Mechatronics Design – Class#3

Liwei Lin

Professor, Dept. of Mechanical Engineering

Co-Director, Berkeley Sensor and Actuator Center

The University of California, Berkeley, CA94720

e-mail: lwlin@me.berkeley.edu

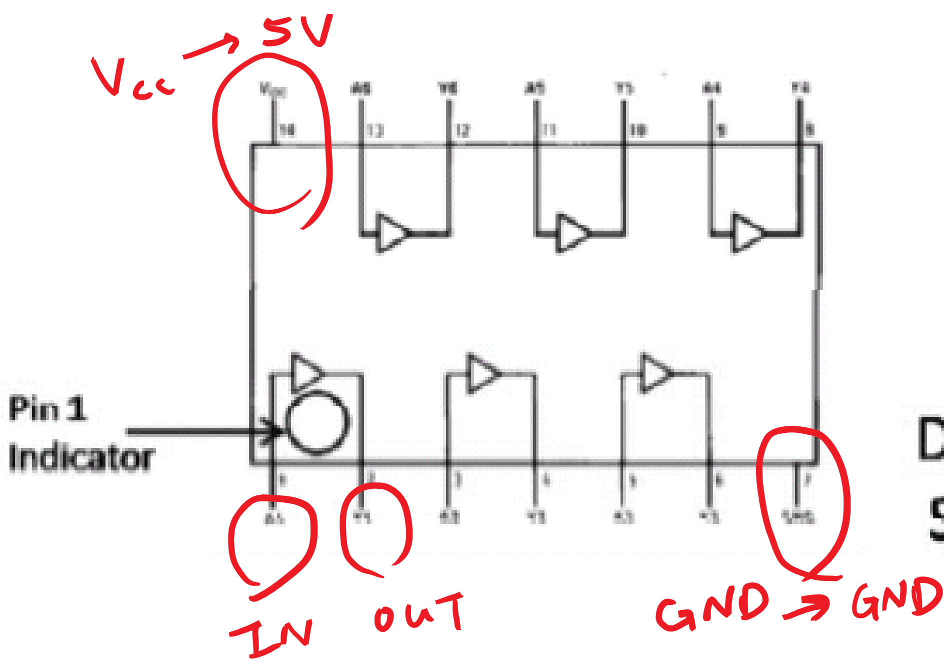
http://www.me.berkeley.edu/~lwlin

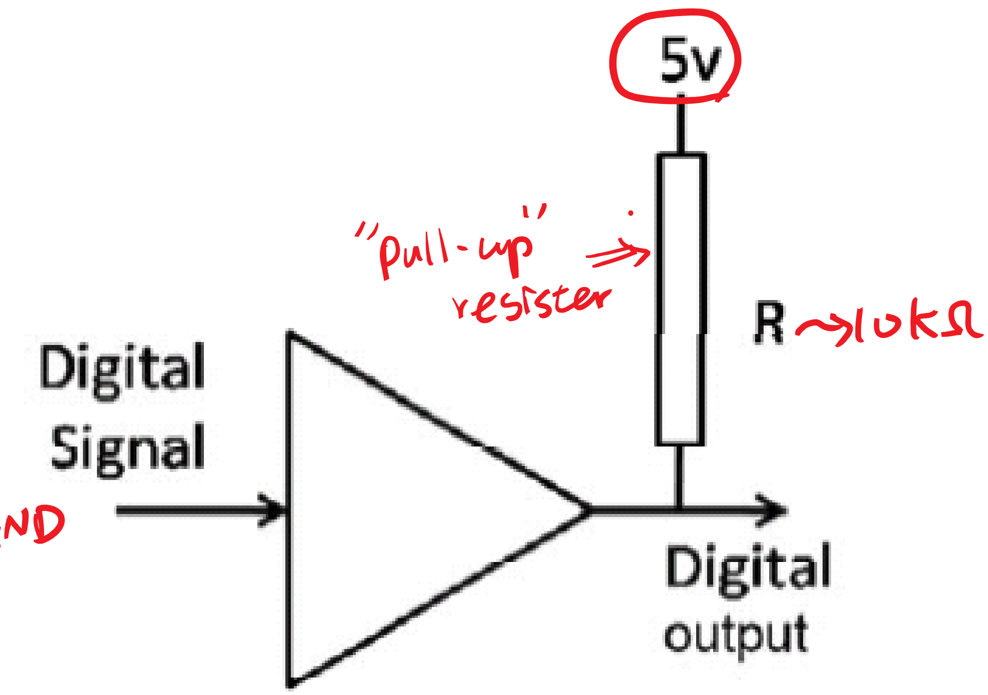
Outline

- Executive Summary is due Monday (9/10)
- Lab #1

Digital Output Buffer – DM7417

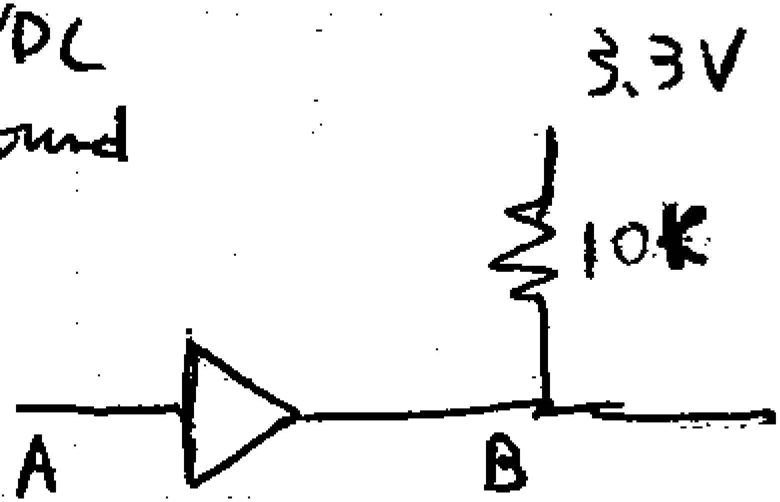
Digital output buffering with the **DM7417** (datasheet) protects the Arduino. The DM7414 is a hex buffer with open collector high voltage output. An open-collector only guarantees that a LOW input results in a LOW output. There are no guarantees for a High Input





Digital Output Buffer – DM7417

+5VDC
ground



Output

A	B	
1	1	→ Output sees high (3.3 V)
0	0	→ Output sees ground

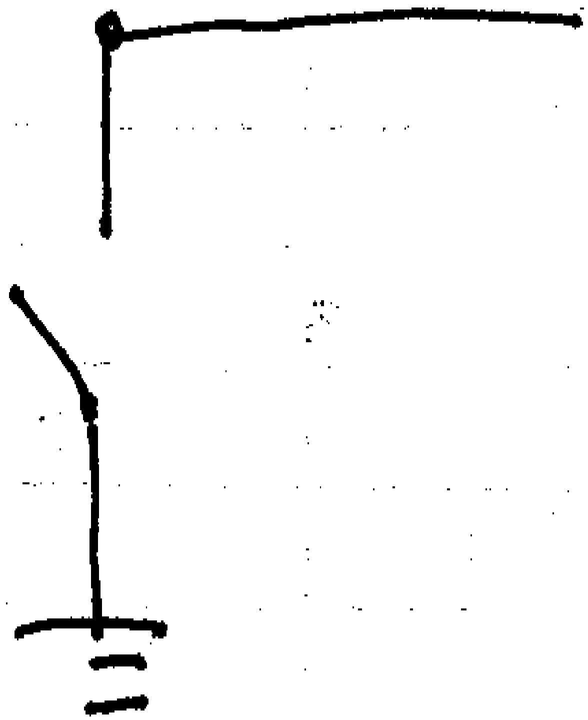
Pull-Up Resistor

~~By using a pull-up resistor on the output end, one can supply any level of voltage within the operational specifications of the IC. For the DM7414, it is 15V.~~

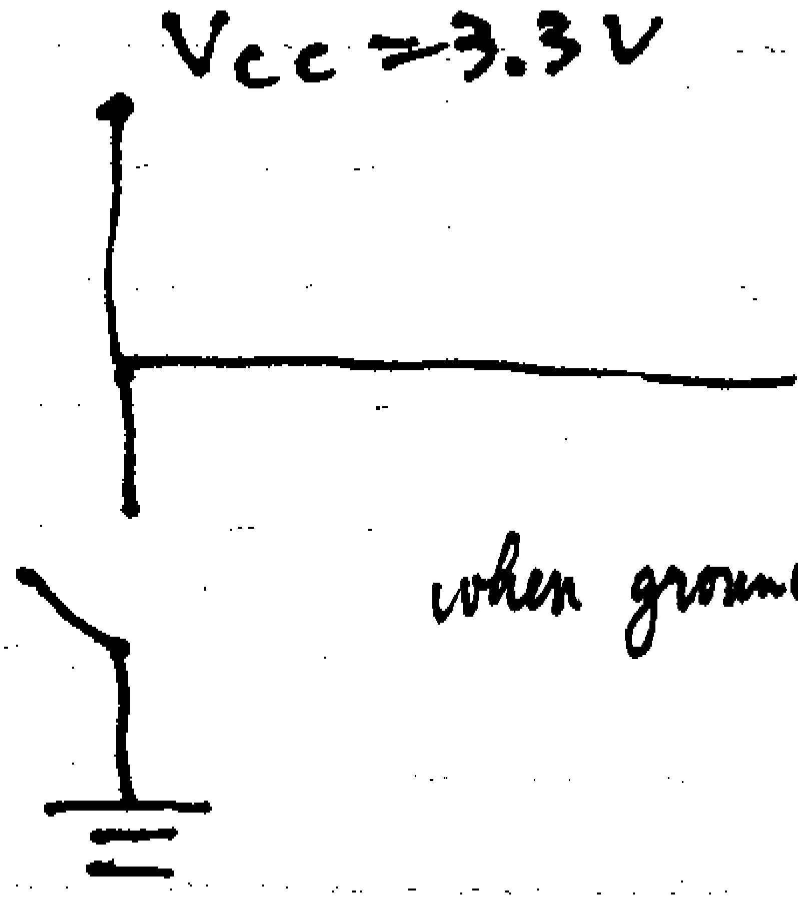
The basic function of a pull-up resistor is to insure that given no other input, a circuit assumes a default value. Consider the circuit in "Configuration of DM7417", when the digital signal input is HIGH, the IC acts as a high impedance part so current flows to the right. When the digital signal input is LOW, the IC becomes a current sink. IN order to prevent IC destruction, **pull-up resistors are generally in the range of 10k to 47k ohms.** Special cases do exist as you will see at the check-off task.

Voltage "High" – "Floating"

floating → gradually to high
→ electrical noise

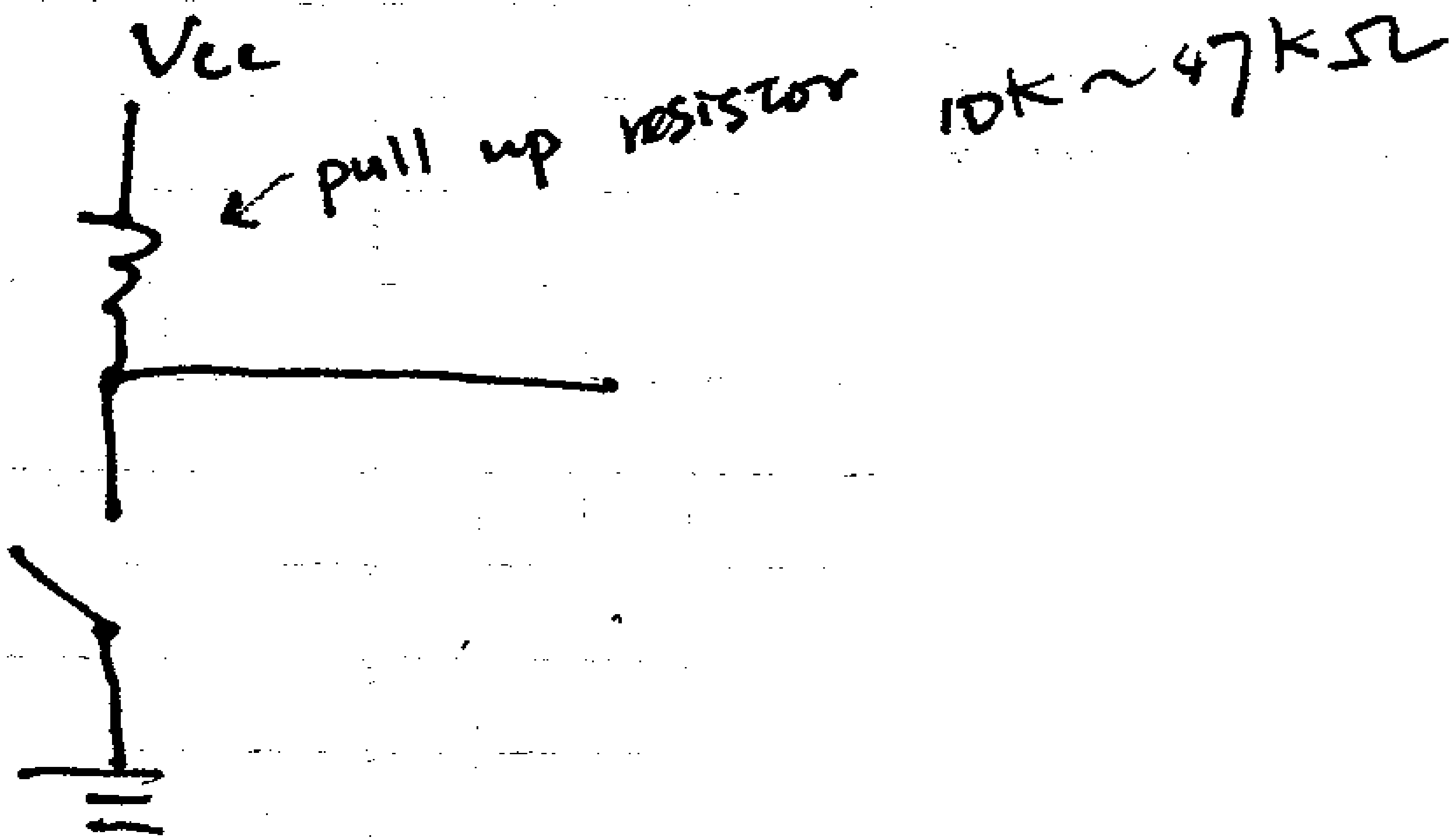


Voltage "Low" – "Short"

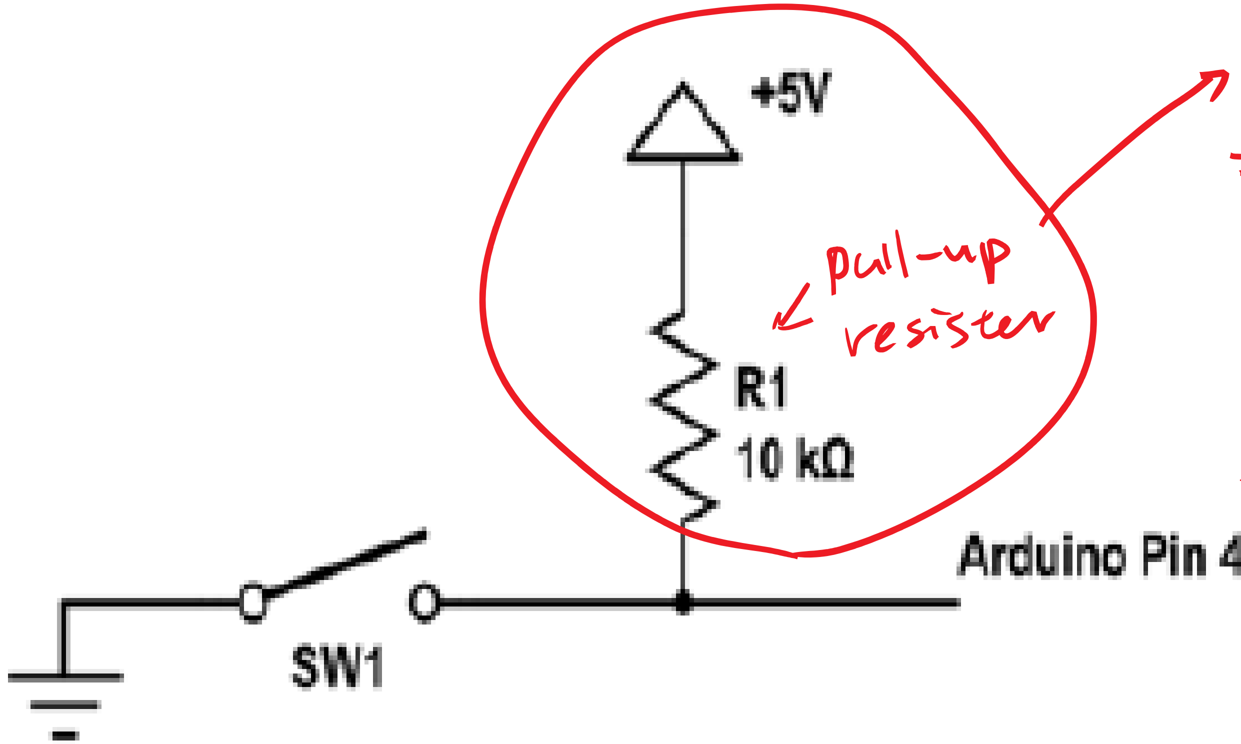


when grounded → short circuit
from V_{cc} → ground

Pull-up Resistor



Control #1 – Digital



without this setup

⇒ GND = GND (low)

OPEN = floating

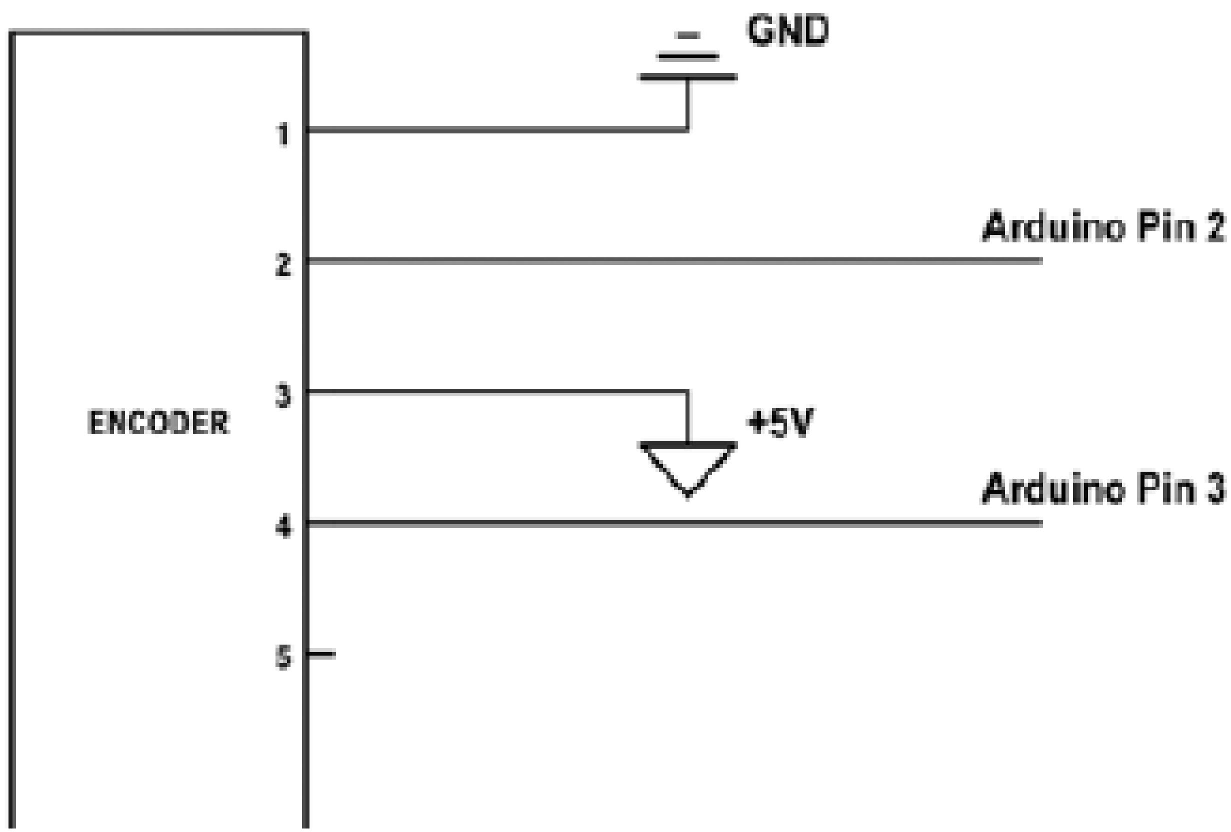
⇓

high or low

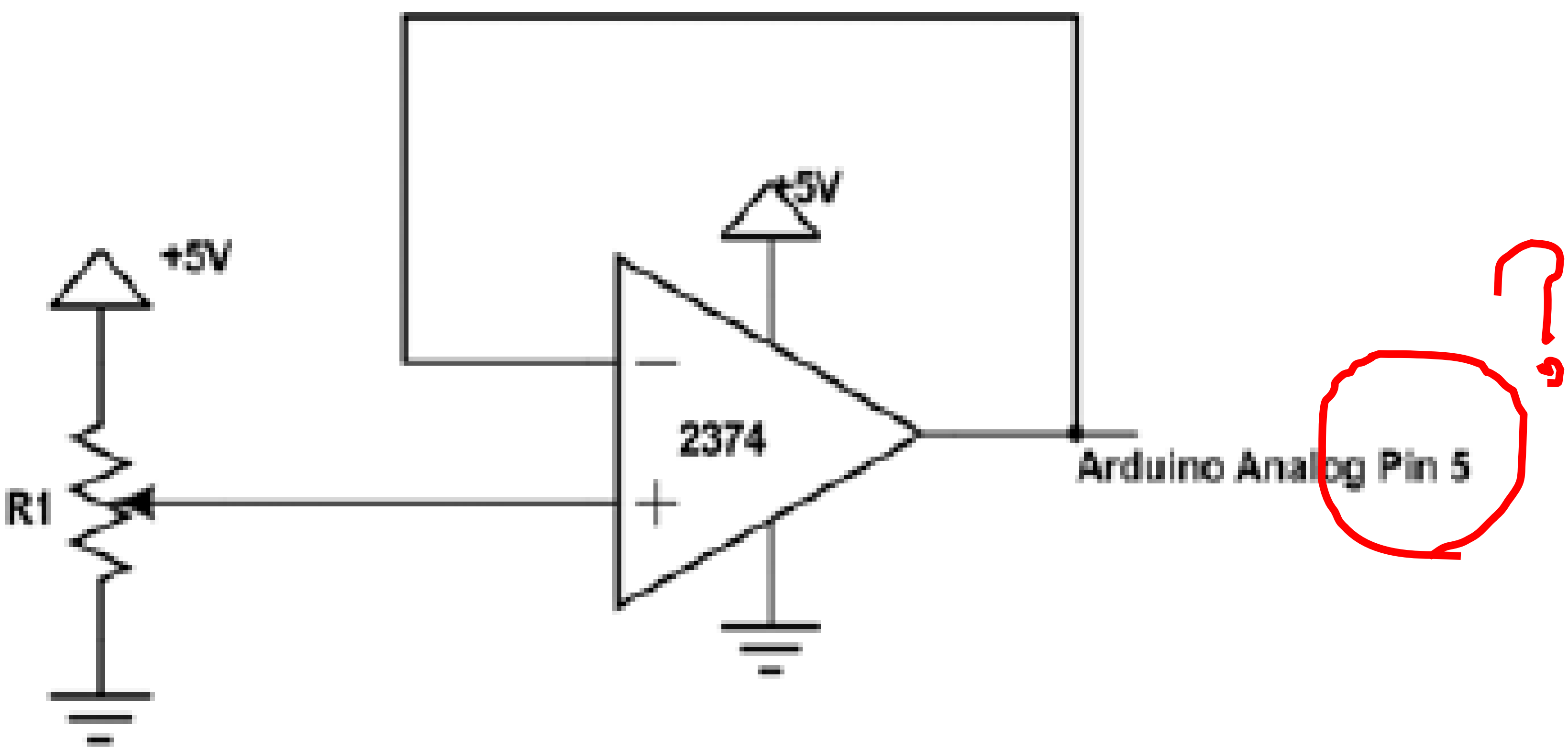
⇒ use +5V

⇒ need pull-up resister or it is a short from 5V → GND

Control #2 –Encoder

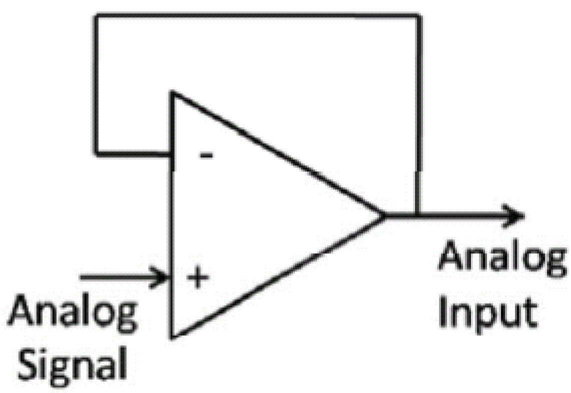


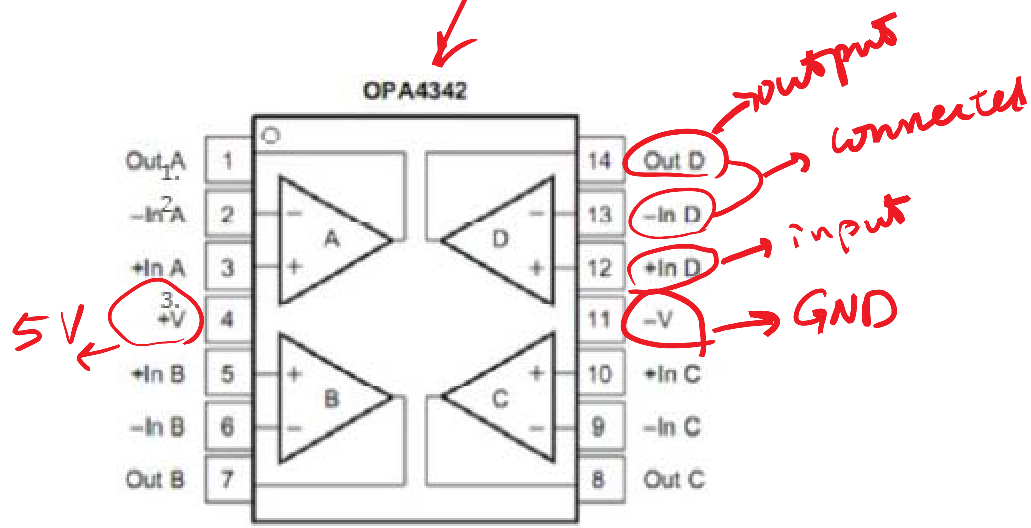
Control #3 – Analog (voltage follower)



ADC (Analog-to-Digital Conversion)

We protect the ADC with a voltage follower. In your lab kits, you may either have a OPA4342 (datasheet) or a TLV2374I (datasheet). Both are suitable for our purposes.

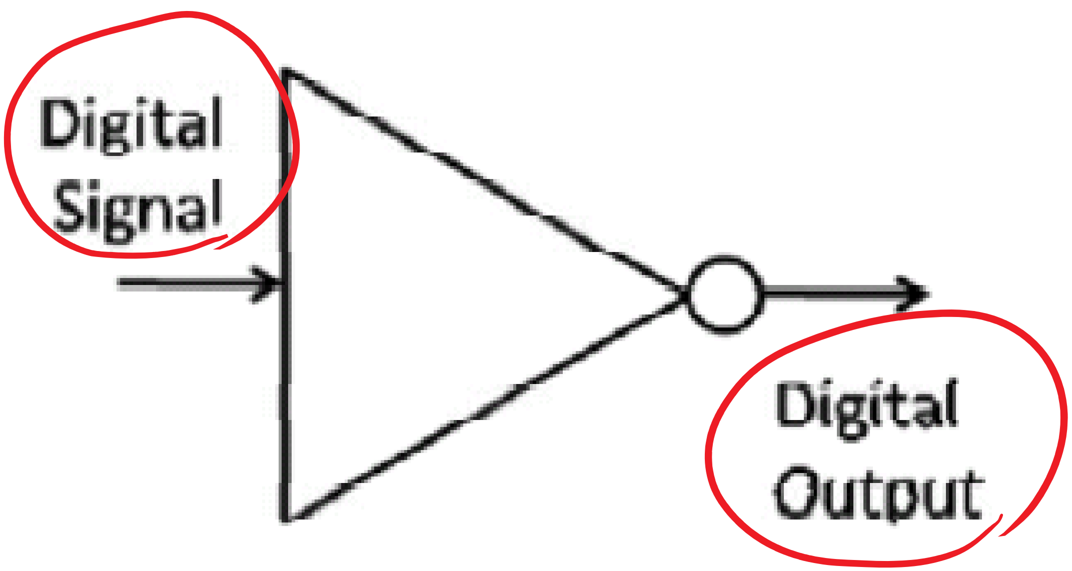


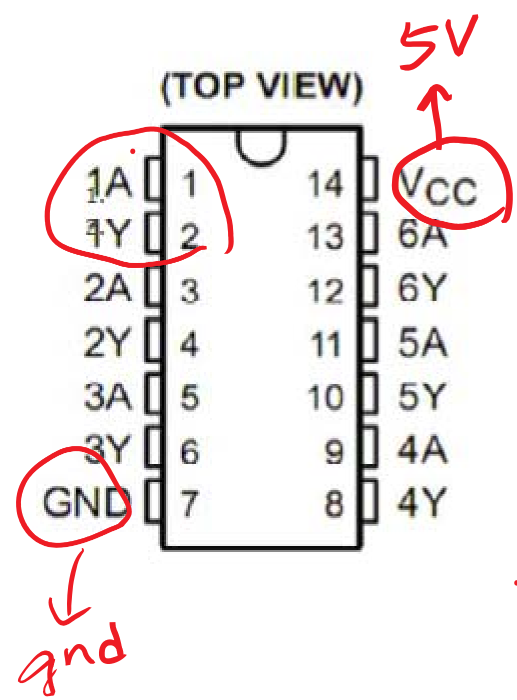


Verify that there is unity gain or Vin = Vout for your voltage follower. You can easily do this by connecting the wiper of your potentiometer, which has been connected between 5V and ground, to the non-inverting input (+ In C) . The wiper is the part that changes voltage as the knob turns.

Digital Input Buffer – 74LS14

To buffer the digital input of the Arduino, we use the **74LS14** (datasheet). The 74LS14 is a hex schmidt trigger inverter. It takes a digital input and outputs the opposite. HIGH becomes LOW, and LOW becomes HIGH. In TTL (Transistor-to-Transistor Logic), a HIGH signal is anything from 2.2V to 5V whereas a LOW signal is anything from 0V to .8V. The area from.8V to 2.2V is essentially undefined behavior.The schmidt trigger is a property of this particular chip that allows it to be slightly less responsive to noise. And finally, there are six such inverters on a single chip (hence hex).

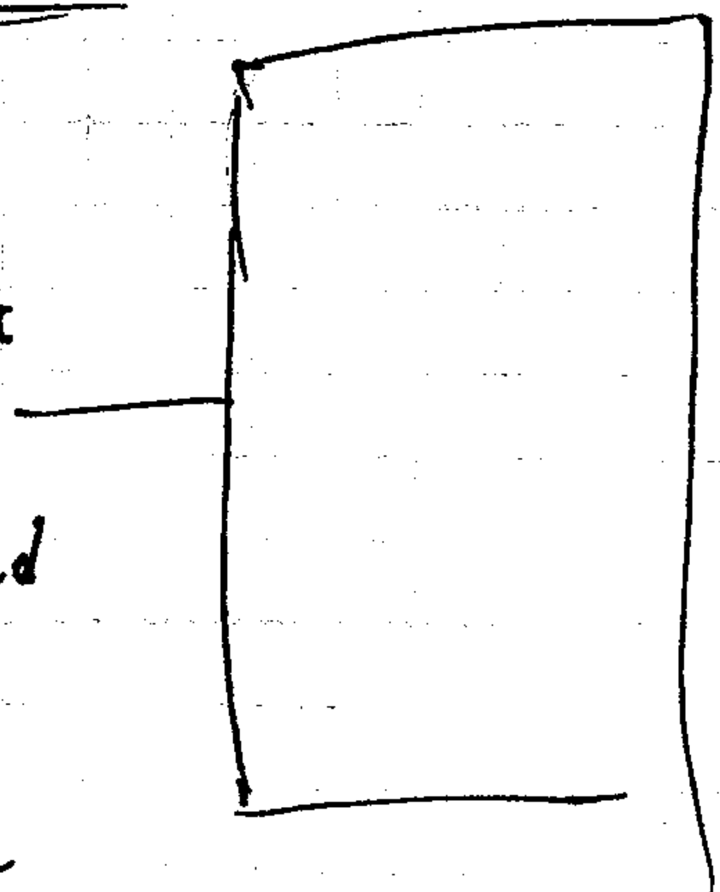




Digital Input for DSP

Digital Input

digital input



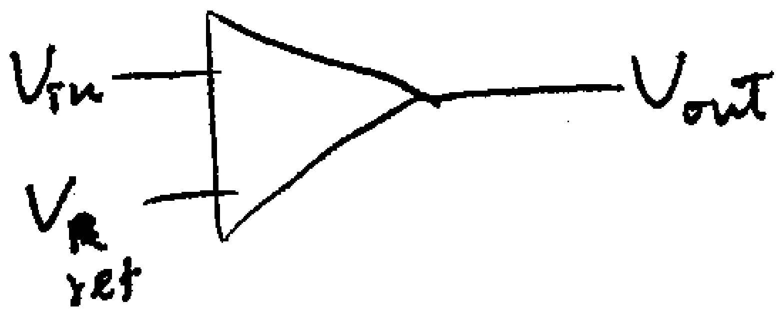
0 – ground

1 – 3.3V

no real power

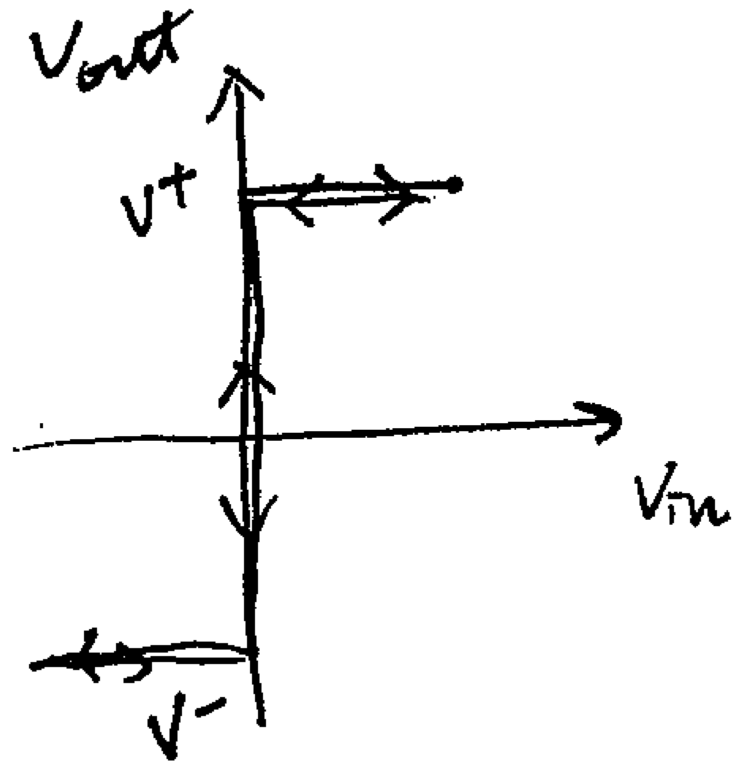
Schmitt Trigger – Comparator

Comparator

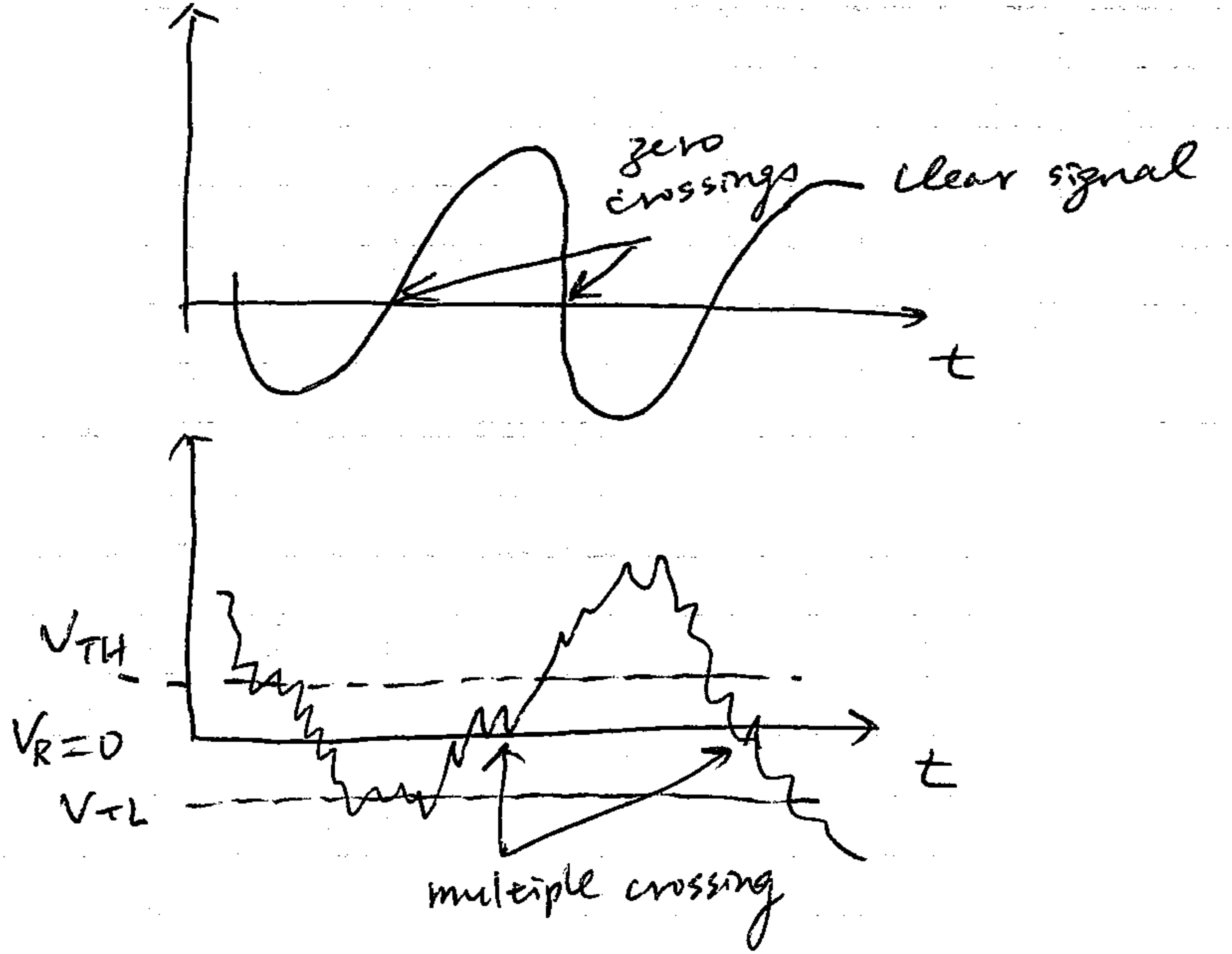


$V_{in} > V_{ref} \rightarrow V_{out} = V^+$

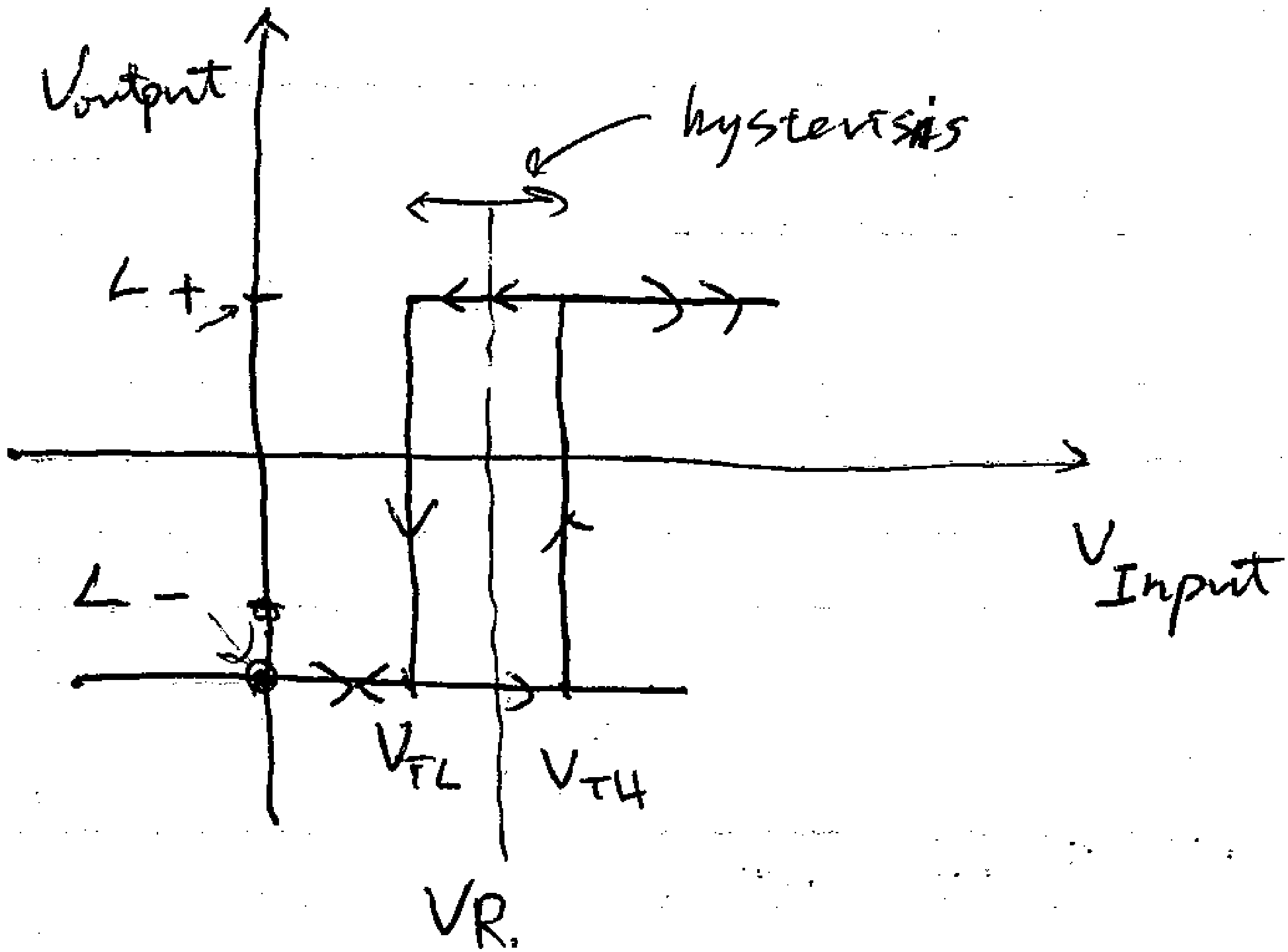
$V_{in} < V_{ref} \rightarrow V_{out} = V^-$



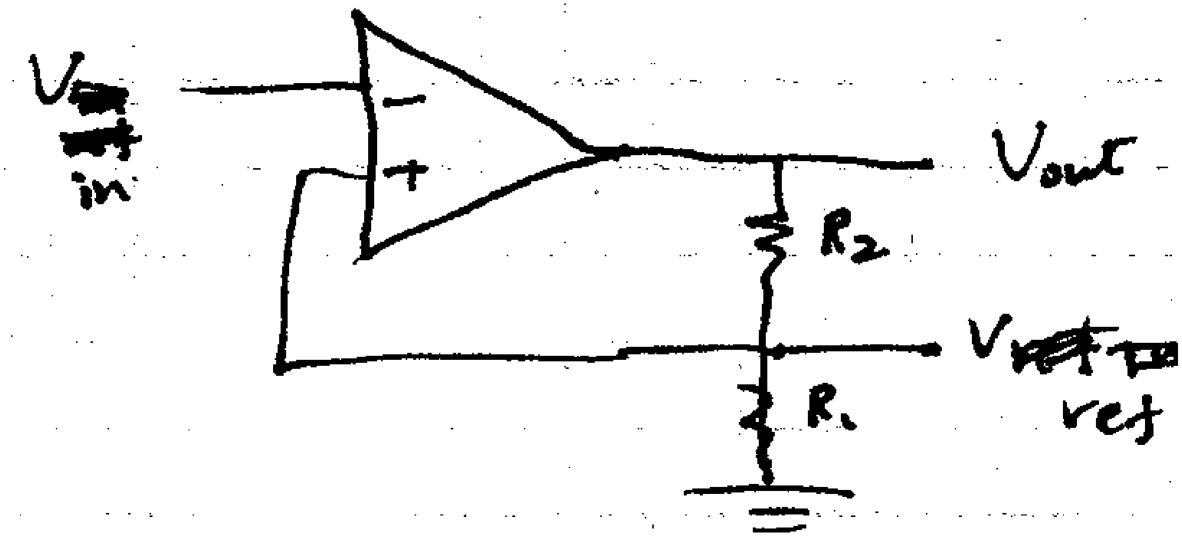
Schmitt Trigger – Signal & Noise



Schmitt Trigger – Reject Interference



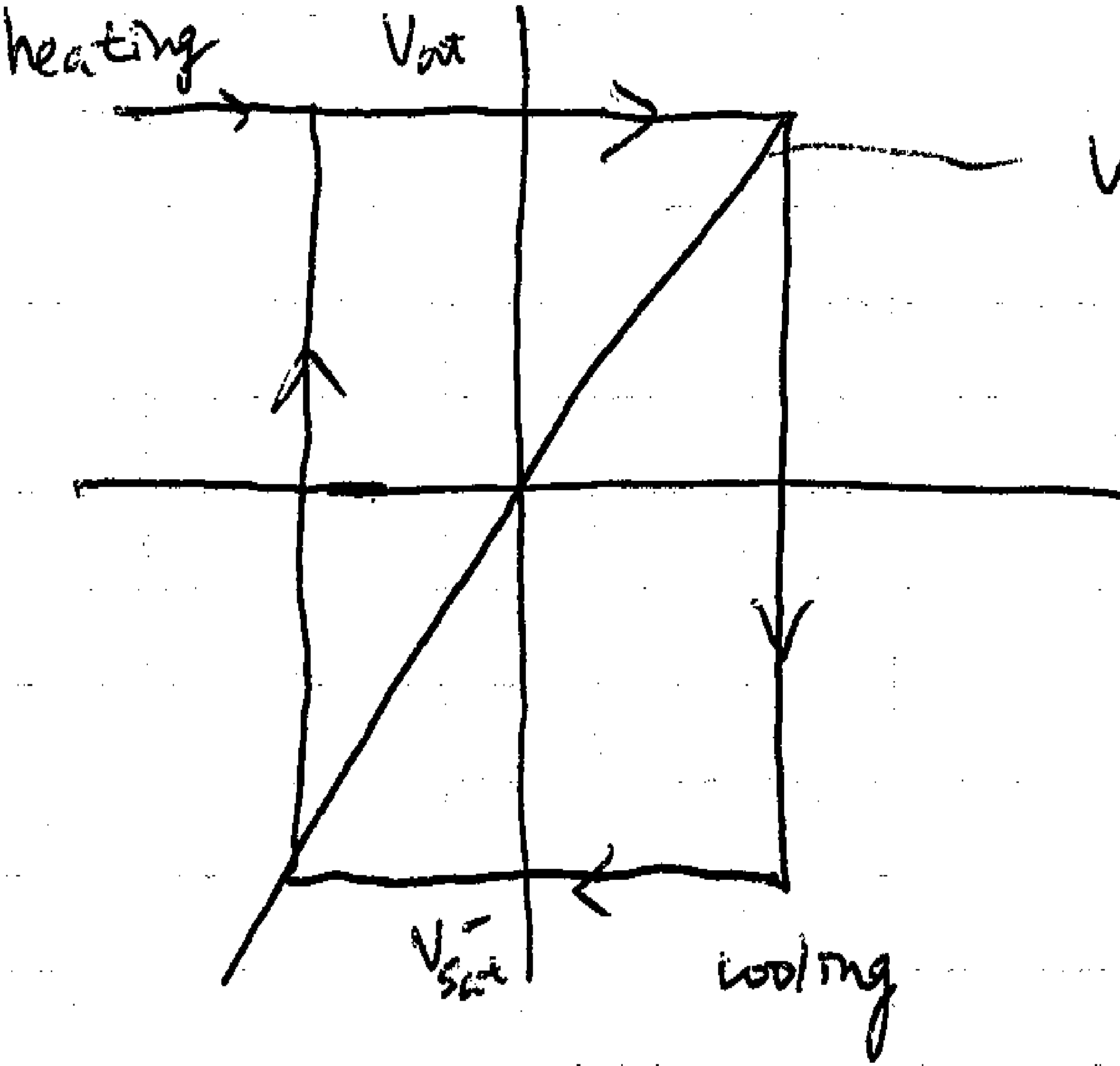
Schmitt Trigger – Circuit



$$V_{in} = V_{ref} = V_{out}\,\frac{R_1}{R_1+R_2}$$

$$\begin{cases} V_{in} < V_{ref} \implies V_{out} = V_{sat}^{+} \\ V_{in} > V_{ref} \quad\;\; V_{out} = V_{sat}^{-} \end{cases}$$

Schmitt Trigger – Responses



$$V_{in} = V_{ref} = V_{out} \frac{R_1}{R_1 + R_2}$$

V_{in} (temperature)

Lab #1

The check off for this lab is a blinking LED that works with your buffered system.

1. Connect Pin13 to the one of the 7417's inputs
2. Connect the corresponding output from the 7417 to the anode of the LED.
3. 3) The pull-up resistor limits current flow. With a 10k resistor, current flow through it is limited to .5mA. This is not enough to drive an LED. Given that the SN7417 can sink 40mA, use a resistor of around 1k ohms as your pull-up resistor.
4. Note that the onboard LED and your recently connected LED should blink in phase.