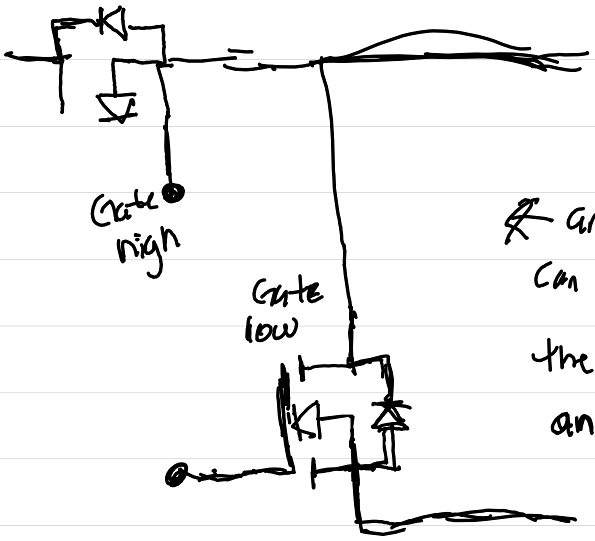
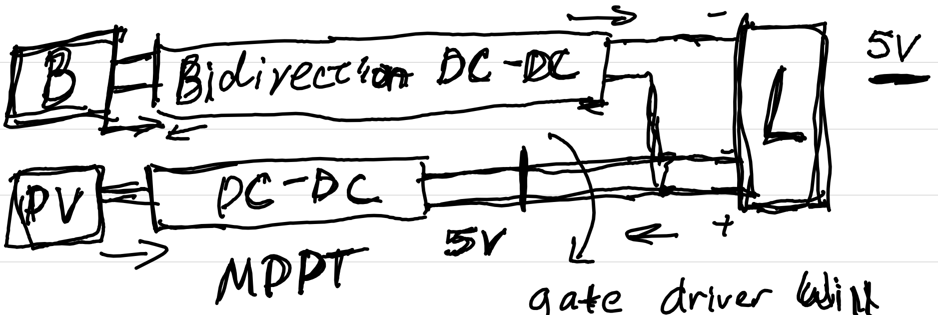


& analyze the direction current can pass through while the driver doesn't do anything, then what happens after it does

PV cell will need to have a dc-dc



gate driver will control the buck & boost modes

MPPT

Maximum power point tracking

≈ $125

If Voltage isnt high enough, it will be boosted accordingly, if Voltage is too high, it will be bucked accordingly.

Note if bucked, more amperage will be provided to the circuit allowing the devices to charge faster (more efficiently)

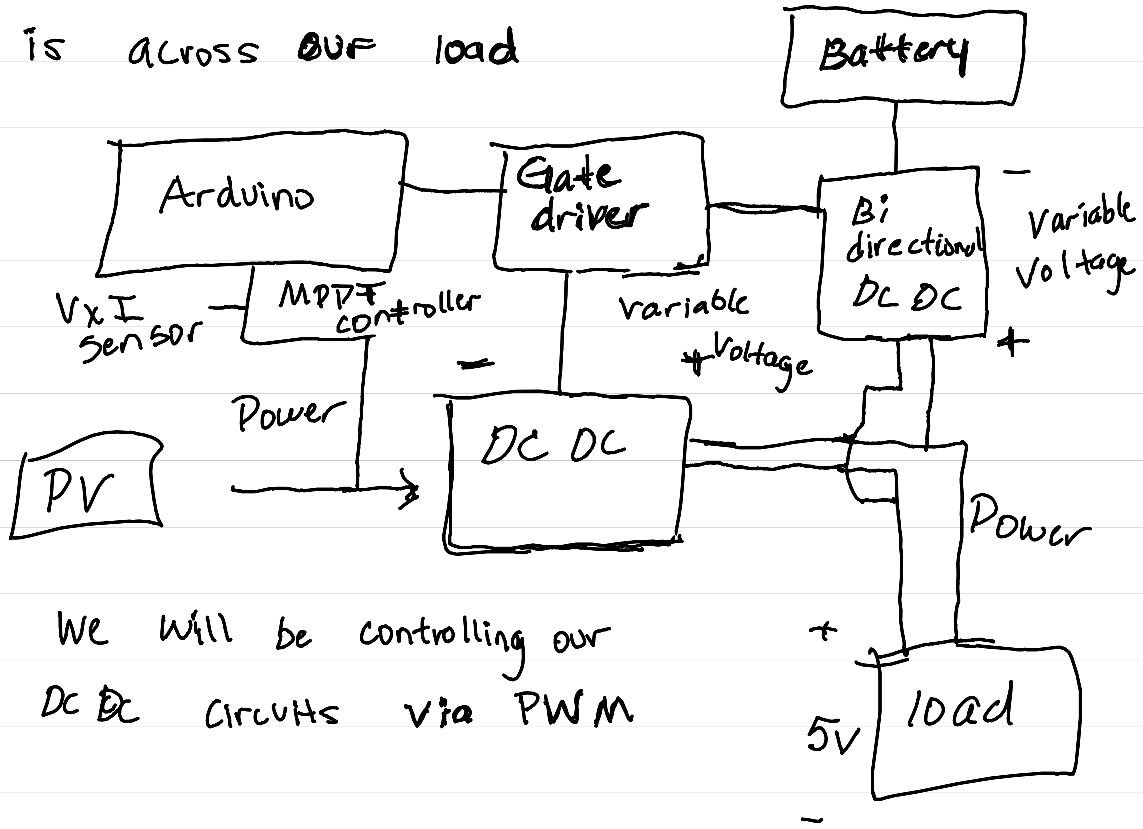
The mppt determines best current × voltage relationship, then based off this, it will

~~Test~~ bidirection portion
Test dc-dc (mppt) portion

PV battery integration

We will be controlling the DC-DC Power converter via DAC (Digital-Analog converter).
⇒ We will be specifically using analog (via pwm) to control our DC DC converters.

We will need our bidirectional dc-dc to be variable to regulate the loads voltage, in our case we will need to ensure 5V is across our load



We will be controlling our DC DC circuits via PWM

The bidirectional dc dc variable voltage will need to change depending on the variable voltage coming from the DC DC.
So:

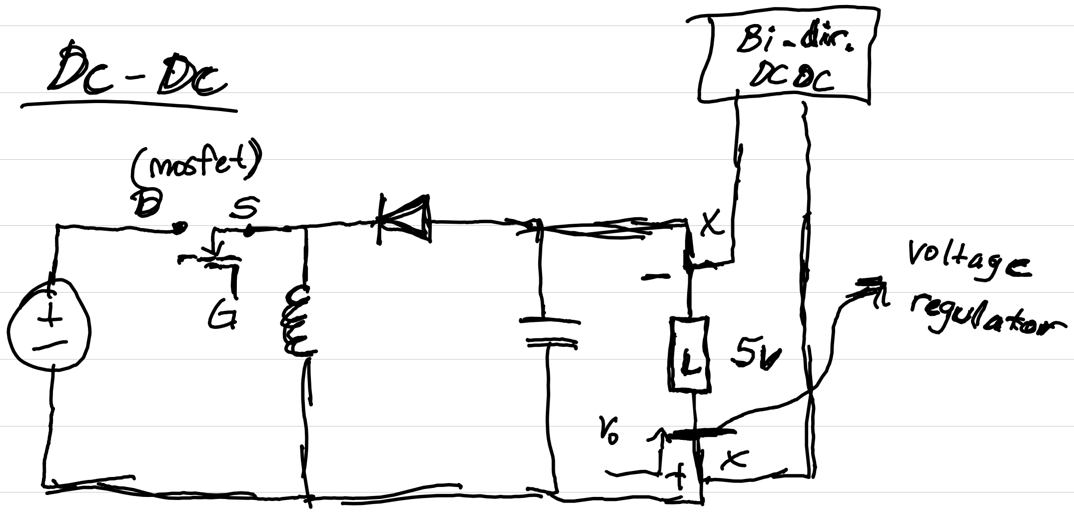
$$V_{Bi} + V_{DC} = V_L$$ where $V_L = 5V$

↳ we will need to measure these VxI values that will be constantly changing

↳ based on V_{DC} values, these values will regulate this to ensure 5V stays across our load

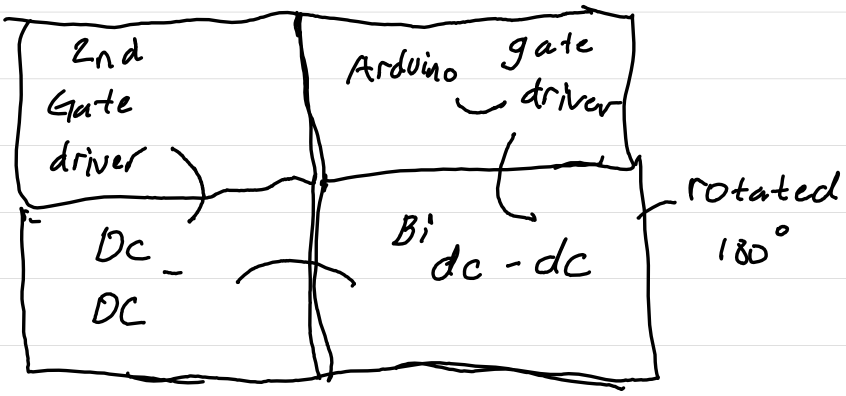
ex:
so if $V_{DC} = 20V$, then $V_{Bi} = -15V$

Dc - Dc



the X means polarity can change

$V = IR$ →



PWM signals
we have   0-100%   0-255

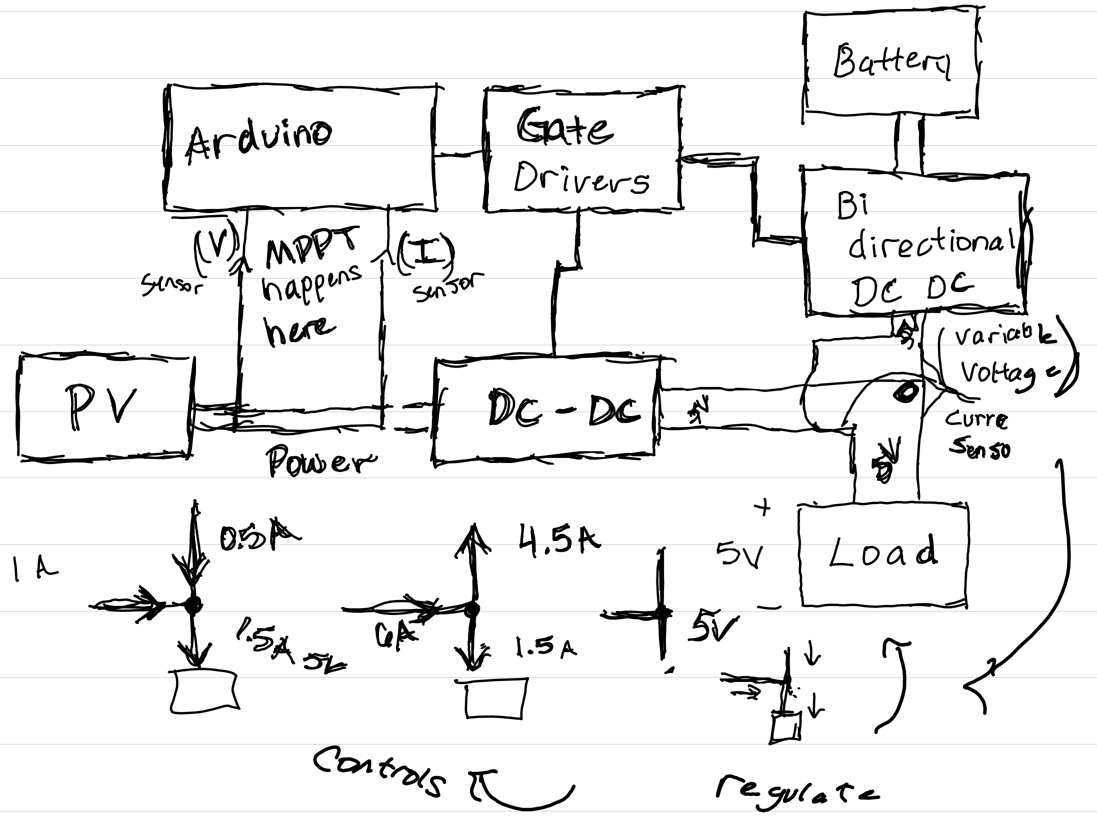
0%	at	0	
25%	at	64	$V = \frac{1}{4} V_o$
50%	at	127	$V = V_o$
75%	at	191	$V = \frac{3}{4} V_o$
100%	at	255	

input of 5v, We get a voltage of

↳ Input

PS	12V	1A
V_{cc}	12V	1A

output	
4.1V	25%
6.1V	50%
7.1V	75%



- Questions for Professor

- ~~Ask~~ Why we are getting half of our desired voltage at the load, show measurements. → are the inductor & capacitor values to blame?
- Ask about the bi-directional dc-dc, & how the duty cycle affects the circuit.
- Is 490 Hz an okay value for our frequency (pwm signals) → this is really low from my research
- Does the PV array generate only what the circuit needs, & dissipate the rest? In our case we have a 100 W PV array; make up random power level #'s & ask if if mppt will be useless most of the time.
- How does mppt happen before the first dc-dc converter, how do we even accomplish this without another dc-dc converter.

- Test dc-dc converter with 20kHz frequency (new code)

- try the new inductor

P Input ⇒ 12V 1A
Vcc → 12V 1A
Vdd ⇒ 5V ? doesn't matter

- Will be measuring ΔV across load (3 scenario's)

- w/ old code (490 Hz)

Duty cycle	V_L
25%	4.14 V
50%	6.13 V
75%	7.13 V

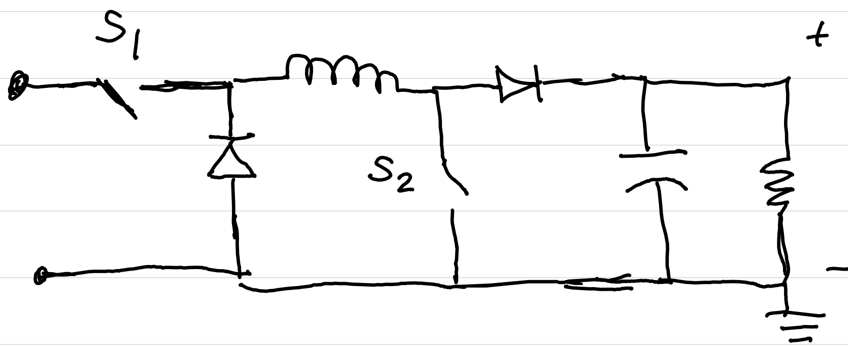
- w/ new code (31 kHz) or 100kHz? ↳ oscillo was reading 10 μs

Duty cycle	V_L
25%	1.63 V
50%	3.76 V
75%	5.91 V

- w/ better inductor & new code

Duty cycle	V_L
25%	
50%	
75%	8.76 V

for all values?



boost mode

S_1 closed (255)

S_2 switched (~)

buck mode

S_1 switched (~)

S_2 open (0)

Begining of Bi-directional Dc-Dc Notes

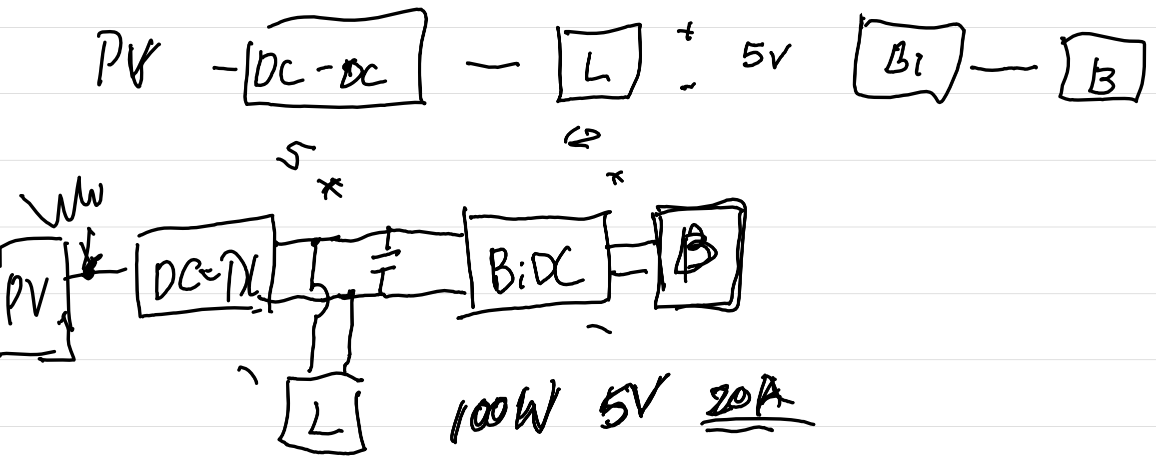
- Questions

- How do we control this circuit:

Refer to website & file which are stored in discord links

multi sim

- What is Vs in the bi-directional dc-dc
- Where is the other Voltage source in multisim, and is the orientation the same as the one on the website (High to low)



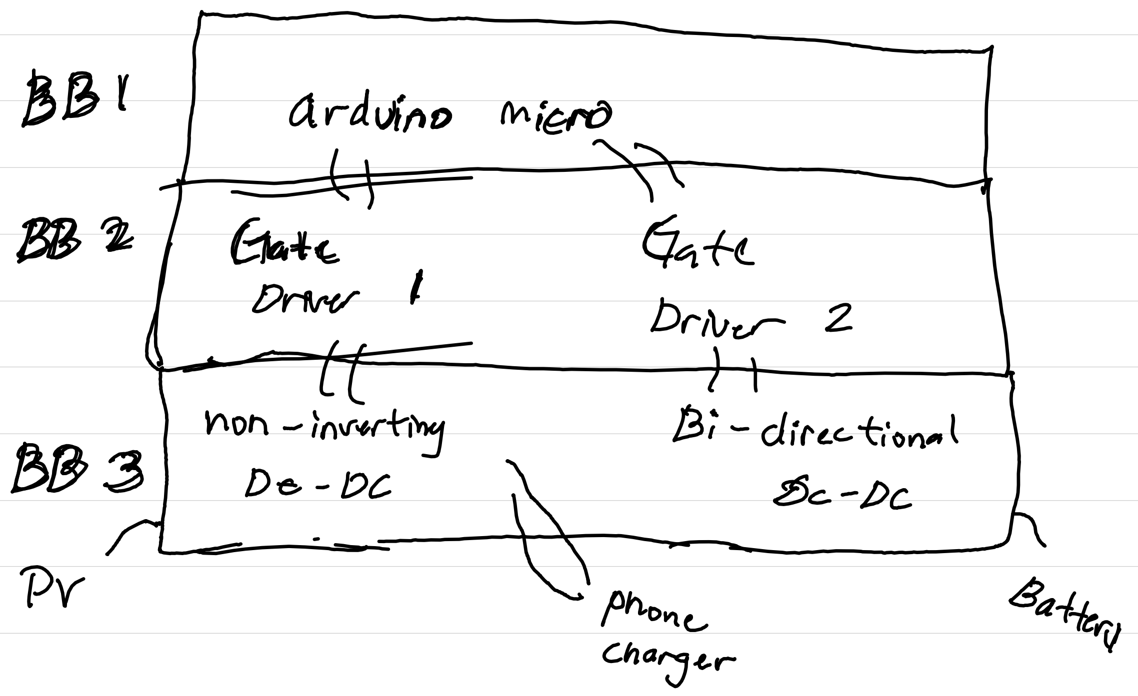
100W 5V 20A

excess A

PV side → Bi DC   B side

- if excess
  input 5V → ouput 12V
- if no excess
  output 5V ← input 12V

I envision:



.

direction of capacitors?

pwm signals?

is it set up correctly on the BB?

timer 1 (16 bit)

pin 9

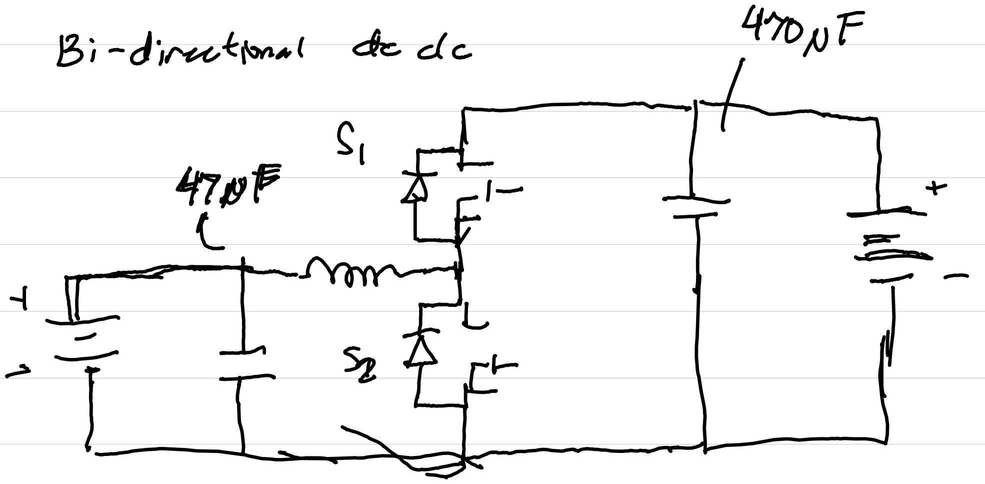
pin 10

timer 4 (10 bit)

pin 13

pin 6

Bi-directional dc dc



$S_1 \Rightarrow$ pin 9 High
$S_2 \Rightarrow$ pin 10 low

Boost S_1 off $\Rightarrow$
S_2 Switching

Buck S_1 switching $\leftarrow$
S_2 off

Working Results: Bidirectional achieved for both tests
5V input voltage
10k ohm resistor

Buck mode (left to right)

	duty cycle for S_1	V across resistor
S_2 off	25% (64)	0.91 V
	50% (128)	2.25 V
	75% (191)	3.59 V

Boost mode (right to left)

	duty cycle for S_2	V across resistor
S_1 off	25% (64)	7.07 V
	50% (128)	10.40 V
	75% (191)	17.54 V

5 V input

10 k Ω

Boost mode (right to left)

	duty cycle for S_2	V across resistor
S_1 off	25% (64)	7.07 V
	50% (128)	10.40 V
	75% (191)	17.54 V

12 V input

10 k Ω

Buck mode (left to right)

	duty cycle for S_1	V across resistor
S_2 off	25% (64)	1.76 V
	50% (128)	3.91 V
	75% (191)	6.04 V

Next Steps

- Automate non-inverting dc-dc
- Automate bidirection dc dc
- Implement current sensors
- Implement voltage divider

What resistors will we need for the voltage divider?

CS
VD

NI DCDC

Bi directional

VD

50W 12V 4.1 A PV array

Charge current for battery $\leq$ 9.6 A

arduino will power the

Analogread of the arduino can only be between 0-5V. I will need to add resistance values in my voltage divider to scale my input down enough

Non-inverting DC-DC

6V input

1kΩ

Boost mode

	duty cycle for S_2	V across resistor
S_1 on	25% (64)	6.8 V
S_2 SW	50% (128)	10 V
	75% (191)	16.86 V

10kΩ

Buck mode

	duty cycle for S_1	V across resistor
S_1 SW	25% (64)	0.51 V
S_2 off	50% (128)	1.78 V
	75% (191)	3.1 V

with new inductor

Non-inverting DC-DC
5 V input

1k Ω

Boost mode

S1 on
S2 SW

duty cycle for S_2	V across resistor
25% (64)	14.0 V
50% (128)	22.1 V ✓
75% (191)	28.1 ✓

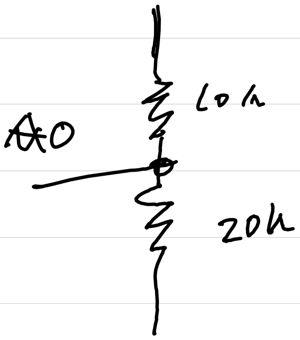
10k Ω

Buck mode

S1 SW
S2 off

duty cycle for S_1	V across resistor
25% (64)	
50% (128)	
75% (191)	

Voltage values seem to be dropping



$$V_{out} = V_{in} \frac{R_2}{R_1 + R_2} = 12V \frac{10k}{10k + 20k}$$
(max)

$$12V \cdot \frac{10k}{30k} = 4V \checkmark$$

within 0-5V range

We ~~being~~ need the current sensor to tell the bi directional dc-dc what to do

We need to show ~~that~~ our project actually works, it isnt automated, but just show that it works

3V input

22k Ω load
for example

Boost mode

S_1 closed (255) → 5V output

S_2 (5)

4V input

S_1 closed (255) → 5V output

S_2 (10)

Prototypes to test

- Simulate PV with bench power source & mimick typical change in $V(x)$, then & connect with the arduino & dc-dc. ↳ load resistor
  - ensure output is 5V, even when input voltage is changed
    ↳ $V = DV_0$ where $V_0 = 5V$ always
    ↳ $D = \frac{V}{V_0} = \frac{V_{input}}{V_{output}}$

→ $\boxed{D = 0.2^{*} V}$

  - ensure output is 5V, even when load resistor is changed (put a potentiometer here & test to ensure 5V is maintained as resistance changes)
  - if current sensor detects $I < 1.5A$ ↳ going to load then make sure the code in the arduino correctly detects that.
    ↳ is there a terminal in arduino

↳ ensure output readings set

1 = battery discharges

0 = battery charges

- Simulate bidirectional dc dc

question (maybe test)

Will the square wave signals from the gate drivers look like this? →

basically Mosfet 2 is off

(direction in circuit) ⟵ for this direction

Mosfel 1 Mosfet 2

ⓐ $D = 20\%$ "buck"

"off" graph will be inverse

ⓑ $D = 80\%$ "boost"

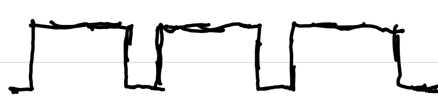
off in this direction

Mosfet 1 direction ⟶ Mosfet 2

"off" graph will be inverse

ⓐ $D = 20\%$ "buck"

ⓑ $D = 80\%$ "boost"



Considering the different modes of battery modes

Bulk -

Absorption -

Float -