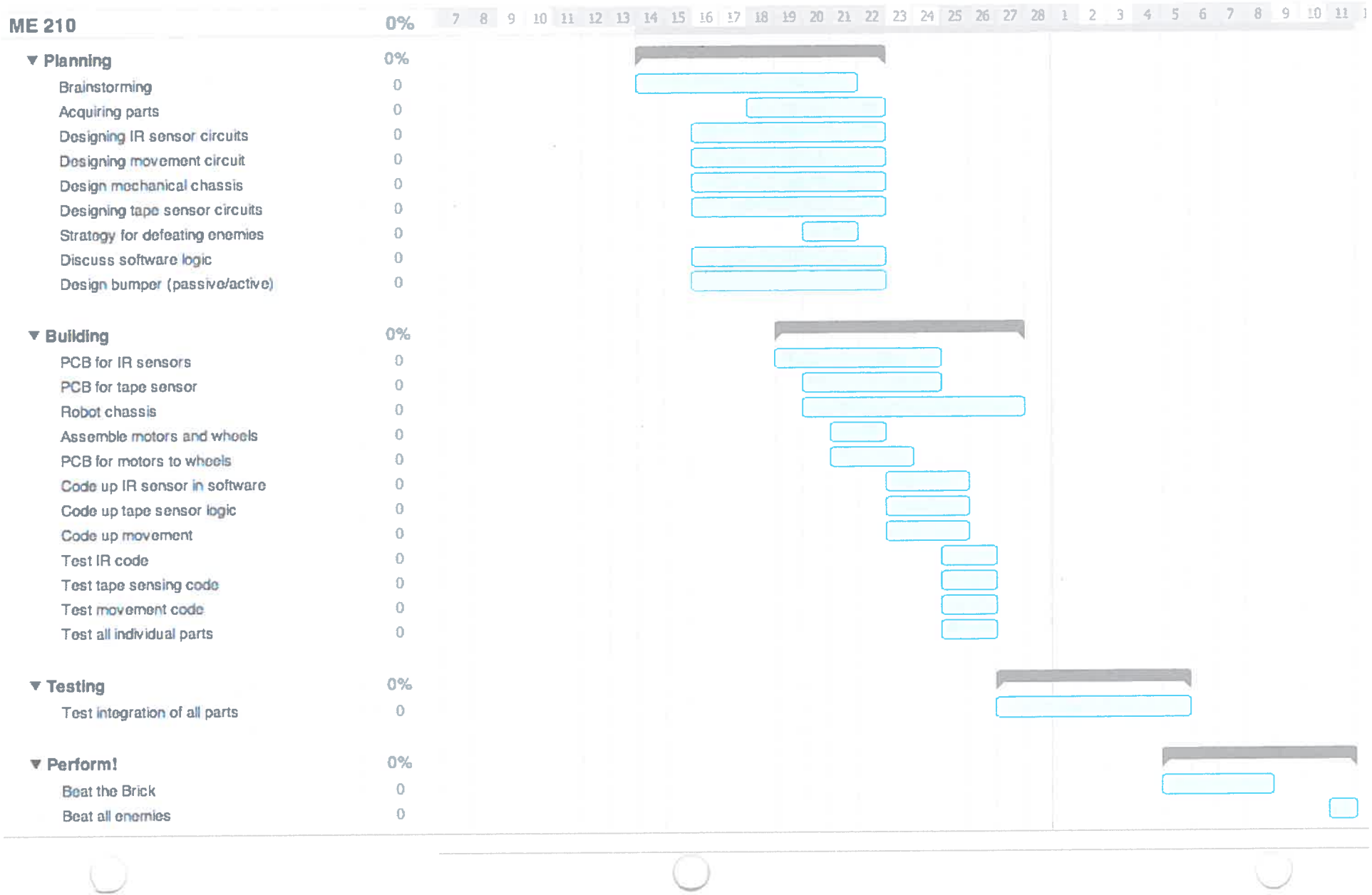
ME 210

Team Pork Barrel
Brian Furciniti
Will Greenbaum
Rahul Sastry
Ying Zhao

Project Planning

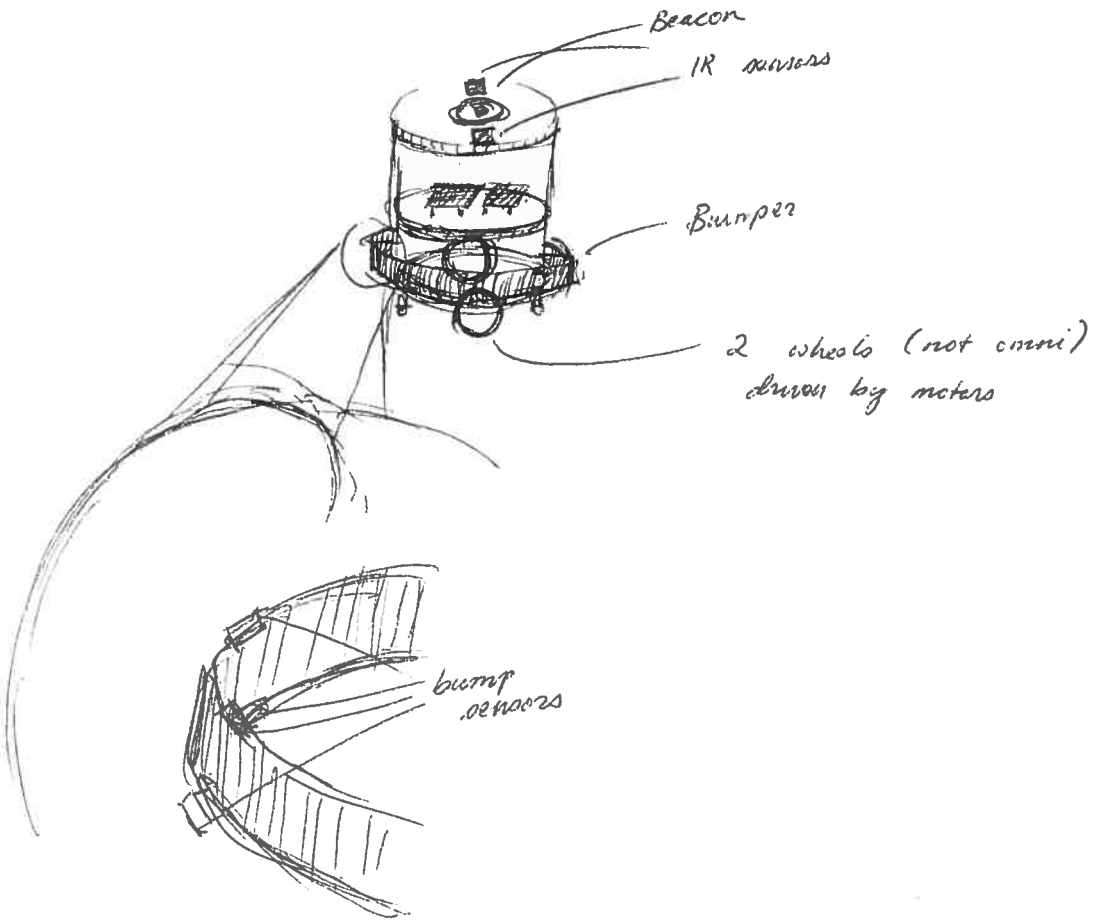


Personnel Assignments

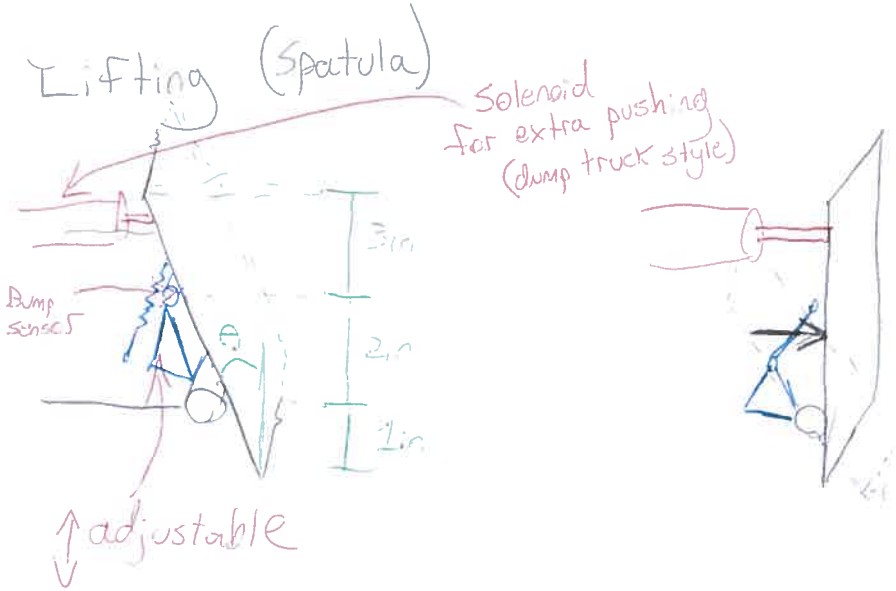
- Everyone:
  - Design IR circuit
  - Tape sensing design
  - Bumper design
  - Soldering and PCB
  - Strategy
- Rahul (shop access):
  - Source and spec motor
  - Sketch tape circuit
  - Coding up tape circuit
- Brian (shop access, car):
  - CAD up IR housing
  - Sketch the IR circuits
  - Code up IR sensing circuits
- Ying (Evil):
  - CAD/design robot chassis
  - Build the robot chassis out of Duron (1st prototype)
  - Code up movement logic
- Will (shop access):
  - Update HTML
  - Sketch bumper circuit (hall sensors?)
  - Physical bumper mechanism
  - Code bumper logic
- Nightly secret strategy meetings

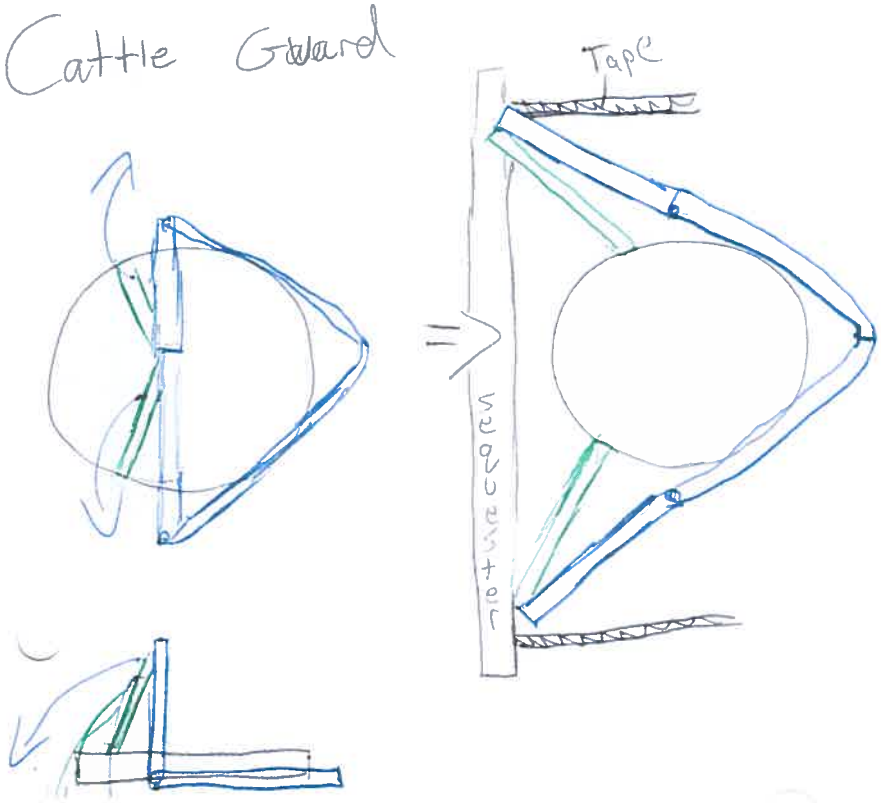
IDEA #1

Bumpers

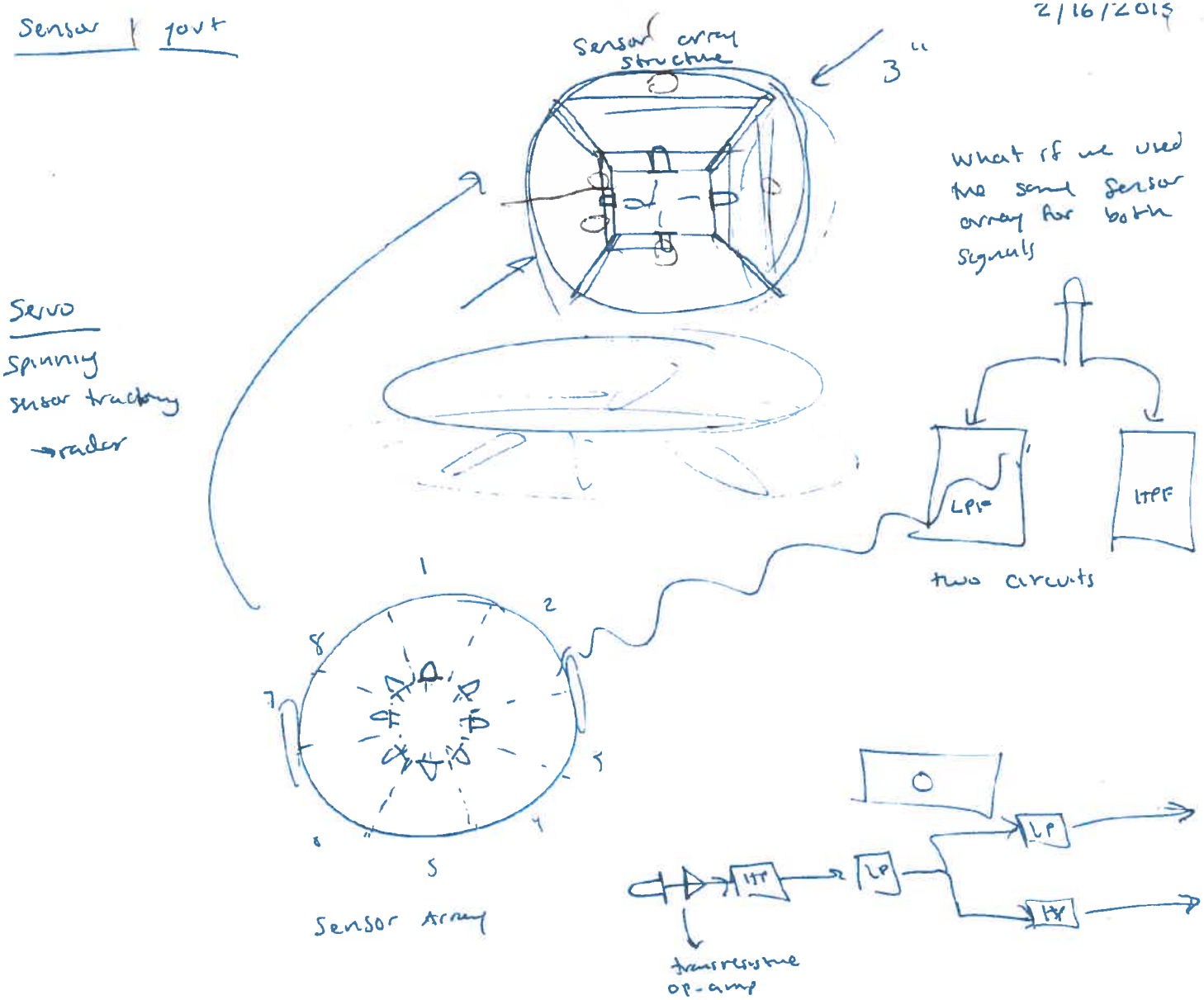


Bumper Ideas



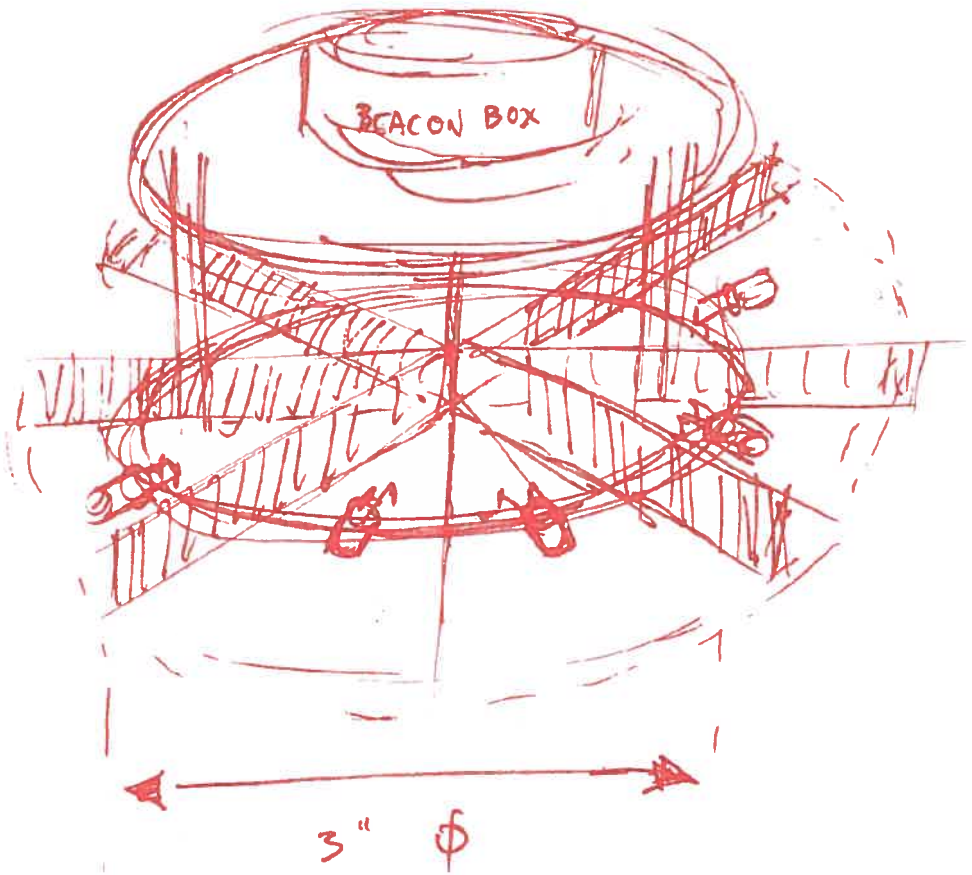


IR Sensor

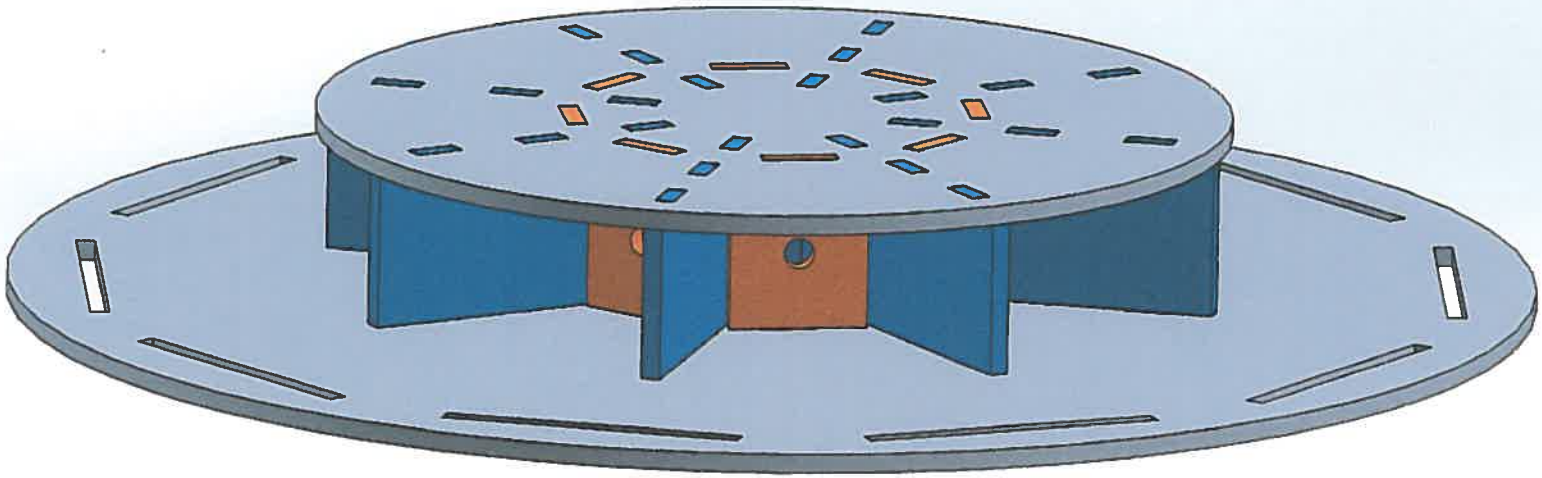

Sensor | 10v+
2/16/2015
Sensor array structure
3"
What if we used the same sensor array for both signals
Servo
Spinning sensor tracking
→radar
LPF
HPF
two circuits
1
2
3
4
5
6
7
8
Sensor Array
LP
HP
transresistive op-amp

Beacon and Sensor Housing

SKETCH 2/16



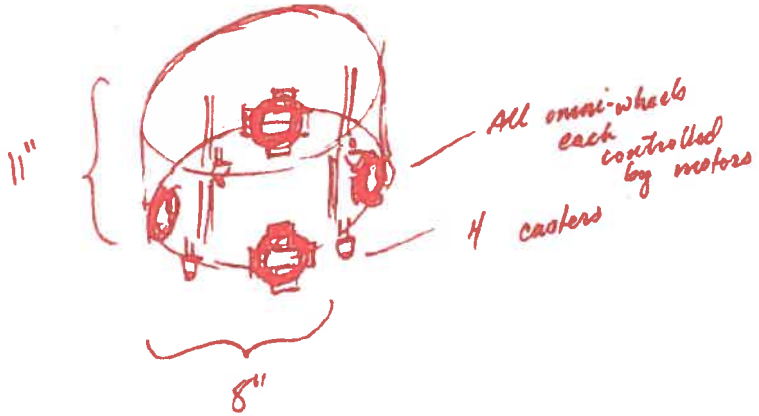
Beacon Array Housing



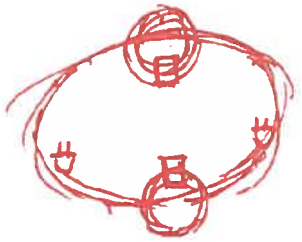
Drive Systems

2/16

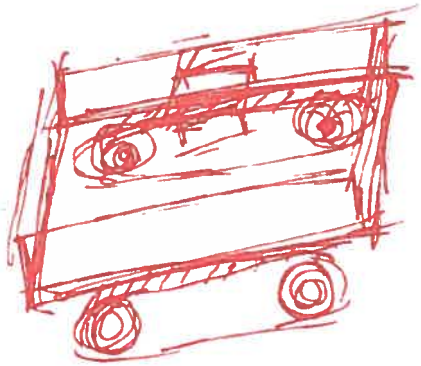
4 OMNI WHEELS



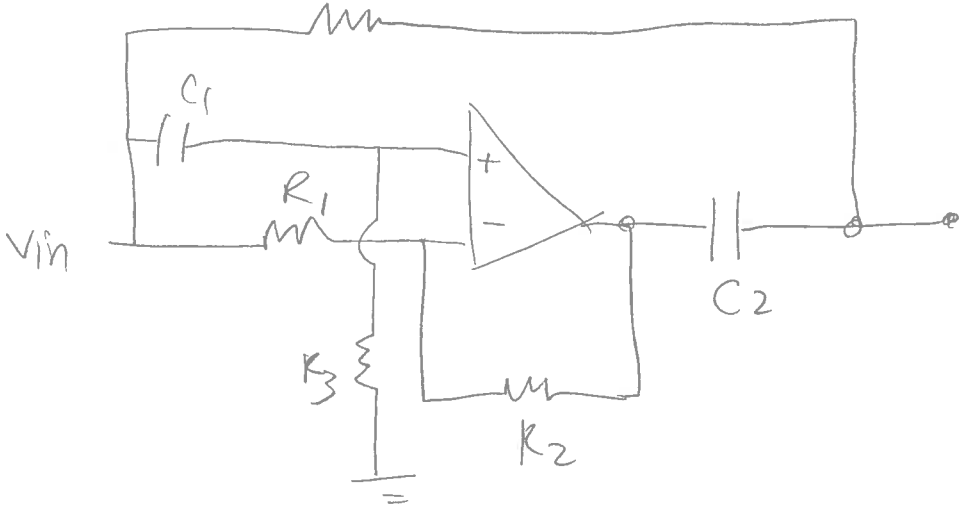
2 WHEELS



TREADS



2/20/13



notch filter

850 Hz

$f_{notch} = \frac{1}{2\pi RC}$

$R = R_3 = R_4$

$C = C_1\ C_2$

$R_1 = R_2$

$R_3 = R_4$

$C_1 = C_2$

$RC = \frac{1}{1700\pi} = .000187$

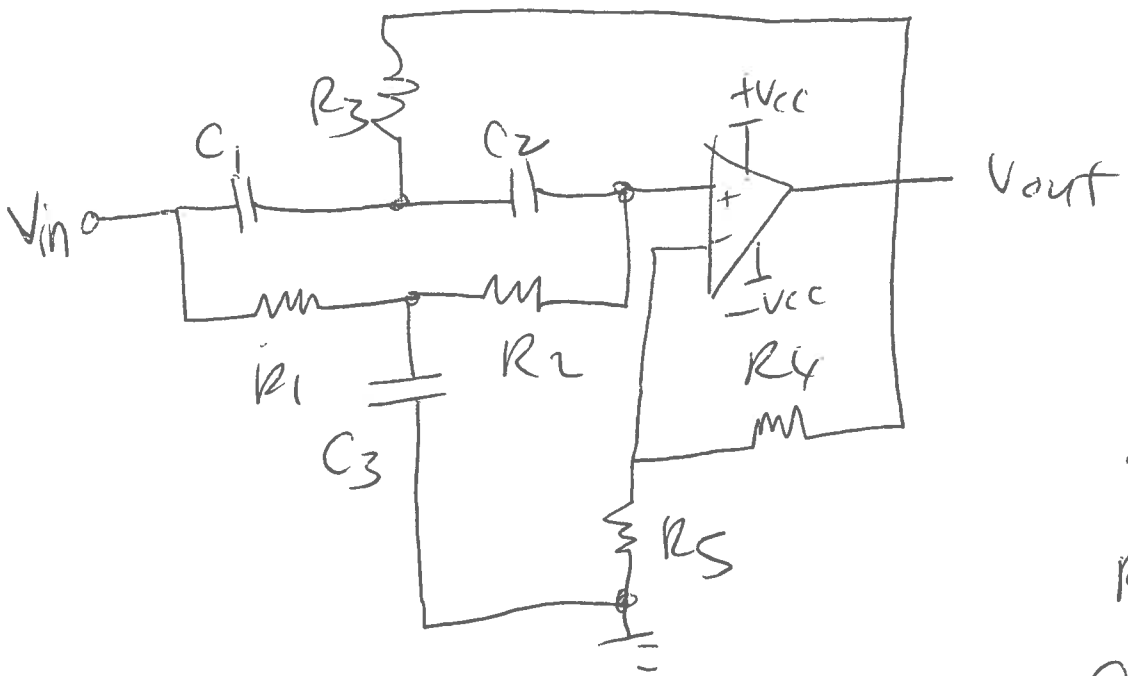
$C_{1,2} = 1\mu F$

$R_{3,4} = 187.241\ \Omega$

$R_{1,2} = 10\ k\Omega$?

sallen-key 2/20/13

notch filter



$$f = \frac{1}{2\pi RC}$$

$R_1 = R_2 = R$

$C_1 = C_2 = C$

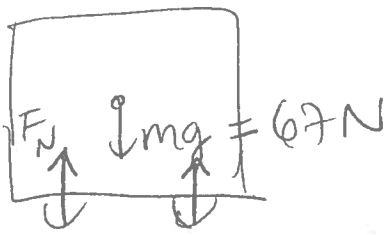
$R_3 = R/2$

$C_3 = 2C$

$R_4 \neq R_5$

↑ one or 2 standard values higher

2 wheels



$67N = 2F$

3" diameter wheels

$F_f = \mu N = .2(67N)$

$F_{rr} = .2(N) = .2(67)$

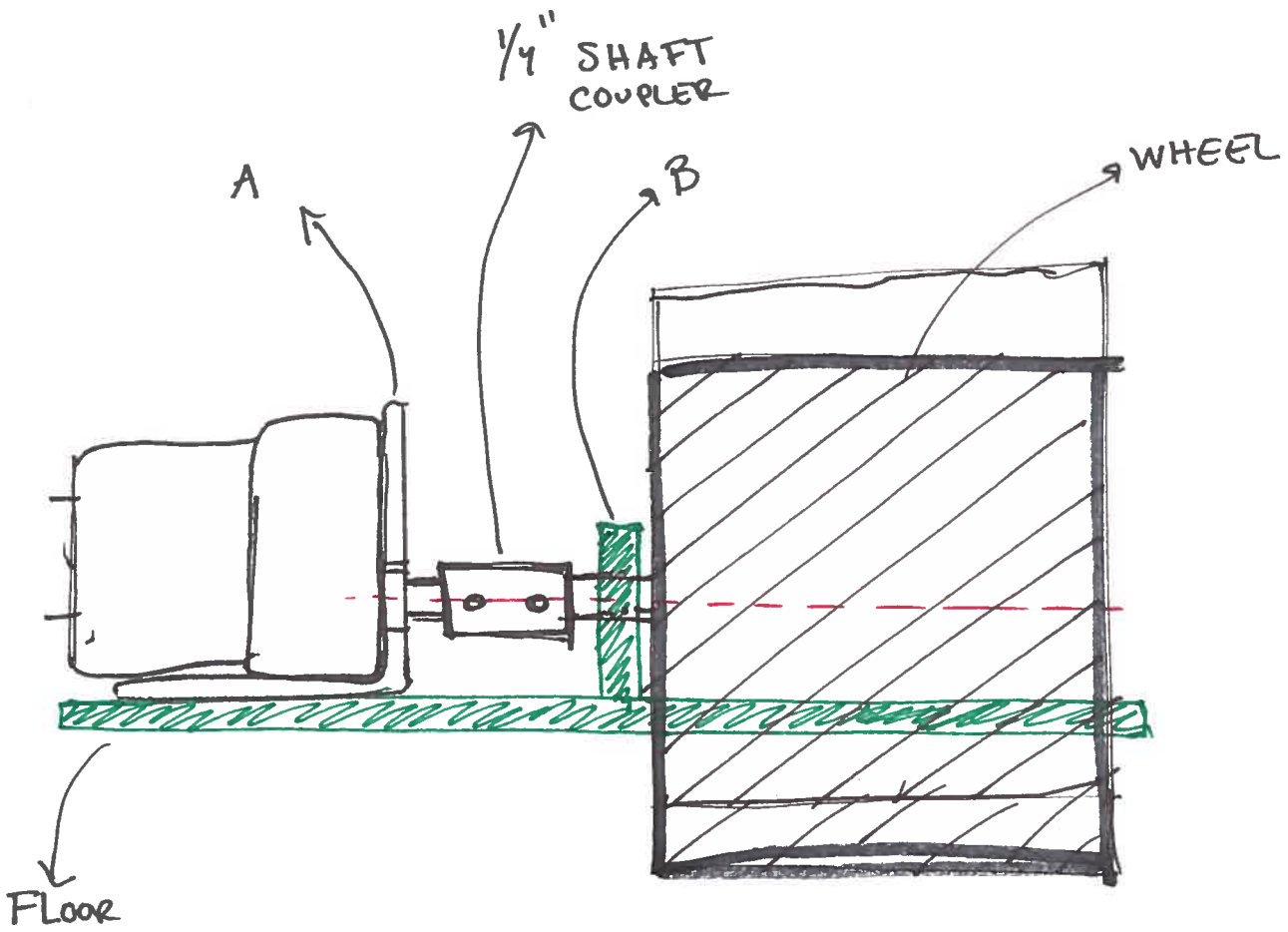
$r = .0381m$

26.8 N force total

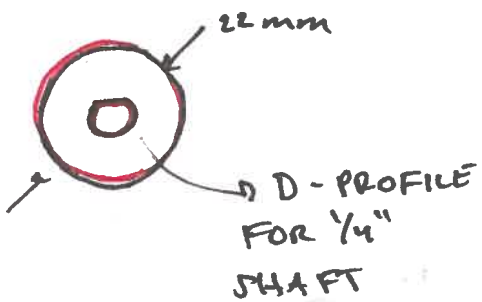
$g \cdot cm \frac{1kg}{1000g} \frac{9.81 \frac{m}{s^2}}{} \tau = 1.021\ Nm$ @ wheel

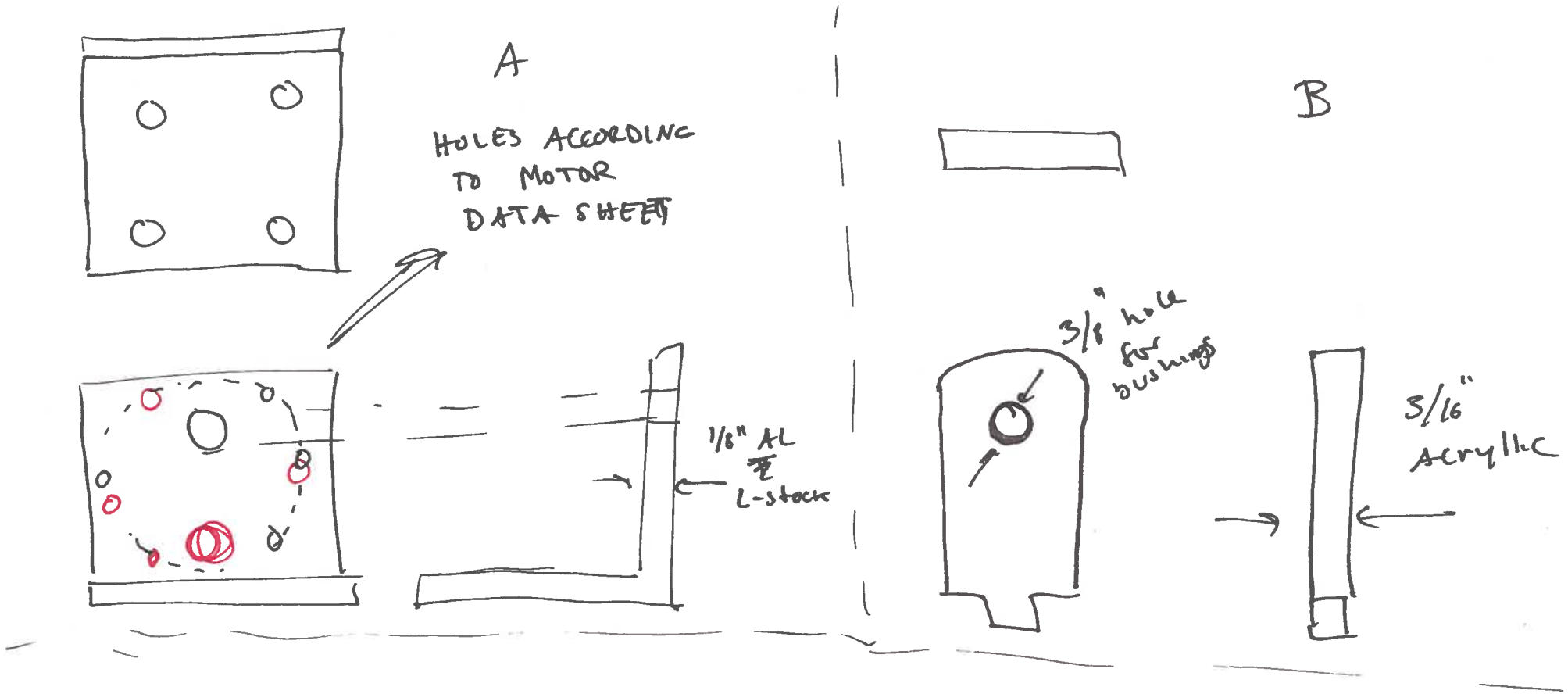
$\tau_{motor} \overset{\omega_{motor}}{=} \tau_{wheel}\ \omega_{wheel}$

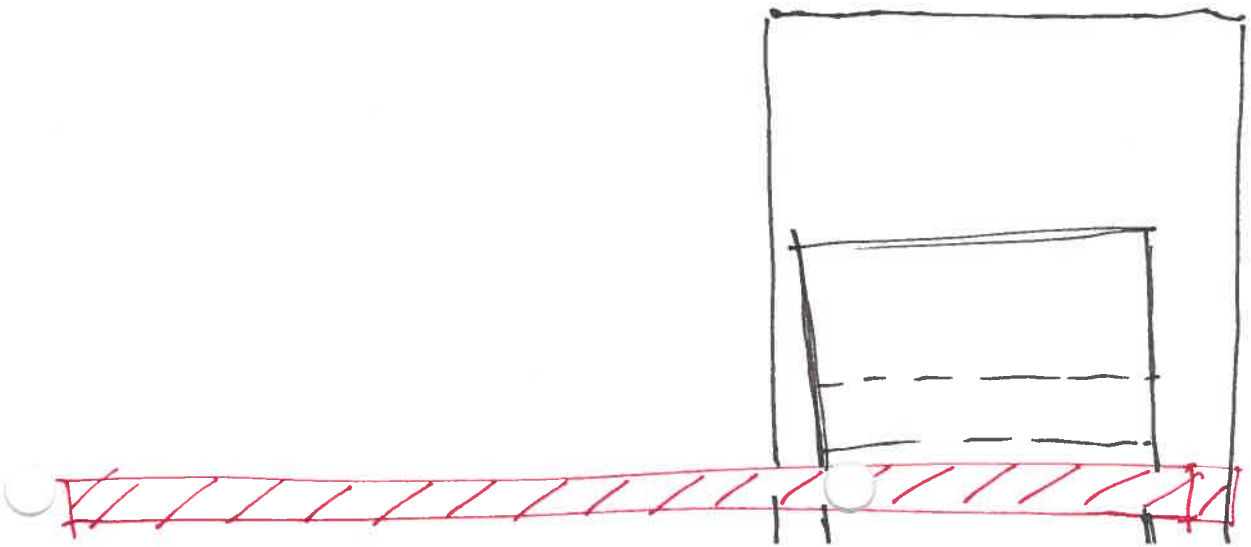
$\frac{\omega_{motor}}{\omega_{wheel}} = \text{gear ratio} = \frac{\tau_{wheel}}{\tau_{motor}}$

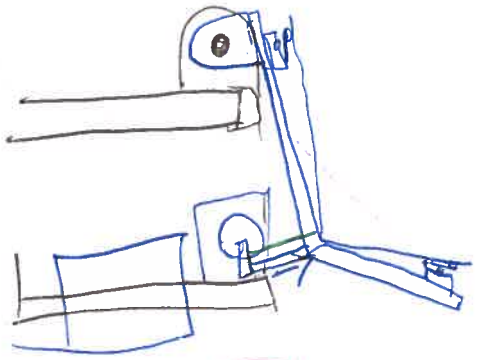


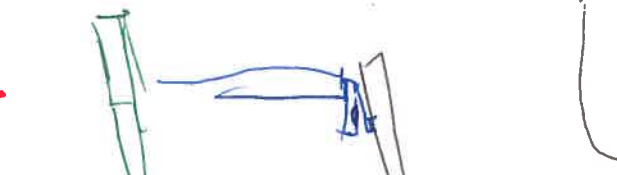
Wheel INSERT




A
HOLES ACCORDING TO MOTOR DATA SHEET
1/8" AL ∠ L-stock
B
3/8" hole for bushings
3/16" Acrylic

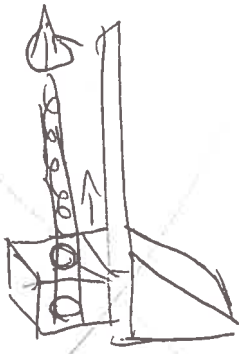


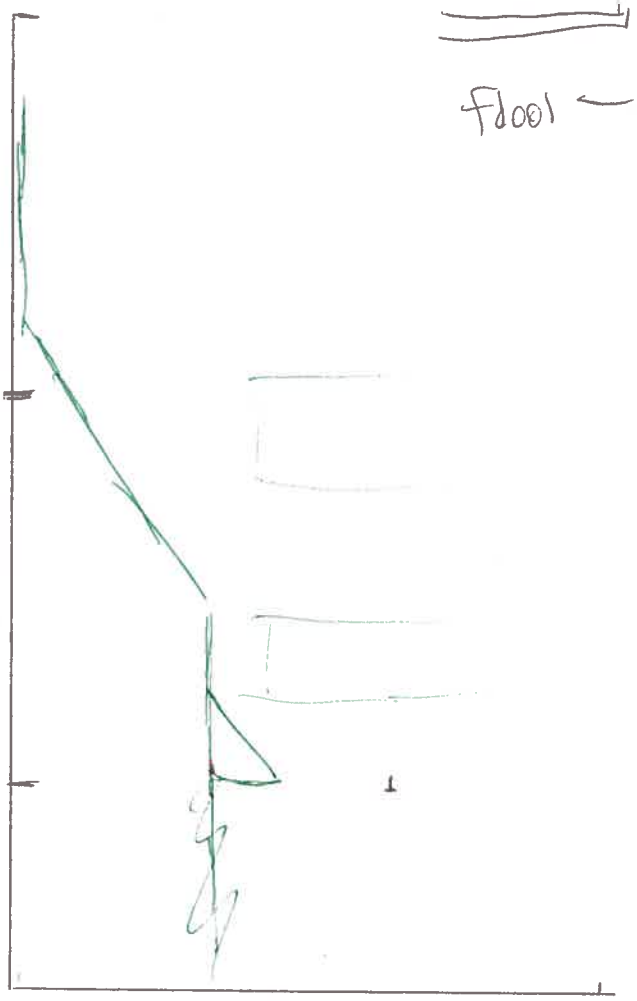


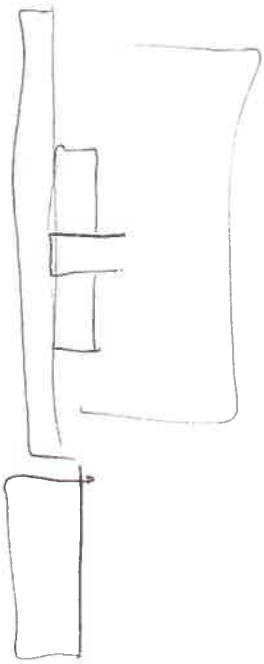


3in
0.5
floor


3in
1in




ground



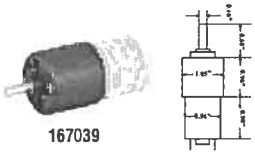
6, 12 & 24VDC Reversible Gear Head Motors

*Web Code: KBB

- Solder-type terminal
- Insulation resistance: 10MΩ
- High torque construction
- Oil bearing design for long service life
- Dielectric strength: 300VDC

HN27GD Series

Part No.	Cross Ref. No.	Rated Voltage (VDC)	Operating Range (VDC)	@ Maximum Efficiency Current (mA)	Speed (RPM)	Torque (g-cm)	Gear Ratio	Gear Case Size Dia. x Length (in.)	Motor Size Dia. x Depth (in.)	Shaft Size Dia. x Length (in.)	Pricing 1	5	25
167039	GH12-0953Y	12	4.5 – 24	90	9	1200	188:1	1.1 x 1.0	1.0 x 0.9	.16 x .60	$18.95	$16.95	$15.25
249480	GH12-1213Y7-0	12	4.5 – 24	51	90	460	70:1	1.1 x 0.6	1.0 x 0.9	.16 x .60	19.95	18.95	17.95
167047	GH12-1828Y	12	4.5 – 24	195	31	1300	90:1	1.1 x 0.8	1.1 x 1.3	.16 x .60	23.95	21.95	19.95

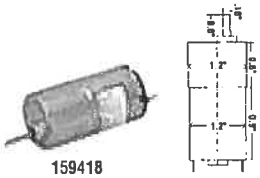


167039

HN27GD Series

GH30GM Series

Part No.	Cross Ref. No.	Rated Voltage (VDC)	Operating Range (VDC)	@ Maximum Efficiency Current (mA)	Speed (RPM)	Torque (g-cm)	Gear Ratio	Gear Case Size Dia. x Length (in.)	Motor Size Dia. x Depth (in.)	Shaft Size Dia. x Length (in.)	Pricing 1	5	25
153438	GH12-1045Y	12	3.0 – 12	90	13	800	200:1	1.1 x 0.6	0.9 x 1.0	.16 x .70	$15.95	$14.95	$13.95
170642	GH12-1828Y-10	12	6.0 – 24	105	8	3500	332:1	1.2 x 0.9	1.2 x 1.2	.16 x .70	22.95	19.95	17.95
159418	GH12-1921Y	12	4.5 – 12	200	25	2000	132:1	1.2 x 0.9	1.2 x 1.2	.16 x .70	23.95	21.95	19.95
162191	GH12-1324Y225	12	4.5 – 12	145	190	300	30:1	1.1 x 0.6	1.0 x 0.9	.16 x .70	17.95	15.95	13.95

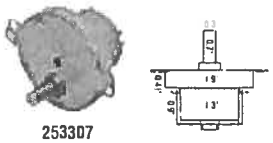


159418

GH30GM Series

32GM Series

Part No.	Cross Ref. No.	Rated Voltage (VDC)	@ Maximum Efficiency Current (mA)	Speed (RPM)	Torque (g-cm)	Gear Ratio	Gear Case Size Dia. x Height (in.)	Motor Size Dia. x Depth (in.)	Shaft Size Dia. x Length (in.)	Pricing 1	5	25
2146505	32-6V3.1RPM	6	90	3	7350	340:1	1.9 x 0.41	1.3 x 0.9	.28 x .87	$17.95	$15.95	$13.95
253323	32-6V7RPM	6	40	6	1500	176:1	1.9 x 0.41	1.3 x 0.9	.30 x .70	12.95	11.49	9.95
253307	32-002	6	38	8	1200	150:1	1.9 x 0.41	1.3 x 0.9	.30 x .70	17.95	15.95	13.95

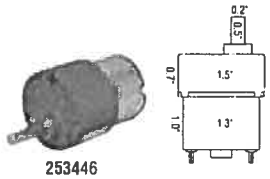


253307

32GM Series

38GM Series

253534	38-010	12	97	24	7500	250:1	1.46 x 1.0	1.3 x 0.9	.24 x .50	$16.95	$14.95	$13.49
253518	38-008	12	87.5	40	4800	150:1	1.46 x 1.0	1.3 x 0.9	.24 x .50	14.95	13.49	11.95
253500	38-007	12	82	60	3200	100:1	1.46 x 0.7	1.3 x 0.9	.24 x .50	17.95	15.95	13.95
253489	38-005	12	76	110	1300	56:1	1.46 x 0.7	1.3 x 0.9	.24 x .50	14.95	13.49	11.95
253471	38-004	12	74	120	1100	50:1	1.46 x 0.7	1.3 x 0.9	.24 x .50	14.95	13.45	11.95
253446	38-001	12	61.8	600	350	10:1	1.46 x 0.7	1.3 x 0.9	.24 x .50	17.95	15.95	14.49



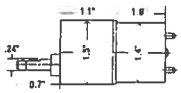
253446

38GM Series

GH35GM Series Plastic Gears

Part No.	Cross Ref. No.	Rated Voltage (VDC)	Operating Range (VDC)	@ Maximum Efficiency Current (mA)	Speed (RPM)	Torque (g-cm)	Gear Ratio	Gear Case Size Dia. x Length (in.)	Motor Size Dia. x Depth (in.)	Shaft Size Dia. x Length (in.)	Pricing 1	5	25
155012	GH12-1926	12	4.5 – 12	250	2	6000	3000:1	1.4 x 0.9	1.3 x 1.0	.23 x .90	$24.95	$22.49	$19.95
155821	GH12-1830Y-P	12	4.5 – 12	220	4.5	4500	1000:1	1.4 x 0.9	1.3 x 1.0	.23 x .90	23.95	21.95	18.95
155839	GH12-1641T-L	12	3.0 – 12	250	20	3000	270:1	1.4 x 0.8	1.3 x 1.0	.23 x .90	25.95	22.95	19.95
152911	GH12-1926Y	12	4.5 – 12	172	40	2370	100:1	1.4 x 0.6	1.3 x 1.2	.24 x .90	24.95	22.49	19.95
155855	GH12-1641T-F	12	3.0 – 12	250	71	1000	60:1	1.4 x 0.6	1.3 x 1.0	.23 x .90	24.95	22.49	19.95
151441	GH12-1632T	12	4.5 – 12	275	57	2200	100:1	1.4 x 0.6	1.3 x 1.0	.23 x .90	23.95	22.95	21.95
155863	GH12-1926Y-F	12	4.5 – 12	300	70	1000	60:1	1.4 x 0.7	1.3 x 1.0	.24 x .70	22.95	21.95	19.95
161374	GH12-1345T	12	4.5 – 12	185	116	650	30:1	1.3 x 0.9	1.5 x 0.7	.23 x .90	23.95	21.95	19.95
161382	GH12-1634T	12	4.5 – 12	293	145	850	30:1	1.4 x 0.6	1.3 x 1.0	.23 x .90	24.95	22.49	19.95
164786	GH12-1640Y	12	4.5 – 24	120	220	180	10:1	1.4 x 0.6	1.3 x 1.1	.23 x .90	24.95	22.49	19.95
176050	GH12-1640Y00	24	12 – 24	340	1.8	6000	3000:1	1.4 x 1.0	1.3 x 1.0	.23 x .90	23.95	21.95	19.95
176032	GH24-1640Y06	24	12 – 24	340	50	2000	90:1	1.4 x 0.6	1.3 x 0.9	.23 x .90	25.95	22.95	19.95
176023	GH24-1640Y19	24	12 – 24	340	148	1000	30:1	1.4 x 0.6	1.3 x 0.9	.23 x .90	25.95	22.95	19.95

155012



155013

GH35GM Series

GH35GM Series Metal Gears

Part No.	Mfr. Part No.	Rated Voltage (VDC)	Operating Range (VDC)	@ Maximum Efficiency Current (mA)	Speed (RPM)	Torque (g-cm)	Gear Ratio	Gear Case Size Dia. x Length (in.)	Motor Size Dia. x Depth (in.)	Shaft Size Dia. x Length (in.)	Pricing 1	5	25
155013	HN-GH12-1632T-R-M	12	4.5 – 12	250	2	6000	3000:1	1.3 x 0.9	1.5 x 1.1	.23 x .90	$23.95	$21.95	$19.95
155822	GH12-1830Y-P-R-M	12	4.5 – 12	250	4.5	4500	1000:1	1.3 x 0.9	1.5 x 1.0	.23 x .90	23.95	21.95	18.95
151442	HN-GH12-1632T-R-M	12	4.5 – 12	275	57	2200	100:1	1.3 x 0.9	1.5 x 0.7	.23 x .90	22.95	20.49	17.95

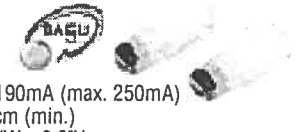
SOLAROBOTICS Gear Head Motor

- Current @ 6V: 57mA
- Stall current @ 6V: 633mA
- Stall torque @ 6V: 59.26 in oz.
- Gear ratio: 143:1
- RPM @ 6V: 80
- Size: 2.2"L x 1.9"W x 0.9"H

Part No.	Mfr. Part No.	1	5	25
400995	GM8	$6.95	$6.25	$5.75

Gear Head Motor Pair w/ 90° Shaft

- Recommended voltage: 4.5VDC
- No load speed: 90 RPM ±10
- No load curret: 190mA (max. 250mA)
- Torque: 800 gf cm (min.)
- Size: 2.5"L x 1.5"W x 0.9"H



Part No.	Mfr. Part No.	1	5	25
2150432	DG01D	$6.49	$5.95	$5.49

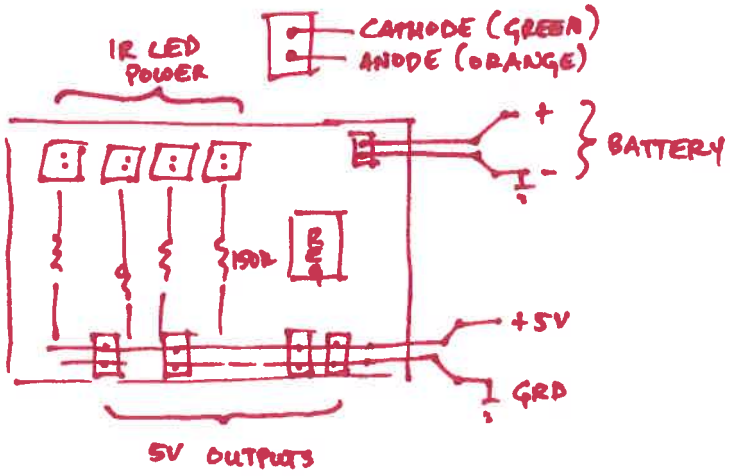
Pololu Miniature Gear Motor

- Input voltage: 6V
- Gear ratio: 100:1
- Free-run speed @ 6V: 320 RPM
- Stall torque @ 6V: 25 oz-in.
- Size: 0.94"L x 0.39"W x 0.47"H
- Weight: 0.34 oz.

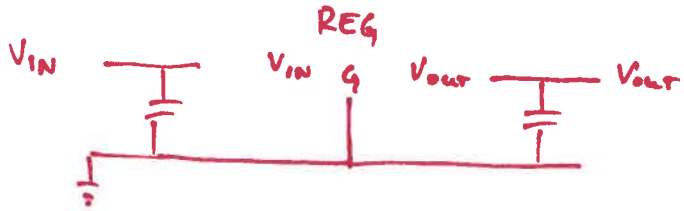
Part No.	Mfr. Part No.	1	5
2128219	1101	$15.95	$14.95

*For additional products, availability, and additional specifications visit Jameco.com and enter the web code in the product search box

VOLTAGE REGULATOR

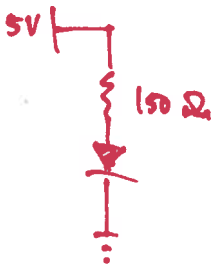


REG:



SOURCES $\leq$ 1 A

LED:



$I_{NL} = 65\ mA$

$\tau_R = 3.2\ kg\cdot cm = 3200\ N\cdot m$

$\omega_R = 60\ RPM$

$I_{12} = 82\ mA$

$\omega_{NL} = 72$

$$\omega = \omega_{NL} - \frac{12/3200}{\omega_{NL}}\tau$$

$(0.07)(11.3\ kg)(9.8\ m/s^2) = 7.77\ N$

$R = 0.035\ m$

$0.2723\ N\cdot m$

$= 2723\ g\,cm$

$-0.3182 \quad +91.091$

$\omega = 72 - \frac{4800}{40}$

$\tau = kI$

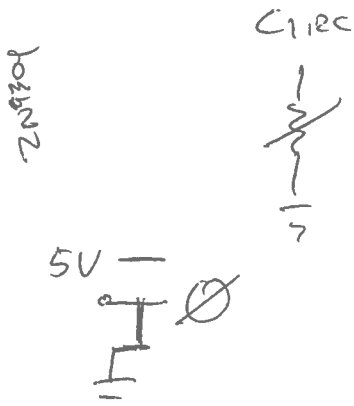
$I = I_{NL} - C\omega_{RPM}$

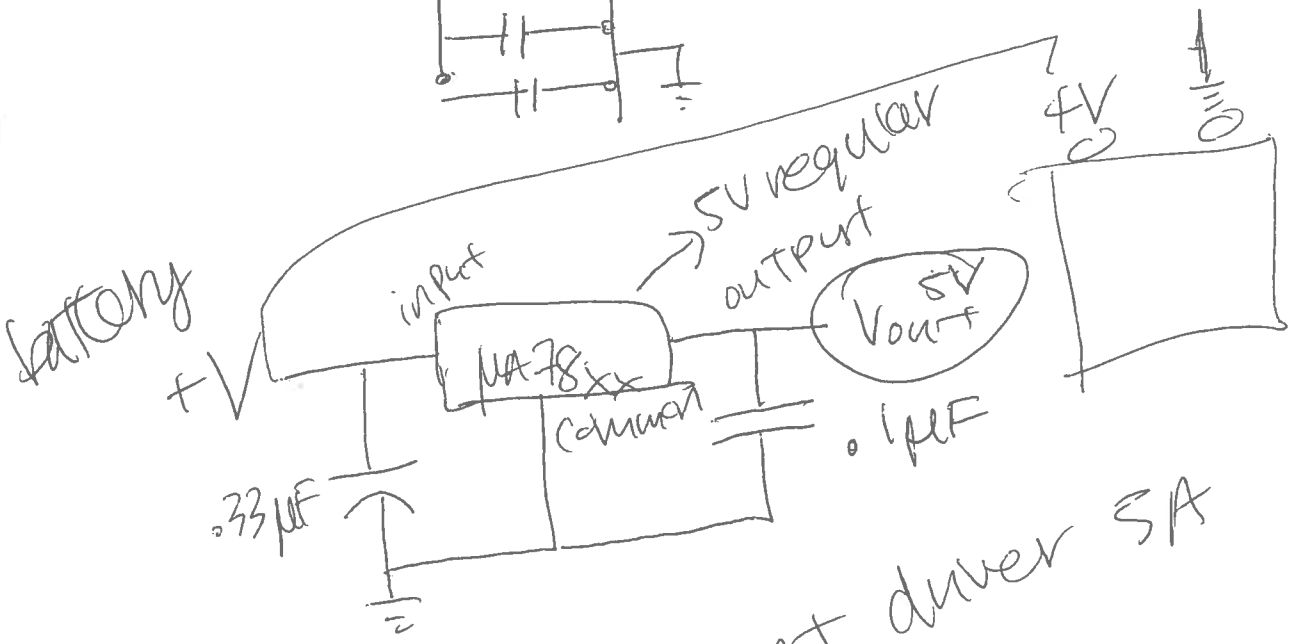
$I = 65\ mA - k\omega$

$\omega = 60 \quad I = 82$

$\omega = 72 \quad I = 65$

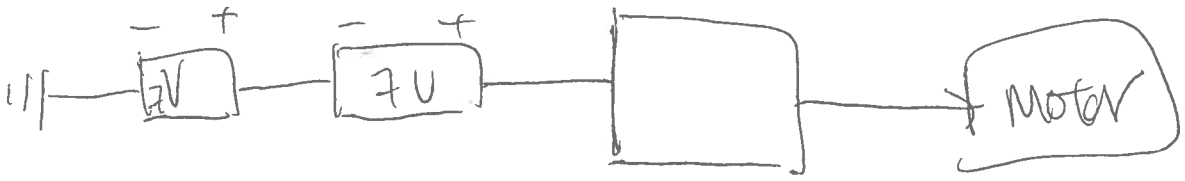
Motor Drivers
LMD 18200 3A





current driver 5A

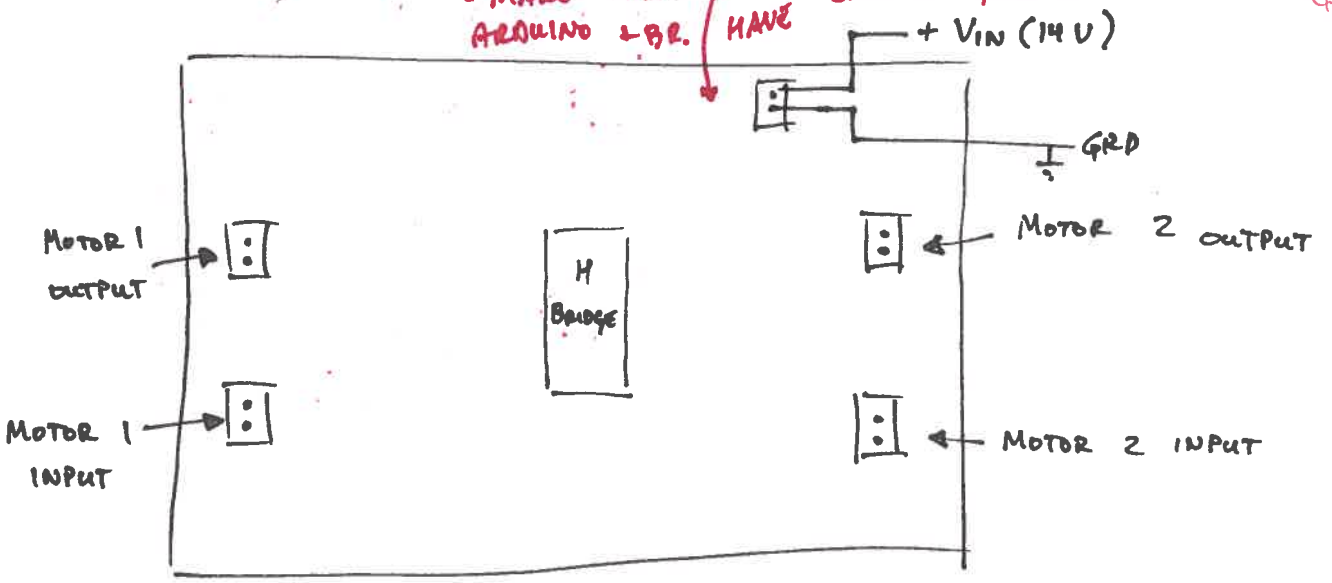
+V 5A driver → NCV7729-5A



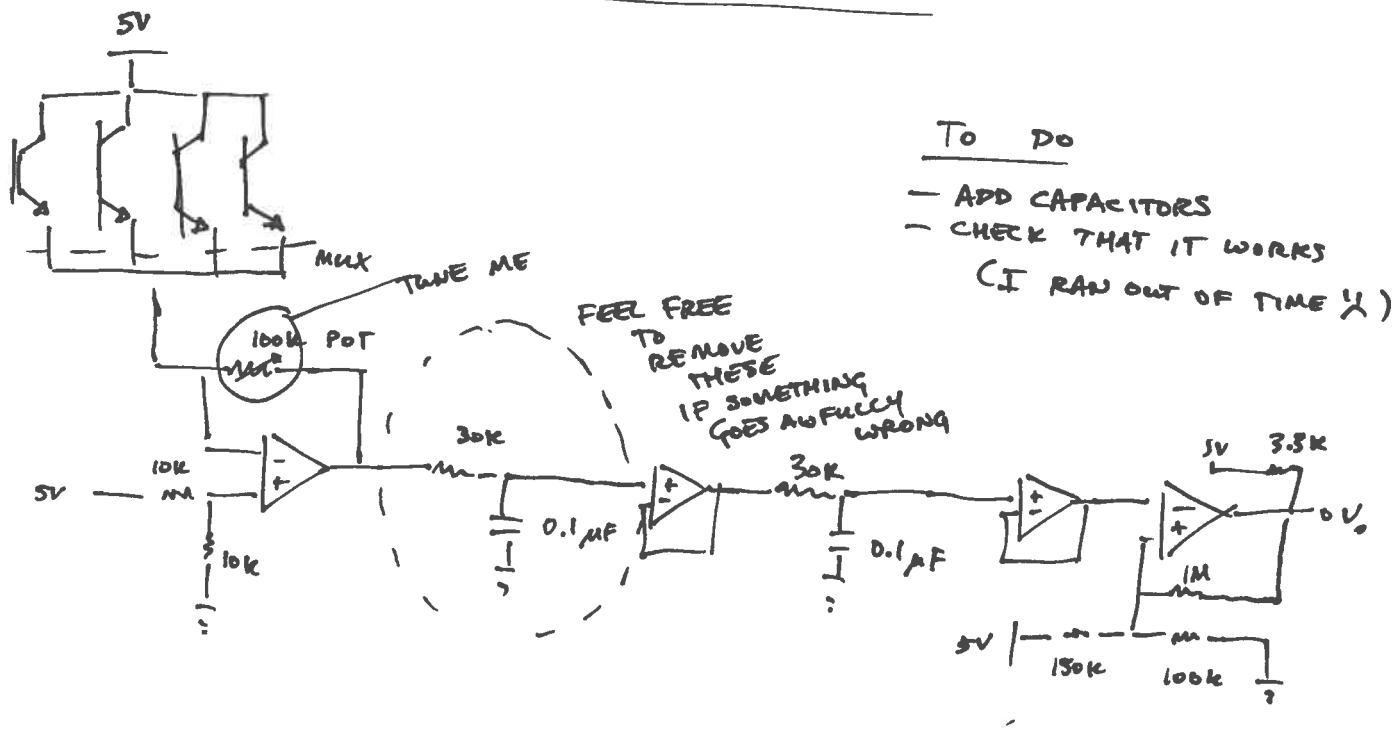
H-Bridge Board

To do

- ADD A BIG ~~DIODE~~ CAPACITOR HERE (ACROSS RAILS) + SMACC ONE ACROSS CHIP
- THERMAL GREASE
- MAKE SURE ARDUINO + BR. HAVE COMMON GROUND

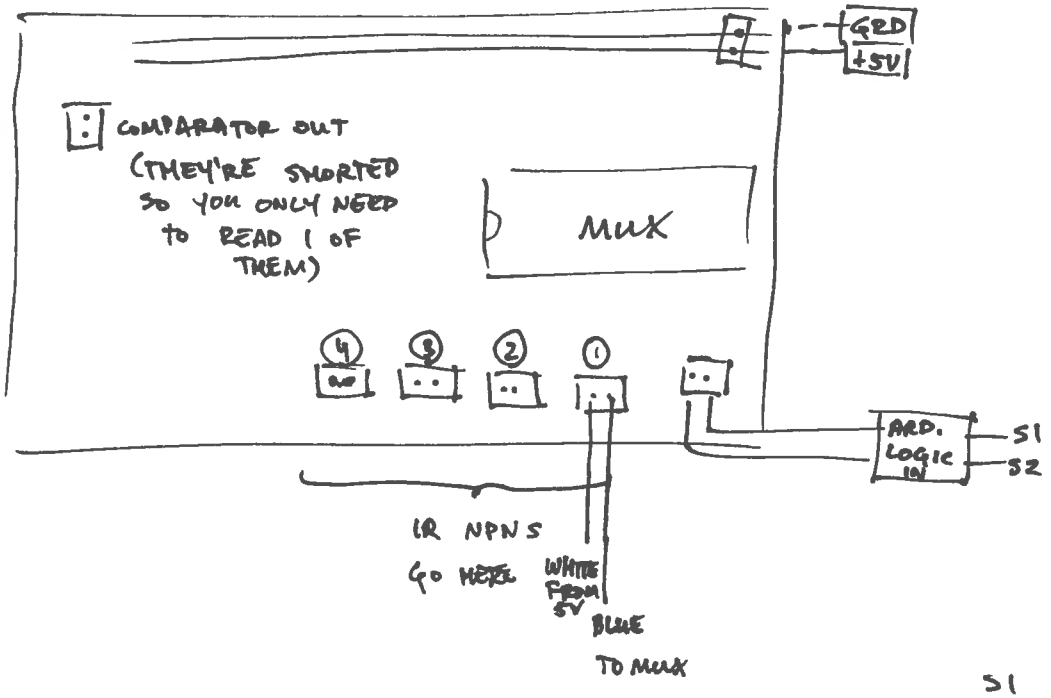


TAPE SENSING BOARD

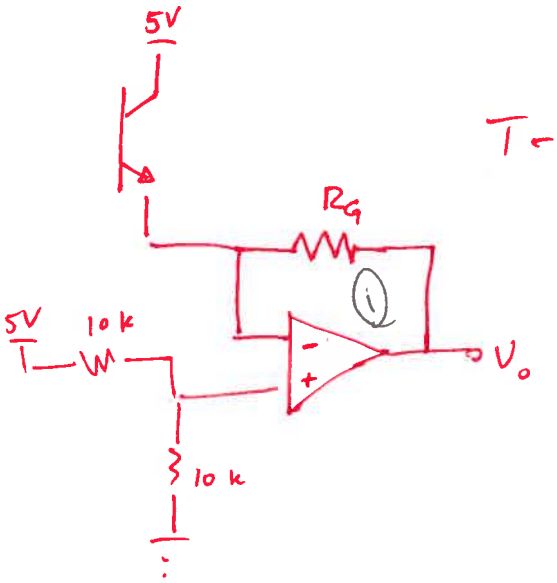


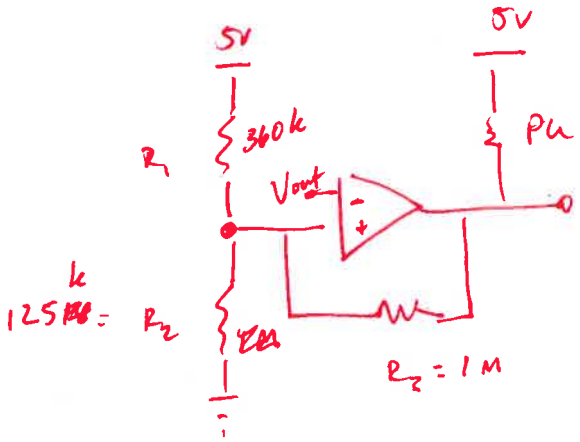
To Do

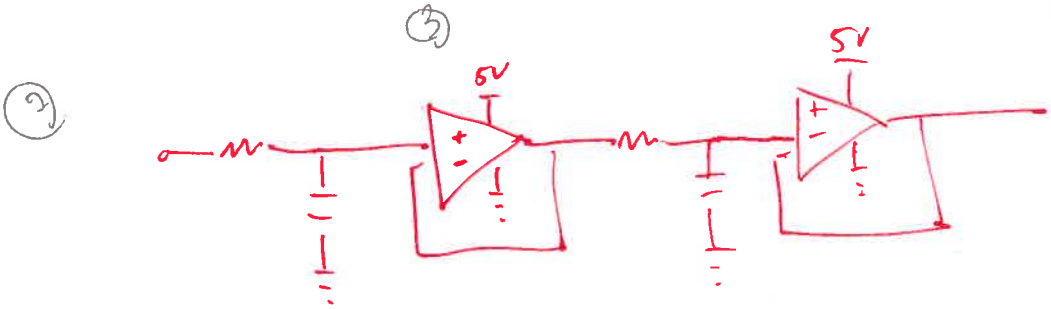
- ADD CAPACITORS
- CHECK THAT IT WORKS (I RAN OUT OF TIME :( )



S1	S2	MUX
0	0	#1
1	0	#2
0	1	#3
1	1	#4

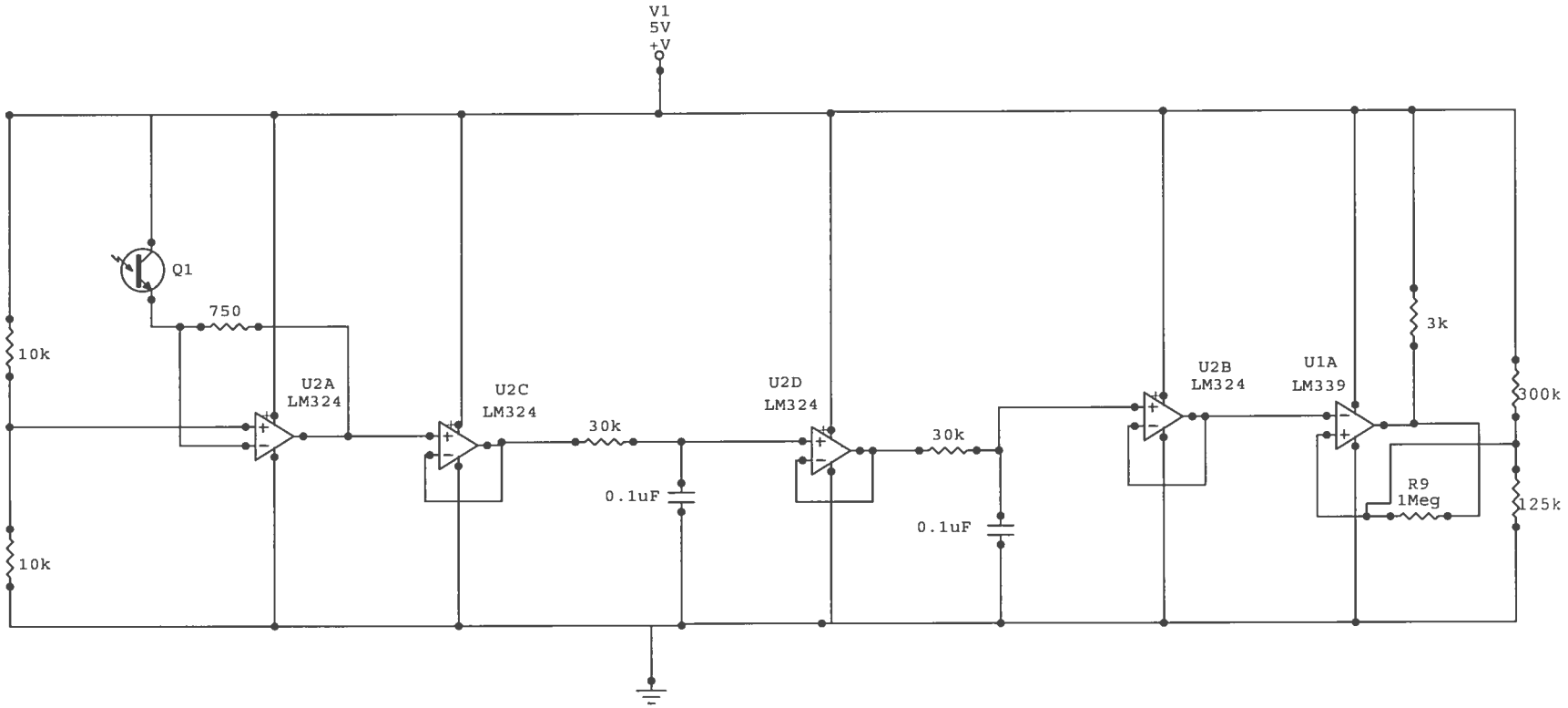




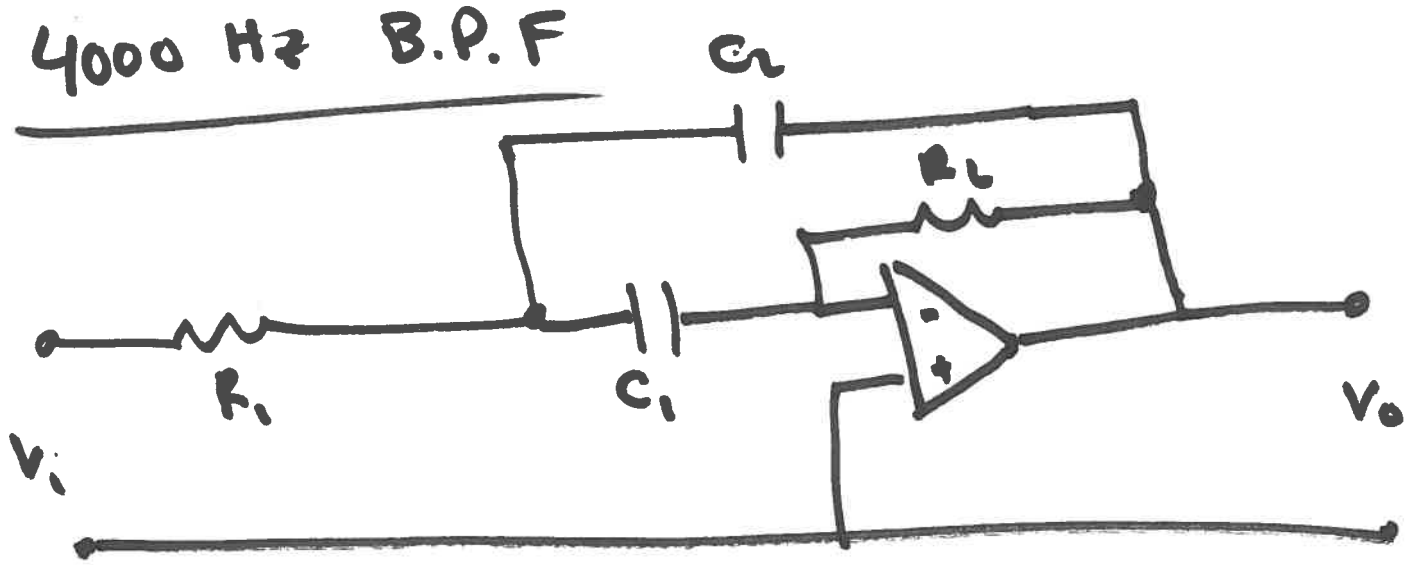


Parts

- 4 Op-Amps
- 2 10 k
- 1 750 Ω
- 2 0.1 μF
- 2 30k
- 1 1M
- 1 125 k
- 1 360 k
- 1 3 Ω


V1
5V
+V
Q1
750
10k
10k
U2A
LM324
U2C
LM324
30k
0.1uF
U2D
LM324
30k
0.1uF
U2B
LM324
U1A
LM339
3k
300k
R9
1Meg
125k

4000 Hz B.P.F



$$Q = \frac{1}{2}\sqrt{\frac{R_2}{R_1}}$$

$$f_r = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}}$$

$$Q = 5 = \frac{1}{2}\sqrt{R_2/R_1} \Longrightarrow \frac{R_2}{R_1} = 100$$

$R_2 = 10k$

$R_1 = 1k$

$$4000 = \frac{1}{2\pi\sqrt{10k^2 C_1 C_2}}$$

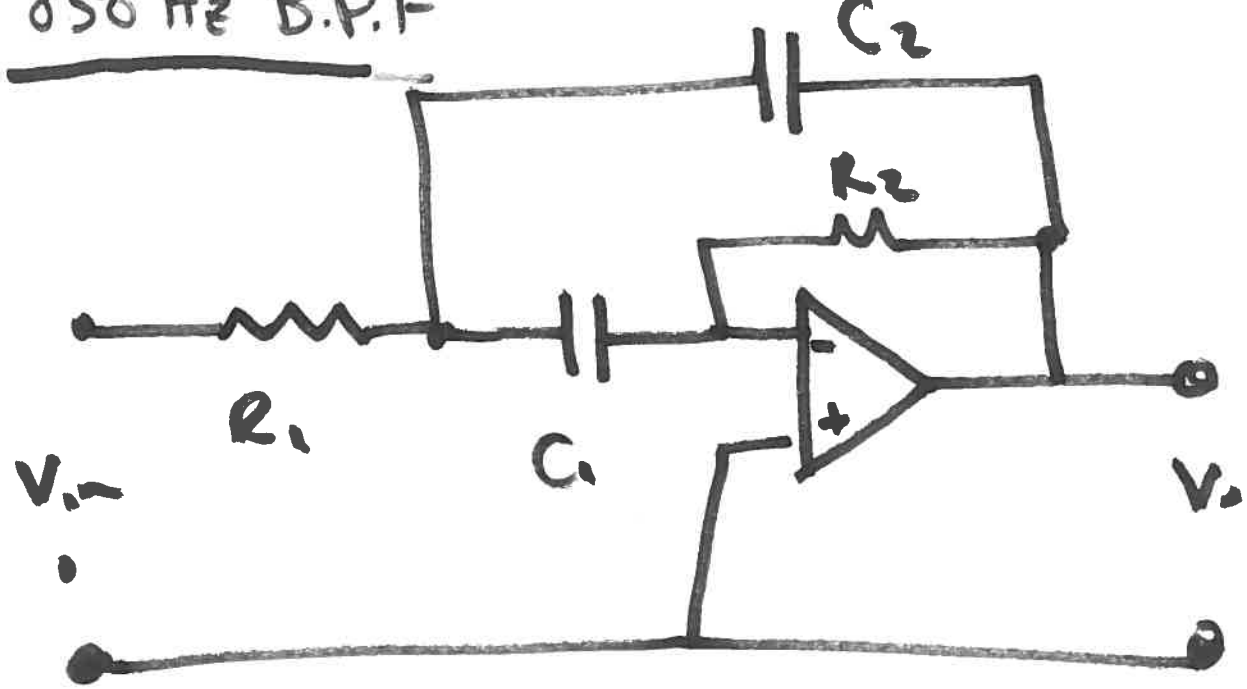
$C_1 = .01\,\mu F$

$C_1 C_2 = \cancel{.0405}$ 1.58×10^{-16}

$C_2 = \sim 1.5 \times 10^{-8}\ F$

2/25/2013

850 Hz B.P.F



$$Q = \frac{1}{2}\sqrt{\frac{R_2}{R_1}}$$

$$f_r = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}}$$

So $Q = 5 = \frac{1}{2}\sqrt{\frac{R_2}{R_1}} \Rightarrow \frac{R_2}{R_1} = 100$ $R_2 = 100k$, $R_1 = 1k$

$$850 = \frac{1}{2\pi\sqrt{100k^2 C_1 C_2}}$$

$C_1 = .1\,\mu F$

$C_1 C_2 = 3.5 \times 10^{-16}$

$C_2 = 3.5e^{-8} \rightarrow 4.7e^{-8}$

2/24/2003

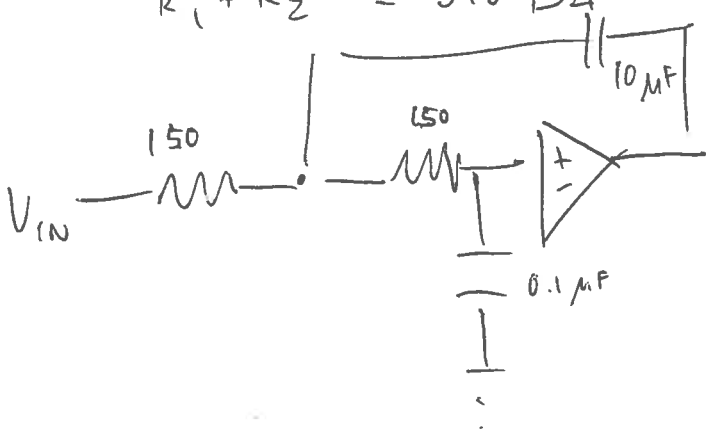
$$\sqrt{\quad} = 1.59 \times 10^{-4}$$

$$\bar{5} = \frac{1.59 \times 10^{-4}}{C_2 (R_1 + R_2)}$$

$C_2 = 0.1\ \mu F$

$$\bar{5} = \frac{1592}{R_1 + R_2}$$

$R_1 + R_2 = 318\ \Omega$



$R_1 = 150$

$R_2 = 150$

$C_2 = 0.1\ \mu F$

$C_1 = 1.1 \times 10^{-5}$

$= 11 \times 10^{-6} = 11\ \mu F$

$f_c = \frac{1}{2\pi RC} = 1\ Hz$

Low Pass

$6\pi = \frac{1}{RC}$

$R = \frac{1}{6\pi C}$

500k
1
0.1 μF
Flattening filter

$\frac{1}{2\pi RC} = 400\ Hz$

3.97×10^{-6}

0.0397

$Q = 5$

$C_1 = C_2 = 0.1\ \mu F$

$R_1 = 10\ k$

$f = 1000\ Hz$

$2\pi f\sqrt{R_1 C^2} = \frac{1}{\sqrt{R_2}}$

$R_2 = 250$

$R = 47\ \Omega$

$\frac{1}{2\pi(47)C} = 1\ kHz = 10^3$

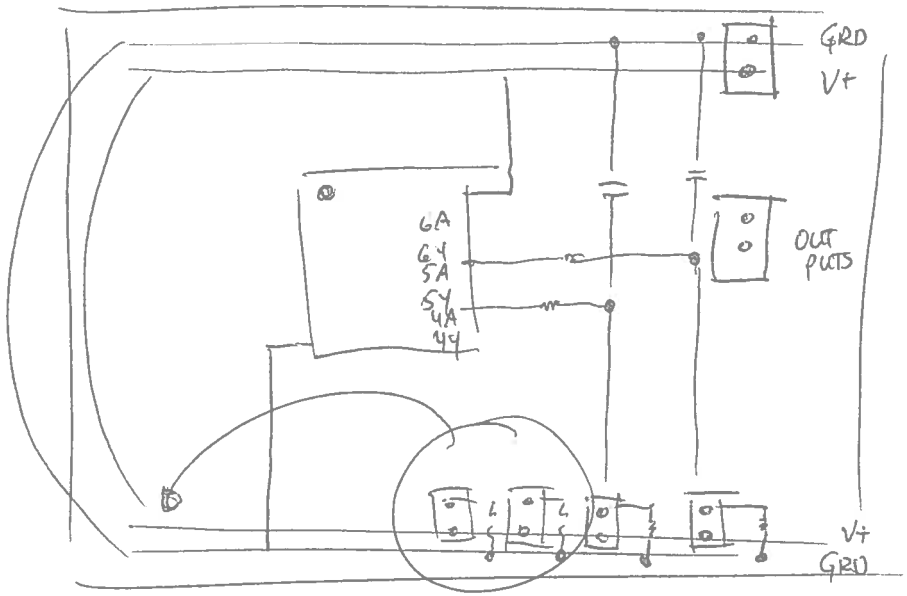
$3.3 \times 10^{-6}\ F$

$3.3\ \mu F$

400 Hz x2

10k

IN



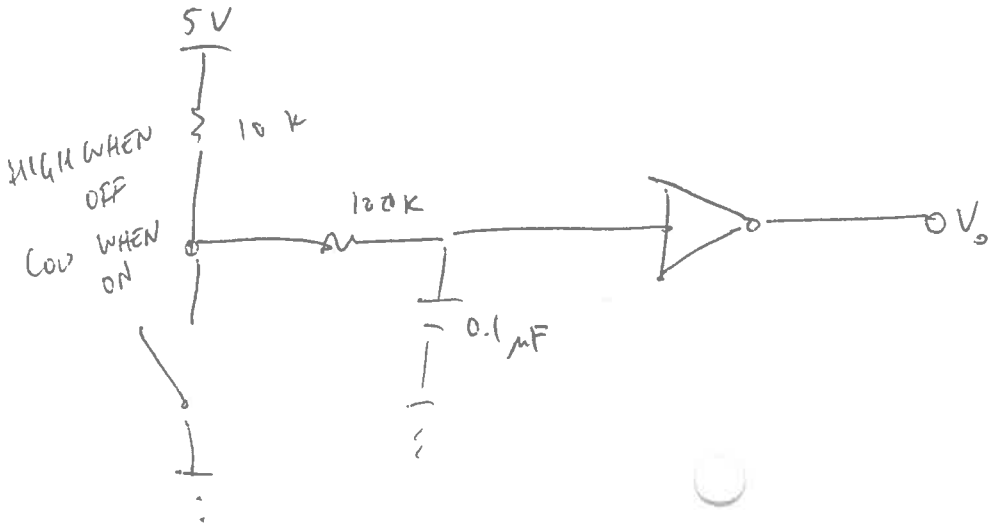
2 0.1 μF caps

2 100 K

2 10 K

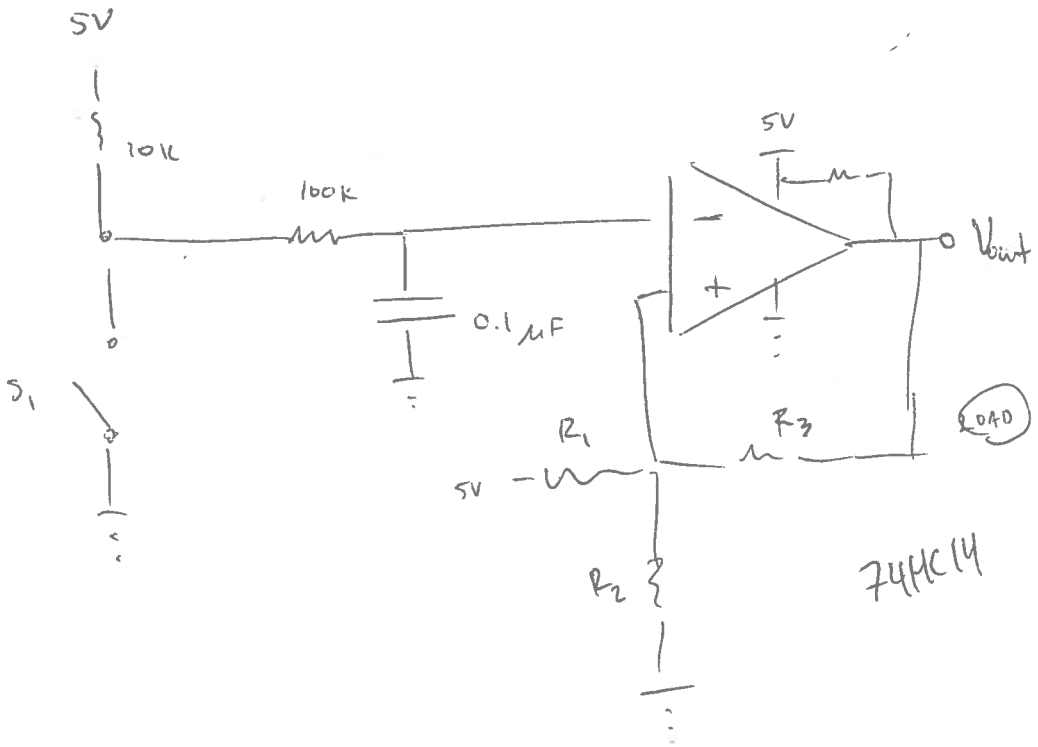
4 MOLEX

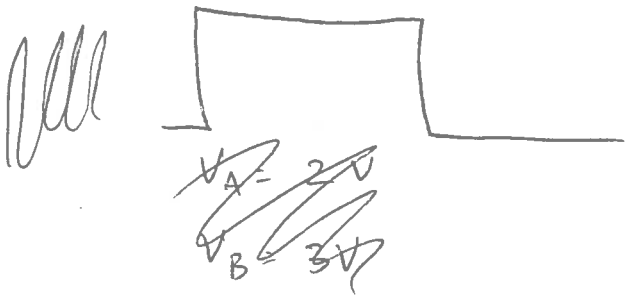
1 74HC14



HIGH WHEN ON

LOW WHEN OFF





$V_{A1} = 3V$

$V_{A2} = 2V$

$\Delta V = 1.0V$

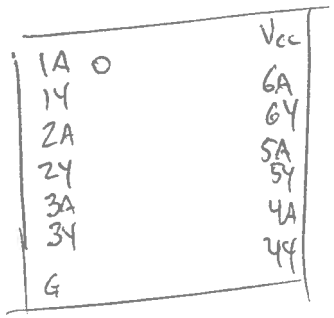
$n = \frac{\Delta V}{V_{A2}} = 0.5$

$R_3 = 1\ M\Omega$

$R_{eq} = 500\ k\Omega$

$R_1 || R_3 = \frac{1}{\frac{1}{1.5} + \frac{1}{1}} = 333\ k\Omega$

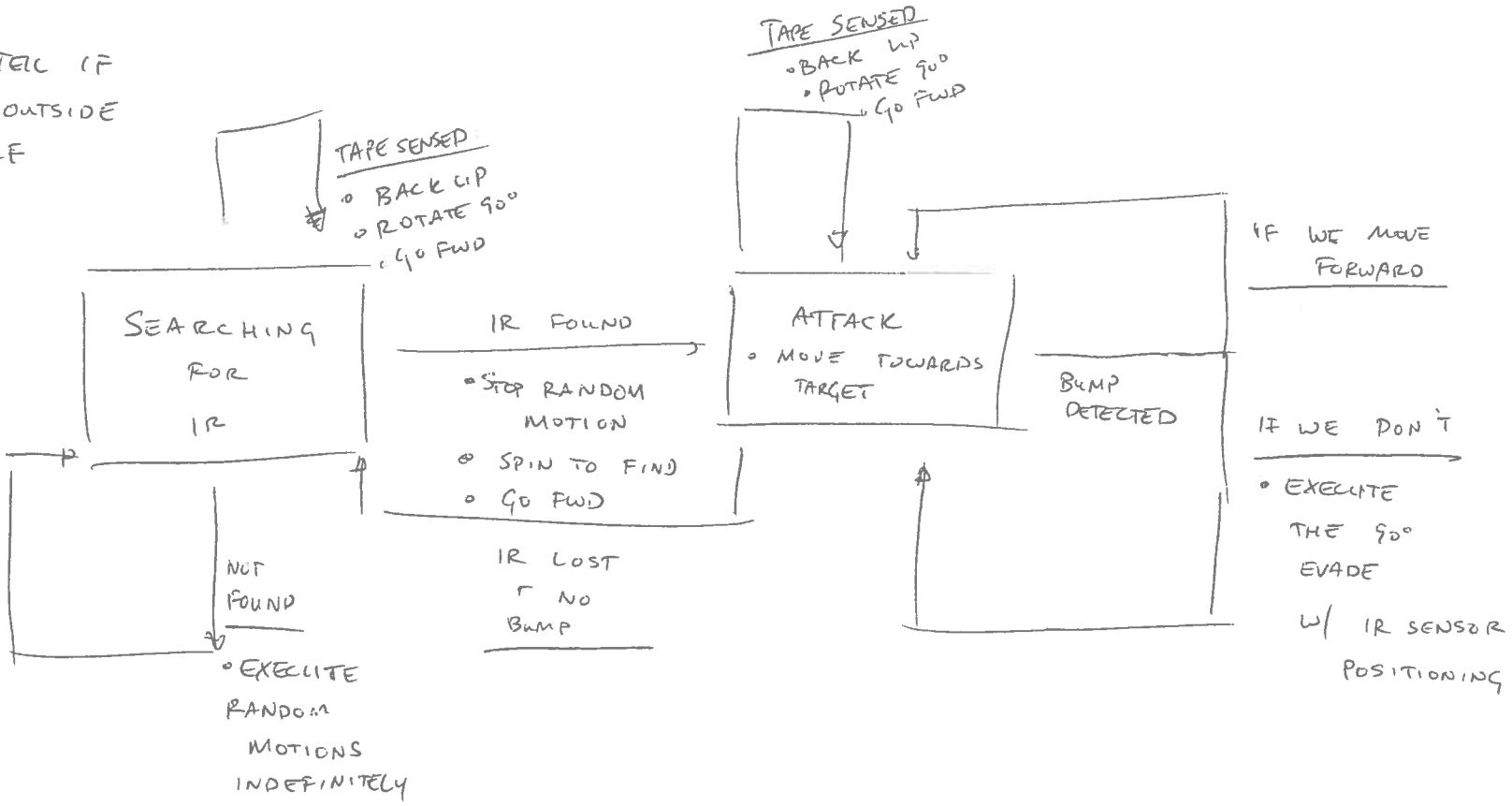
$R_2 = \underline{333}$

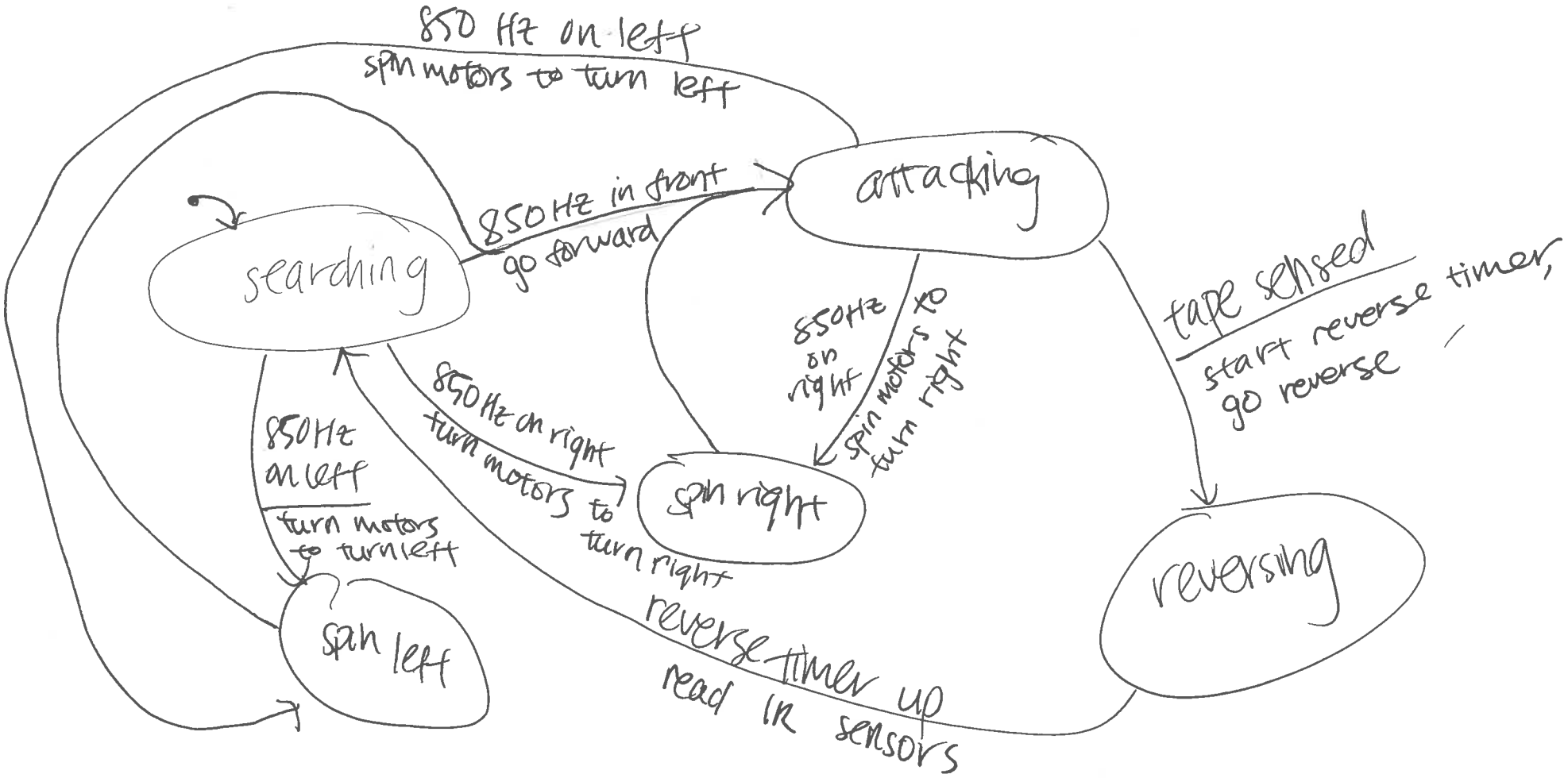


STATE DIAGRAM

TO ADDRESS

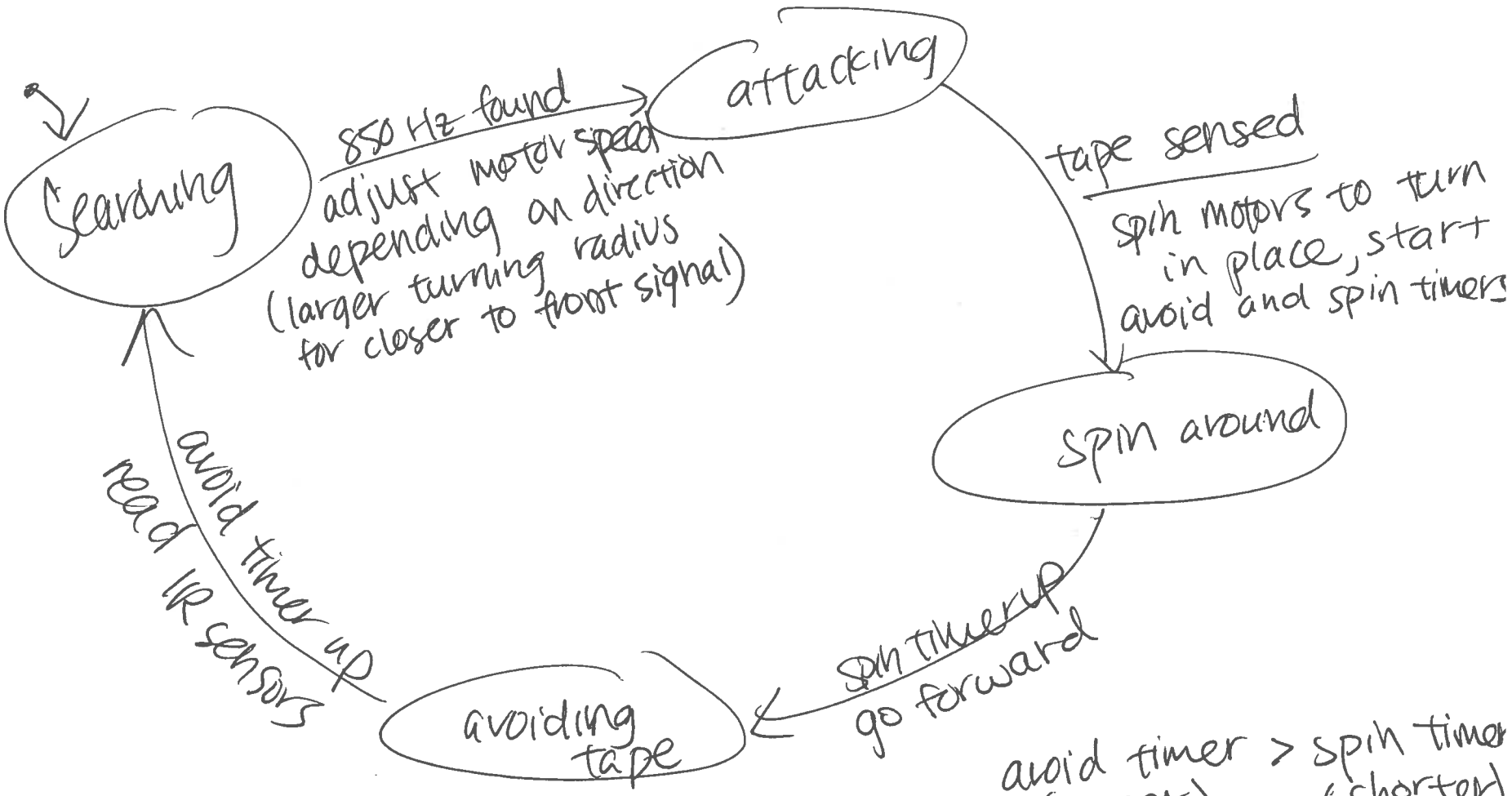
- HOW TO TELL IF WE MOVE FORWARD
- HOW TO TELL IF WE'RE OUTSIDE CIRCLE
- REMOVE CASTER





brick code

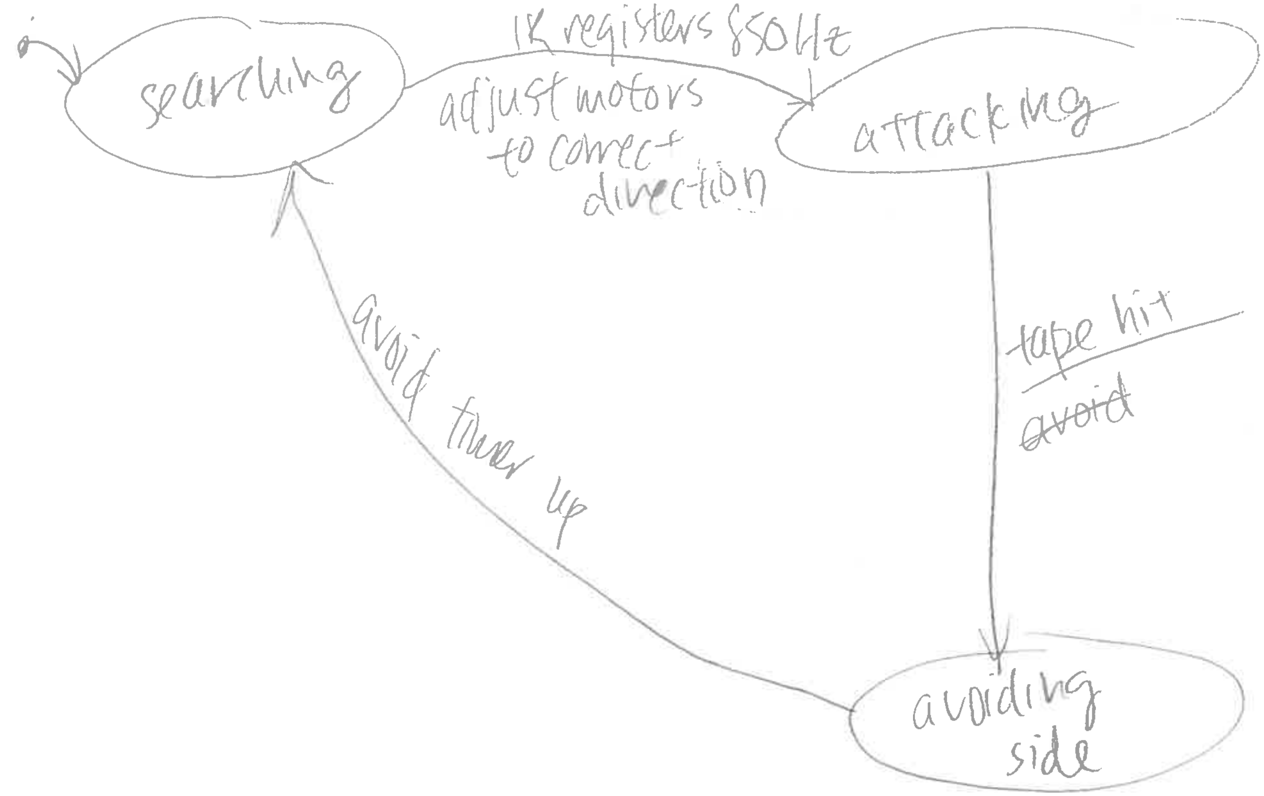
3/5/13



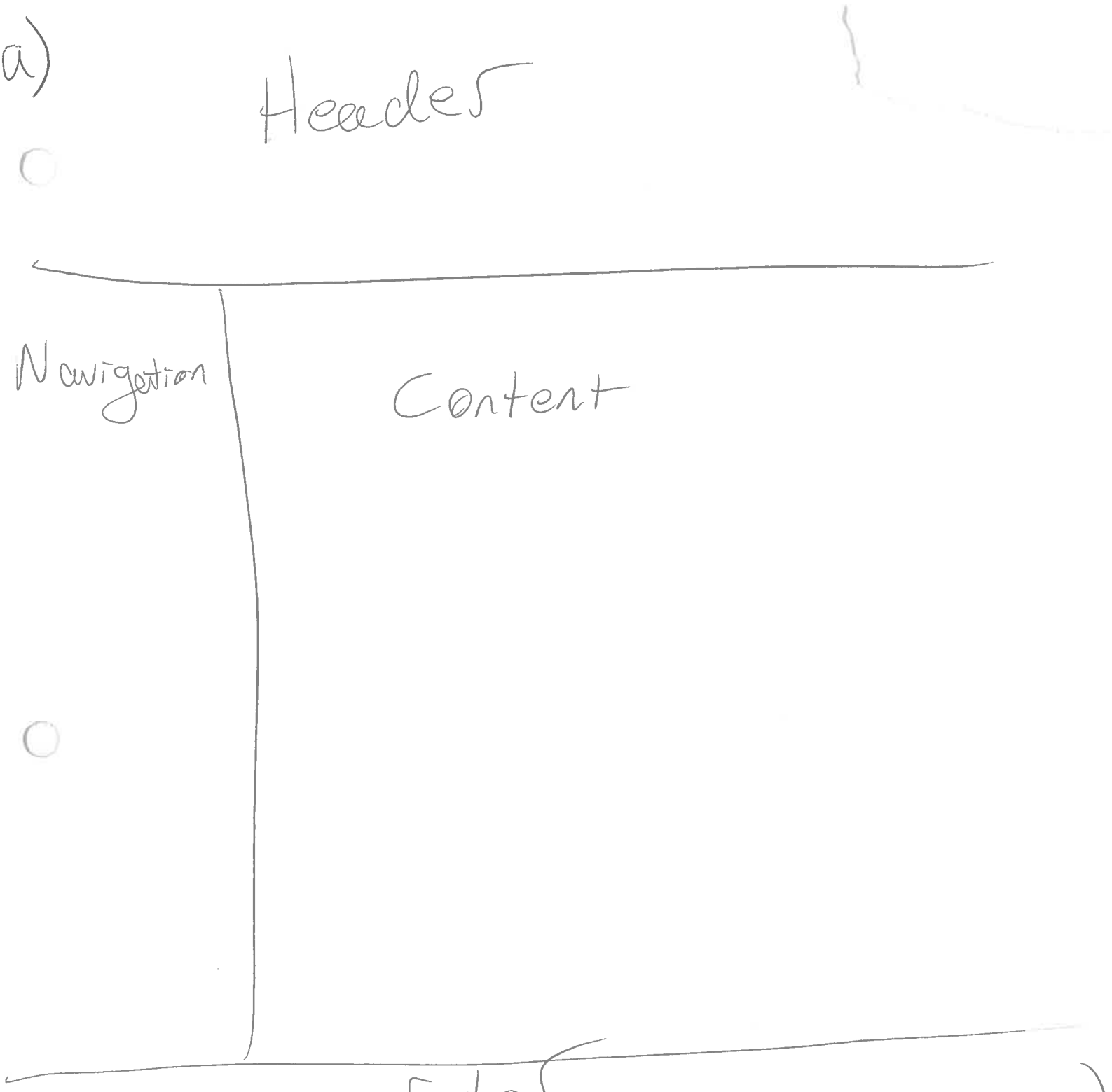
avoid timer > spin timer
(longer) (shorter)

brick code

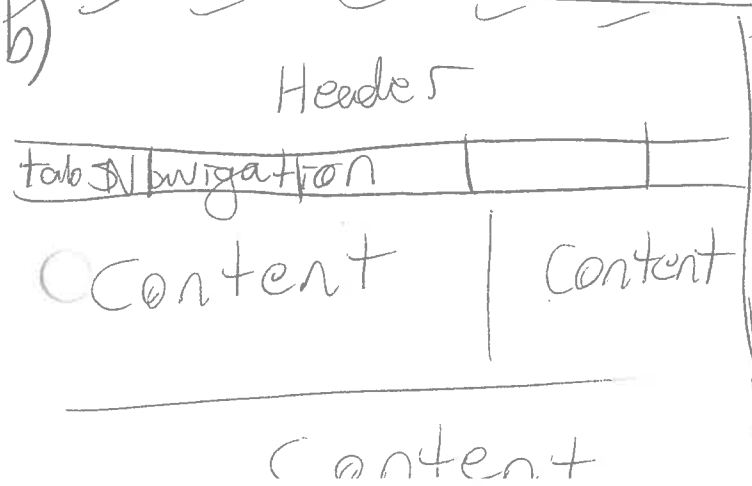
3/3/13


searching
IR registers 850Hz
adjust motors to correct direction
attacking
tape hit
~~avoid~~
avoiding side
avoid timer up

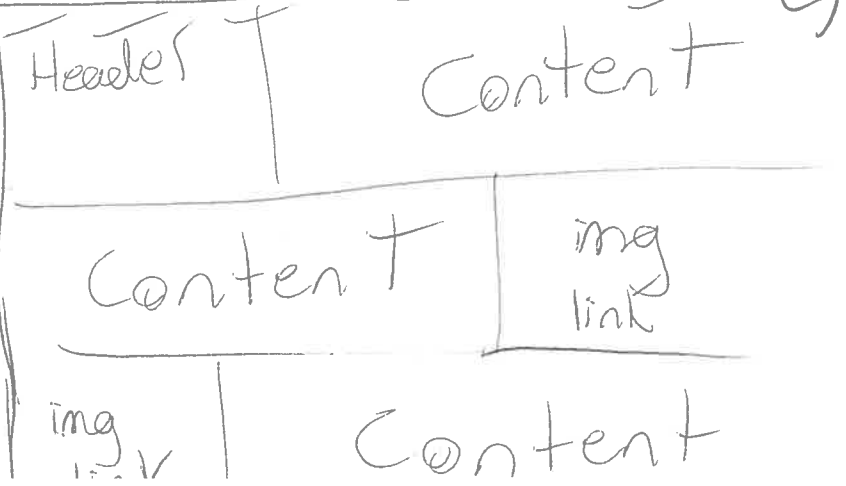
a)


Header
Navigation
Content
footer

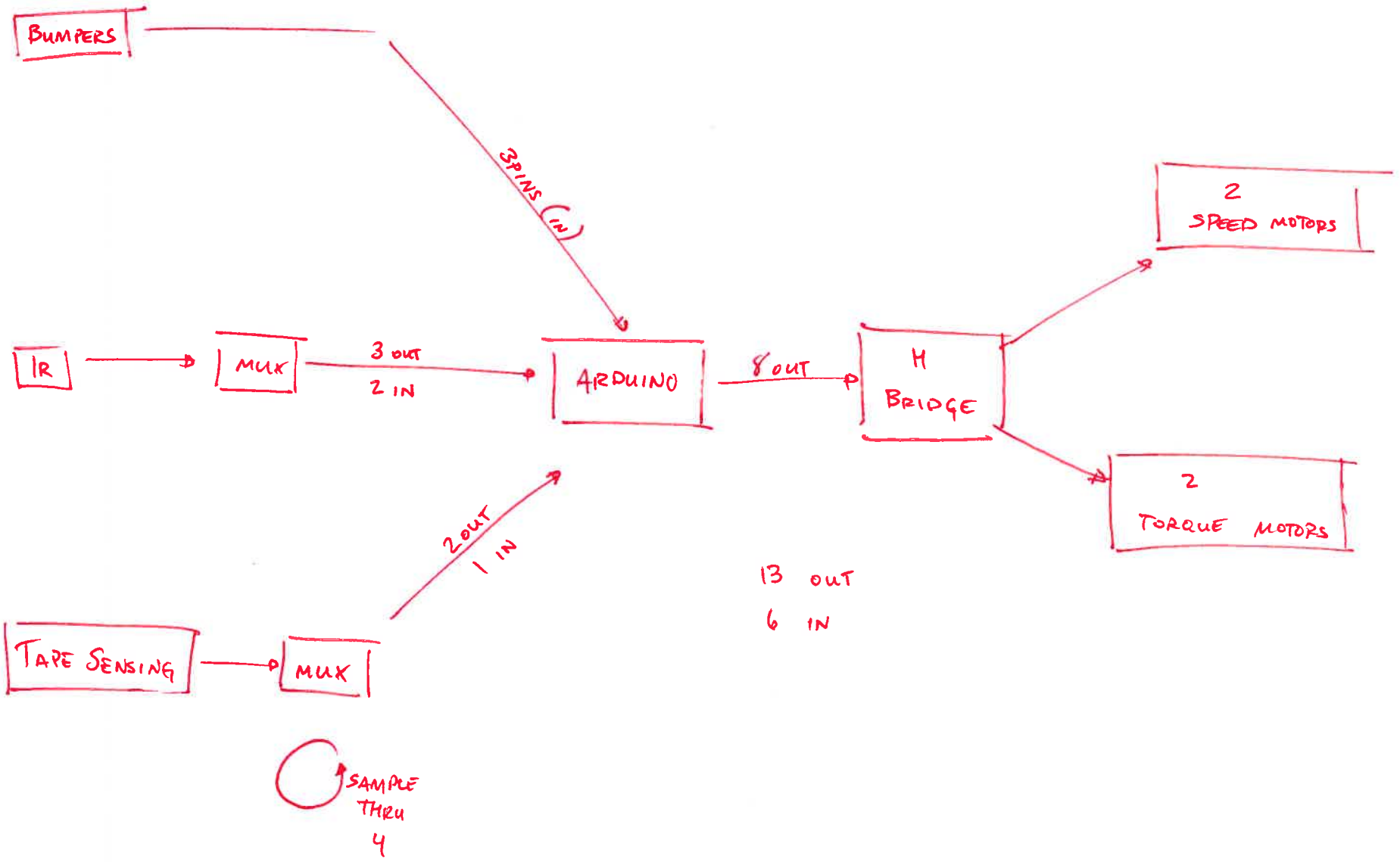
b)


Header
tab Navigation
Content
Content
Content

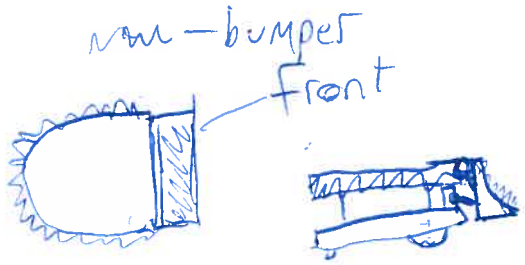
c)

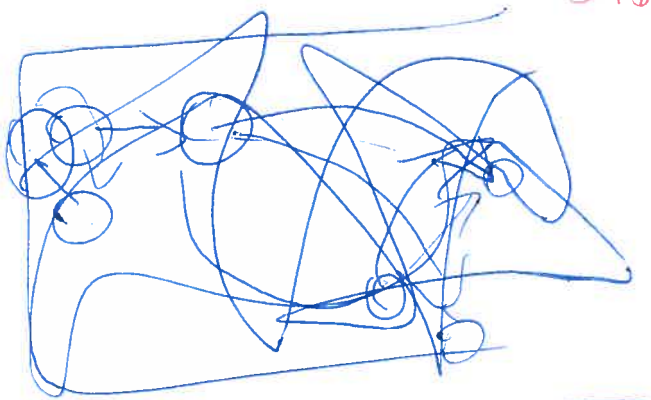

Header
Content
Content
img link
img
Content

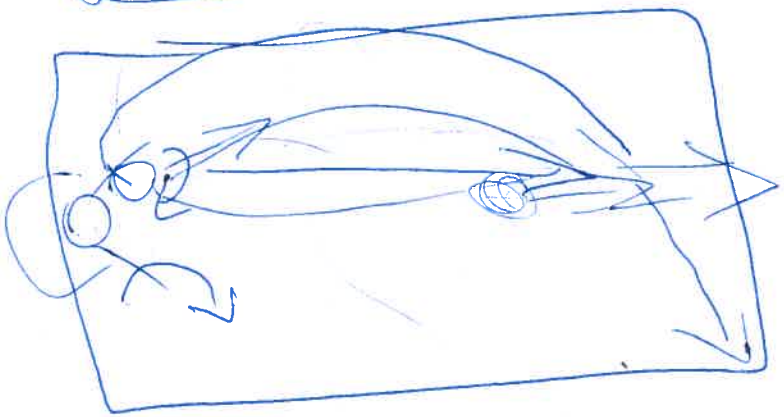
System Integration

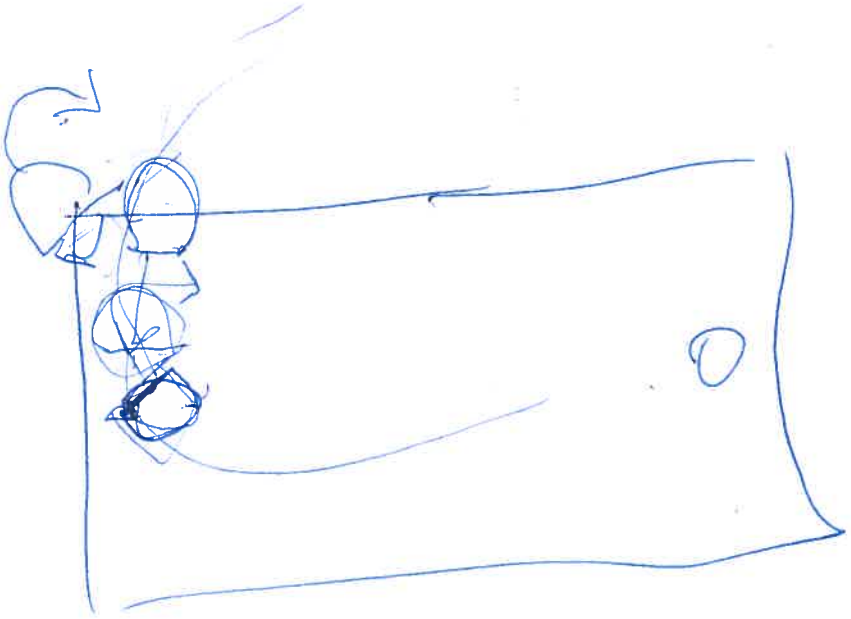


Top View



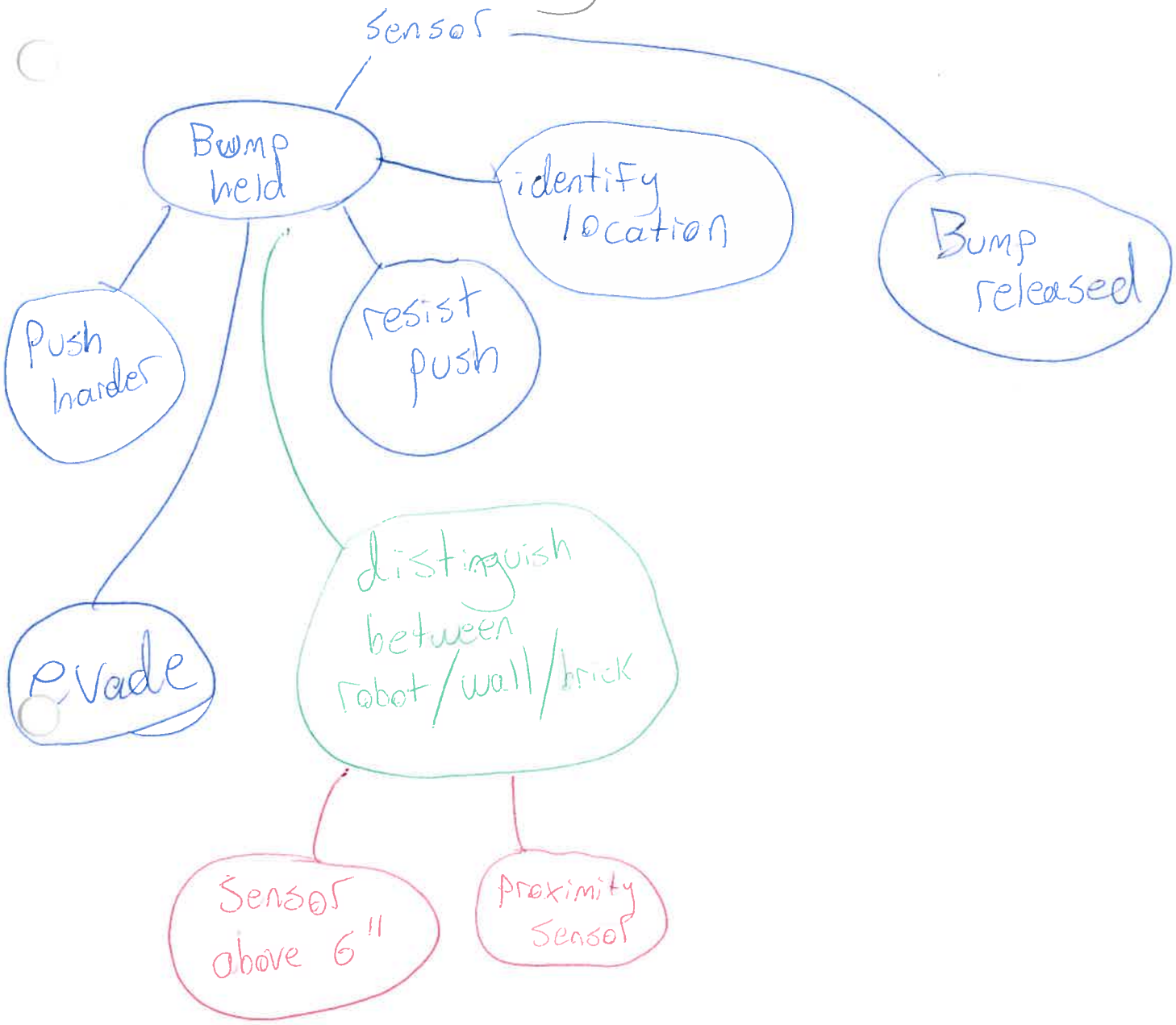






Uses For Bump Sensing

2/18/13

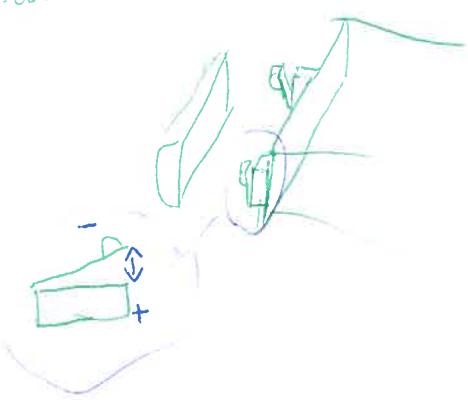


2/18/13

Bumper Sensors

Mechanical Switches

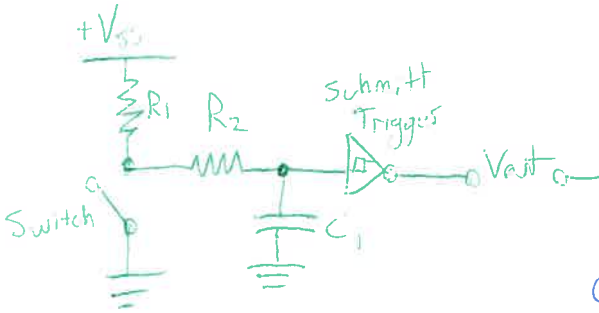
home made



Debounce Techniques

Hardware

see textbook 283-284



For Arduino

$V_{SS} \approx 1.1 \cdot V_{IH}$

$R_1 \approx 10\ k\Omega$ — much smaller than Arduino impedance

$\tau = R_2 \cdot C_1 <$ switch bounce time (order of 10 ms)

Chip LM339 Comparator w/ $V_{ref} > V_{out}$ at time τ

74HC14 Inverter w/ Schmitt Trigger

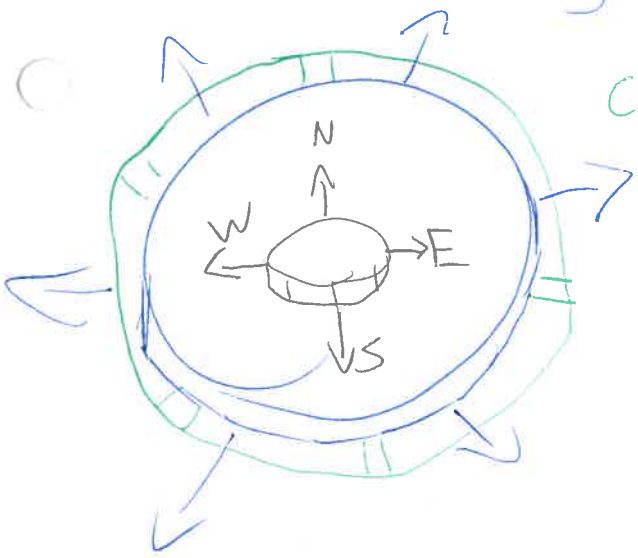
Software

τ = switch bounce time

```
TestForSwitch
    if switch changed && (CurrentTime - LastSwitchTime > τ)
        flip switch var
        lastSwitchTime = CurrentTime
    end
    CurrentTime = GetTime()
```

Circle

Fully Maneuverable 360°

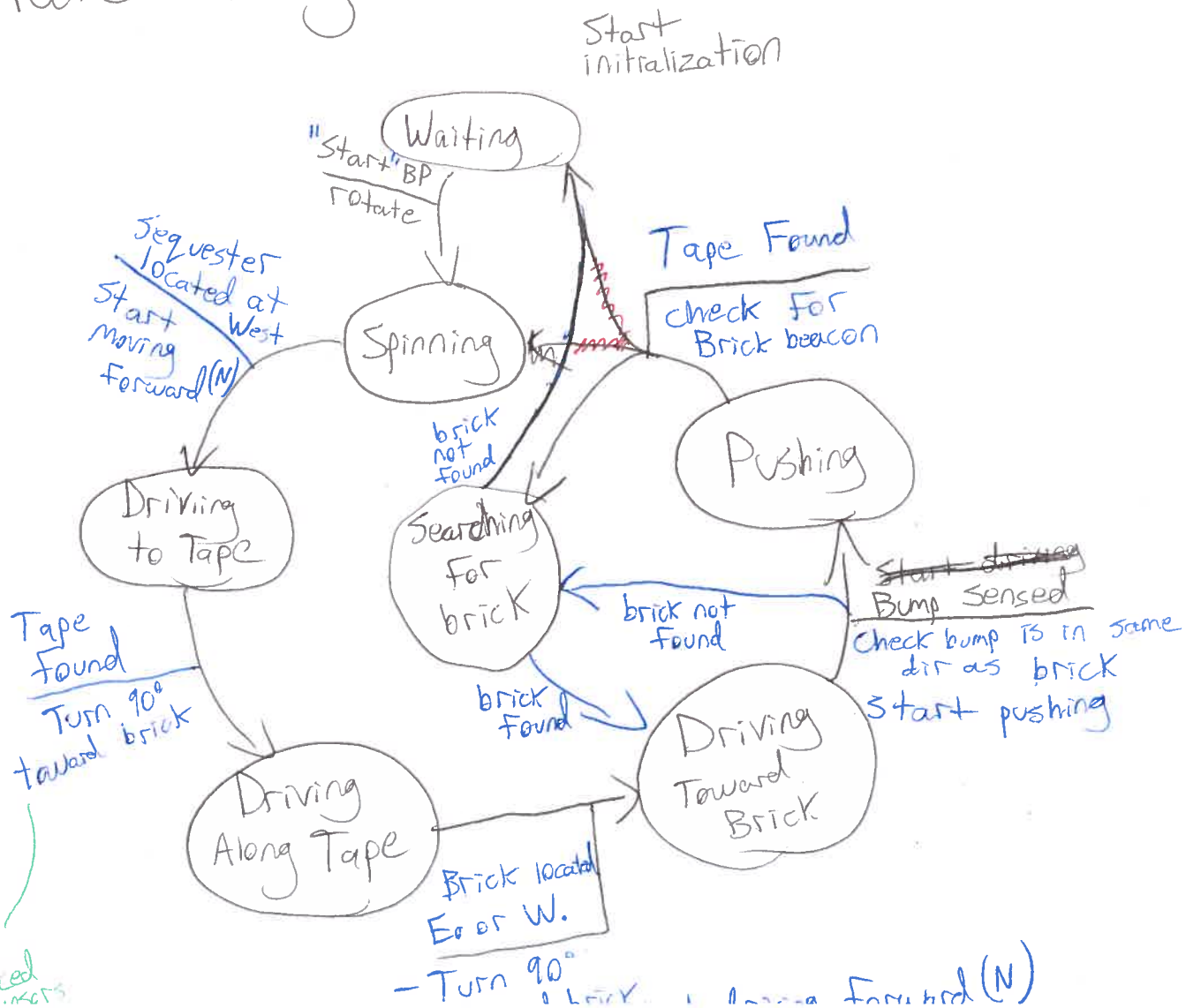


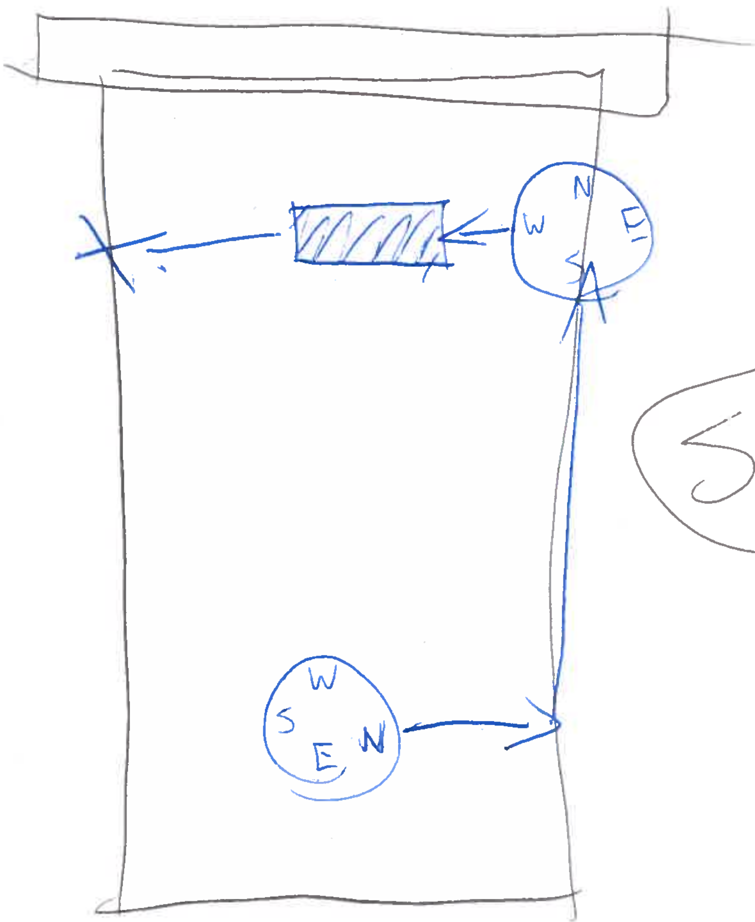
Can bump/push in any direction

-no need to rotate

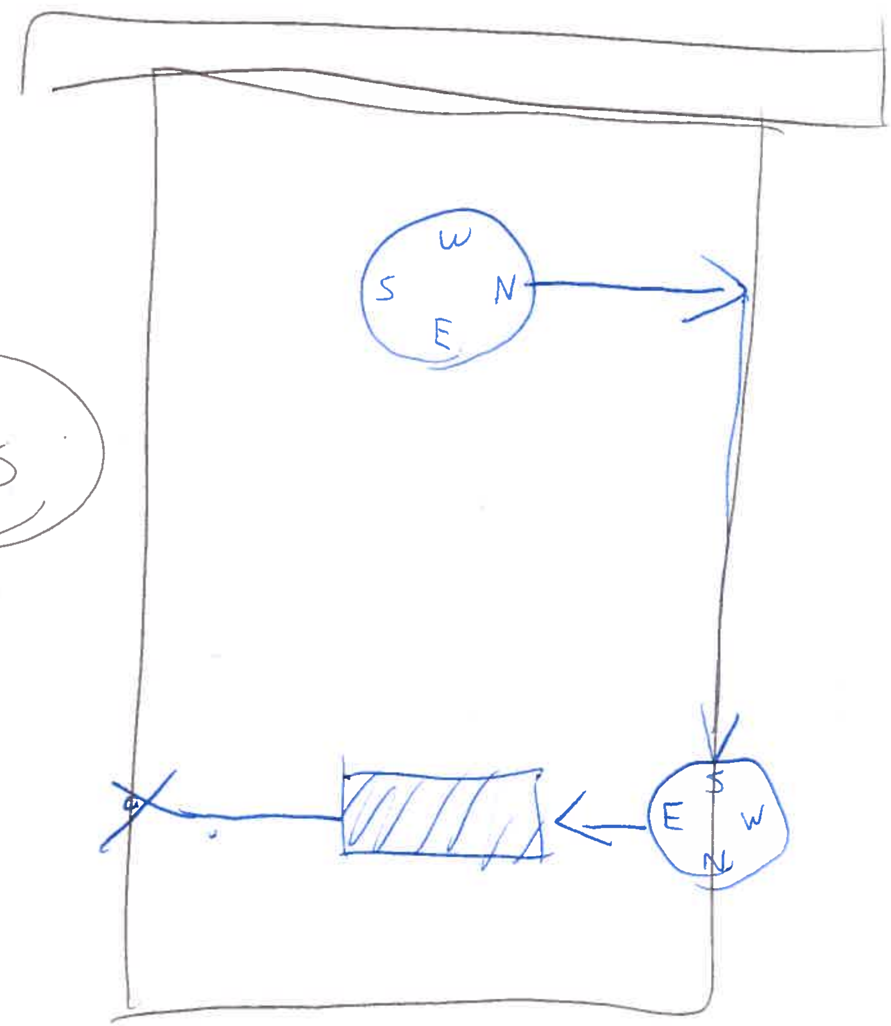
2/19/13

State Diagram



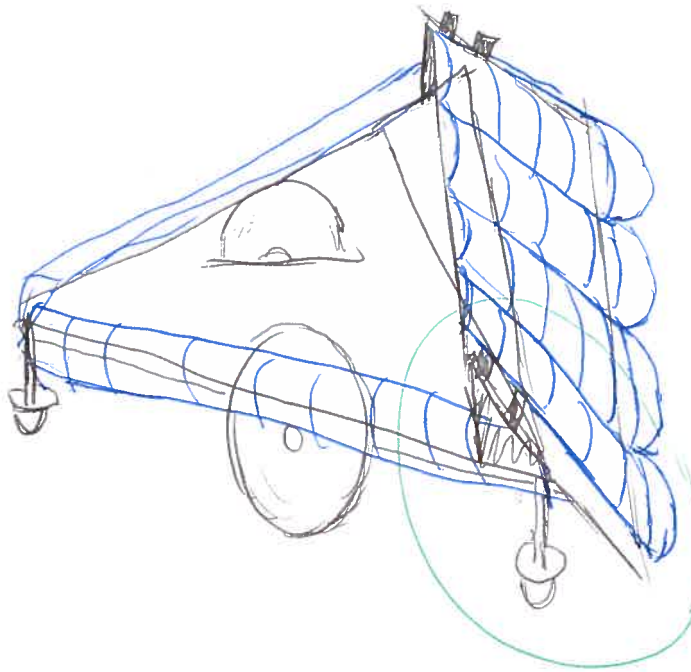


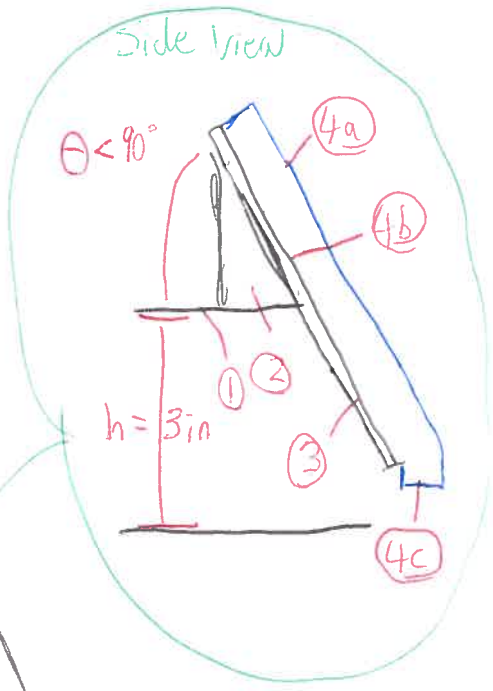
Strategies



Front Bumper Array

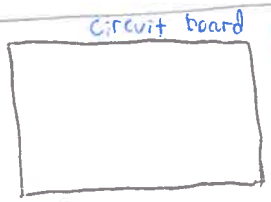
2/21/13

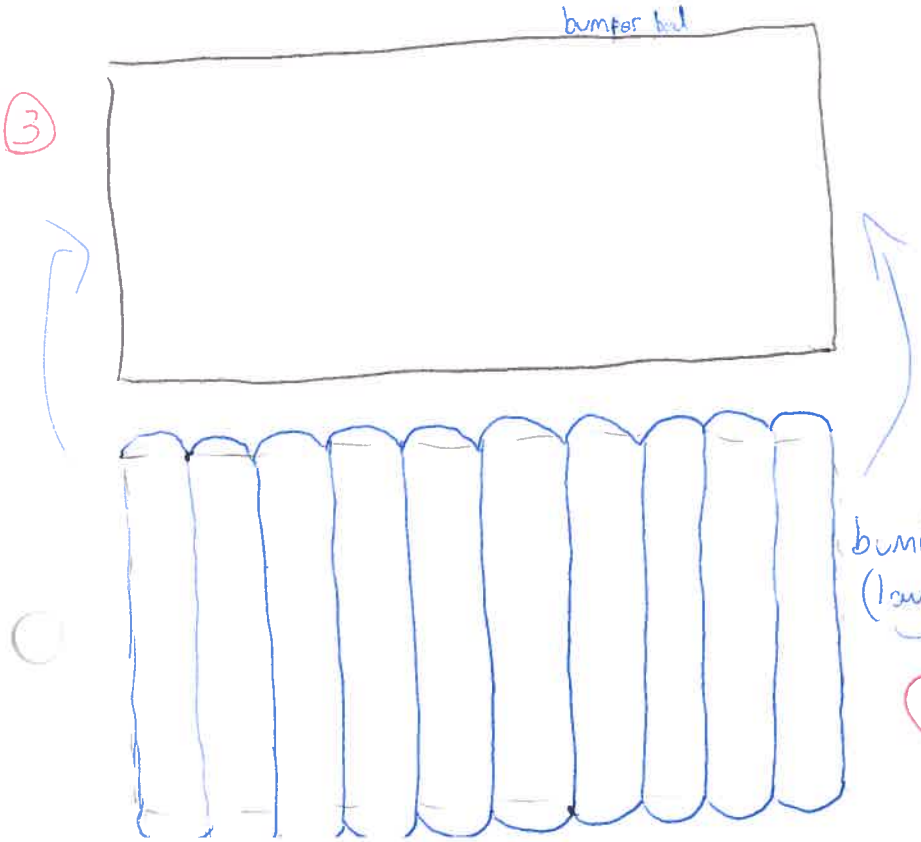


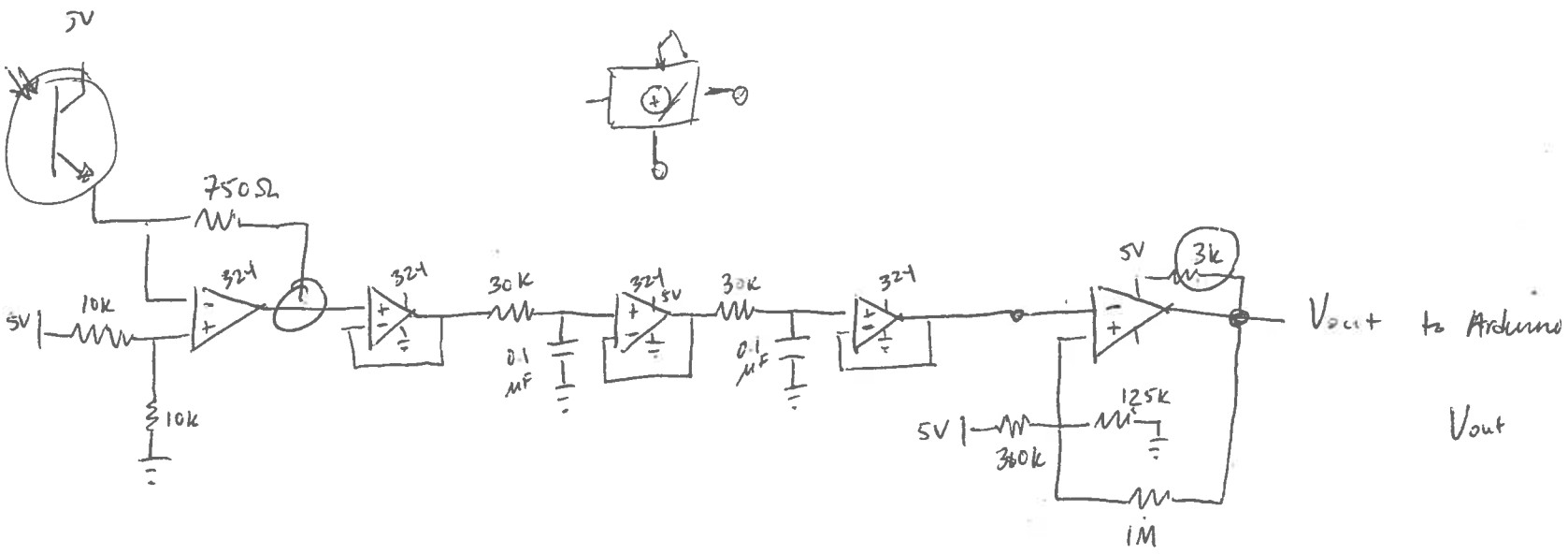


1. bot platform
2. bumper support
   - determines bumper angle (possibly adjustable)
3. bumper bed (grounded contact surface)
4. a. bumper foam (Flexible)
   b. inner surface of bumper held at high voltage
   c. inner bumper switch specifically designed for wall bumps

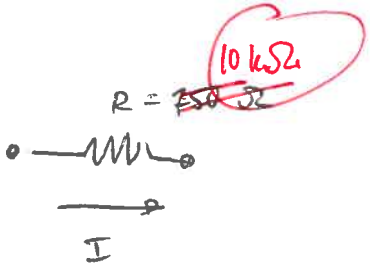
Switch Design







TEST INFO:



$\Delta V \approx 0$ for black

$\Delta V \approx 0.50\,V$ to $0.01\,V$ ∴ I is ranging from $\frac{\Delta V}{R} = 0.013\,mA$ to $0.667\,mA$

~~We'd like~~ If we'd like $0.667\,mA$ to map to $0.5\,V$, $R = \frac{\Delta V}{I} = 3k\Omega$?

" $0.020\,mA$ to map to $0.5\,V$, $R =$ ~~2.5k~~ $100k\Omega$

$V_{A1} = 2.0$

$V_{A2} = 1.7$

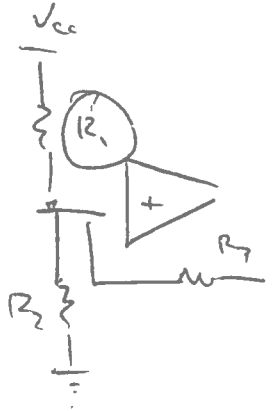
$n = \frac{0.3V}{1.7V} = 0.176$

$R_{pu} = 3k\Omega$

$R_3 = 1\,M\Omega$

$R_1 = nR_3 = \underline{176\ k\Omega}$

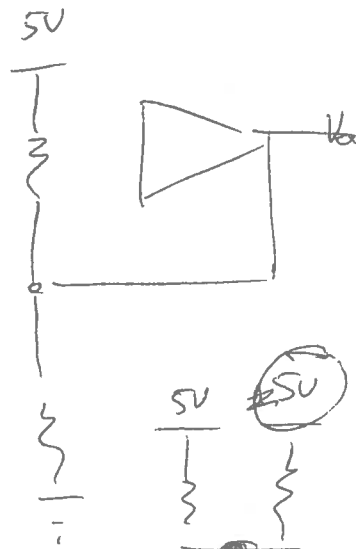
$R_2 = \frac{R_1 \| R_3}{\frac{5V}{2V} - 1} = \underline{100\ k\Omega}$ ✓



$R_3 = 100k$ ✓

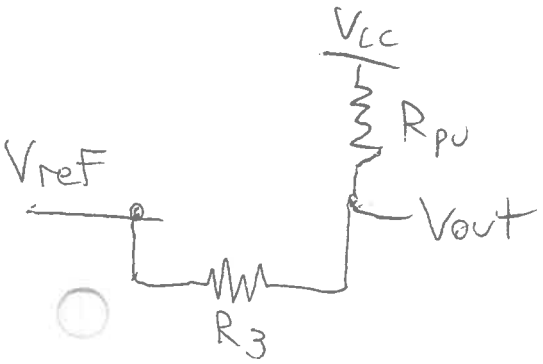
$R_1 = 17.6\ k\Omega$ ✓

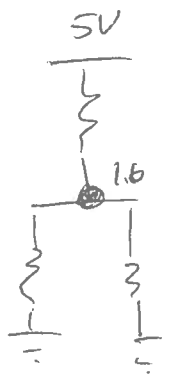
$R_2 = 10\ k\Omega$ ✓

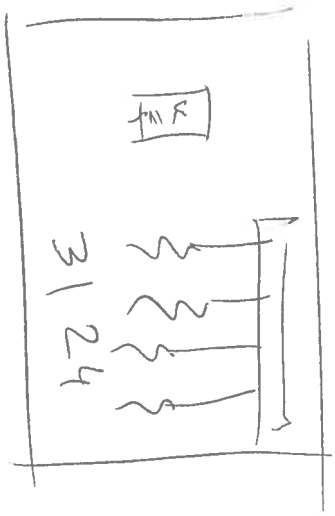


$V_{out} = (V_{cc} - V_{ref}) \frac{R_3}{R_{pu} + R_3}$

$(5 - 1.6) = 3.4$ high ✓





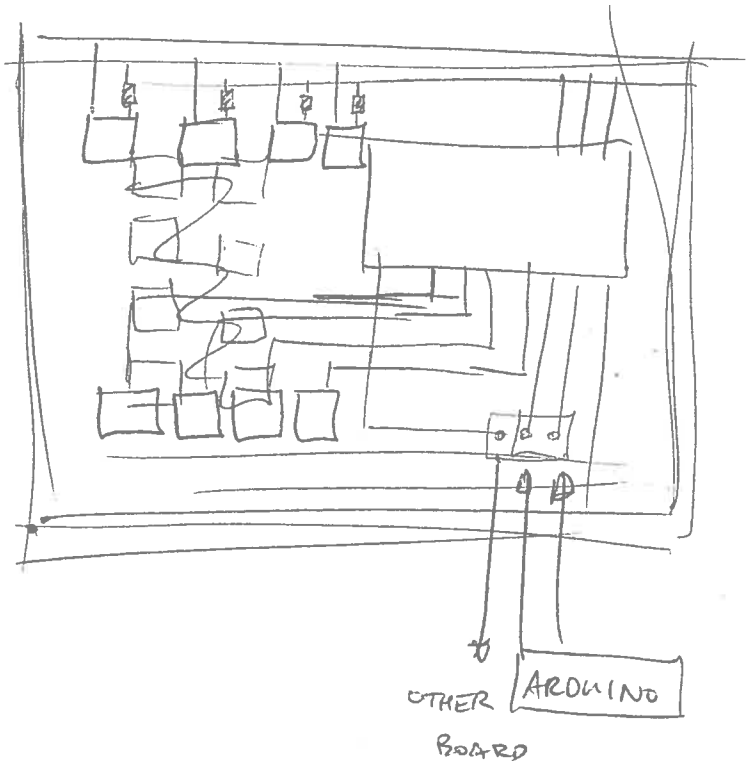

W
24

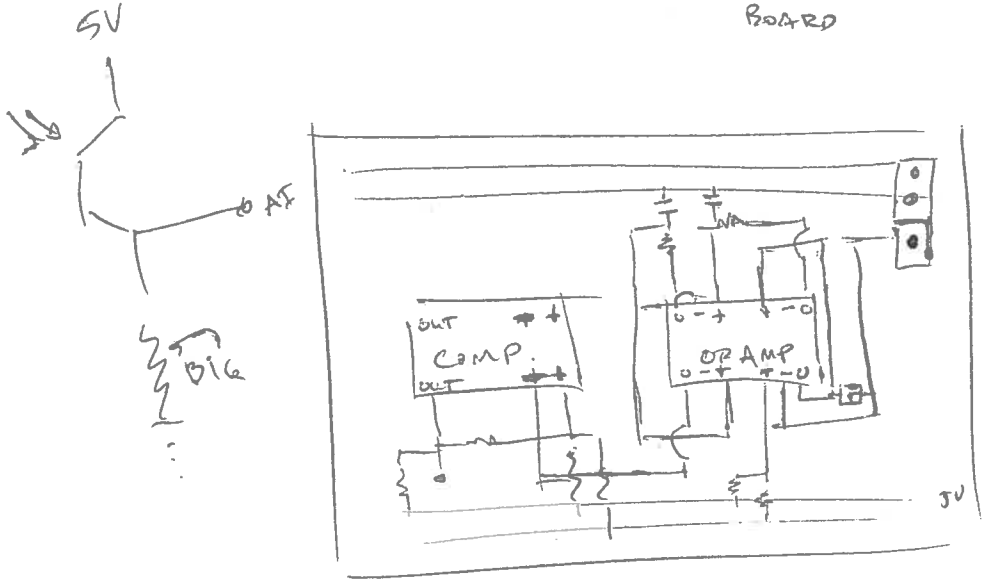
- 90° EVADE STRATEGY
- RANDOM CONFUSED STATE
- BUMP SENSORS
- TECC IF

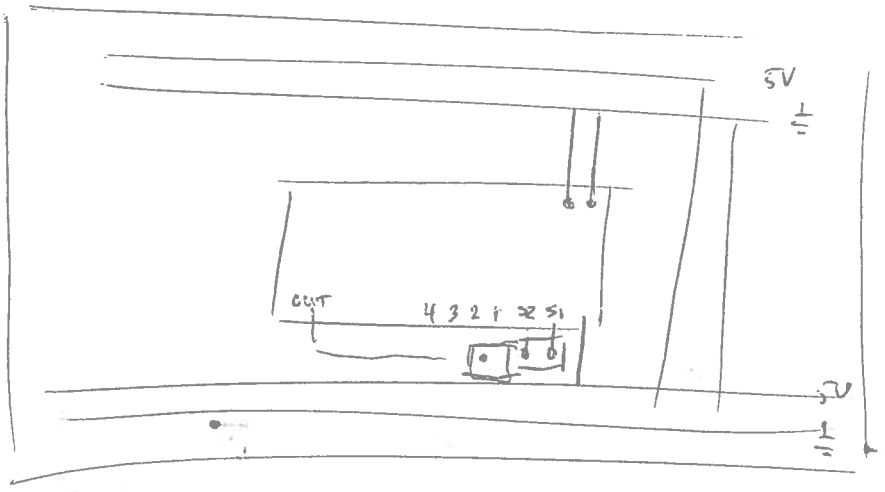
  WE'RE

  ~~ABOU~~ MOVING

  FWD


OTHER
BOARD
ARDUINO


5V
A1
BIG
OUT
COMP.
OUT
OP AMP
5V


5V
OUT
4 3 2 1 x2 S1
5V

200 mV but must be ≥ 500mV

$V_{A_1} = 600mV$

$V_{A_2} = 400mV$

$n = \frac{200}{400} = \frac{1}{2}$ $\quad R_3 = 1M\Omega$

$R_1 = \frac{1}{2} M\Omega$

$R_2 = \frac{.33 M\Omega}{\frac{5}{.6} - 1}$ $\rightarrow R_2 = 450K$

~~A~~ $V_{A_1} = 650$

$V_{A_2} = 400$

$n = \frac{200}{400} = .444$

$R_1 = .44 M\Omega$

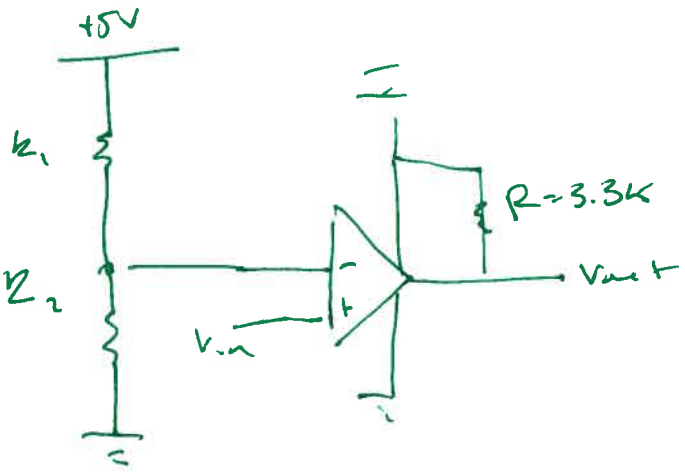
$V_{A_1} = 750$

$V_{A_2} = 650$

$n = \frac{200}{650} = .307$

$R_1 = 33K$

$R_2 = 4.7K$



I want Vout to be 200 mV

$$\left(\frac{R_2}{R_1+R_2}\right) 5 = .2$$

$$\frac{R_2}{R_1+R_2} = .04 \rightarrow \frac{25}{25} = \frac{R_1}{R_2} + 1 \qquad \frac{R_1}{R_2} = 24$$

$R_1 = 24\ k$

$R_2 = 1k$

GAIN

$$\left(\frac{R_2}{R_1+R_2}\right) 5 = .6$$

$$\frac{R_1}{R_2} + 1 = 8.33$$

$$\frac{R_1}{R_2} = 7.33$$

$R_1 = 6.8\ k$

$R_2 = 1k$

$f_c = 10$

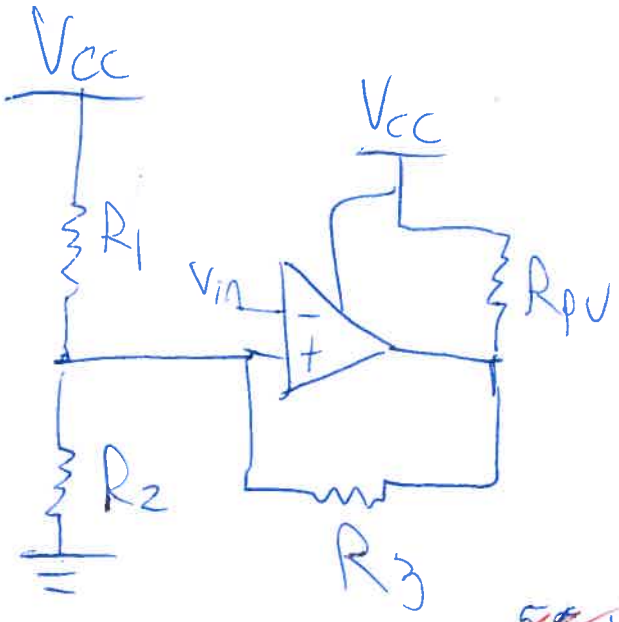
$\tau_2 = .015$

$C =$

$$R = \frac{V}{I} = \frac{100mV}{5mA} = 20$$

$$2.5V / R = 5mA$$

$$V = IR \qquad R = \frac{100mV}{3mA} = 33$$



$R_{PU} = 3.3V$

$R_3 = 1 M\Omega$

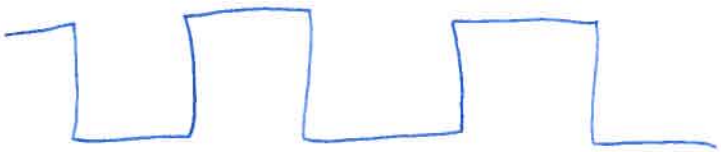
$R_1 = \cap R_3 = 1 M\Omega$

$$R_2 = \frac{500k}{\frac{5}{.065} - 1} = 6.1K$$

Threshold to be high: $VA_1 = 60mV$ (~~55mV~~, 10mV)

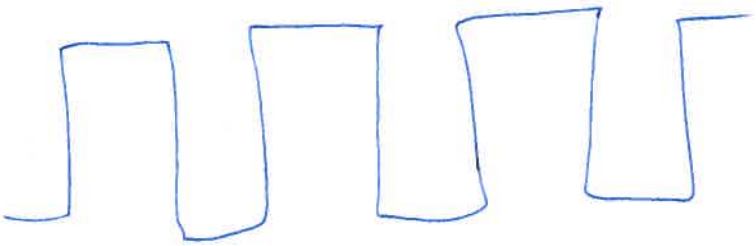
to go low: $VA_2 = 30mV$ (~~35mV~~, 5mV)

$$\cap = \frac{\Delta VA}{VA_2} = \frac{60 - 30}{30} = 1$$

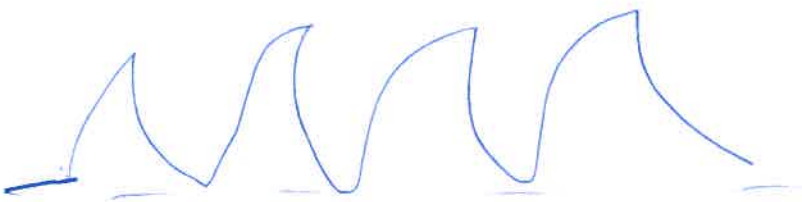


light

sensor



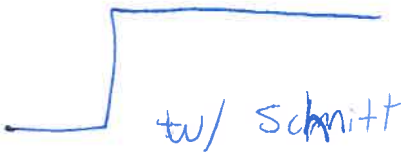
w/
gain



850 kHz

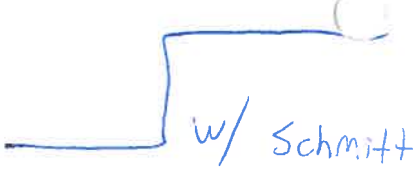
4 kHz

4 kHz
to
DC



w/ Schmitt

850 Hz
to
DC



w/ Schmitt

high pass design

Sequester Beacon Sensing

want 850 Hz to be attenuated ~.001

use high pass filter

$$\frac{\omega\tau}{(1+\tau^2\omega^2)^{1/2}}$$

$\tau = RC \rightarrow C = .1\,\mu F \rightarrow R =$

$f_c = 1 \rightarrow \tau = .159 \rightarrow \left|\frac{V_{out}}{V_{in}}\right| = .7$

This is bad

try $f_c = 10$

$\tau = .0159$

$C = .1\,\mu F \Rightarrow R = 159k$

$\left|\frac{V_{out}}{V_{in}}\right| = .999$

try $f_c = .1$ Hz $\rightarrow \tau = 1.59 \rightarrow \left|\frac{V_{out}}{V_{in}}\right| = 1$

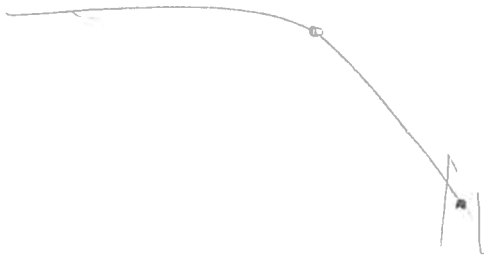
$\tau = 1.59$ $C = 10\,\mu F$ $R = 159k$

~

low Pass

$$\left|\frac{V_{out}}{V_{in}}\right| = \frac{1}{(1+\tau^2\omega^2)^{1/2}} \qquad .01 = \frac{1}{(1+\tau^2(2\pi 4000)^2)^{1/2}} \rightarrow \tau = .0039$$

$f_c = 100$
$\tau = .00159$
$R = 15.9k$
$C = .1\,\mu F$



$$\left|\frac{V_{out}}{V_{in}}\right| = \frac{1}{(1+\tau^2(2\pi 850)^2)^{1/2}} = .04795$$

try double

$$\frac{V_{out}}{V_{in}} = .01 = \frac{1}{1+\tau^2(2\pi 4000)^2} \rightarrow \tau = .000396$$

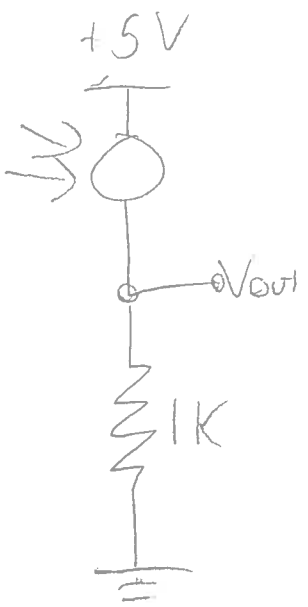
$$\frac{1}{1+\tau^2(2\pi 4000)^2} = .1027$$

$C = .1\,\mu F$ $R = 3.9k$

1 kΩ BE $I = \frac{V}{R}$

Pk-Pk Voltage

4.9V



$$V_{out} = 5V \cdot \left(\frac{1k}{R_{CE} + 1k}\right)$$

High pass → want 4kHz, not 850

$\left|\frac{V_o}{V_{in}}\right| = \frac{(\omega\tau)^2}{1+\omega^2\tau^2}$ for double high pass

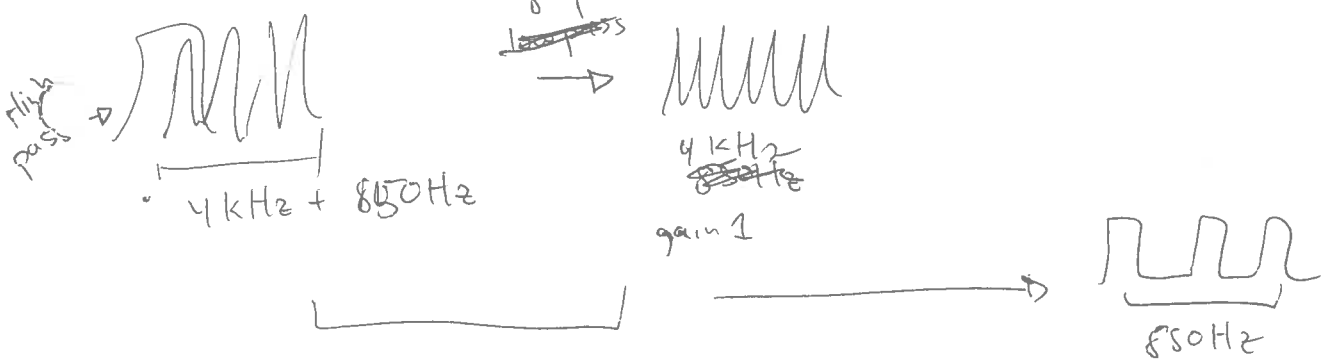
$.01 = \frac{(2\pi 850)^2 \tau^2}{1+(2\pi 850)^2\tau^2}$ → $\tau = .000019$

$\left|\frac{V_o}{V_{in}}\right| = \frac{(2\pi(4000)(\tau))^2}{1+(2\pi 4000)^2(\tau)^2} = .185$ ok

$C = .1 \times 10^{-6}$ F

$R = 190\ \Omega$

amplified signal



high pass subtract

$R_3 = R_4$ 4x

~~2.2kΩ~~

3.3kΩ

orange/orange/red

2x $R_1 = 10k\Omega$ Brown/Black/orange

1x $R_2 = 1k\Omega$ Brown/Black/red.

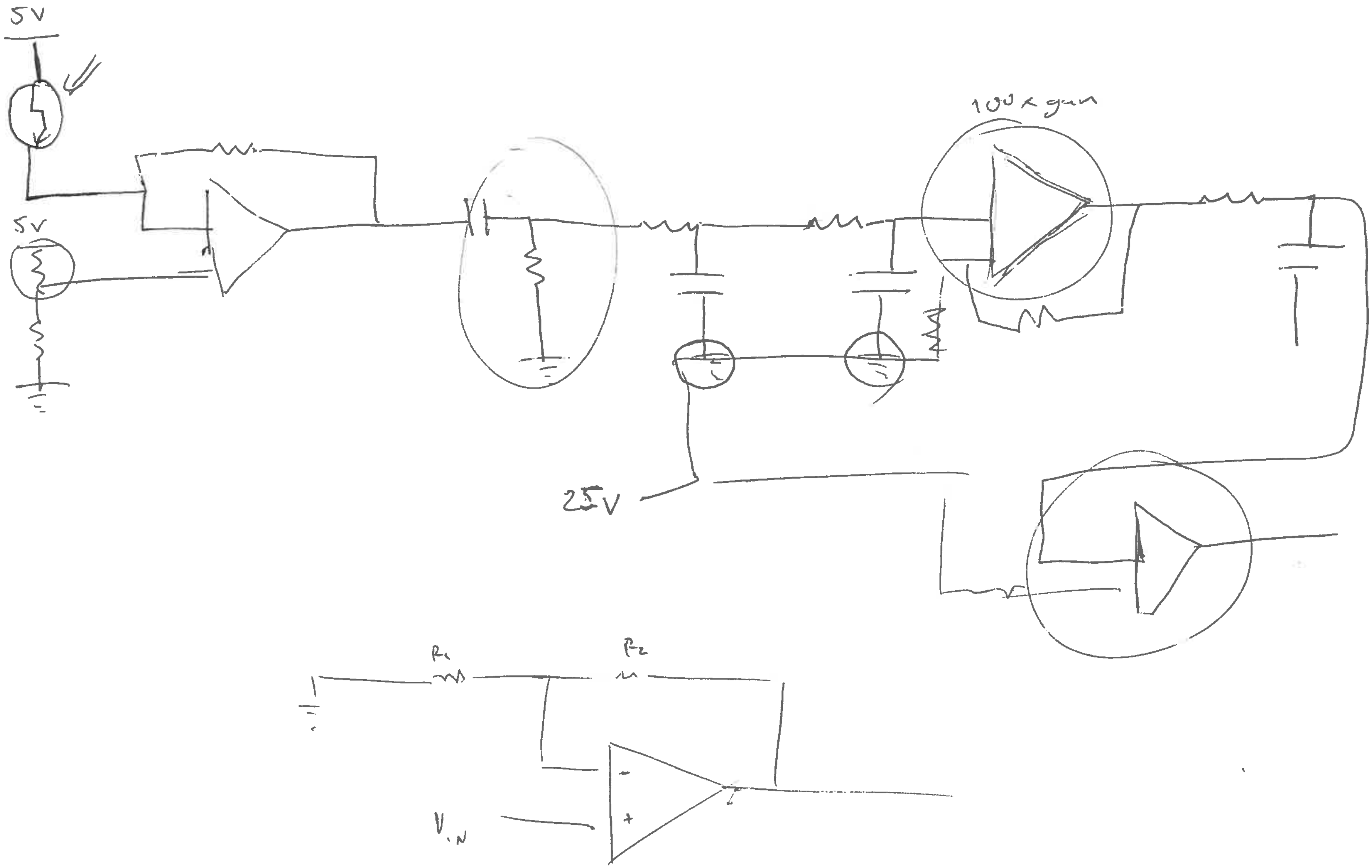
TEAM

19

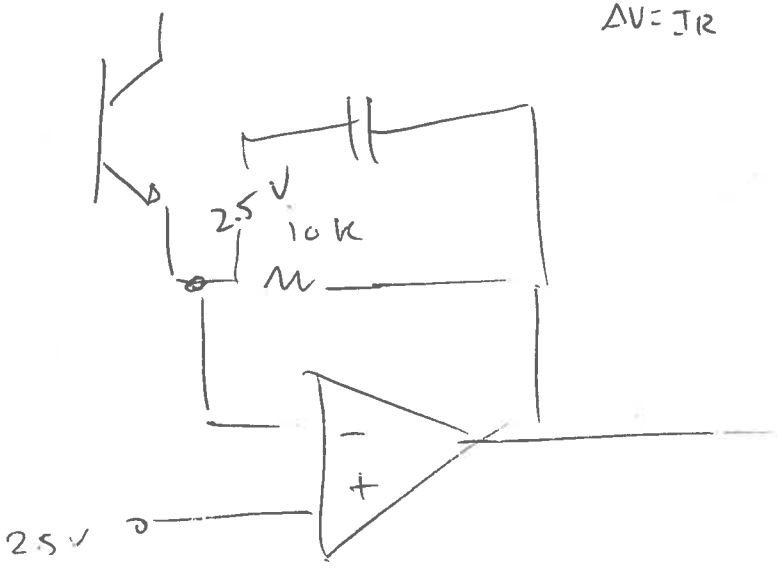
Arduino = freq counter

purpose see if signal is 850Hz or 4kHz ??

Be right Back!


5V
5V
100x gain
2.5V
R1
R2
-
+
Vin

$\Delta V = IR$



ΔV

$$f_c = \frac{1}{2\pi RC}$$

$0.022\ \mu F = C$

$R = 10\ K$

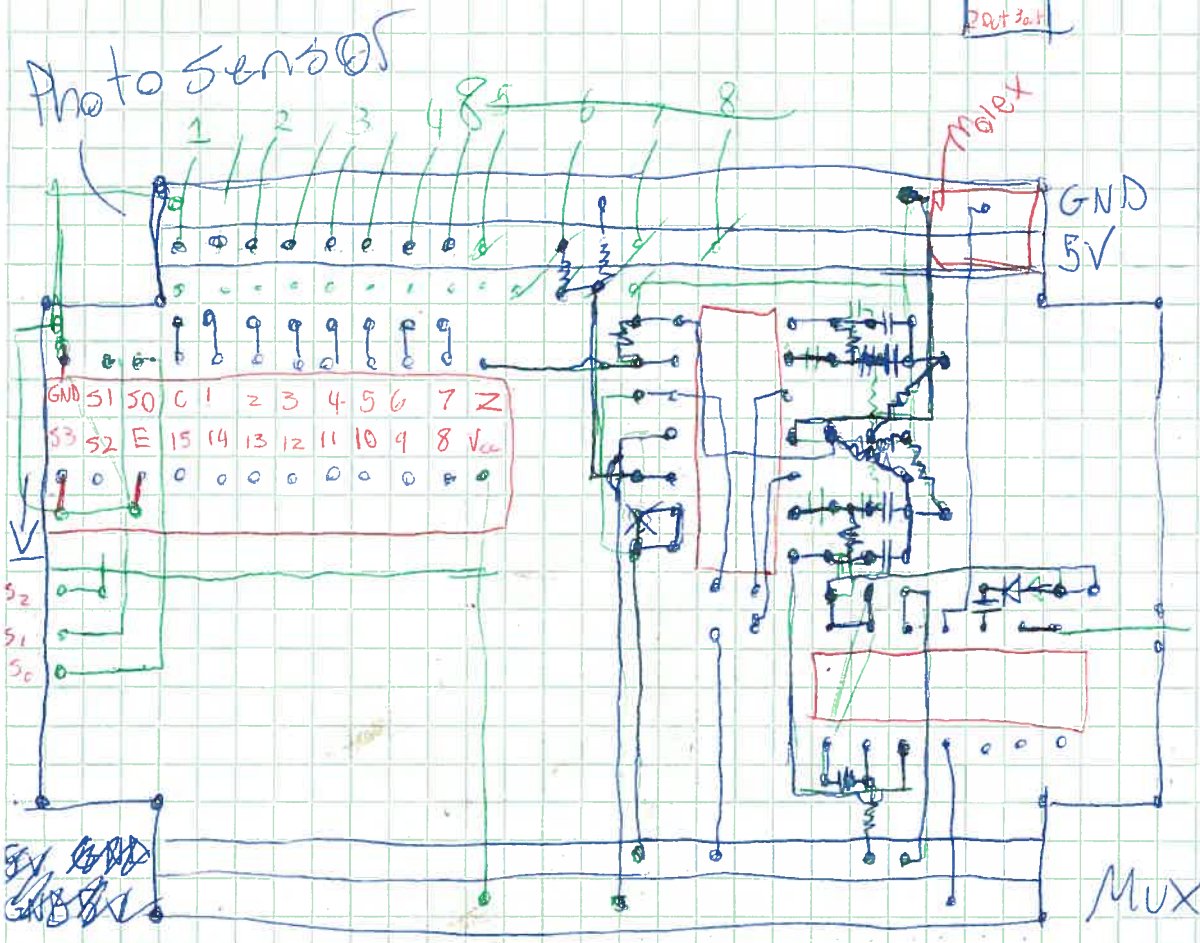
$\Big\}$ 723 Hz

Low Pass

~~Low Pass~~

7.

$0.01\ \mu F$



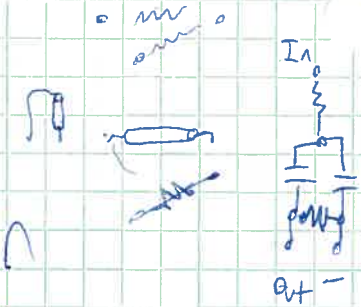
S3	S2	S1	S0	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	10
1	0	1	1	11
1	1	0	0	12
1	1	0	1	13
1	1	1	0	14
1	1	1	1	15

E
low

High 0→8
Low

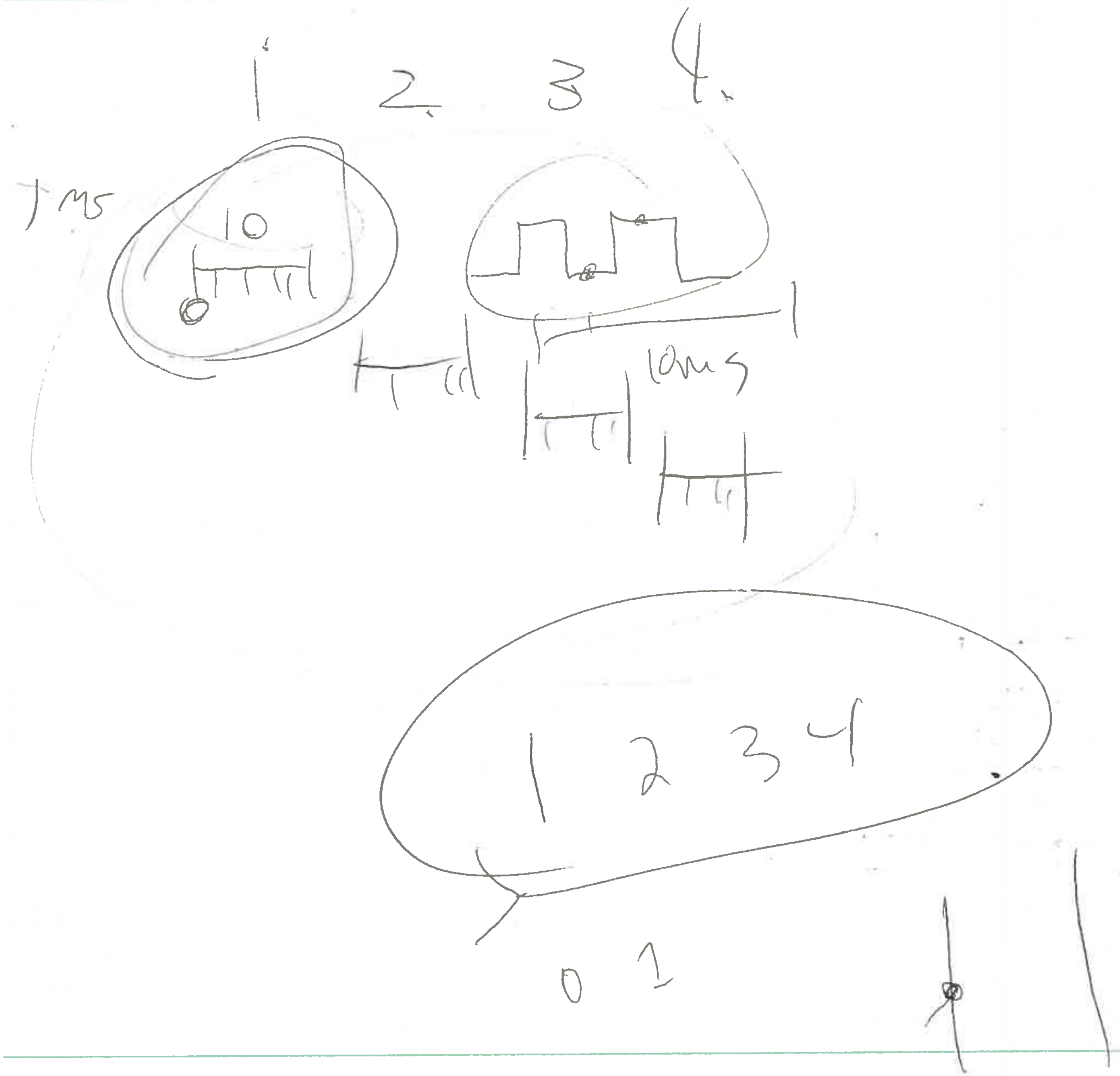
Molex
2×3

1out	4out
1-	4-
1+	4+
Vcc	GND
2+	3+
2-	3-
2out	3out



1 Pwr in
1 GND in
8 out — Photosensor pwr
8 in — Photosensor signal
3 in — mux control
~~1 out — mux signal~~
2 out — 850/4K

Mux — 2.5V
— 5V


1
2
3
4
1ms
10
10ms
1 2 3 4
0 1