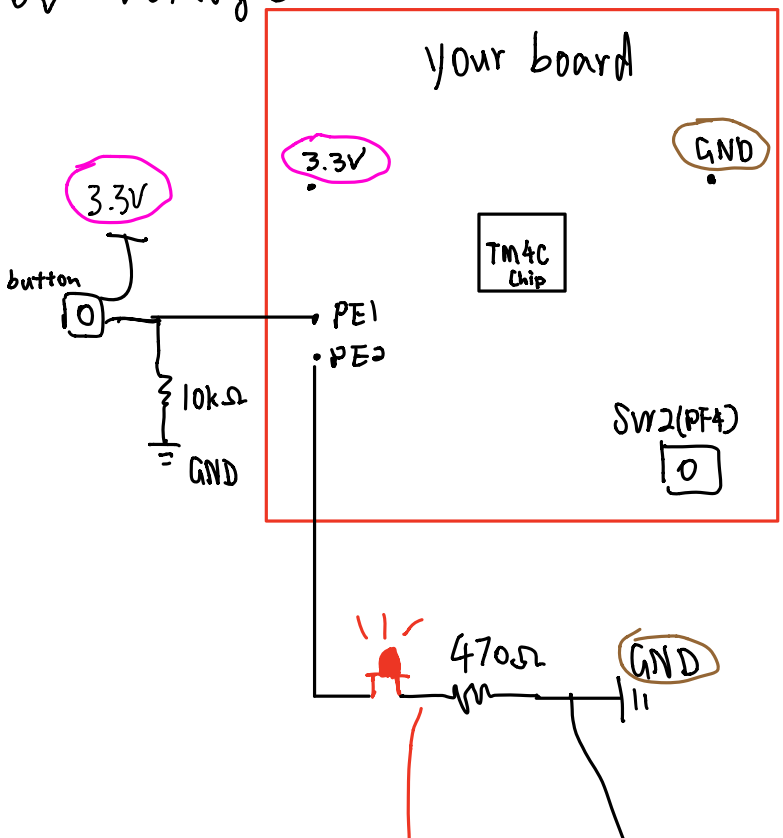


Current

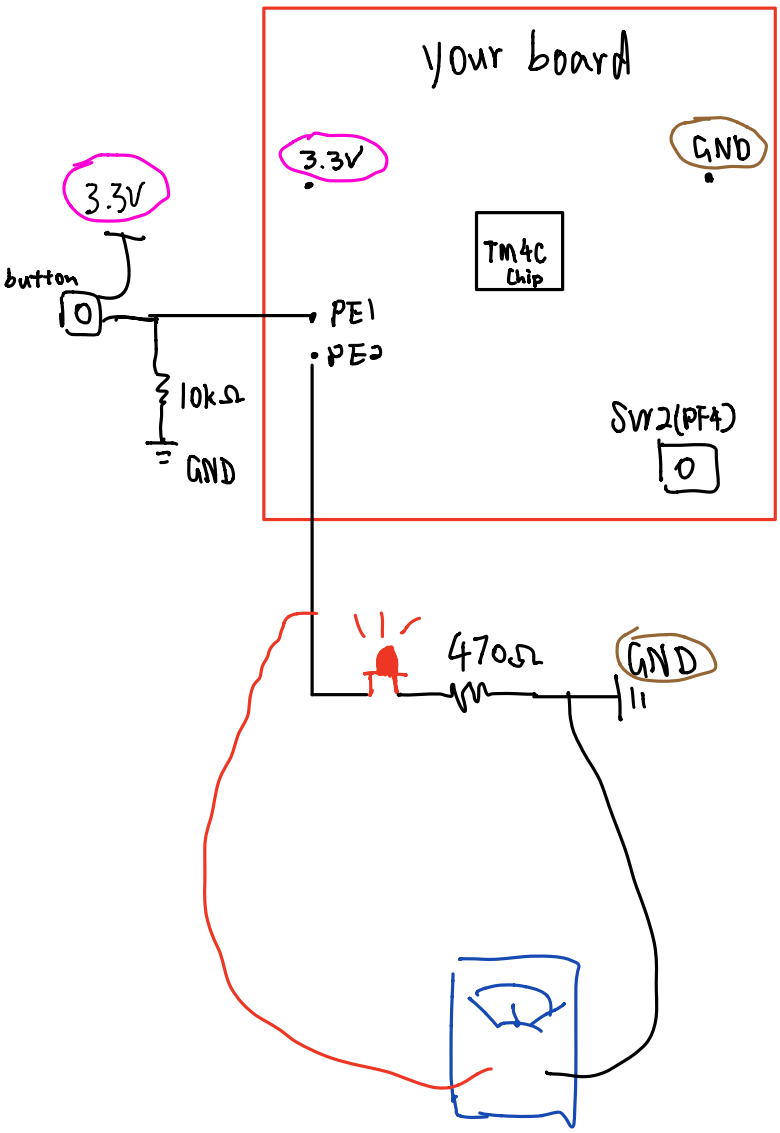


LED data

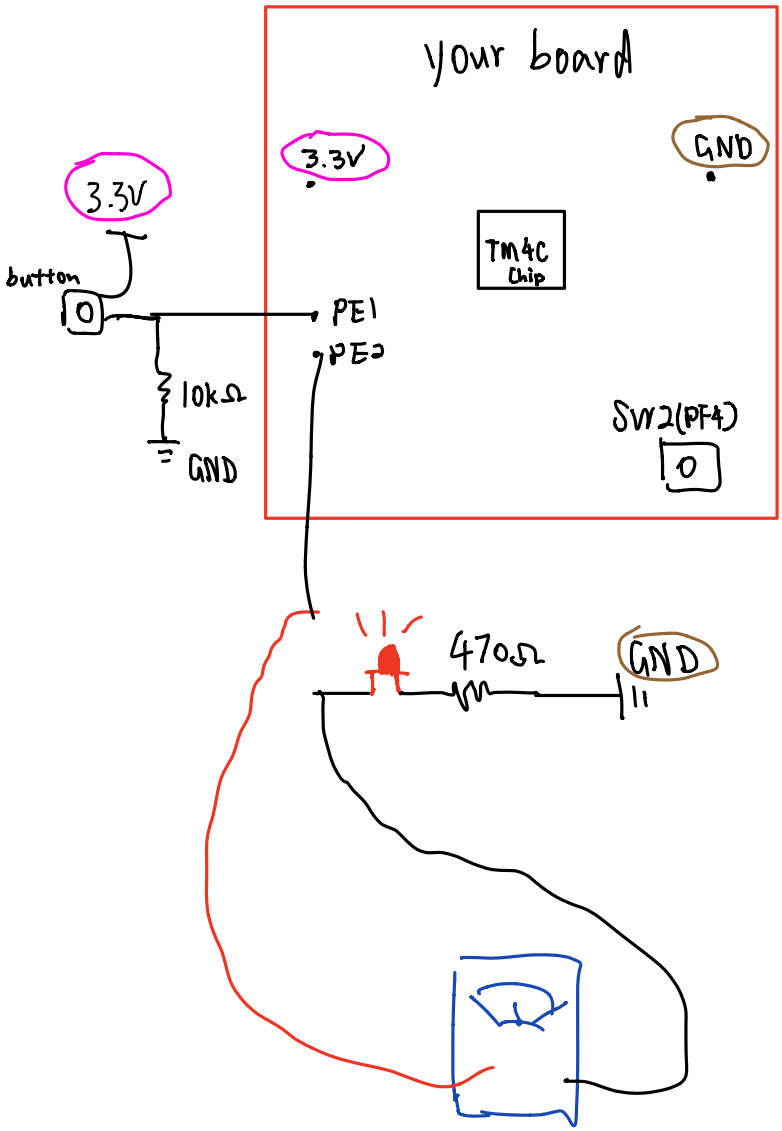
resistor Voltage



Output Voltage



LED current


your board
3.3V
GND
3.3V
TM4C
Chip
button
PE1
PE2
10kΩ
GND
SW2(PF4)
470Ω
GND

Things to notice

- make sure simulator work before using on circuit.

- always rebuild whenever made a change!

careful
- calling subroutine inside another subroutine
  save LR using PUSH & POP!

- connect long side of LED to PE2!

- use multimeter on PE2 & PE1 & PF4