<u>Mouse Version 6.0</u>

Objectives:

- Add missing hardware and essentials
    - Add missing external crystal
    - Add serial out
- Hardware upgrades and changes
    - ~~Remove or replace BJT array IC~~
        - Remove the IC
    - Consider resistor array ICs
    - ~~Consider smaller DIP switch~~
        - Remove DIP switch
    - Consider smaller JTAG connector
    - Consider TH reset switch
    - Move reset button towards center of pcb
    - Add error LED vs debugger LEDs
    - Add 4 wheel drive gears
    - Add faster motors or new gears to make mouse faster
    - Add vacuum w/ new regulator
    - Consider 11.1V lipo battery for when adding vacuum
    - Switch to diagonal IR sensors
    - Remove IMU
    - Consider smaller on/off switch
    -
- Software upgrades and changes
    - Clean embedded code
        - Add thorough comments
        - Make functions intuitive to use
            - Wrap functions together and make the wrapped functions private
        - Add error return values with enumerated errors
    - Gradually increase/decrease speed
        - “Move forward until intersection or turn found” function
        - Mouse slows down upon finding intersection or front wall
        - Adjust to front wall upon stopping
        - Return number of spaces moved
    - Maze solving
        - Maze mapping upon traversing through maze (recording maze as mouse moves forward and detects walls)
        - Optimal maze traversal for first run via flood fill
        - Maze exploration mode on return from first run

                - Movement time estimation method needed
                - Explore as much as possible until time is up
            - Solve for optimal path on second run
                - Time wise most optimal (time cost for turns, move forward, long forward, etc)

10/15/23:

- Checking out UC3 L0 Xplained development board: HERE
    - The board uses MOSFETs to turn on/off LEDs
        - Digikey MOSFET array ICs to turn on/off IR sensors: HERE
        - ~~**Solid 4 N-channel MOSFET array IC for us to use: HERE**~~
            - Mouser symbol, layout, and 3D model: HERE
            - We need a current limiting resistor between MCU pin and MOSFET gate
            - Current limiting resistor: $R_g = (V_{MCU} - V_{gs(th)}) / I_{gate}$
                - V_{MCU} is output HIGH voltage
                    - max 3.3V, min 3.3-0.4, so 2.9V

V_{OH}	Output high-level voltage	V_{VDD} = 3.0V, I_{OH} = 3mA	V_{VDD} - 0.4			V
		V_{VDD} = 1.62V, I_{OH} = 2mA	V_{VDD} - 0.4			

                - $V_{gs(th)}$ on datasheet of MOSFET array
                    - Max 3V, min 1V

ON CHARACTERISTICS (Note 8)						
Gate Threshold Voltage	$V_{GS(TH)}$	1	—	3	V	$V_{DS} = V_{GS}$, I_D = 250μA

                - I_{gate} is calculated via gate charge of MOSFET
                    - $I_{gate} = Q_g / t_{rise}$
                    - Where you can choose the t_{rise} to control switching time
                - Whatever, we'll just provide max current available on MCU when the pin is driving HIGH so I_{gate} = 3mA
                - R_s = (3.3 - 1V) / 3mA = 766.66 Ohms
                    - 750 and 820 are standard
                    - **We'll go with 820 Ohms for current limiting resistor for MOSFET gate**
    - XIN and XOUT for external crystal are PA8 and PA9 (pg 12 on mcu datasheet)
        - Currently used by IMU and DIP switch, so easy switch
        - External clock isn't needed for DFLL, but a 12MHz crystal might let us use 240MHz PLL which would be cracked
        - AT32UC3C example (clock example 33) downloaded has PLL example, looks straight forward to configure once clock is in

- 240MHz is plenty of speed to do complicated calculations during PD which is great

3.2.6 Oscillator Pinout

The oscillators are not mapped to the normal GPIO functions and their muxings are controlled by registers in the System Control Interface (SCIF). Please refer to the SCIF chapter for more information about this.

Table 3-5. Oscillator Pinout

48-pin	Pin Name	Oscillator Pin
3	PA08	XIN0
46	PA10	XIN32
26	PA13	XIN32_2
2	PA09	XOUT0
47	PA12	XOUT32
25	PA20	XOUT32_2

- (system control interface chapter- page 186 on pdf)

10/16/23:

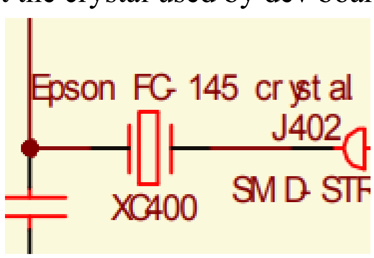
- External clock continued
    - CPU can't operate at 240MHz
    - Right now we're breaking down 140MHz from DFLL down to 35MHz (we couldn't get MCU to run at 50MHz by taking half of 100MHz or directly making DFLL 50MHz found experimentally at runtime blinking an LED)
        - Maybe an external crystal would allow PLL to be a stable 50MHz or 200MHz to break down into 50MHz
    - We want a 16MHz crystal oscillator given MCU OSC0 is limited to 0.45-16MHz

- Temperature = -40°C to 85°C

Table 32-4. Clock Frequencies

Symbol	Parameter	Description	Min	Max	Units
f_{CPU}	CPU clock frequency			50	MHz
f_{PBA}	PBA clock frequency			50	
f_{PBB}	PBB clock frequency			50	
f_{GCLK0}	GCLK0 clock frequency	DFLLIF main reference, GCLK0 pin		50	
f_{GCLK1}	GCLK1 clock frequency	DFLLIF dithering and SSG reference, GCLK1 pin		50	
f_{GCLK2}	GCLK2 clock frequency	AST, GCLK2 pin		20	
f_{GCLK3}	GCLK3 clock frequency	PWMA, GCLK3 pin		140	
f_{GCLK4}	GCLK4 clock frequency	CAT, ACIFB, GCLK4 pin		50	
f_{GCLK5}	GCLK5 clock frequency	GLOC		80	
f_{GCLK6}	GCLK6 clock frequency			50	
f_{GCLK7}	GCLK7 clock frequency			50	
f_{GCLK8}	GCLK8 clock frequency	PLL source clock		50	
f_{GCLK9}	GCLK9 clock frequency	FREQM, GCLK0-8		150	

-
- Mmm everything is capped off at 50MHz and DFLL is capable of going at 50MHz on a 32kHz crystal
    - Development board also has a 32kHz crystal, and no crystal for OSC0
        - Oscillators
            – OSC0 (crystal oscillator) stopped
            – OSC32K (32KHz crystal oscillator) running with external 32KHz crystal
            – DFLL running at 50MHz with OSC32K as reference
    -
    - A 32kHz crystal + DFLL might be enough instead of using a 16MHz crystal + PLL
        - It's a more attractive choice because we know DFLL works and the 32kHz crystal is on the dev board schematic to steal directly
- Damn it the crystal used by dev board is obsolete: [HERE]



    -
- A stable input to DFLL is an upgrade we want for stable performance, and the example clock code by Microchip shows how to use a 32kHz crystal oscillator + DFLL so let's keep going with this option

Table 32-12. 32 KHz Crystal Oscillator Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{OUT}	Crystal oscillator frequency			32 768		Hz
$t_{STARTUP}$	Startup time	R_S = 60kOhm, C_L = 9pF		30 000[1]		cycles
C_L	Crystal load capacitance[2]		6		12.5	pF
C_i	Internal equivalent load capacitance			2		pF
I_{OSC32}	Current consumption			0.6		μA
R_S	Equivalent series resistance[2]	32 768Hz	35		85	kOhm

- Limitations for the external crystal (pg 801 of mcu datasheet: HERE)
- **Good crystal candidate: HERE**
  - Ultra librarian link w/ symbol, layout, and 3D model: HERE
  - Other crystals on digikey: HERE

Figure 4-2. Crystal oscillator example schematic.

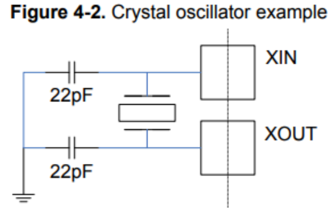


Table 4-2. Crystal oscillator checklist.

☑	Signal name	Recommended pin connection	Description
	XIN	Biasing capacitor 22pF[1][2]	External crystal between 3MHz and 16MHz, powered by VDDIO
	XOUT	Biasing capacitor 22pF[1][2]	Powered by VDDIO

Notes: 1. These values are given only as a typical example The capacitance C of the biasing capacitors can be computed based on the crystal load capacitance C_L and the internal capacitance C_i of the MCU as follows:

$C = 2(C_L - C_i)$

The value of C_L can be found in the crystal datasheet and the value of C_i can be found in the MCU datasheet.

2. Capacitor should be placed as close as possible to each pin in the signal group, vias should be avoided.

- **Provided the equation to find decoupling cap, we need two 22pF caps**
  - C = 2(12.5pF - 2pF) = 22pF, and we round up to 22pF
  - Same as dev board
- We need pins PA10 and PA12, which are used by IR enable right now
  - Easy change

- <u>Materials for serial out</u>
  - 3 pins from MCU -> DE-9 connector -> 3.3V TTL to RS232 translator -> DE-9 to USB-A cable
    - we need to translate from MCU 3.3V TTL logic to RS232 12V logic to avoid all that translation hardware on the PCB
    - ~~DE-9 connector pack on Amazon: HERE~~
    - **DE-9 to USB-A cable: HERE**
    - **Pins to DE-9 female connector w/ TTL to RS232 translator: HERE**

    - This thing lets us jumper from MCU to translator, for this thing to directly connector to the cable to hook up to laptop for TeraTerm

- Resistor array ICs
    - Digikey resistor array ICs: HERE
    - **330 Ohm resistor array IC**
        - IR sensor voltage divider needs it
        - Debug and error indication LEDs need it
        - Digikey link: HERE
        - Mouser 3D model: HERE
        - Ultra Librarian symbol and layout: HERE (UL symbol is better)
    - **750 Ohm resistor array IC**
        - IR sensor voltage divider needs it
        - Digikey link: HERE
        - Mouser 3D model: HERE
        - Ultra Librarian symbol and layout: HERE
    - ~~**820 Ohm resistor array IC**~~
        - ~~NEW- IR sensor on/off MOSFETs will need it~~
        - ~~Digikey link: HERE~~
        - ~~(same package as 750 Ohm, can use same files and rename)~~

10/17/23:
- ~~DIP switch~~
    - ~~TH version of the DIP switch we're using now: HERE~~
        - ~~Same 3 pos, but it'll be more stable and would save space~~
        - ~~This is probably as small as we're going to get~~

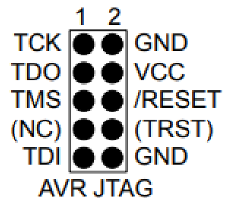
- (10/24): Ditch DIP switch for push button
    - **Use same button as chosen for reset switch: HERE**
    - We can connect this button to interrupt for all software configuration purposes, and then count number of presses for anything that needs to be done

- 50 mil JTAG connector

4.3.2.1. AVR JTAG Pinout

When designing an application PCB, which includes an Atmel AVR with the JTAG interface, it is recommended to use the pinout as shown in the figure below. Both 100-mil and 50-mil variants of this pinout are supported, depending on the cabling and adapters included with the particular kit.

Figure 4-6. AVR JTAG Header Pinout



- 50 mil small connector instead of regular TH pins
- ATMEL ICE supports direct connection via 50 mil connector with this pinout instead of bridging with the adapter board so all good
- **JTAG w/ key slot on Digikey: HERE**
    - 3D model, symbol, and layout downloaded to desktop
    - This thing takes just as much space as our connector now, but the plastic key is worth to never get JTAG orientation wrong again or plug in wrong

- TH reset switch
    - **TH version of reset switch: HERE**
    - 3D model, symbol, and layout downloaded to desktop

- Extra debug LED
    - **Blue LED digikey link: HERE**
    - Needed to allocate red LED for error

- Vacuum for grip to handle speed
    - Youtube video: HERE
    - Website for the mouse in the video: HERE
        - Why the fuck is thing so cracked
        - 180MHz STM controller w/ solid regulators, small DC motors, a vacuum, IMU, IR sensors everywhere
    - Look into how vacuum is set up tmr

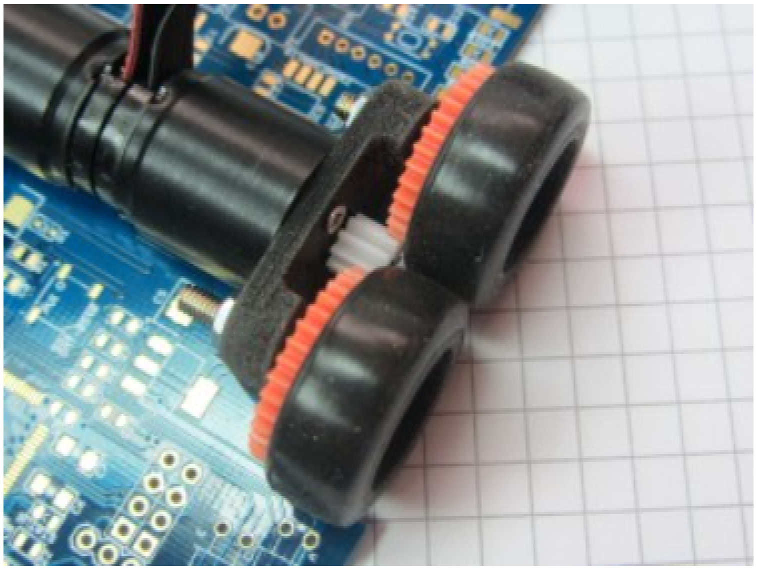
    - …these mfos better watch out- guess next next step after getting the basic circuitry and setup for the mouse working is to upgrade the MCU itself for faster processing: HERE
        - ATSAM using ARM Cortex-M7 running at 300MHz
        - BGA package would be as much of a pain in the ass as it gets
        - Evaluation board is close to $200: HERE

        - But probably essential when the MCU is $15 a piece each and it's capable of so damn much
    - Would have to reconsider sensors to match the MCU speed
    - Challenge accepted
    - But upgrading MCU is a much later problem for now

10/21/23:

- We'll get back to the fan business later
    - Needs regulator, a motor, a fan driven by the motor
    - Need to calculate motor and battery needed to keep ~200g or so on a surface
- Let's do the 4 wheel setup first since it's easier

- <u>4 wheel setup and speed up</u>
    - IEEE paper on half-size micromouse: HERE
        - Talks about everything including 4 wheel vs 2 wheel, accelerometer, etc
    - There's no way around less encoder counts per revolution for a faster motor
    - There's no way around less torque for a faster motor
    - We either:
        - Choose a fast motor and gear ratio the speed down
            - Motor shaft has a small gear, wheels have large gears
        - Choose a slow motor and gear ration the speed up
            - Motor shaft has a large gear, wheels have small gears
    - Fusion 360 guide to make gears: HERE
        - We'll consider the fast motor option first to avoid a weird large gear in between each wheel on the left and right
            - It's what everyone does too
    - We can do something like the "Decimus 4" mouse: HERE



- Servocity motors
    - Motors faster than the 900 RPM motor on Servocity are the 2600 and 4900 RPM motors
    - Current mouse takes ~4 seconds to traverse 4 squares on the practice maze
    - We can always make a fast motor go slower using PWM, so let's try the 4900 RPM motors
        - 60.8077 countable events per revolution
        - We want some reasonable torque to keep the mouse from drifting too much (though fan should fix that) and so that the motors can move ~200g or however much the mouse will weigh
        - Hello physics my old friend
        - Small LiPo battery is 23g, large HOSIM battery is 133g

10/22/23:

4 wheel setup continued:

The half-size micromouse in Fig. 2 is a 4-wheel differential wheeled robot. The reason for 4-wheel differential driven configuration and not 2-wheel structures is the higher coefficient of friction it can provide during acceleration and deceleration, although extra torque is needed in making turns. All the motor mount and wheel configurations shown in Fig. 2

- IEEE paper mentions the need for more torque

- Total force required by the micromouse:
    - $Force_{total}$ = Rolling resistance + acceleration force

    - "Rolling resistance" is the force that resists the movement of the load due to friction
        - Rolling resistance = coefficient of friction * load weight, or
        - $F_r = \mu_r N$
        - This coefficient of friction isn't either coefficients of static or kinetic friction, but the coefficient of rolling friction: HERE
        - Coefficient of static friction for rubber on wood: HERE

soft rubber on dry wood	0.95

        - Finding coefficient of rolling friction is a pain in the ass (can't find a table with rubber to wood and don't want to try experimentally), so we'll assume this worst case of 0.95 since coefficient of rolling friction and kinetic friction are both lower than this value
        - We want our vacuum fan to hold up our mouse on a surface resisting gravity just like in the youtube video: HERE
        - "Micromouse online" website here mentions an additional 200g? downforce does the job: HERE
            - 200 g as in 9.81m/s^2 * 200 is absurd (what is this vegeta in the training room?), so going to assume that it means 200 grams on earth worth of force
        - Assuming our mouse will be around 200g, let's assume that our fan will provide enough force to oppose gravity and keep the mouse on a surface
        - F = ma, so F = (0.2kg) * (9.81m/s^2), so F = 1.962 N
        - The mouse when on a surface and not hanging upside down will have both gravity and the fan pulling the mouse down, so F = 3.924 N total
        - F_r = (0.95) * (3.924 N), so <u>F_f = 3.7278 N</u>
    - Acceleration force
        - Wikipedia says that competitive mice are able to accelerate at 2.5g, or around 24.5 m/s^2: HERE
        - "Micromouse online" says that competitive mice can go well over 1g: HERE
        - Not sure whether our sensors + MCU will be able to handle competitive speeds, but let's prepare the rest of hardware like vacuum and wheels regarding torque to be able to handle that
        - F = ma, so F = (0.2kg) * (24.516m/s^2), so <u>F_{acc} = 4.9032 N</u>
    - Total force

        - F_{total} = (3.7278 N) + (4.9032 N), so F_{total} = 8.631 N required to accelerate a mouse of 200g at 24.516 m/s^2 with a vacuum pulling the mouse down

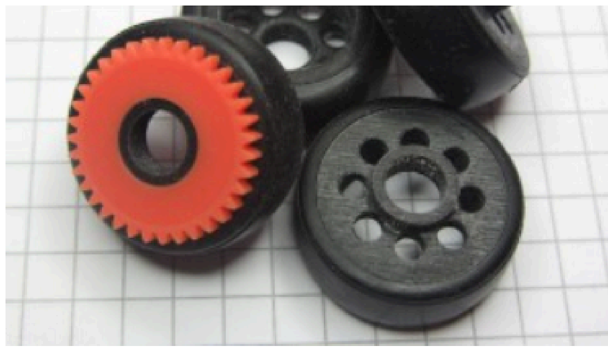
- Total torque required by the micromouse:
    - Torque = Force * wheel radius
    - For reference
        - 90 RPM motors provide 70 oz-in of torque on stall w/ 12V DC
            - Or 0.49 N-m of torque
        - 4900 RPM motors provide 2 oz-in of torque on stall w/ 12V DC
            - Or 0.014 N-m of torque
    - We're using 32mm diameter wheels from Pololu, so radius of 16mm
    - Provided the F_{total} we need and wheel radius, the torque that the motor shaft provides needs to be: Torque = (8.631 N) * (0.016m), so ~~0.138 N-m of torque~~
    - ~~0.138/0.014 = 9.864, so the motor shaft gear to wheel gear needs to have a gear ratio of 9.864~~
    - Mmm a gear ratio of 9.864 reduces the speed of the mouse by a lot…
        - Currently mouse has 900 RPM motors and can go 5 squares in 4 seconds, so that's around 225mm/s, or (225 / (32*pi)) * 60 = 134 RPM right now
        - Mouse should be going at 900 RPM * (5/12) = 375 RPM, or with 32mm diameter wheels (375 * (32mm * pi))/60 or 628 mm/s
        - It's not going at this speed, so either
            - Mouse needs more torque to move at its advertised speed provided the mouse mass (servocity does mention that the RPM is provided no load at 12VDC)
            - Motor RPM isn't linear with voltage supplied
            - Motor needs more current for the voltage to have a linear relationship with voltage
    - 11.1V LiPo battery is definitely the way to go, regulated down to something higher than 5V to supply the motors driving the wheels and the motor that will serve as the vacuum
        - Amazon 11.1V LiPo battery 4.9oz or around 138g: HERE
    - Putting aside the fact that our motor goes slower than what's advertised provided the voltage it's supplied, we want our mouse to go fast
    - Wikipedia says that competitive mice can go faster than 3m/s: HERE
    - If we want our mouse to go at 3000mm/s with our 32mm diameter Pololu motors, we need (3000mm/s)*60 / (32mm * pi) = RPM, or around 1790 RPM on the motors
    - We can check how fast the 4900 RPM motors are capable of moving a mouse at 5V supply, and then find a new regulator accordingly

- It could also be the cap on current that's preventing the mouse from going at high speeds
- **We need a power supply- ~~provide motor driver with 5V and 0.5A and ramp up each to figure out what we need to get the motor moving as advertised~~**
    - Or enough to reach around 1800 RPM
    - We can steal one from IEEE maybe

- The other issue is that we can't have a torque of 0.138 N-m AND an RPM of 1800…
- Torque of 0.138 means gear ratio of 9.864, which means 4900 RPM / 9.864 = 496.76 RPM
    - This is around 3.7 times faster than our mouse right now
    - This is plenty for now- **our objective should be to get the vacuum, 4 wheel setup, and other basic mouse features down before delving into making mouse as fast as humanly possible**
    - Servocity's website says the 4900 RPM motor has a 2 oz-in torque at 12V DC stall, so at full speed full power
        - The "9.864" gear ratio was calculated assuming that our motors output full speed full power torque, but our motors aren't going full speed full power
        - We'll find a new gear ratio provided the RPM that our motors go on our 5V 1.5A regulator

- Objectives:
    - Get 4900 RPM motors to output around 496.76 RPM
        - Find out how fast the 4900 RPM motors go when a motor driver supplied 5V 1.5A drives two motors
        - Find the gear ratio needed to gear ratio down the motor speed to around 496 RPM so we can have the torque we need to move the mouse while having a vacuum on it
        - This will result in a setup that should allow the mouse to:
            - go 3.7 times faster than current mouse
            - accelerate at 2.5g provided it weighs around 200 grams
            - Move to begin with provided the static friction from the rubber wheels resisting movement together w/ vacuum
        - 3D print gears
        - Design a mount to hold the gear train
            - APEC mice don't have fasteners on ends of gears: HERE

    - Decimus 4 doesn’t either, but the wheels are fastened with screws somehow and the shafts that are used sit on bearings: HERE
    - The strat is probably a mount that fits two bearings, a printed D shaft that has a stopper on one end and just a shaft on the other so that the wheel can act as a plug on the shaft end, and a hole in the middle for the motor d shaft to drive a pinion to drive the two wheels
- We should order both 2600 and 4900 RPM motors since if the 4900 RPM motor does move at close to 4900 RPM then we’d need a gear ratio of 9.8:1 which isn’t physically possible unless we add more gears to the train



The drive gears are 35 tooth, 0.5 mod Scalextrix gears that are a push fit over the boss on the rear of the wheel. The gears come in packs of five with one each of 34, 35, 36, 37 and 38 teeth. There are matching pinions with 8, 9, 10, 11 and 12 teeth which makes it easy to change ratio without changing the centre-to-centre distance.

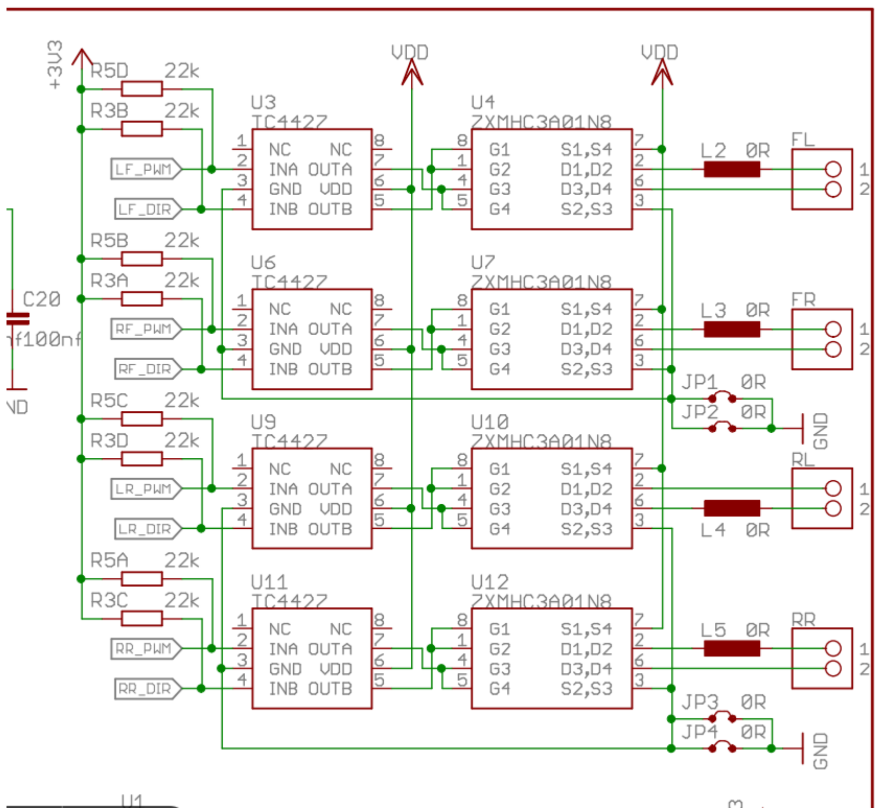
  - 2600 RPM would require 5.2:1 gear ratio
  - Our limit is probably something like 2:1 or 3:1 even with our larger wheels
  - Here are bearings we can try to embed into our mount: HERE

- Todo for now:
  - **Buy 4 wheel configuration components and test**
    - Check for what RPM these motors run at when supplied 5V 1.5A
      - 2600 RPM motor: HERE
      - 4900 RPM motor: HERE
    - Confirm physical dimensions of this bearing, and check for whether D shaft can plug into it:
      - ⅛” (3.175mm) bore and 6.35mm OD ball bearings: HERE
      - 4mm bore and 10mm OD ball bearings: HERE
      - 4mm spacer to reduce friction: HERE
    - After above design a mount with gears to mesh everything together

            - Bad scenario would be if motors output close to what they should be outputting, or if they output below the 496 RPM we want
                - If output is above, we can decide on a cap for PWM
                - If output is below for both, we'd have to find a new regulator setup to supply higher voltage and current
                    - To find that out, we'd need a power supply

Next steps:
- Find the right vacuum setup to provide 200g * 9.81m/s^2 worth of downward force
    - Look into regulator setup for the motor
    - Look into potentiometer to control motor output
    - Design a test board for just the vacuum setup and test how much it can pull down
- Test 4 wheel configuration parts once they arrive, and design a mount
- 4 regular pins + 2 interrupt pins freed by IMU
    - Add a pushbutton to initiate second run
    - Add a pin that goes to MOSFET? To turn on/off vacuum
    - (one more pin already taken by extra LED)
    - (Two more pins already taken by RX and TX USART output)
- Start new PCBs
    - Reallocate MCU pins
    - Rewire schematic together with new parts
    - Design layout provided space taken up by vacuum and 4 wheel setup

10/23/23:
- Alright it's time to look into the vacuum again
- Looking back at that famous youtube micromouse again…
    - Reflecting on Ilan's strat with the 12V buck boost converter
    - This thing with the vacuum uses only 3.3V and 5V regulators too, with 4 DC motors that drive wheels w/ gear ratio 64:12 (almost 5:1 just like 4900 RPM motors)
    - Makes sense that there are that many motors provided the amount of torque that would be needed to move a mouse sticking so close to the base w/ vacuum
        - Must eat through batteries like nothing
    - 3.3V buck-boost converter that provides max 4A: HERE
    - Step-up voltage regulator used to provide 5V at 1.4A
    - Aight aight 4A is a lot, but this thing is trying to drive 4 DC motors at 3.3V
    - Hold the phone the motors are directly supplied VDD

- 

    - Lmao the regulators are for just the other ICs hot damn
    - The motors are directly draining the batteries…

- ~~Alright alright found a 5V regulator that supplies 3A: [HERE]~~
    - ~~Has schematic for 5V 3A output~~
    - ~~Has layout example~~

    - ~~It's still below the 6-12V range that we would ideally want, but the issue is that there are no switching regulators that regulate down to 6V, and more than that gets shady if we decide to use a 2S 7.4V LiPo battery~~
        - ~~We can go for higher voltage regulators if we commit to the 3S 11.1V regulator~~
    - ~~We could also go for a buck-boost converter just like Ilan~~
        - ~~The best option would be if the high RPM servocity motors can operate w/ the step-down buck converters we have now, since step-down converters are more efficient than buck-boost converters~~
    - ~~Worst case if the servocity motors that arrive can't supply 500 RPM w/ load, then we'll try to run the motors using a higher current supply (3A) but 5V using a power supply to see if that helps~~
        - ~~If it does, then we'll switch to the step-down regulator found above~~

- ~~If it doesn’t, then we’re gonna have to ramp up the voltage to see what voltage we have to supply the motors to look into buck-boost converters or committing to the 3S 11.1V LiPo battery to find step-down converters that step down to higher voltages~~
    - ~~There are plenty of 12V step-down switching regulators on Digikey, but barely any step-up just like stepping down to voltages between 6V and 12V~~
        - ~~All of the step-up converters boost to 12V but supply 30mA or something so~~

switching regulator × | Function × | Voltage - Output (Min/Fixed) × | Product Status × | Stocking Options × | Media × | Marketplace Product ×

Showing 1 - 12 of 12 | Pricing Quantity

Compare	Mfr Part #	Quantity Available	Price	Series	Package	Product Status	Function	Output Configuration	Topology	Output Type	Number of Outputs	Voltage - Input (Min)	Voltage - Input (Max)	Voltage - Output (Min/Fixed)	Voltage - Output (Max)	Current - Output
	R1218N021A-TR-FE IC REG BOOST ADJ 700MA SOT23-6 Nisshinbo Micro Devices Inc.	6,281 In Stock	1 : $1.43000 Cut Tape (CT) 3,000 : $0.60802 Tape & Reel (TR)	R1218x	Tape & Reel (TR) Cut Tape (CT) Digi-Reel®	Active	Step-Up	Positive	Boost	Adjustable	1	1.8V	5.5V	8.5V	10.5V	700mA (Switch)
	R1213K001B-TR IC REG BOOST ADJ 2.5A 12DFN Nisshinbo Micro Devices Inc.	4,489 In Stock	1 : $1.58000 Cut Tape (CT) 5,000 : $0.69589 Tape & Reel (TR)	R1213K	Tape & Reel (TR) Cut Tape (CT) Digi-Reel®	Active	Step-Up	Positive	Boost	Adjustable	1	2.3V	5.5V	6V	15V	2.5A
	ST8R00WPUR IC REG BOOST ADJ 1A 8DFN STMicroelectronics	58,290 In Stock	1 : $2.44000 Cut Tape (CT) 4,500 : $1.11804 Tape & Reel (TR)	-	Tape & Reel (TR) Cut Tape (CT) Digi-Reel®	Active	Step-Up	Positive	Boost	Adjustable	1	4V	6V	6V	12V	1A (Switch)
	MAX20474ATDA/V+ IC REG BOOST ADJ 14TDFN Analog Devices Inc./Maxim Integrated	1,465 In Stock 490 Factory	1 : $2.83000 Tray	Automotive	Tray	Active	Step-Up	Positive	Boost	Adjustable	1	3V	5.5V	6V	18V	-
	MAX662ACPA+ IC REG CHARGE PUMP 12V 30MA 8DIP Analog Devices Inc./Maxim Integrated	154 In Stock 3,900 Factory	1 : $5.75000 Tube	-	Tube	Active	Step-Up	Positive	Charge Pump	Fixed	1	4.5V	5.5V	12V	-	30mA
	MAX662ACSA+ IC REG CHRG PUMP 12V 30MA 8SOIC Analog Devices Inc./Maxim Integrated	1,422 In Stock	1 : $6.40000 Tube	-	Tube	Active	Step-Up	Positive	Charge Pump	Fixed	1	4.5V	5.5V	12V	-	30mA
	MAX662ACSA+T IC REG CHRG PUMP 12V 30MA 8SOIC Analog Devices Inc./Maxim Integrated	4,828 In Stock	1 : $6.41000 Cut Tape (CT) 2,500 : $3.21938 Tape & Reel (TR)	-	Tape & Reel (TR) Cut Tape (CT) Digi-Reel®	Active	Step-Up	Positive	Charge Pump	Fixed	1	4.5V	5.5V	12V	-	30mA
	LT1109ACS8-12#PBF IC REG BOOST 12V 2A 8SO Analog Devices Inc.	316 In Stock	1 : $7.12000 Tube	-	Tube	Active	Step-Up	Positive	Boost	Fixed	1	2V	9V	12V	-	2A (Switch)
	MAX662AEPA+ IC REG CHARGE PUMP 12V 30MA 8DIP Analog Devices Inc./Maxim Integrated	100 In Stock 11,350 Factory	1 : $7.19000 Tube	-	Tube	Active	Step-Up	Positive	Charge Pump	Fixed	1	4.5V	5.5V	12V	-	30mA
	MAX662AESA+T IC REG CHRG PUMP 12V 30MA 8SOIC Analog Devices Inc./Maxim Integrated	4,694 In Stock	1 : $7.55000 Cut Tape (CT) 2,500 : $4.12282 Tape & Reel (TR)	-	Tape & Reel (TR) Cut Tape (CT) Digi-Reel®	Active	Step-Up	Positive	Charge Pump	Fixed	1	4.5V	5.5V	12V	-	30mA
	LT1109CS8-12#PBF IC REG BOOST 12V 1.2A 8SO Analog Devices Inc.	13 In Stock	1 : $7.74000 Tube	-	Tube	Active	Step-Up	Positive	Boost	Fixed	1	5V	20V	12V	-	1.2A (Switch)
	MAX662AESA+ IC REG CHRG PUMP 12V 30MA 8SOIC Analog Devices Inc./Maxim Integrated	236 In Stock 200 Factory	1 : $8.08000 Tube	-	Tube	Active	Step-Up	Positive	Charge Pump	Fixed	1	4.5V	5.5V	12V	-	30mA

- ~~How is that possible~~
- ~~Welp we’ll delve into this issue if both servocity motors don’t supply sufficient RPM on 5V 1.5A and ramping up current doesn’t do the job either~~

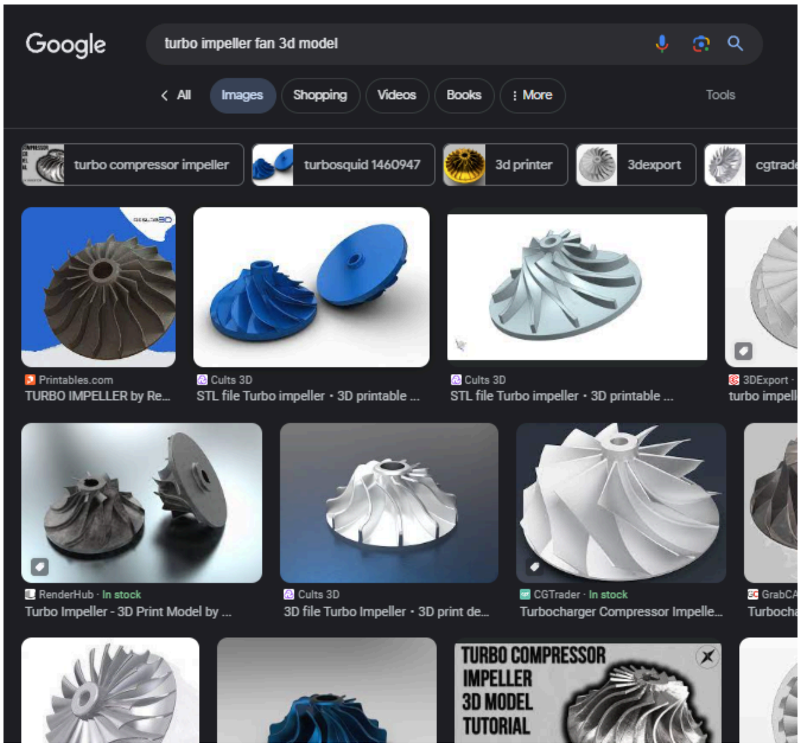
- Let’s just use 12V buck boost w/ 3A supply, you’re just not looking hard enough on Digikey
    - We need the 4900 RPM DC motors to provide its advertised RPM to settle on a gear configuration

<u>Vacuum continued</u>

- Brushless DC motor is the way to go

- There are axial, centrifugal, and blower fans are common fans, but micromice use centrifugal fans for high pressure and small form factor
- Youtube video comparing different impeller fans: [HERE]
    - Turbo, linear, and centrifugal fans compared
    - Turbo fan provided the most suction

- Aight let’s try to integrate this turbo impeller fan into our mouse



Next steps:
- Look into whether we can design or steal a turbo impeller fan
- Look into 1S brushless motor and associated regulator and motor driver IC we’re going to need

- Reflecting on chris input
    - We can ditch DIP switches and pushbuttons altogether if we rely on IR sensors or wheel encoders
        - If we handle modes and software configuration with one button on an interrupt w/ software debouncing it might be best
            - Clean handling w/o polling in exchange for using a pin
            - We can get rid of DIP switches this way, and just count push button presses
    - IR sensors should be two front and diagonals

- Find smaller power switch
    - Browsing through list: HERE
    - Would have to consider current that we end up needing for vacuum fan, but smaller switch is needed for sure
    - Some obsolete but smaller switches: HERE and HERE

- ~~**Found a vacuum fan motor candidate: HERE**~~
    - We need to make a fan vacuum model using this motor, and then test how it does

- Found powerful JST connector Amazon link that has almost every connector type: HERE

- Can't find ribbon cables for JST connectors, but we can crimp: HERE

10/25/23:
- Update on torque required to move the mouse
    - If the mouse is on four wheels, then the force on each of the wheels is the total load divided by four
    - Crazy
        - I need to go through kinematics again actual monkey
    - F_{total} = 8.631 N is still true
    - Torque = Force * wheel radius
    - For reference
        - 90 RPM motors provide 70 oz-in of torque on stall w/ 12V DC
            - Or 0.49 N-m of torque
        - 4900 RPM motors provide 2 oz-in of torque on stall w/ 12V DC
            - Or 0.014 N-m of torque
        - So if we divide the force by 4 and recalculate torque
        - (8.631 N / 4) * (0.016m) = 0.0345 N-m
        - If we use the 4900 RPM motors
            - 0.0345 / 0.014 = **2.466 gear ratio**
                - w/ this gear ratio, mouse will be able to handle 2.5g of acceleration provided mouse weighs around 200g and vacuum is providing another 200g of downward force even when the motors are driving the pinions at max speed of 4900 RPM
        - If we use the 2600 RPM motors
            - 0.0345 / 0.49 = 0.074 (difficult to interpret)
            - 0.49 / 0.0345 = 11.586 gear ratio

    - Alright the math is mathing now

- So we want our 4900 RPM motor to move the wheels at 4900/2.466 = **<u>1987 RPM</u>** for each of the wheels to have enough torque to move the mouse with a vacuum
    - We just need the wheel gear to have 2.466 times the number of teeth than the pinion gear that the motor will drive
- The 2600 RPM motors would require the pinion to have 11.586 times the number of teeth than the wheel gears or else each wheel would have too much torque, so that's a pass
    - Small pinion and large gears on wheels is physically convenient over large pinion and small gears on wheels

11/5/23:
- Alright finally back on mouse
- Above RPM on the wheels and gear ratio is provided the mouse is providing max speed of 4900 RPM consistently
    - The 2.466 gear ratio is the ratio needed to slow down the 4900 RPM motors enough so that the mouse will still move provided all of the forces acting on it w/ 2.5g of acceleration, the mouse weight, and the vacuum pushing the mouse down
- We need a new speed for the mouse to slow down to for when the force on the mouse is greater on the turns

- The wikipedia page from a while back says that competitive mice are capable of 6g of centripetal acceleration
    - If we assume our mouse is going to be around 200g, then centrifugal force caused by 6g would be F = (0.2g) * (9.81 * 6 m/s/s) = 11.772 N
    - This means that friction should prevent this much force at all times, and that the motors should provide more than this much force to get the mouse moving to where it needs to go
    - Using the 0.95 coefficient of friction from before between rubber and wood, resistive force from friction is F = (0.95) * (normal force on the mouse)
    - If we want friction force to be 12N, then normal force needs to be 12N/0.95 = 12.63 N
    - 200 g mouse causes 0.2kg * 9.81 m/s/s = 1.962 N of downward force
    - We're missing 10.669 N of downward force 💀
        - So here's why all the mice have so much vacuum force
    - We need our vacuum to provide that missing 11N or so of downward force
        - With earth's acceleration, this means that our mouse vacuum needs to be able to hold 11N / 9.81m/s/s = 1.121kg of mass up in the air
        - That's pretty crazy

    - Calculating for the torque required gives us

        - Torque = Force * radius
        - Torque = (12.63N / 4) * (0.016m) = 0.05 N-m of torque required
        - At 4900 RPM the motor provides 0.014 N-m of torque
        - We need the motors to be 0.05 / 0.014 = 3.609 times slower for each wheel to provide enough torque
        - This means our motors need to be dropped down to 4900 / 3.609 = **1357.7 RPM** to provide the torque required on a turn w/ 6g of centripetal acceleration and a 200g mouse
        - …slowing down the mouse and having high centripetal acceleration is contradictory, but the point is that we have to balance the speed of the mouse and provide high vacuum force on turns

- **Found new candidate for battery 2s battery: HERE**
    - Same size as HOSIM lipo battery, but provides 900mAh instead of 800
    - We need more juice, but 3s batteries are too big

- Green ye's micromouse website: HERE
    - Has fan and power schematics
    - This guy uses gate driver IC to pulse the gates of MOSFETS to control the vacuum fan
    - We can reduce this down to a fan driver IC

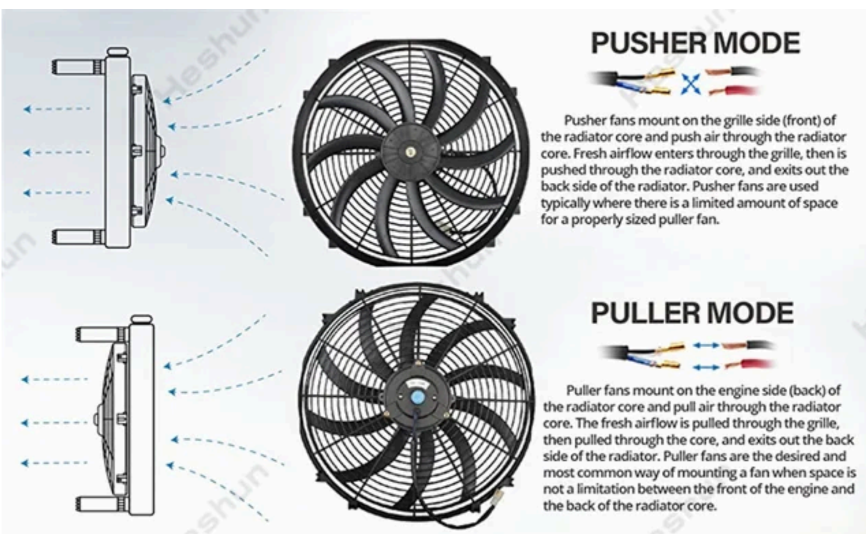
Vacuum setup

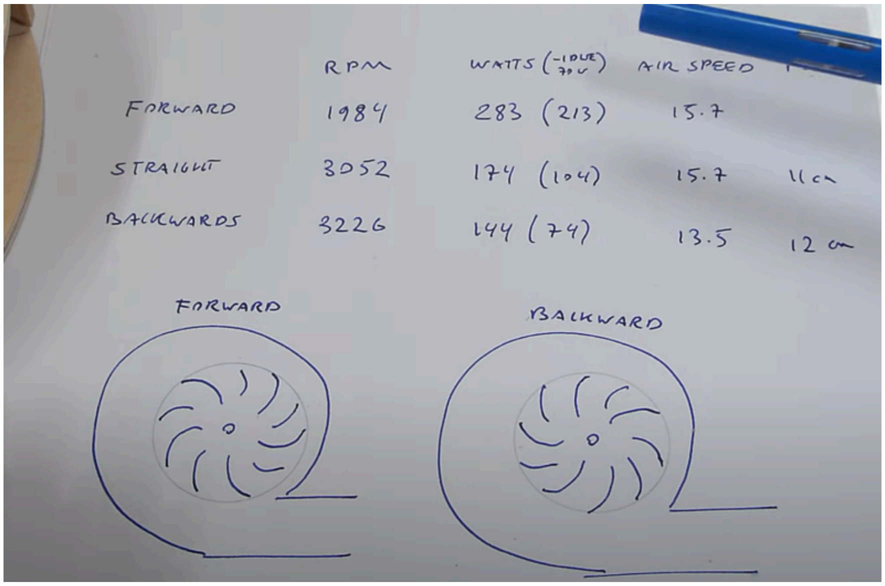
- We want a simple impeller fan driven by a fast dc motor
    - These small motors made for drones are typically 1S, so we should supply around 3.7V to them controlled by PWM
    - We need to check the current and voltage that the motor demands
        - We need printed parts to confirm vacuum performance
        - Tektronix power supply guide: HERE
        - The small crazepony 70,000 RPM motors caps off around 1.6A at 3.3V supplied when the motor has a high load on it
        - Tried to limit test the motors, burned out after 2S lipo battery supplied the motor 4A
        - We need a motor w/ a datasheet or description that includes current or power limitations provided 1S rating
    - Amazon has a link to the GHLRC specter 1002 brushless motor, and the vendor has their own website w/ brushless motors w/ specs defined: HERE

- The 10A 21000KV 1S brushless motor is probably the most powerful thing we can get, but we can go down to the 5A version if there aren't any regulators and/or motor drivers that can handle 10A
- HGLRC 10A brushless 1S motor: HERE
- **HGLRC 5A brushless 1S motor: HERE**
    - Trying to get answers on more motor details
        - JST connector type- got answer 1.25mm pitch
        - Whether it can be driven w/ 3 phase motor driver
    - HGLRC links a facebook page: HERE
        - Which then links a google drive page w/ documents: HERE

- Welp, 10A output regulators aren't conventional, so we'll go with the 5A brushless motor
    - Browsing 5A, 3.3V regulators since 3.7V regulation isn't conventional: HERE
    - **3.3V 5A output step down regulator: HERE**
        - This is a new IC and it doesn't have a 3d model, but it does have symbol and layout on ultralibrarian: HERE
        - It's either this or another regulator that's about to die

- Impeller blower configuration test video: HERE
- Impeller fan crafted by hand video: HERE





- For higher efficiency and pressure we want to use the puller configuration, so the backward configuration above where the fins in above image are moving counter-clockwise
    - Backward facing impellers (puller configuration) has higher efficiency at the cost of less air flow, where we want both high pressure and air flow for max vacuum force
    - Puller configuration demands a larger fan to make up for the lack of airflow
        - Green Ye's mouse allocates a 3cm diameter circle for the fan, and around 1.5cm opening to vacuum the floor to the mouse, so we'll copy that as a starting point and see much we can vacuum
- Air is sucked in from the side where you see the fins moving counter-clockwise

<u>New wheel motor setup</u>

- We want to provide 12V and close to 1.6A each to our 4900 RPM motors to get max performance
- Stall current of 1.6A means that there's no case where the motor will draw more than 1.6A, so we need to find a regulator that can supply around 3.2A

<u>On/off switch replacement</u>

- Slide switches aren't capable of high currents like 13+ Amps, so we need to switch to rocker switches if we decide to go w/ the 10A brushless motor from HGLRC
- Browsing through rocker switches on Digikey: [HERE]

11/12/23:

- (Vacuum setup continued):
- BLDC motor driver:
    - **3-phase 5A brushless motor driver that we can try: HERE**
    - Demands 3 PWM waves from the MCU to control each of the inputs on the brushless motor, so we need to use timer counter and manually generate pwm waves with a 120 degree phase offset
        - Can't find a way to generate pwm waves w/ offset using AT32UC3L0256
        - Easier solution would be to find a brushed motor or 1 phase brushless motor driven w/ a single half bridge, but whatever let's try to go w/ this

- (New wheel motor setup continued):
- Brushed 12V 1.5A (on each channel) motor driver
    - Browsing motor drivers: HERE
    - ~~**MP6508GF-Z 2.7-18V 1.2A 2 channel brushed motor driver: HERE**~~
        - ~~Ultralibrarian files for the SSOP version: HERE~~
        - ~~QFN4 package available on Mouser: HERE~~
    - ~~We'll pass this chip 12V using a buck boost regulator~~
        - This thing sucks too- doesn't have usual PWM pins
    - **TB6561FG,8,EL 36V, 1.5A, 2 channel brushed motor driver: HERE**
        - Ultralibrarian all files: HERE
        - The downside is that this thing is huge (16mm x 11mm)
        - Screw it we need it now that we found a sufficient regulator below
- Buck boost converter to supply motors
    - Browsing switching regulators: HERE
    - ~~**LT1107 1.5A 12V fixed regulator: HERE**~~
        - ~~Couldn't find a regulator that outputs close to 2.4A~~
        - ~~LT1109 (the 2A version of this IC) datasheet recommends using LT1107 for applications where input voltage fluctuates~~
        - ~~Unfortunately no layout example~~
        - ~~Ultralibrarian files w/ all files: HERE~~
        - This thing is a piece of shit- doesn't provide any current at all after looking at realistic inductors
    - Fantastic tool by TI: HERE, and the optimal design using IC below: HERE
    - **TPS61288RQQR adjustable regulator for 12V 3A: HERE**
        - Ultralibrarian w/ all files: HERE
        - Goodness sake TI is goated

- (on/off switch replacement continued):
    - Now we know max current draw from the battery
        - 5A for vacuum

- 0.5A for 3.3V for mcu
- 0.5A for 5V for sensors
- 1.5A for 12V for motors
- That's a total of 7.5A
- **Cheap rocker switch rated for 15A (AC): HERE**
  - 2.1cm x 1.5cm or so
  - Datasheets for mechanical components suck ass
  - There's no rated DC current, but hopefully this thing can handle switching our 2S lipo on/off

11/16/23:

- Archiving all old ideas below now dead due to TI's tool

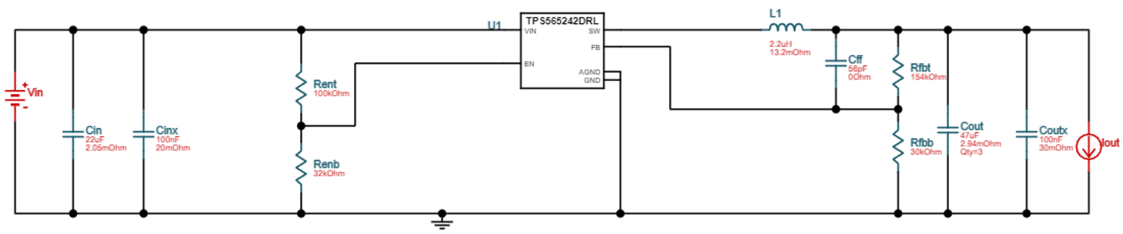
- ~~**3.3V 5A output step down regulator: HERE**~~
- ~~**Needs various external components**~~
  - ~~We want to use 3.3V 2.2MHz configuration on pg 42 of datasheet~~
  - ~~Individual part values and equations on pg 36-39~~
  - ~~Cin~~
    - ~~RMS current > 2*$I_{load\ max}$, so > 10A~~
    - ~~Use high quality ceramic caps to minimize input ripple~~
    - ~~**C1A- 10uF, big, Cin: HERE**~~
    - ~~**C1B- 10uF, big, Cin: HERE**~~
    - ~~**C1C- 0.1uF, small, Cin: HERE**~~
    - ~~**C1D- 0.1uF, small, Cin: HERE**~~
  - ~~**R1- 100k, small, Ren: HERE**~~
  - ~~**R2- 100k, small, Ren: HERE**~~
  - ~~**R3- 15k, small, Rfreq: HERE**~~
  - ~~**R4- 100k, small, Rpgood: HERE**~~
  - ~~**C3- 22nF, small, Css: HERE**~~
  - ~~**C4- 0.1uF, small, Cbst: HERE**~~
  - ~~**L1- 1uH, huge: HERE**~~
    - ~~Ultralibrarian files: HERE~~
    - ~~DC current rating should be > 1.25*$I_{load\ max}$, so > 6.25A~~
    - ~~Choose low DC resistance for higher efficiency~~
    - ~~Ripple current should be 0.3*$I_{load\ max}$, so 1.5A~~
    - ~~Peak current = I_{load} + V_{out} / (2*f_{sw} * L) * (1 - V_{out} / V_{in}), so 5A + 3.3V / (2* 2.2 * 1) * (1- 3.3/7.4) = 5.4A~~
  - ~~Cout~~
    - ~~Use low ESR caps to minimize output ripple~~
    - ~~**C2A- 22uF, 10V, 1210, huge, Cout: HERE**~~

        - ~~**C2B- 22uF, 10V, 1210, huge, Cout:** [HERE]~~
    - ~~**C5- 1uF, small, Cvcc:** [HERE]~~

- ~~Buck boost converter to supply motors~~
  - ~~**LT1107 1.5A 12V fixed regulator:** [HERE]~~
    - ~~Ultralibrarian files w/ all files: [HERE]~~
    - ~~Our motor driver is limited to this regulator- there’s no regulator that provides more than this much current w/ a decent form factor~~
    - ~~If we need to save pins we can pull up the standby pins to HIGH to save 2 pins~~
  - ~~**Needs various external components**~~
    - ~~Schematic on page 9 for buck-boost configuration~~
    - ~~Math to choose inductor~~
      - ~~R_{switch} = 0.8 Ohms at 25 degrees C~~
      - ~~t_{switch_on} = 11us~~
      - ~~V_{out} = 12V~~
      - ~~V_{in_min} = 5V~~
      - ~~I_{out} = 1.5A~~
      - ~~V_D = 0.37V (from schottky diode found below)~~
      - ~~f_{osc} = 50 kHz (min)~~
    - ~~$P_L = (V_{out} + V_D - V_{in\_min})(I_{out})$~~
      - ~~P_L = (12V + 0.37V - 5V)(1.5A) = 11.055W~~
    - ~~$E_{required} = P_L / f_{osc}$~~
      - ~~$E_{required}$ = 11.055W / 50kHz = **0.22mJ**~~
    - ~~$I_{peak} = (V_{in\_min} / (R_{sw} + R_{inductor\_dc})) * (1 - e^{-((R\_sw + R\_inductor\_dc) * t\_sw\_on) / L})$~~
      - ~~(5V / (0.8 Ohms + x Ohms)) * (1 - $e^{-((0.8 + x) * 11us) / y}$) = 3.6mA peak~~
    - ~~$E_L = 0.5 * L * (I_{peak})^2$~~
    - ~~And $E_L > E_{required}$ for the inductor to be valid~~
    - ~~L1~~
      - ~~Maybe 40 Ohms, 15mH~~
    - ~~D1~~
      - ~~1N5818 schottky, or any other schottky~~
      - ~~CMS04(TE12L,Q,M) schottky diode: [HERE]~~
      - ~~Ultralibrarian all files: [HERE]~~
      - ~~0.37 V peak forward voltage~~
    - ~~R3~~
    - ~~C1~~

~~- Find links~~

11/19/23:



- The built-in input transient and load transient simulations are beautiful

Summary of changes and new parts:

- Removed components
    - BJT array IC
        - SHARP sensors are too slow to pulse, so we'll always keep sensors on
        - Frees up 4 pins
    - DIP switch
        - A single pushbutton on an interrupt pin can handle all software configuration
            - Pushbutton needed over polling wheel encoders or sharp sensors to prevent anything from triggering during mouse traversal
        - Frees up 2 pins
    - IMU
        - IR sensors alone seem to be sufficient for stabilizing mouse position
            - we'll limit test the SHARP sensors this next round
        - Frees up 6 pins

- External crystal
    - **RT3215-32.768-12.5-TR-10PPM: HERE**
        - Ultra librarian link w/ symbol, layout, and 3D model: HERE
        - 32.768kHz crystal
        - Other crystals on digikey: HERE
    - **Needs two 22pF capacitors: HERE**
    - Needs two new pins: PA10 and PA12

- USART out
    - **DE-9 to USB-A cable: HERE**
    - **Pins to DE-9 female connector w/ TTL to RS232 translator: HERE**
        - Lets us jumper from MCU to translator, for this thing to then directly connect to the DE-9 to USB-A cable to hook up to laptop for TeraTerm
    - Needs two new pins for RX and TX

- Resistor array ICs
    - Digikey resistor array ICs: HERE
    - **330 Ohm resistor array IC**
        - IR sensor voltage divider needs it
        - Debug and error indication LEDs need it
        - Digikey link: HERE
        - Ultralibrarian all files: HERE
    - **750 Ohm resistor array IC**
        - IR sensor voltage divider needs it

    - Digikey link: HERE
    - Snapeda all files: HERE

- New reset switch
  - **TH version of reset switch: HERE**
  - 3D model, symbol, and layout downloaded to desktop

- Pushbutton for software configuration
  - **Use same button as chosen for reset switch: HERE**
  - 3D model, symbol, and layout downloaded to desktop

- New JTAG connector
  - **JTAG w/ key slot on Digikey: HERE**
  - 3D model, symbol, and layout downloaded to desktop

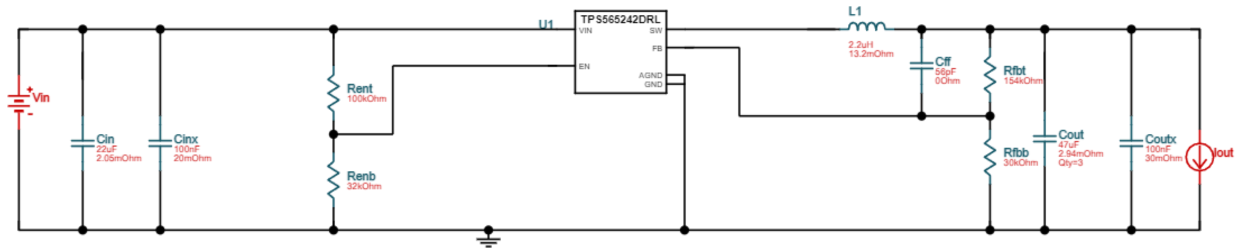
- Extra debug LED
  - **Blue LED digikey link: HERE**
  - Needed to allocate red LED for error
  - Needs one new pin

- 4 wheel setup
  - The ball bearing goes inside of the custom wheel, the M3 screw acts as the shaft, and the spacers reduce friction between the screw head and the custom mount
    - Screw can't be tightened too hard or else the wheels won't move, but this should work otherwise
  - Wheels should have 16mm radius to be consistent w/ math for now
  - Faster motors
    - **4900 RPM motor: HERE**
  - **3mm shaft size ball bearings: HERE**
  - **3mm shaft size plastic spacers: HERE**
  - **M3 screws: HERE**

- Vacuum setup
  - Math
    - Assuming
      - Mouse will weigh 200 grams
      - μ_s = 0.95 (rubber wheel and wooden floor maze)
      - Mouse has 4 wheels w/ 0.016m radius
      - Mouse accelerates forward at 2.5g (g = 9.81m/s/s)
      - Mouse accelerates on turns w/ 6g centripetal acceleration

- 4900 RPM motors provide 2 oz-in of torque on stall w/ 12V DC
    - Or 0.014 N-m of torque
- Total force required to accelerate/move mouse
  - $F_{centrifugal}$ = (0.2kg) * ((9.81m/s/s) * 6) = **11.772N**
  - $F_{resistive}$ = $F_{centrifugal}$ to keep mouse on track
    - $F_{resistive}$ = (0.95) * ((0.2kg * 9.81m/s/s) + (F_{vacuum}))
    - F_{vacuum} = 11.772N / 0.95 - (0.2kg * 9.81m/s/s) = **10.429N**
      - 10.429 / (9.81m/s/s) = **1.06kg** vacuum needs to be able to hold up against gravity
- Total torque required on each wheel to overcome $F_{resistive}$ needed to keep mouse on track
  - τ_{wheel} = (11.772N / 4) * (0.016m) = **0.047088N-m**
- Gear ratio required between motor and wheels to accelerate/move mouse
  - Gear ratio = 0.047088 / 0.014 = **3.363**
- Final speed of motors
  - 4900 RPM / 3.363 = **1456.8 RPM**
- Final mouse top speed
  - Mouse speed = (π * 0.032m) * 1456.8 rotations / 60s = **2.44m/s**
  - This speed and torque allows mouse to
    - Accelerate at up to 6g either forward or centripetal
- …These numbers need to be fine tuned after finding true mouse mass and final vacuum capabilities, but these are the estimates for now

- Custom fan
  - We should allocate 3cm diameter circle for vacuum w/ 1.5cm hole following Green Ye
  - Fan needs to be in puller configuration
    - Impeller fan will suck air from the side where you see the backward facing fins moving counter-clockwise
  - Needs to have 1mm shaft opening for motor below
- BLDC motor for vacuum
  - **HGLRC 5A brushless 1S motor: HERE**
  - **Needs JST 1.25 pitch connector: HERE**
    - **(need to confirm connector type before looking for 3D model, symbol, and layout)**
  - Motor itself is around 12mm diameter and 13mm height w/ shaft
- Switching regulator for vacuum

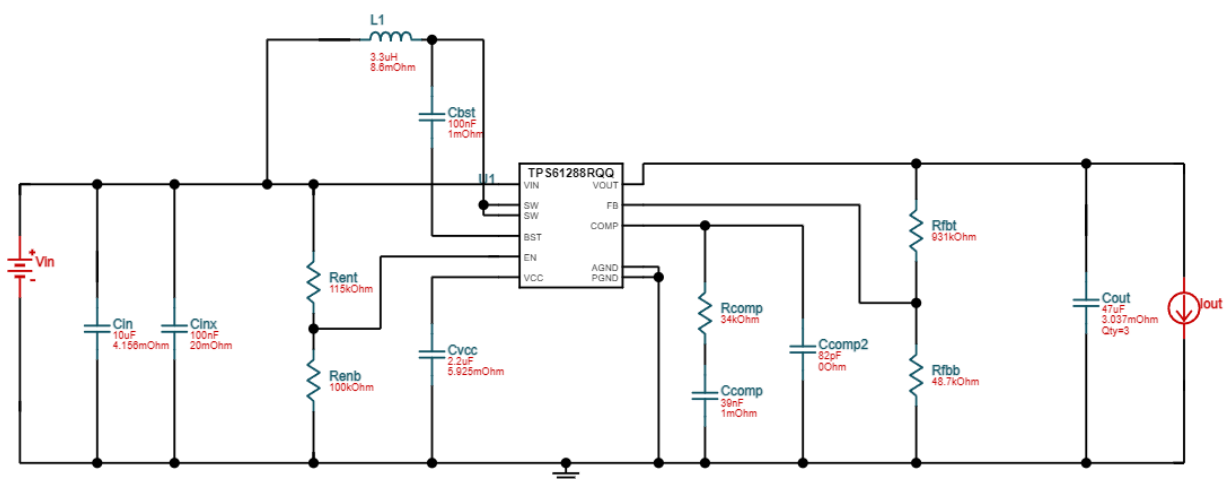


- **6A 1V drop rectifier diode: HERE**
    - Ultralibrarian symbol and layout: HERE
    - Mouser 3D model: HERE
- **U1: HERE**
    - Ultralibrarian all files: HERE
    - 3.7V 5A for vacuum TI tool: HERE
    - Schematic is vastly different from example in datasheet, but layout example provided on datasheet pg 21
- **Cin: HERE**
- **Cinx: HERE**
- **Rent (trying out tiny 0402 1mm x0.5mm package): HERE**
- **Renb: (tiny 0402): HERE**
- **L1: HERE**
    - Ultralibrarian all files: HERE
- **Cff (tiny 0402): ~~HERE~~ need new: HERE**
- **Rfbt (tiny 0402): HERE**
- **Rfbb: HERE**
- **Cout: HERE**
- **Coutx: HERE**

- Motor driver for vacuum
    - **3-phase 5A brushless motor driver: HERE**
        - Ultralibrarian all files: HERE
    - Needs 3 new pins + 1 fault pin if we want to detect faults + 1 vacuum sleep pin
        - Pull up INLx pins to AVDD for 3x mode, since we don't need to put motor output pins to high impedance
    - Schematic for DRV8311H on pg 81 of datasheet
    - **Needs various external components**
        - **Cvm1- X5R/X7R, 0.1uF VM (3.3V) rated, big: HERE**
        - **Cvm2- >= 10uF, VM rated electrolytic cap, huge: HERE**
        - **Cvin_avdd1- X5R/X7R, 0.1uF VIN_AVDD (3.3V) rated, small: HERE**
        - **Cvin_avdd2- >= 10uF, VIN_AVDD rated, small: HERE**

            - **Ccp- X5R/X7R, 16V, 0.1uF, small: [HERE]**
            - **Cavdd- X5R/X7R, 6.3V, 0.7uF to 7uF, small: [HERE]**
            - **Rnfault- 5.1k: [HERE]**
            - Rmode- (not needed- tie to AVDD for 3x mode)
            - Rslew- (not needed- tie to AVDD for highest 230V/us mode)
            - Rgain- (not needed- tie to GND for lowest gain)
            - **Ccsaref- X5R/X7R, 0.1uF csaref (3.3V) rated, small: [HERE]**

- <u>New wheel driver setup</u>
    - **6A 1V drop rectifier diode: [HERE]**
        - Ultralibrarian symbol and layout: [HERE]
        - Mouser 3D model: [HERE]
    - **TB6561FG,8,EL 36V, 1.5A, 2 channel brushed motor driver: [HERE]**
        - Brushed 12V 1.5A (on each channel) motor driver
        - Browsing motor drivers: [HERE]
        - Ultralibrarian all files: [HERE]
        - Uses one less standby pin, but implements a new current limiter detection output pin to read
            - IN1A, IN2A, IN1B, IN2B, SB, PWMA, PWMB, CLD
        - **Needs various external components**
            - **C1: [HERE]**
                - 0.1uF cap for 5V output from motor driver
            - **C2: [HERE]**
                - "Power supply capacitor"- specs not specified
                - We'll use same polymer cap as before
    - 12V 3A regulator to supply motor driver



        - **U1: [HERE]**
            - Ultralibrarian all files: [HERE]

        - 12V 3A for motor driver TI Tool: HERE
        - Example layout available on pg 21 of datasheet
    - **Cin: ~~HERE~~ need new: HERE**
    - **Cinx: ~~HERE~~ need new: HERE**
    - **L1: HERE**
        - Ultralibrarian all files: HERE
    - **Cbst: ~~HERE~~ need new: HERE**
    - **Rent: HERE**
    - **Renb: HERE**
    - **Cvcc (tiny 0402): HERE**
    - **Rcomp (tiny 0402): HERE**
    - **Ccomp (tiny 0402): ~~HERE~~ need new: HERE**
    - **Ccomp2: ~~HERE~~ need new: HERE**
    - **Rfbt: HERE**
    - **Rfbb: HERE**
    - **Cout: ~~HERE~~ need new: HERE**

- New on/off switch
    - Max current draw from the battery
        - 5A for vacuum
        - 0.5A for 3.3V for mcu
        - 0.5A for 5V for sensors
        - 3A for 12V for motors
        - Total of 9A
    - **Rocker switch rated for 15A (AC): HERE**
        - Mouser 3D model: HERE
        - Ultralibrarian symbol and layout: HERE

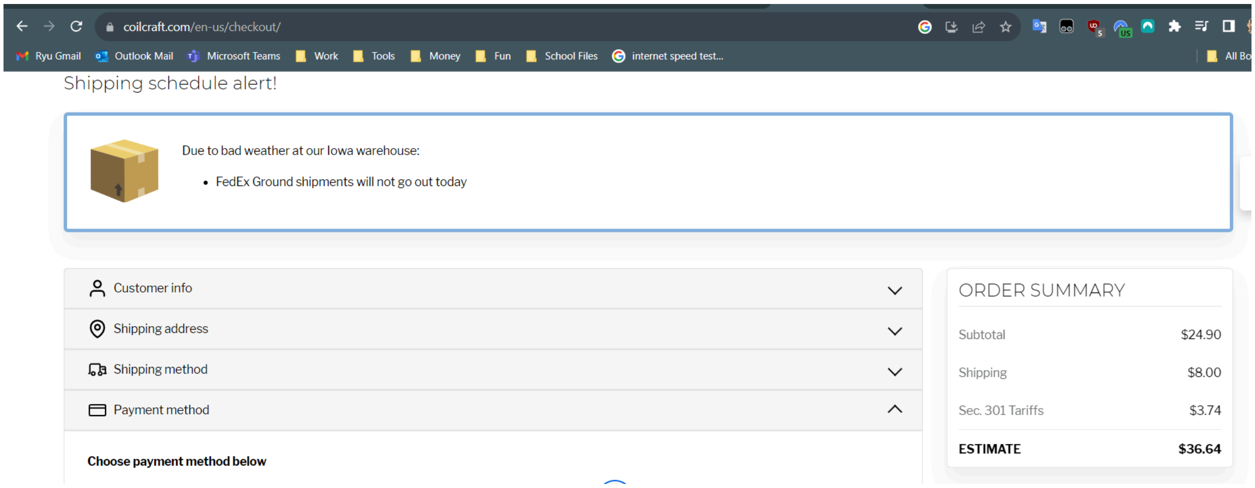
- New battery
    - **900mAh 30C 2s LiPo battery: HERE**
        - 46g, w-29mm x h-16mm x l-53mm

11/19/23:

Next steps and testing
- Clone Git repo and assign chris freeman specific algo task
    - Other potential tasks
        - SHARP -> IR receiver & emitter
        - ~~Low battery indication LED w/ comparator~~

- Voltage divider to detect low (0.9V) on interrupt pin when battery voltage is low
- Update all old caps for better ESR and ESL
- Update inventory spreadsheet for parts we have already
- Design breakout board for AT32UC3L0256 w/ caps, JTAG programmer, crystal, and serial out to use for testing to use like Arduino Nano
    - Test new crystal, serial out setup, and JTAG connector
    - Test soldering 0402 package
- Test new regulators
    - Design test board for new power setup
- Test IR sensors
    - Design test board for SHARP sensor tailored to AT32UC3L0256
    - Test for output from sensor using oscilloscope provided fast movements
- Test vacuum setup
    - Design test board for vacuum motor driver
    - Write timer counter code to pulse motor driver to control motor speed
    - Design 3D vacuum fan and mount
    - Test vacuum strength w/ 3D printed parts and motor
    - Test 3.7V 5A regulator on power test board
- Test new motor setup
    - Design 3D wheel, mount, and gears
    - Check how close motor encoders are allowed to be
    - Check how much load motors can handle and associated current
    - Check motor speed w/ MCU
    - Test 12V 3A regulator on power test board
- Final mouse design
    - Combine all parts and select remaining parts
        - Need to know final space taken up by all components
            - Circuit w/ components, vacuum, IRs, motors, new battery
        - Spacer w/ screws to connect PCBs together
        - TH connector to pass signals from one PCB to the other

11/20/23:
- Coilcraft inductors are marketplace, but coilcraft has a fee too



- Welp, looks like the source is better

- …left off updating spreadsheet w/
    - MCU parts
        - Development board has 0603 packages, so doesn't seem like we can try using smaller capacitors for MCU
    - Serial out
    - Wheel motor driver
        - Needs additional parts
    - Need to mark all old components for potential swap to small 0402 package
        - Need to test solder
    - Vacuum motor itself

11/21/23:

Next steps and testing
- Consider buying things on sale
    - HGLRC brushless motor on sale
    - Servocity washer on sale
    - Amazon ball bearings on sale for whatever reason
- Finish BOM
    - 3D models for some parts
    - Replace caps and resistors based on layout suggestion sizes for 0402s for old regulators
- Voltage divider to detect low (0.9V) on interrupt pin when battery voltage is low

- Update inventory spreadsheet for parts we have already
- Design tasks in order
    - Design breakout board for AT32UC3L0256 w/ caps, JTAG programmer, crystal, and serial out to use for testing to use like Arduino Nano
        - Test new crystal, serial out setup, and JTAG connector
    - Test new regulators
        - Design test board for new power setup
        - Test solder 0402 packages
    - Test IR sensors
        - Design test board for SHARP sensor tailored to AT32UC3L0256
        - Test for output from sensor using oscilloscope provided fast movements
    - Test vacuum setup
        - Design test board for vacuum motor driver
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        - Test 3.7V 5A regulator on power test board
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        - Check how close motor encoders are allowed to be
        - Check how much load motors can handle and associated current
        - Check motor speed w/ MCU
        - Test 12V 3A regulator on power test board
    - Final mouse design
        - Combine all parts and select remaining parts
            - Need to know final space taken up by all components
                - Circuit w/ components, vacuum, IRs, motors, new battery
            - Spacer w/ screws to connect PCBs together
            - TH connector to pass signals from one PCB to the other

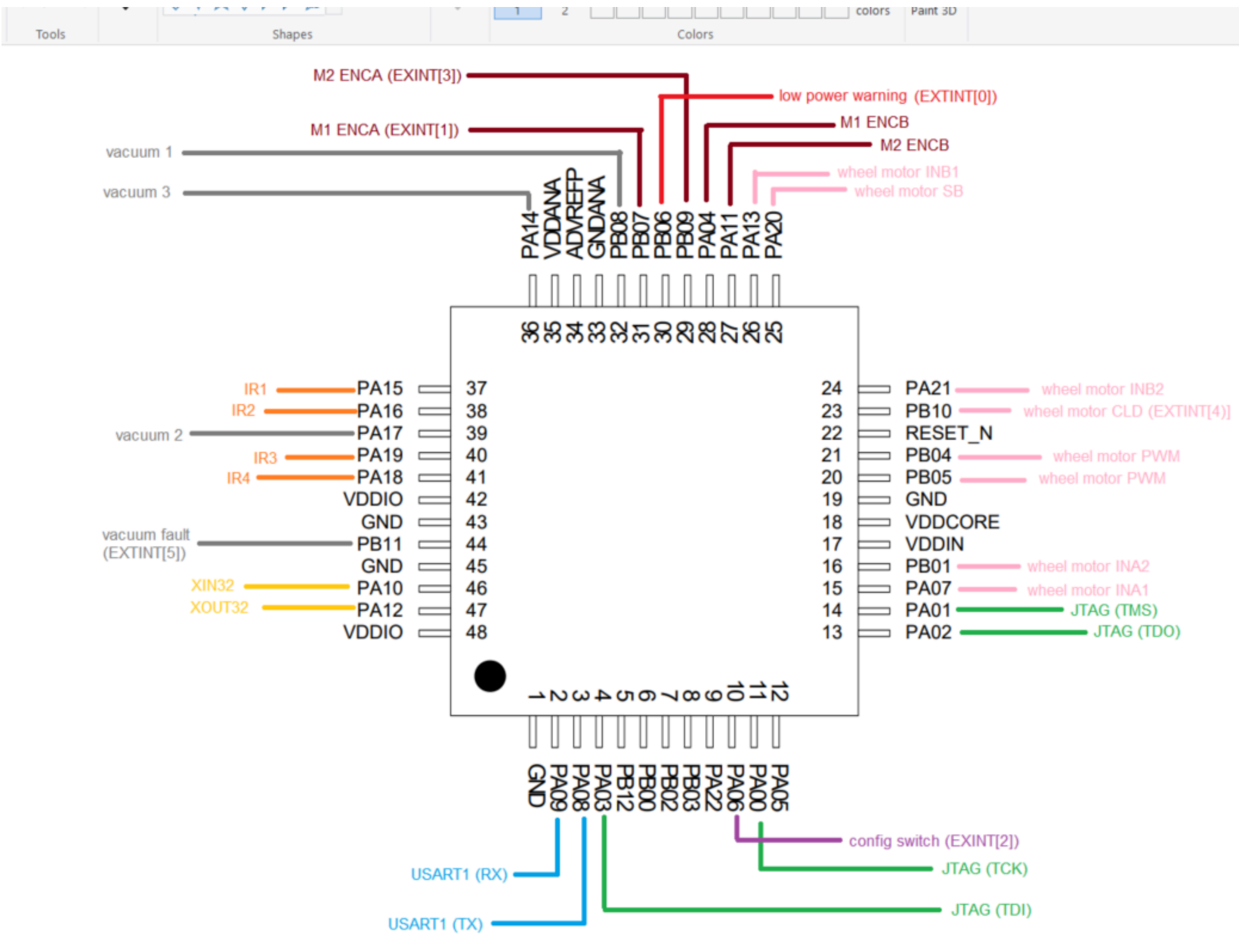
12/27/23:

- The time has come
    - …to cry that Fusion isn't getting any cheaper
- Unfortunate, but we're back in business

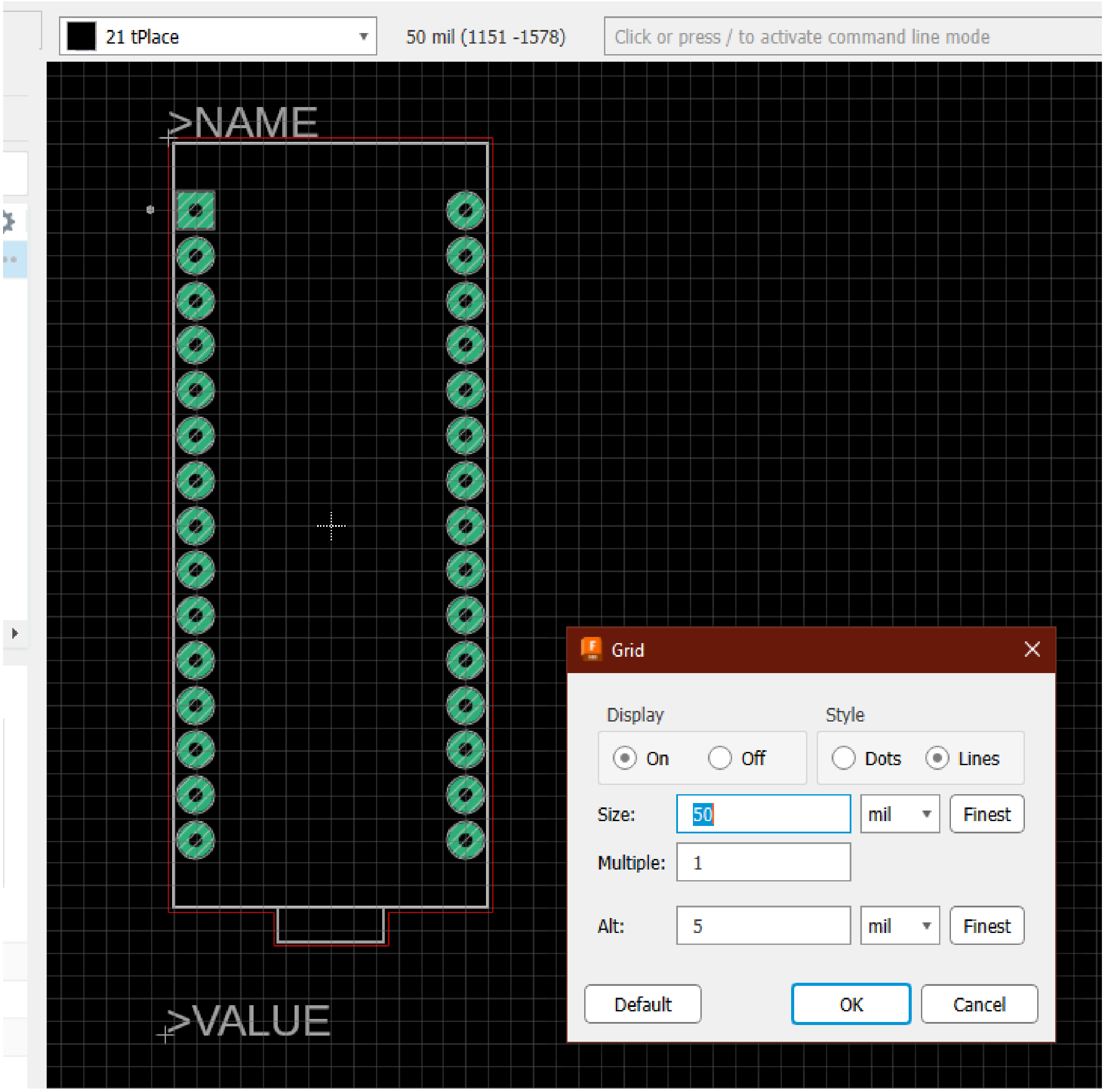
- First we make our AT32UC3L0256 breakout board
    - To do that we first need to clarify our MCU pinout
    - We need to clarify pins needed for
        - New vacuum driver

- New wheel driver

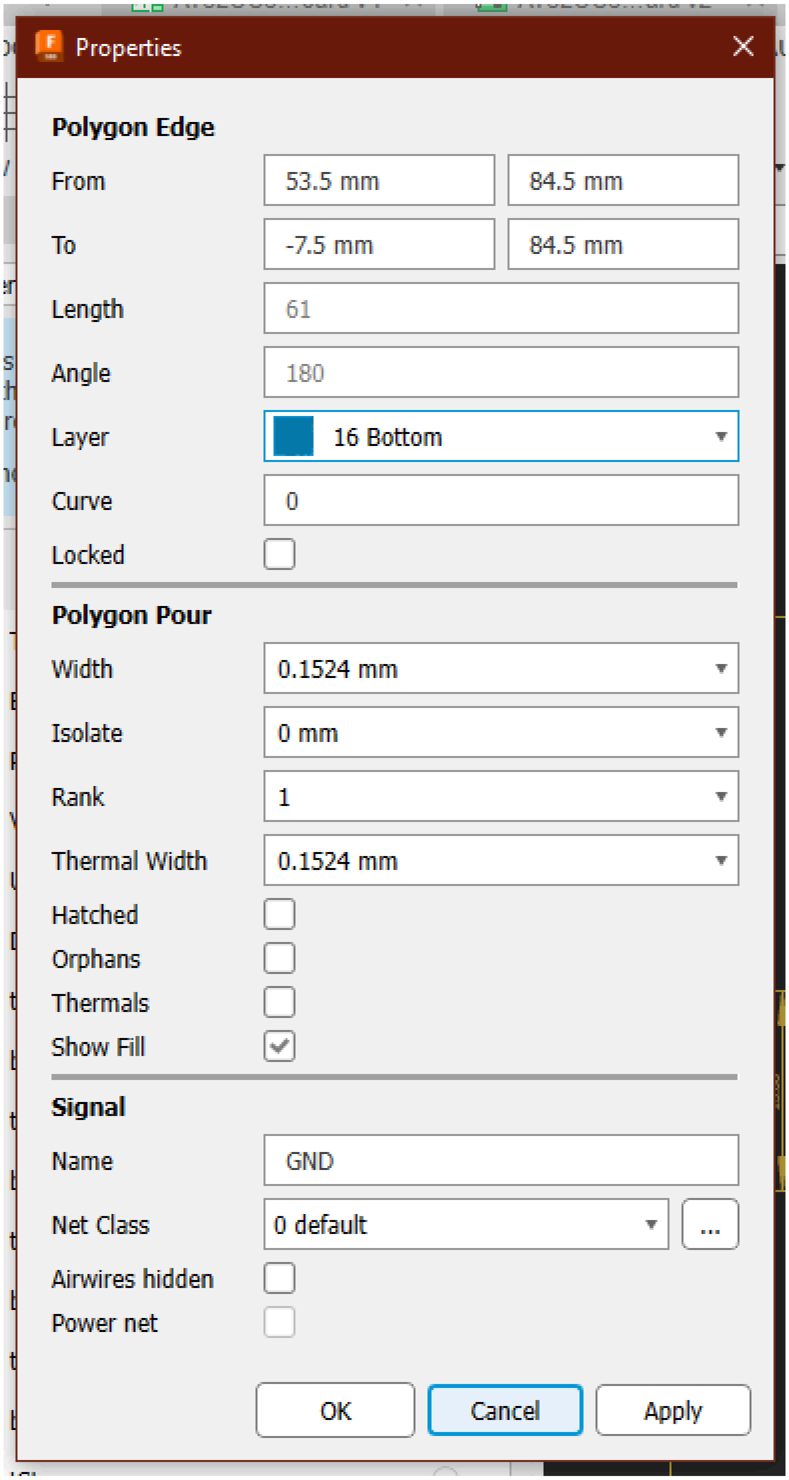
- 8 pins for wheel driver, and 4 pins for vacuum driver, 3.3V for MCU, 5V for IRs, GND, so 15 pins to connect the bottom board to the top board



- Aight pinout's good to go for now

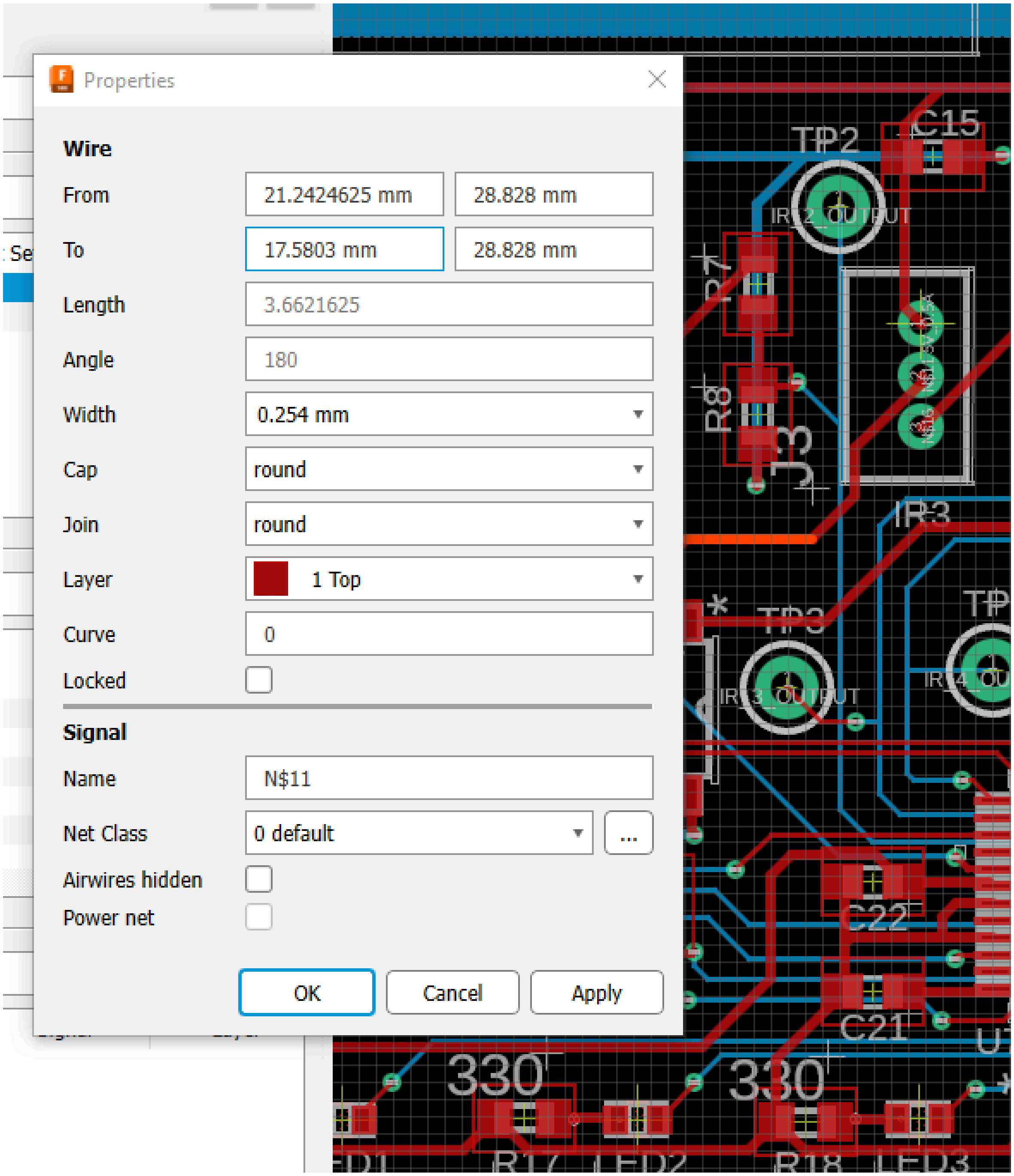


- breakout board should have pins spaced out by 600 mils

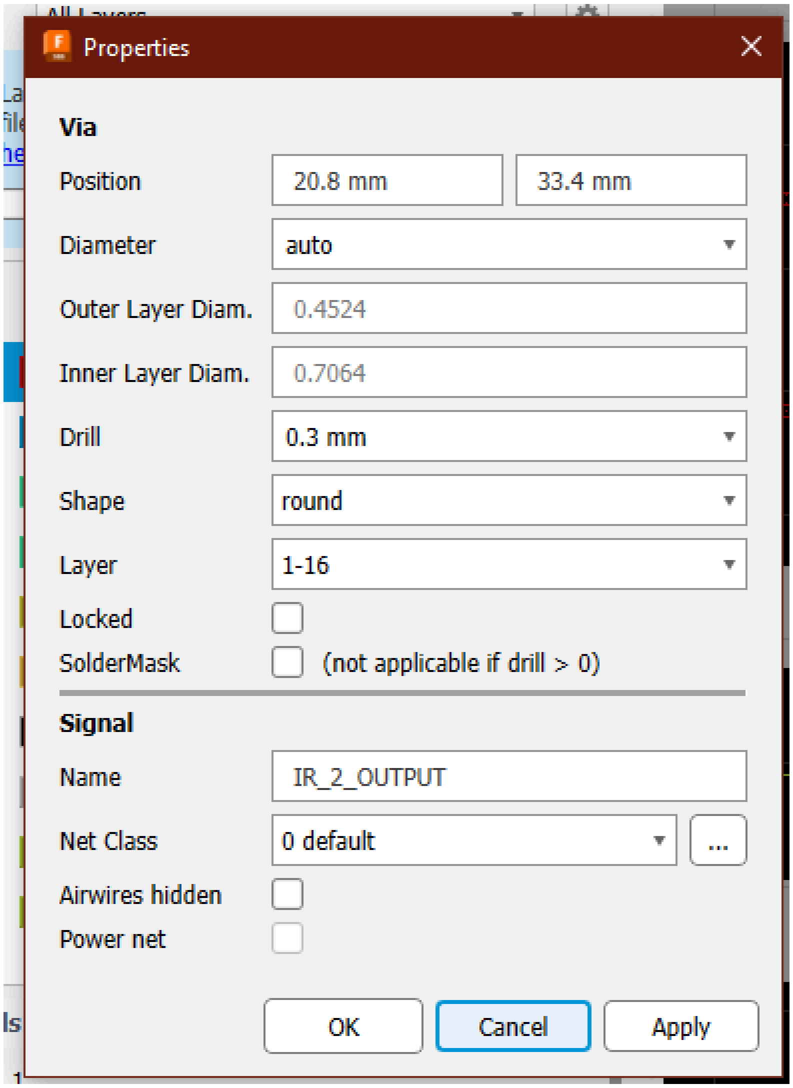


- Polygon settings

12/28/23:



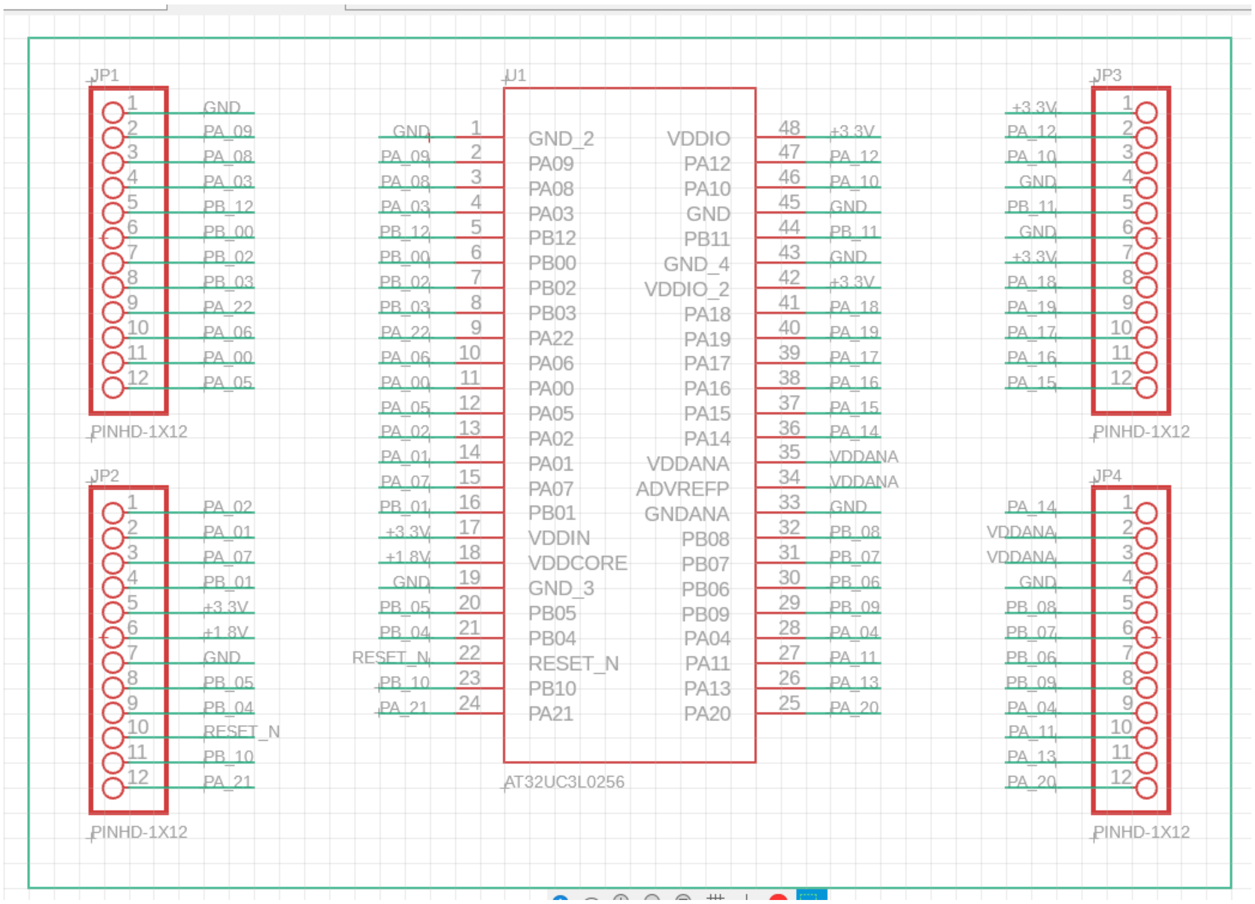
- Thick traces are 10 mils
- Left off w/ blind vs thru via

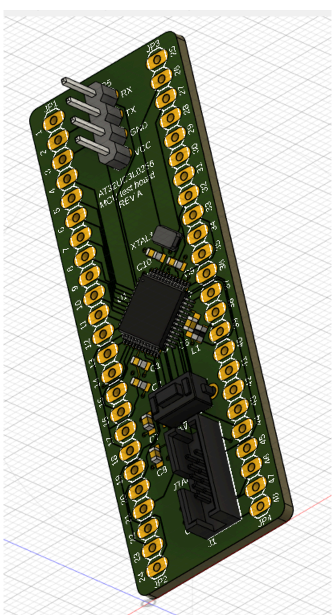


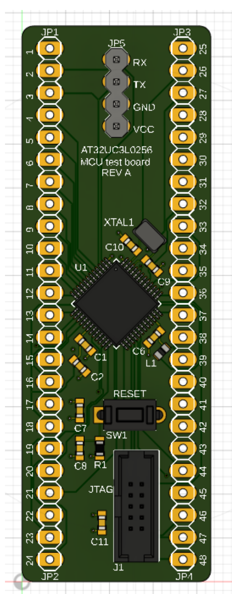
- Tiny via properties

https://github.com/oxullo/jlcpcb-eagle

12/29/23:



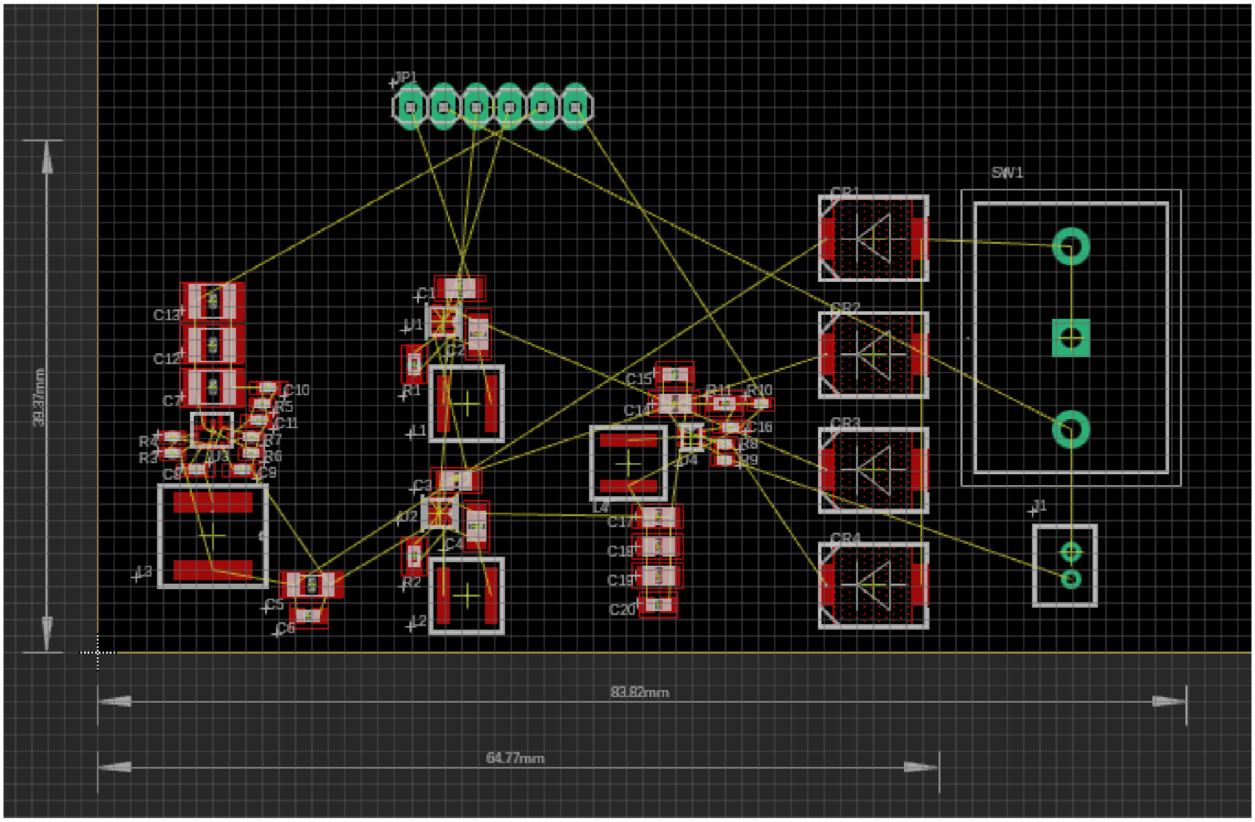




- Aight donezo, next up is regulator test board

- 3d models for JST connectors:

- https://www.jst-mfg.com/product/index.php?series=199

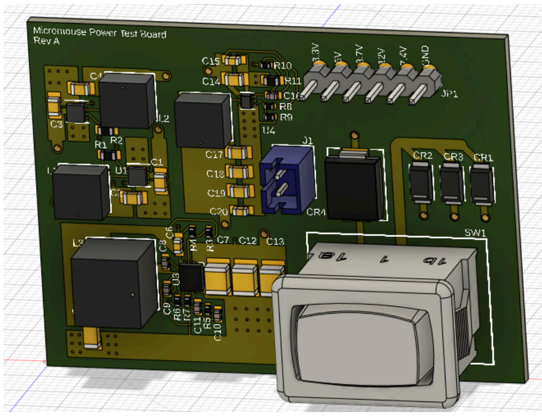


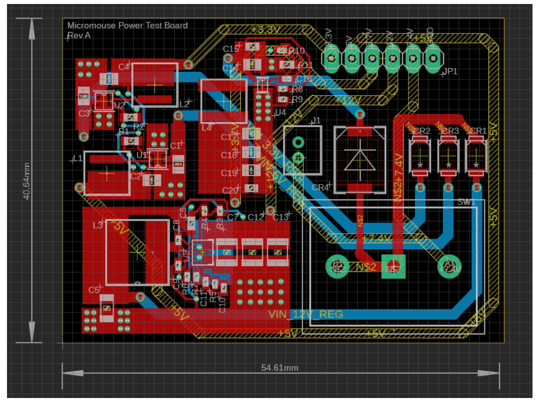
- A lot of space wasted
- We can use the old small diode for 3.3V and 5V since they're still within 2A, but we have to find a new smaller diode for the 12V 3A regulator

12/30/23:
- 5A for vacuum
- 3A for wheels
- 2A max for IRs and MCU?

- Aight found a smaller diode that caps at 5A: HERE
    - Seems like this 5mm x 3mm size is the limit even w/ lower currents

- Blind vias aren't supported by JLC PCB- we need to convert all blind vias to thru vias

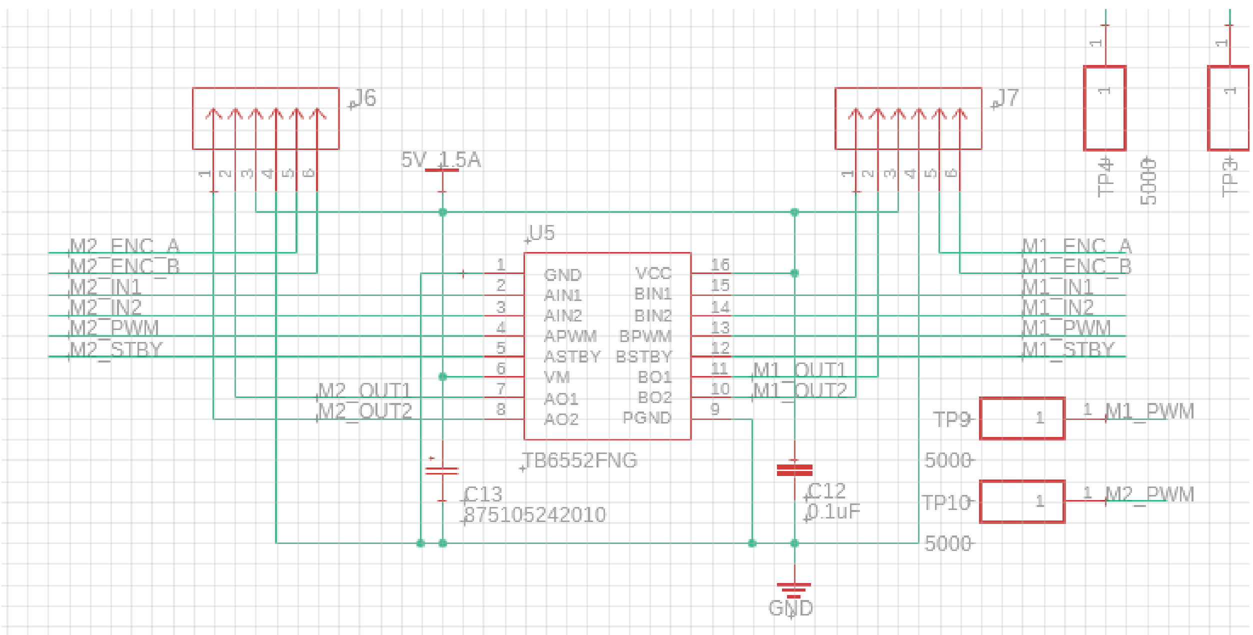




- Aight donezo

- Next up is a board for:
    - vacuum motor driver (w/ hole and IR sensor spaces)
    - Wheel motor driver

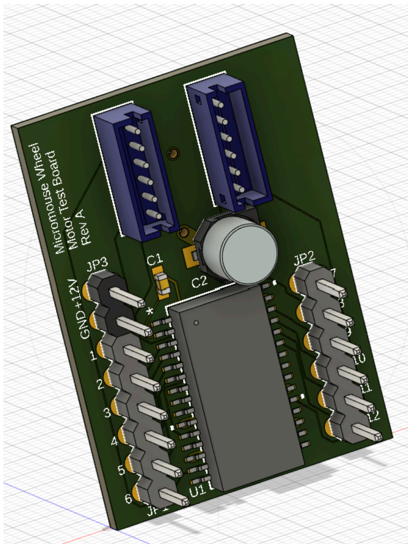
1/1/2024:
- Goodness it's 2024

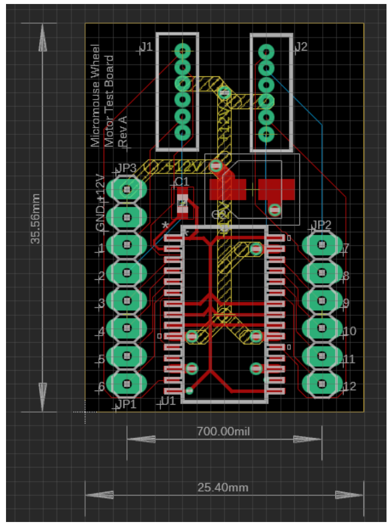


- And here we are- routing chips
    - Embedded 4 ever

1/7/2024:
- We'll assume the entirety of the ground plane is power ground

- We want to route all the signal ground signals together before routing it to the power ground (the ground plane)





- Motor driver test board donezo
- Motor driver is big… we'll see what we can do
    - Placing this thing above the mouse on/off switch is probably the way to go
    - If we can tetris this out maybe we won't need a second board for final mouse

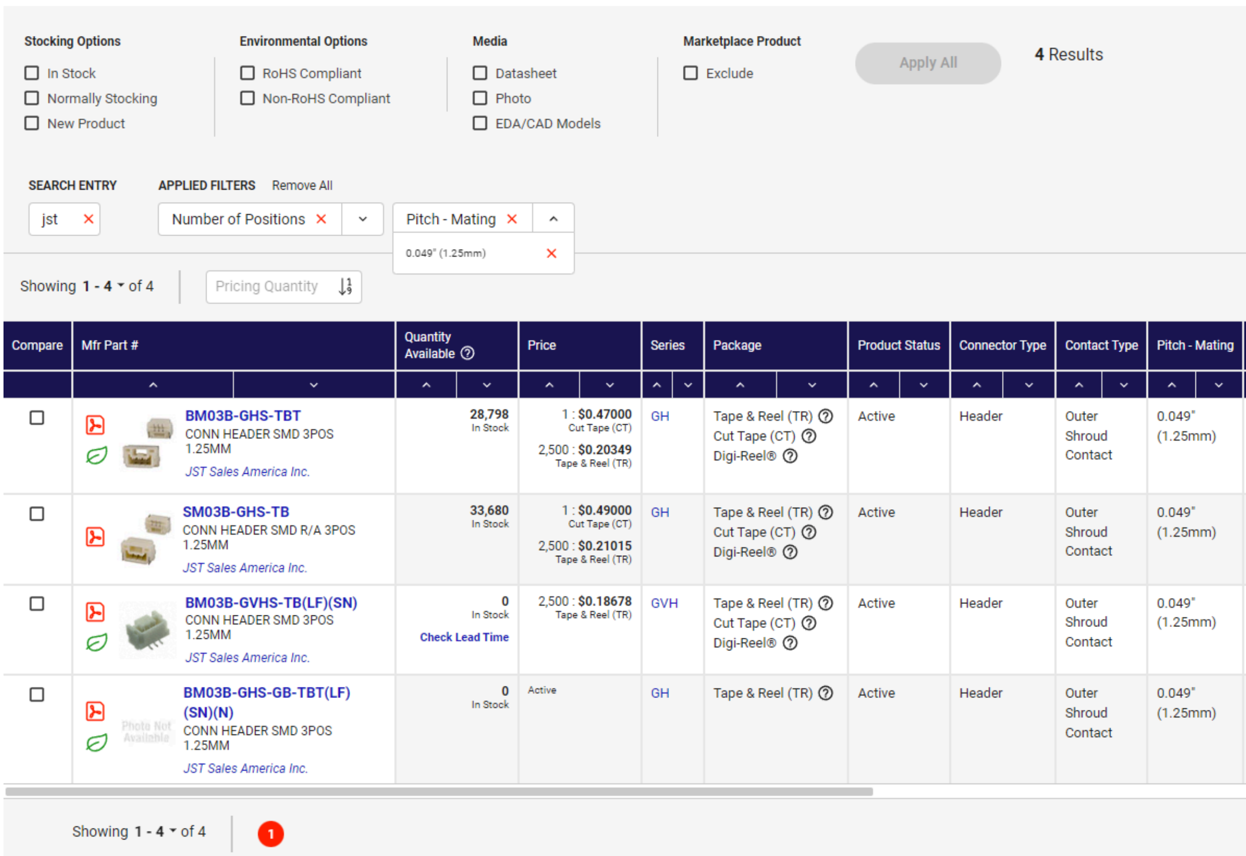
Wire-to-board connectors

JST series	Pin-to-pin pitch	Pin rows	Current (Amp)	Voltage (Volt)	Wire size (AWG)	Shroud	Lock	Notes	Datasheet
VH [5]	3.96 mm (0.156 in)	1	10	250	22 to 16	Yes/No	Yes	Unshrouded seems to be more popular than shrouded.	JST VH
RE [6]	2.54 mm (0.100 in)	1	2	250	30 to 24	No	No	Similar to female "DuPont" connectors and male pin headers. RF series is double row.[7]	JST RE
EH [8]	2.50 mm (0.098 in)	1	3	250	32 to 22	Yes	No	Not 0.1-inch pitch.	JST EH
XA [9]	2.50 mm (0.098 in)	1	3	250	30 to 20	Yes	Yes	Not 0.1-inch pitch.	JST XA
XH [10]	2.50 mm (0.098 in)	1	3	250	30 to 22	Yes	Yes	Not 0.1-inch pitch. Used by many radio control (R/C) batteries.	JST XH
PA [11]	2.00 mm (0.079 in)	1	3	250	28 to 22	Yes	Yes	Used by FMA Cellpro R/C battery chargers.	JST PA
PH [12]	2.00 mm (0.079 in)	1	2	100	32 to 24	Yes	No	Many stepper motors. Compatible with KR (IDC), KRD (IDC), CR (IDC) series.[13][14][15]	JST PH
ZH [16]	1.50 mm (0.059 in)	1	1	50	32 to 26	Yes	No	Compatible with ZR (IDC) and ZM (crimp) series.[17][18]	JST ZH
GH [19]	1.25 mm (0.049 in)	1	1	50	30 to 26	Yes	Yes	Not 0.05-inch pitch. Sometimes confused with Molex PicoBlade.[20]	JST GH
SH [21]	1.00 mm (0.039 in)	1	1	50	32 to 28	Yes	No	Compatible with SR (IDC) and SZ (IDC) series.[22]	JST SH

- For our JST connectors we have:

- 2 position 2.0 pitch PH connector for LIPO battery
- 6 position 1.5 pitch ZH connector for wheel motors
- 3 position 1.5 pitch ZH connector for IR sensors
- ~~3 position 1.25 pitch GH connector for vacuum fan motor~~

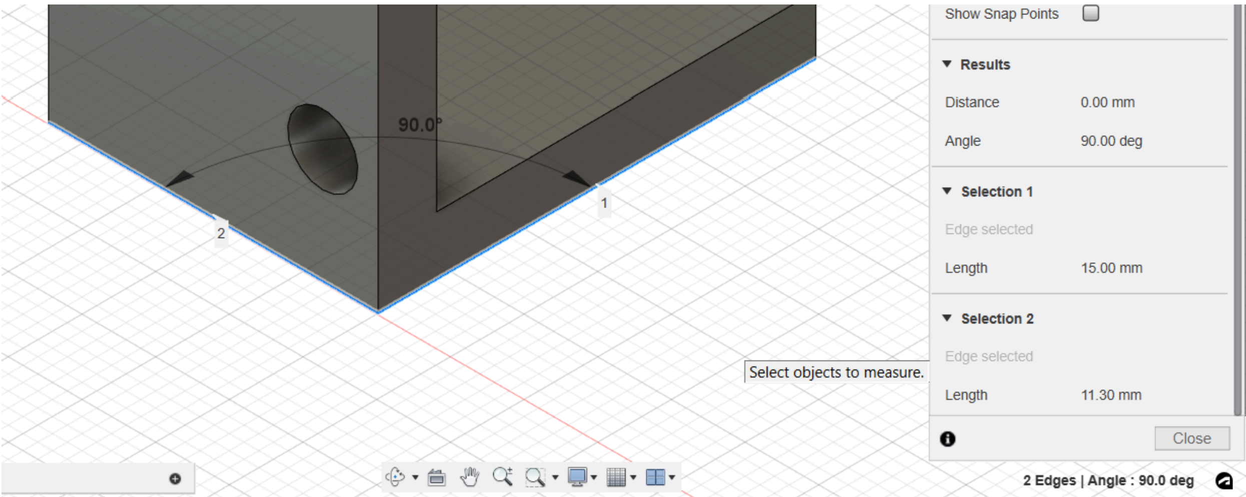
- The main issue is that the wire from the vacuum fan motor is too short- need to crimp and extend the wire
- If we're going to crimp we can go ahead and crimp for the IR sensors too
- We'll go w/ 28 gauge wire to crimp for both the vacuum motor and the IR sensors: HERE
  - Crimping guide: HERE
  - Crimping tool: HERE



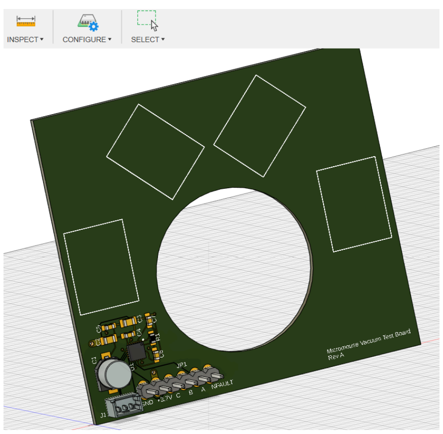
Compare	Mfr Part #	Quantity Available	Price	Series	Package	Product Status	Connector Type	Contact Type	Pitch - Mating
	BM03B-GHS-TBT CONN HEADER SMD 3POS 1.25MM JST Sales America Inc.	28,798 In Stock	1 : $0.47000 Cut Tape (CT) 2,500 : $0.20349 Tape & Reel (TR)	GH	Tape & Reel (TR) Cut Tape (CT) Digi-Reel®	Active	Header	Outer Shroud Contact	0.049" (1.25mm)
	SM03B-GHS-TB CONN HEADER SMD R/A 3POS 1.25MM JST Sales America Inc.	33,680 In Stock	1 : $0.49000 Cut Tape (CT) 2,500 : $0.21015 Tape & Reel (TR)	GH	Tape & Reel (TR) Cut Tape (CT) Digi-Reel®	Active	Header	Outer Shroud Contact	0.049" (1.25mm)
	BM03B-GVHS-TB(LF)(SN) CONN HEADER SMD 3POS 1.25MM JST Sales America Inc.	0 In Stock Check Lead Time	2,500 : $0.18678 Tape & Reel (TR)	GVH	Tape & Reel (TR) Cut Tape (CT) Digi-Reel®	Active	Header	Outer Shroud Contact	0.049" (1.25mm)
	BM03B-GHS-GB-TBT(LF)(SN)(N) CONN HEADER SMD 3POS 1.25MM JST Sales America Inc.	0 In Stock	Active	GH	Tape & Reel (TR)	Active	Header	Outer Shroud Contact	0.049" (1.25mm)

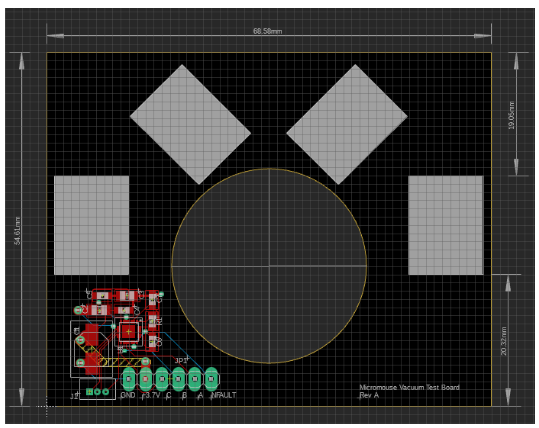
- 1.25mm pitch JST connectors don't exist
- We're probably dealing w/ a 1.25mm picoblade connector on the GHLRC motor
  - People talking about it: HERE and HERE
  - Searching on official Molex website: HERE

- Alright we'll use this kit: HERE to extend the wires on the motor
- We'll hook that extension to the board w/ this: HERE



- 15mm long x 11.3mm wide





- Aight vacuum board is donezo, so that completes the exodia pieces for now
- Last one on the list is IR sensor board, but we need a better idea of where everything is going to be to finalize IR positions
    - Mainly this vacuum hole and whether we need more/less real estate

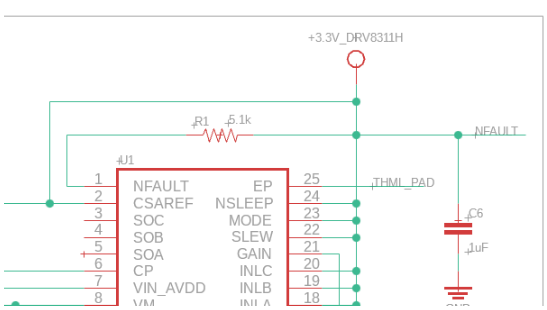
Next steps and testing

- Voltage divider to detect low (0.9V) on interrupt pin when battery voltage is low
- Update inventory spreadsheet for parts we have already
- Design tasks in order
    - ~~Design breakout board for AT32UC3L0256 w/ caps, JTAG programmer, crystal, and serial out to use for testing to use like Arduino Nano~~
        - Test new crystal, serial out setup, and JTAG connector
    - Test new regulators
        - ~~Design test board for new power setup~~

        - Test solder 0402 packages
    - Test IR sensors
        - Design test board for SHARP sensor tailored to AT32UC3L0256
        - Test for output from sensor using oscilloscope provided fast movements
    - Test vacuum setup
        - ~~Design test board for vacuum motor driver~~
        - Write timer counter code to pulse motor driver to control motor speed
        - Design 3D vacuum fan and mount
        - Test vacuum strength w/ 3D printed parts and motor
        - Test 3.7V 5A regulator on power test board
    - Test new motor setup
        - ~~Design test board for new motor driver~~
        - Design 3D wheel, mount, and gears
        - Check how close motor encoders are allowed to be
        - Check how much load motors can handle and associated current
        - Check motor speed w/ MCU
        - Test 12V 3A regulator on power test board
    - Final mouse design
        - Combine all parts and select remaining parts
            - Need to know final space taken up by all components
                - Circuit w/ components, vacuum, IRs, motors, new battery
            - Spacer w/ screws to connect PCBs together
            - TH connector to pass signals from one PCB to the other

1/27/24:

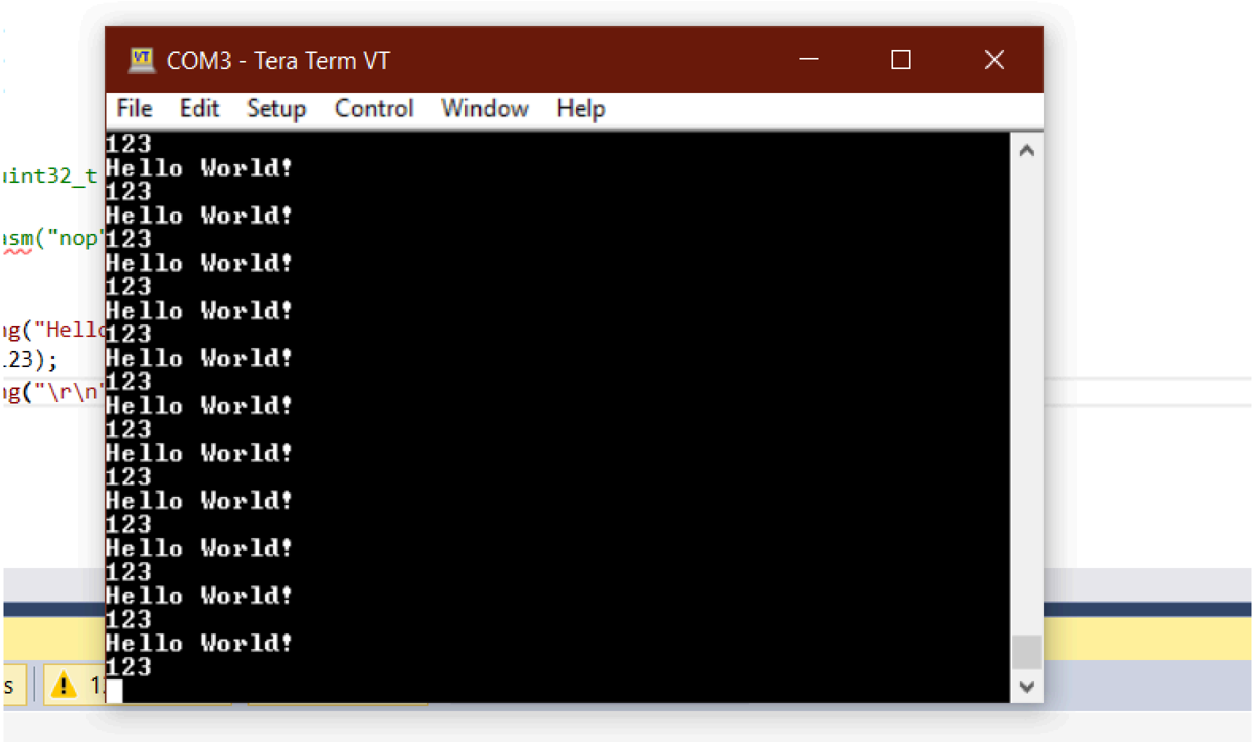
Mistakes:

- Wrong cap purchased for external crystal
- Bad switch for on/off for power
- 3D model for MCU has JTAG backwards
- LiPo 2p PH connector is backwards on layout and 3D model
- 

        - Fault pin on vacuum motor driver always going high- supposed to go through resistor and then 3.3V (pg 81 on motor driver datasheet)
- Unnamed capacitor on pg 81 of datasheet missing from parts spreadsheet and list of parts above on this doc
    - We don't have a "voltage supervisor" so we can probably just get rid of C8
- Cap C7 too close to 12V regulator IC- difficult to see solder job

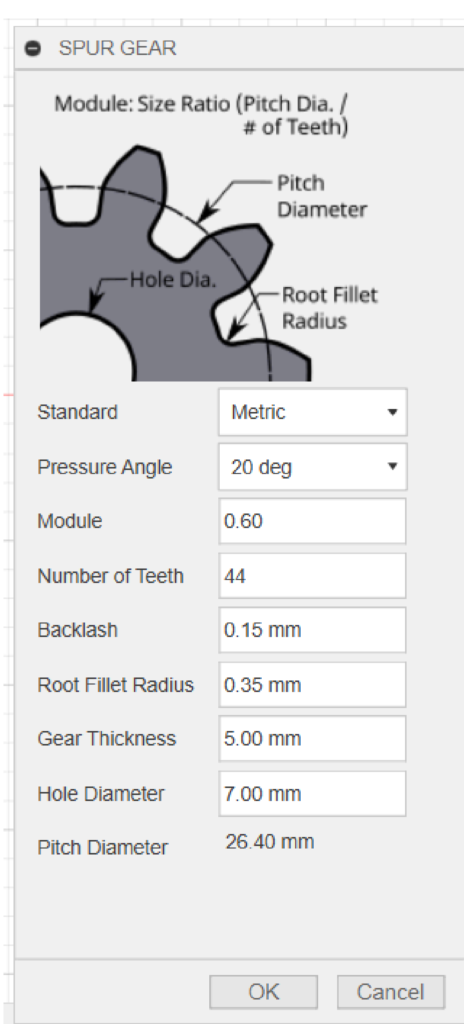
- Aight all problems above aside, finished soldering
- Power test board works- all regulators supply what they're supposed to supply
- Next step is to test:
    - Mcu (serial out and JTAG, external crystal once we get those caps)
    - Motor driver
    - Vacuum fan driver w/ timer interrupts
    - Design and print wheel motor mount and gears
    - Design and print vacuum fan
    - Design mouse w/ all parts combined
        - Allocate a pin from mcu to enable signals on regulators
        - Design op amp comparator circuit for low battery voltage detection
            - ~~Design voltage divider to get HIGH above 6.2V and LOW below from battery- voltage on battery doesn't seem to sway that drastically even w/ rapid motor speed changes~~
        - Add IR sensor circuit and parts
        - Add debug and error LEDs

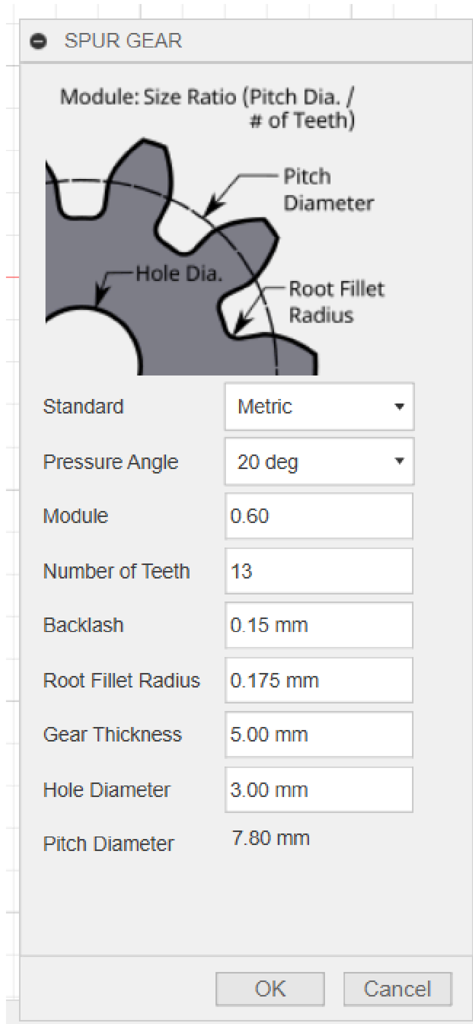
1/28/2024:



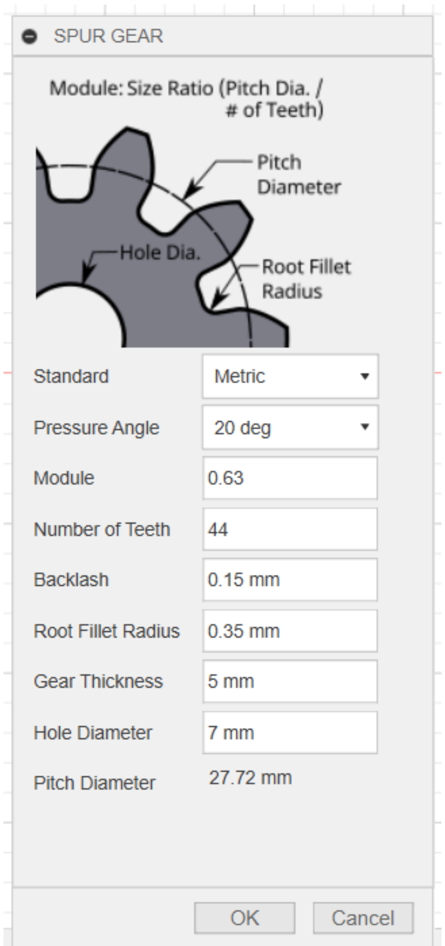
- Aight serial's done we can roll with this
- Serial works w/ some offset on baudrate macro
- Reset works
- JTAG works, but there's some wear on the JTAG cable?
    - Programmer needs to be lifted to flash consistently- getting new JTAG cable

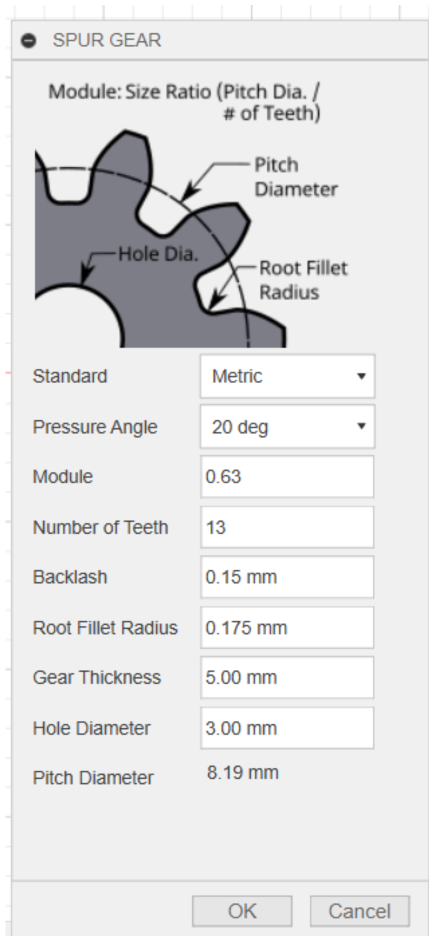
- Done testing 12V w/ motor driver
    - We can put motor encoders as close together as we want at max speed on 4900 RPM motors- encoder output will still be stable
    - Low torque as expected- we need to design our mount
    - Battery drained from 7.8V to 7.6V after a bit of testing w/ motors going full speed

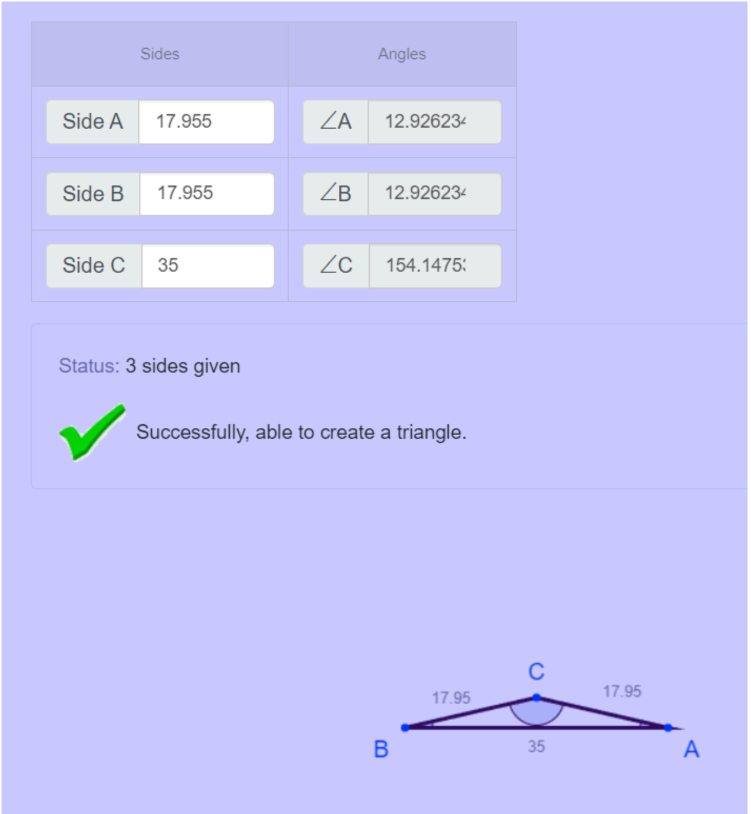




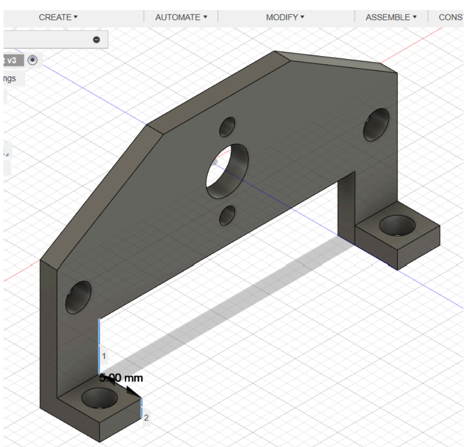
- Bad pair
    - Causes small gear to large gear distance of 17.1mm, and that means max wheel to wheel distance of 34.2mm
    -

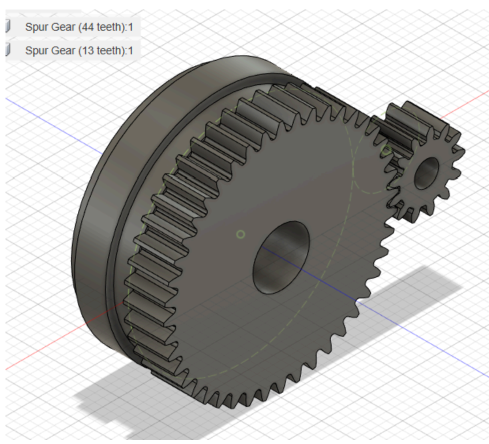

SPUR GEAR
Module: Size Ratio (Pitch Dia. / # of Teeth)
Pitch Diameter
Hole Dia.
Root Fillet Radius
Standard
Metric
Pressure Angle
20 deg
Module
0.63
Number of Teeth
44
Backlash
0.15 mm
Root Fillet Radius
0.35 mm
Gear Thickness
5 mm
Hole Diameter
7 mm
Pitch Diameter
27.72 mm
OK
Cancel


SPUR GEAR
Module: Size Ratio (Pitch Dia. / # of Teeth)
Pitch Diameter
Hole Dia.
Root Fillet Radius
Standard
Metric
Pressure Angle
20 deg
Module
0.63
Number of Teeth
13
Backlash
0.15 mm
Root Fillet Radius
0.175 mm
Gear Thickness
5.00 mm
Hole Diameter
3.00 mm
Pitch Diameter
8.19 mm
OK
Cancel

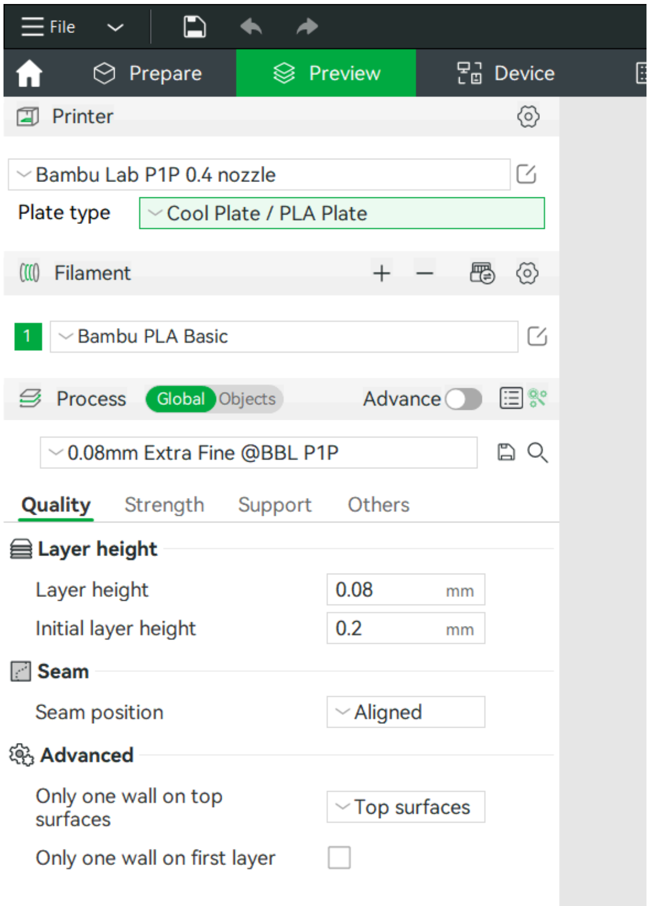


- This works





- Wheel mount and custom wheel w/ gear done
- We'll print this shit tmr and see how it goes



1/29/24:
- Got gear train setup working after a bunch of revisions
- Need to get m3 spacers to reduce friction

1/30/2024:
- Aight got vacuum setup ready to go after a million revisions
- Just need timer interrupts to drive the motor now
- Screw it we'll get that working this weekend
- Remote work micromouse dual wielding toxic

- We need the op amp comparator for detecting low battery voltage mouse/Micromouse/datasheets/Atmel-32145-32-bit-Flash-MCU-UCL0_datasheet.pdf

Read aloud | Ask Copilot — + 796 of 852

AT32UC3L0128/256

32.5 I/O Pin Characteristics

Table 32-6. Normal I/O Pin Characteristics[1]

Symbol	Parameter	Condition	Min	Typ	Max	Units
R_{PULLUP}	Pull-up resistance		75	100	145	kOhm
V_{IL}	Input low-level voltage	V_{VDD} = 3.0V	-0.3		0.3*V_{VDD}	V
		V_{VDD} = 1.62V	-0.3		0.3*V_{VDD}	
V_{IH}	Input high-level voltage	V_{VDD} = 3.6V	0.7*V_{VDD}		V_{VDD} + 0.3	V
		V_{VDD} = 1.98V	0.7*V_{VDD}		V_{VDD} + 0.3	
V_{OL}	Output low-level voltage	V_{VDD} = 3.0V, I_{OL} = 3mA			0.4	V
		V_{VDD} = 1.62V, I_{OL} = 2mA			0.4	
V_{OH}	Output high-level voltage	V_{VDD} = 3.0V, I_{OH} = 3mA	V_{VDD} - 0.4			V
		V_{VDD} = 1.62V, I_{OH} = 2mA	V_{VDD} - 0.4			
f	Output frequency[2]	V_{VDD} = 3.0V, load = 10pF			45	MHz

-
- We want high reading above 6V or so (dead 2S LiPo battery) and low below it, but the MCU pin can't do that pinpoint

2/4/24:

More mistakes:

- ~~Vacuum sleep pin needs to be hardwired to 3.3V externally~~

I_{OUT}	Peak output current	OUTA, OUTB, OUTC		5	A
V_{IN}	Logic input voltage	INHx, INLx, nSCS, nSLEEP, SCLK, SDI, ADx, GAIN, MODE, SLEW, PWM_SYNC	-0.1	5.5	V
V	Open drain pullup voltage	nFAULT	-0.1	5.5	V

-
    - ~~We can tie it to 3.7V~~
- Choosing a brushless DC motor for the vacuum 💀

- There's a ton we're missing after digging into this
    - Need for floating pins (ideally)
    - Pins to check rotor position via feedback from drv8311 hall effect sensor pins

- We're going to give up on this and find a brushed dc alternative

- Alright switching back to Amazon brushed DC motors asap

- <u>New brushed motor driver setup</u>:
    - **Amazon brushed DC motor**: HERE

- Uses **2p picoblade connector**: HERE
- Datasheet for the part (HERE) says that 1A is the limit for 30 AWG so we'll go with that

4.2 RATED CURRENT AND APPLICABLE WIRES

Wire Size	Rated Current (MAX.)	Insulation O.D.
AWG #26	1.0 A	Insulation Diameter φ 0.5 ~φ1.04 mm
AWG #28	1.0 A	
AWG #30	1.0 A	
AWG #32	0.8 A	

-
- **Brushed DC 1.76A 1.65-11V motor driver**: HERE

  8.3.1 External Components

  Table 8-1 lists the recommended external components for the device.

  Table 8-1. Recommended external components

COMPONENT	PIN 1	PIN 2	RECOMMENDED
C_{VM1}	VM	GND	0.1-µF, low ESR ceramic capacitor, VM-rated.
C_{VM2}	VM	GND	Section 10.1, VM-rated.
C_{VCC}	VCC	GND	0.1-µF, low ESR ceramic capacitor, VCC-rated. Only needed for DSG package variant.

  -
  - By pulling up MODE pin HIGH we can control speed w/ one PWM pin on EN and direction on PH
  - Schematic on pg 18 of datasheet

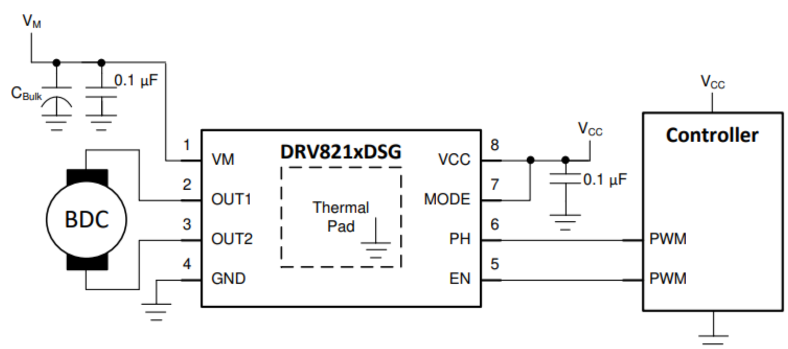
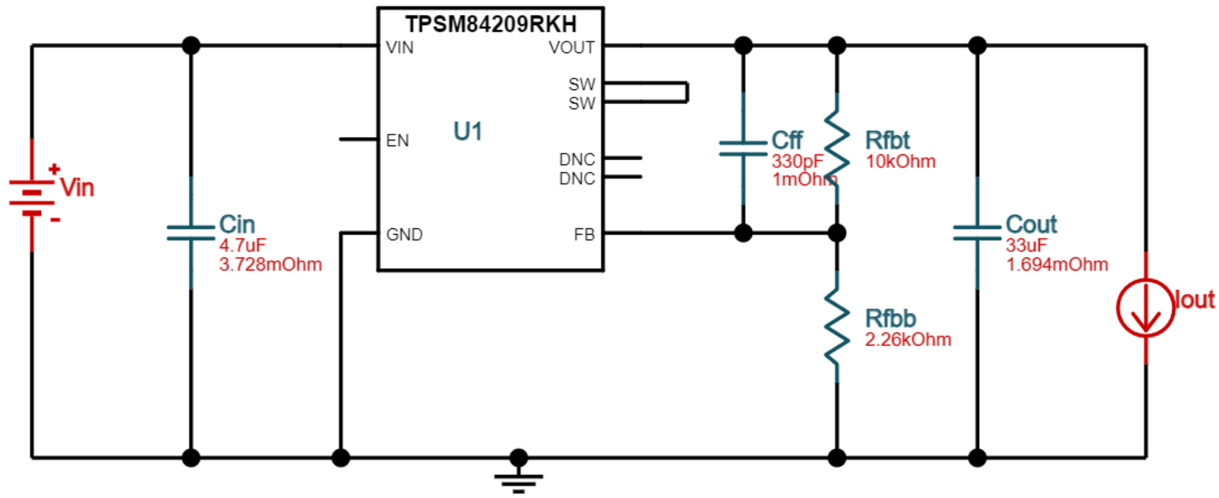


Figure 9-4. PH/EN interface motor-driving application for DSG package

  -
  - **Cvcc**: HERE (already have, we'll go w/ smallest 0.1uF we have)
  - **Cvm2**/Cbulk: (already have, we can use our polymer cap)
  - **Cvm1**: HERE (same as Cvcc)

- <u>New vacuum regulator setup</u>:
  - **3.2V 1A regulator**: HERE

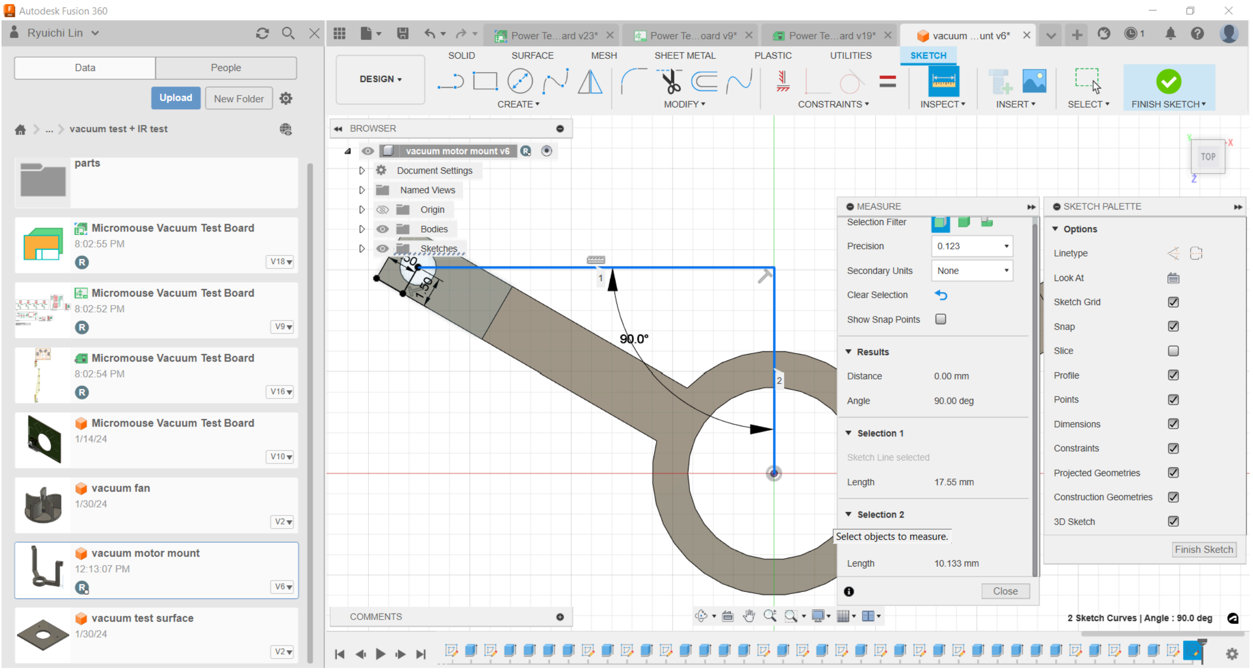


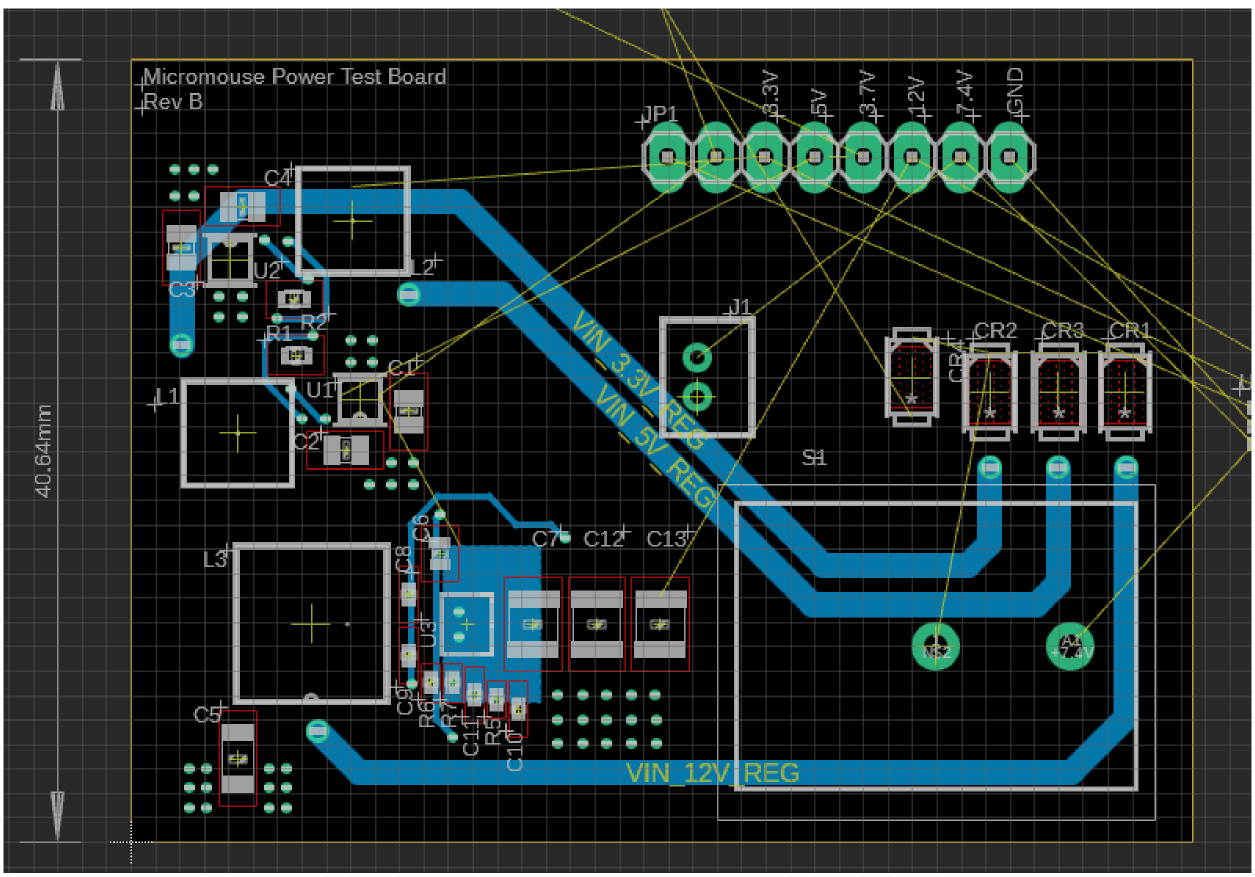
-
    - **Cout**: HERE
    - **Cff**: HERE
    - **Rfbt**: HERE
    - **Rfbb**: HERE
    - **Cin**: HERE

Next steps:

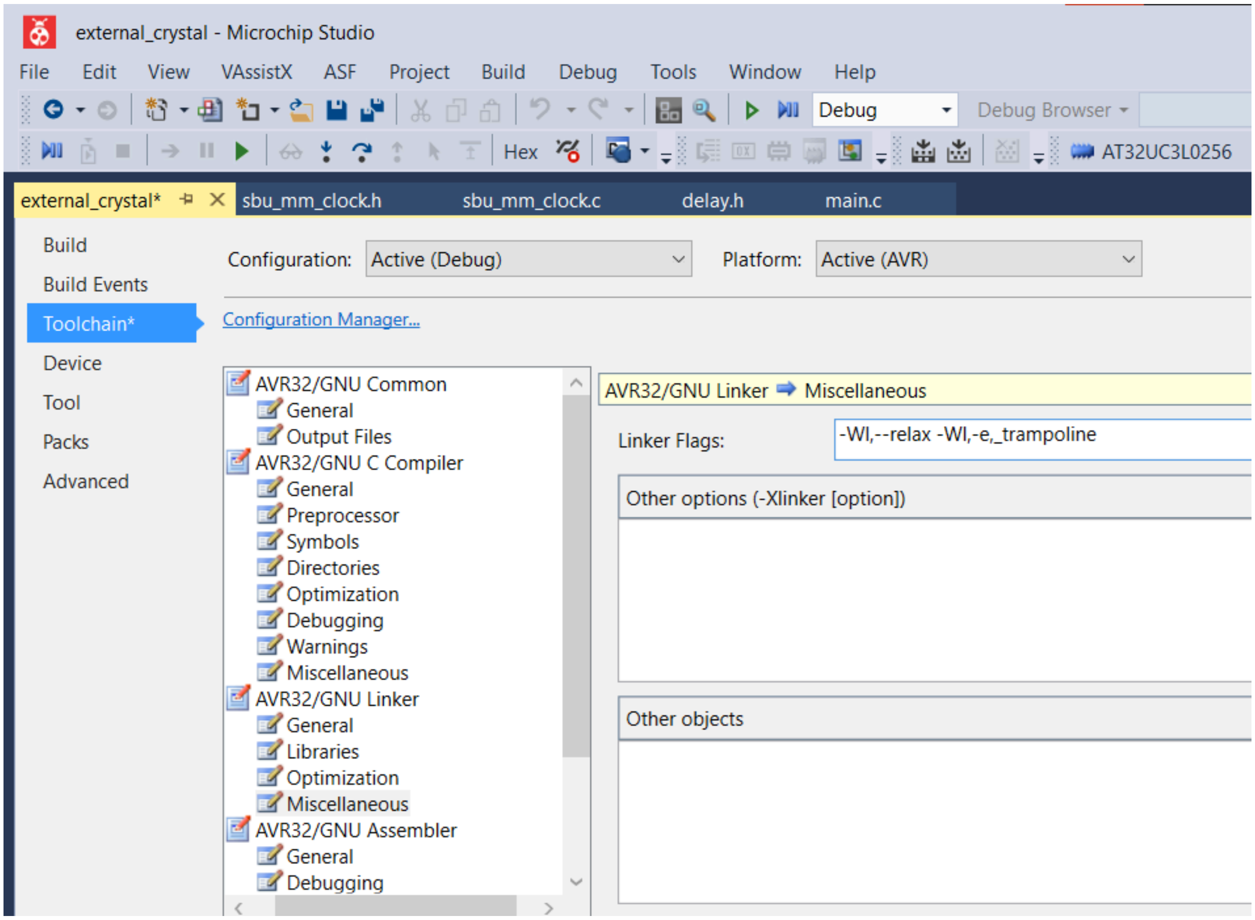
- Update schematics
    - Power board
        - New regulator
        - Fix JST connector orientation
        - Change switch layout and symbol for new switch
        - Push 12V regulator farther away from capacitor
        - Replace large diode w/ small diode
        - Pull out enable on all non 3.3V regulators for mcu to write to
            - Remove unnecessary resistors
        - Add op amp to circuit for mcu to read
    - Vacuum board
        - New driver and parts
        - Design new mount provided Amazon motor
- Order new parts
    - All new Digikey parts
    - Amazon motor
    - Servocity motors and spacers
    - 3D printer filament
    - Pololu wheels

2/5/2024:




Micromouse Power Test Board
Rev B
40.64mm
JP1
3.3V
5V
3.7V
12V
7.4V
GND
VIN_3.3V_REG
VIN_5V_REG
VIN_12V_REG
J1
S1
CR2
CR3
CR1
L1
L2
L3
U1
U2
U3
C1
C2
C3
C4
C5
C7
C12
C13
R1
R2
M2
A1

2/18/2024:



- Removing relaxation flag in project settings disables instruction optimization during linking, and gets rid of the "input is not relaxable" warning during compilation
- Remove: -Wl,--relax

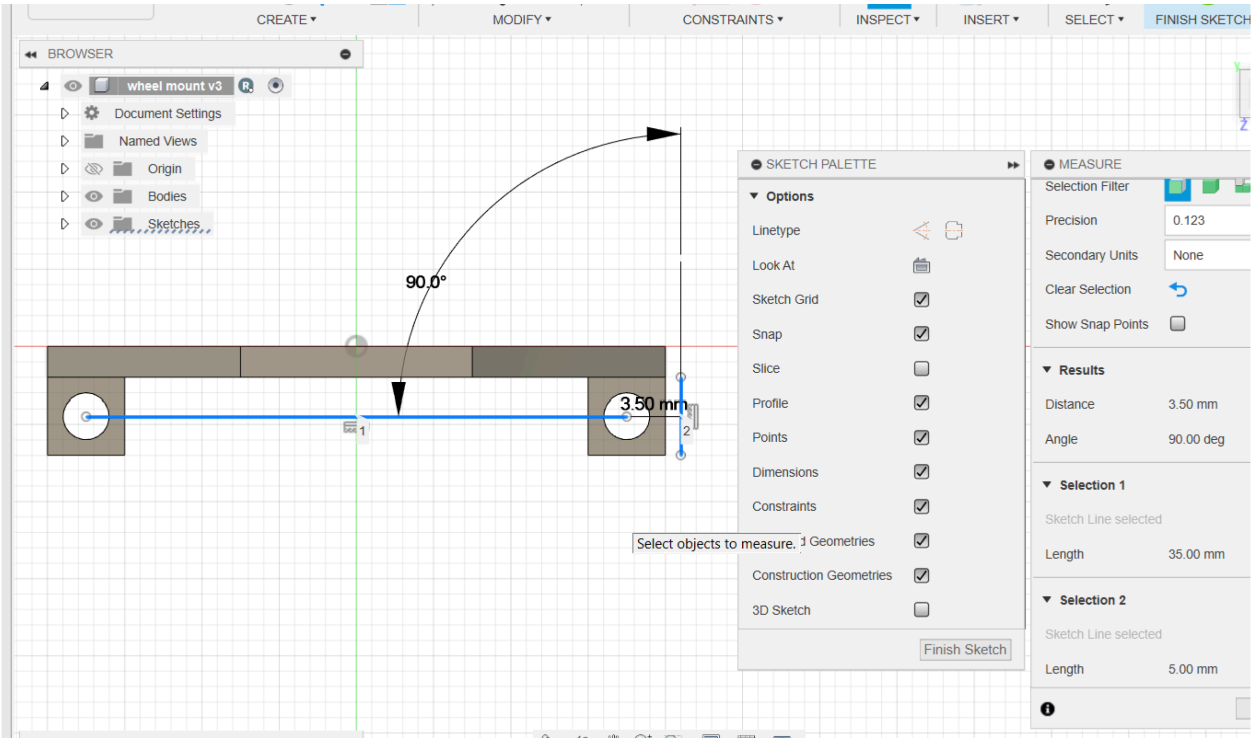
Testing tasks
- Test external crystal project
- Test serial project w/ new clock files
    - Find out what PBA macro is supposed to be provided 50MHz target
- Test PWM project w/ new vacuum code
- Test PWM project w/ new clock files
    - Try to set SBU_MM_PWMA_GCLK_FREQUENCY to some preferred frequency and replace sysclk_get_pba_hz w/ our PBA macro and test:

```
/* initialize PWM clock frequency */
div = div_ceil((sysclk_get_pba_hz()), SBU_MM_PWMA_GCLK_FREQUENCY);
genclk_enable_config(SBU_MM_PWMA_GCLK_ID, SBU_MM_PWMA_GCLK_SOURCE, div);
```

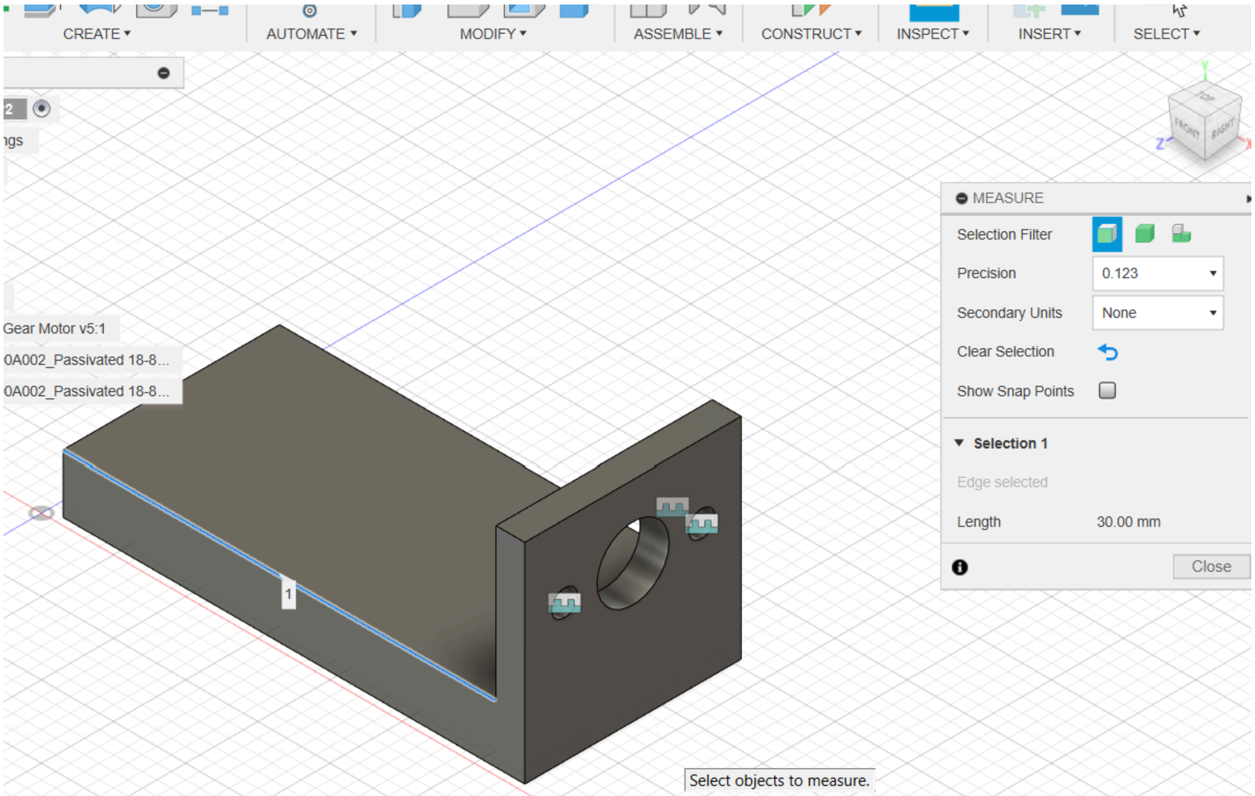
        -
- Change wheel motor interface pins to be convenient for PCB

- Left off cleaning pwm functions

2/19/2024:

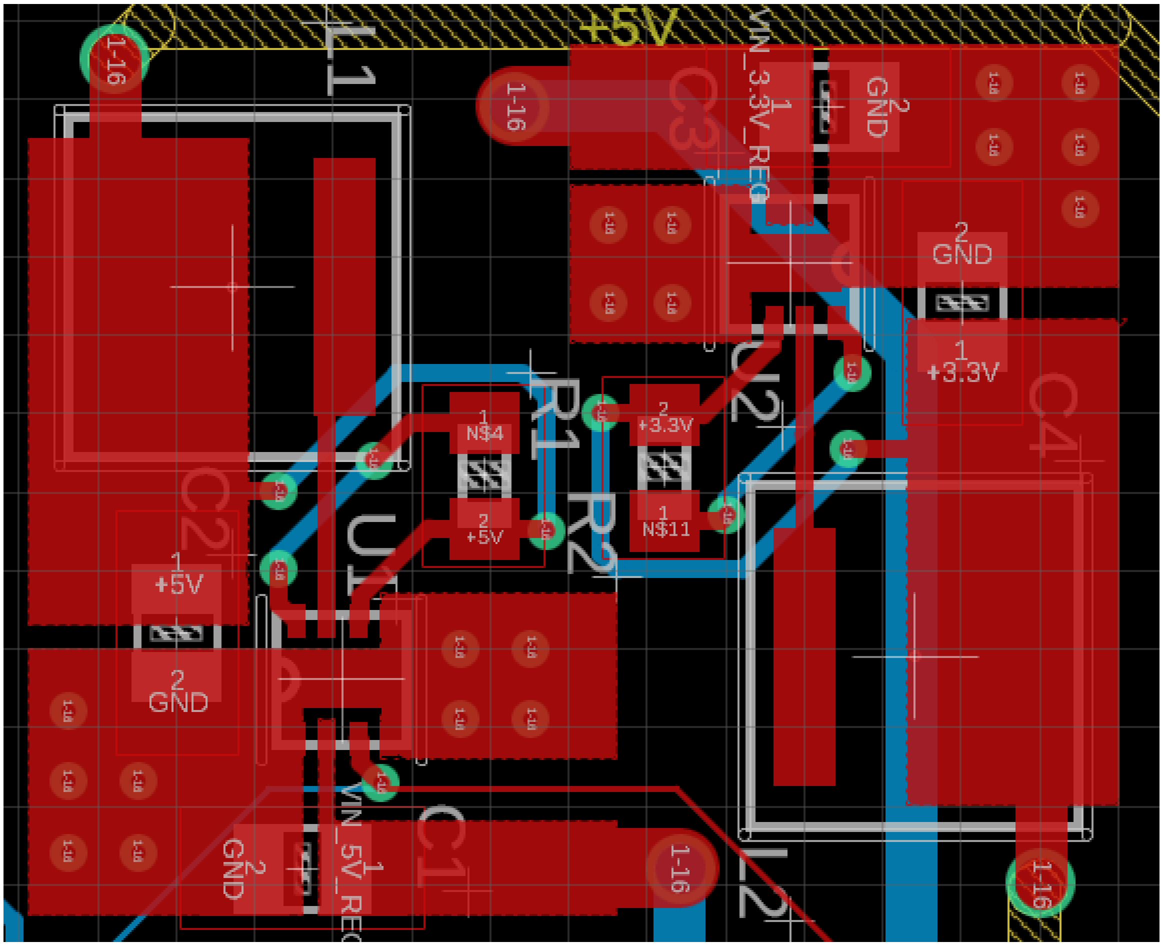


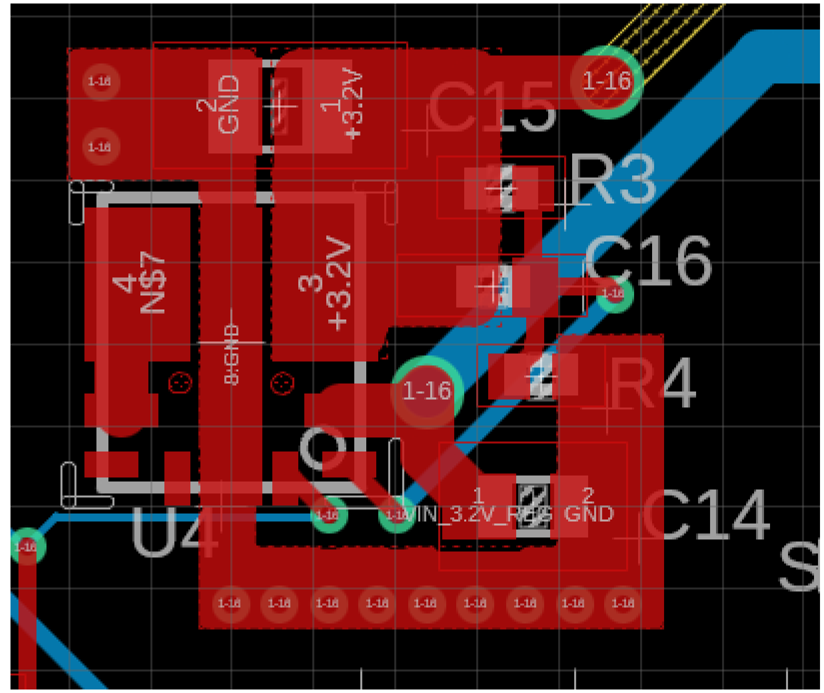
- 35mm long, 5mm wide, 3mm diameter circles

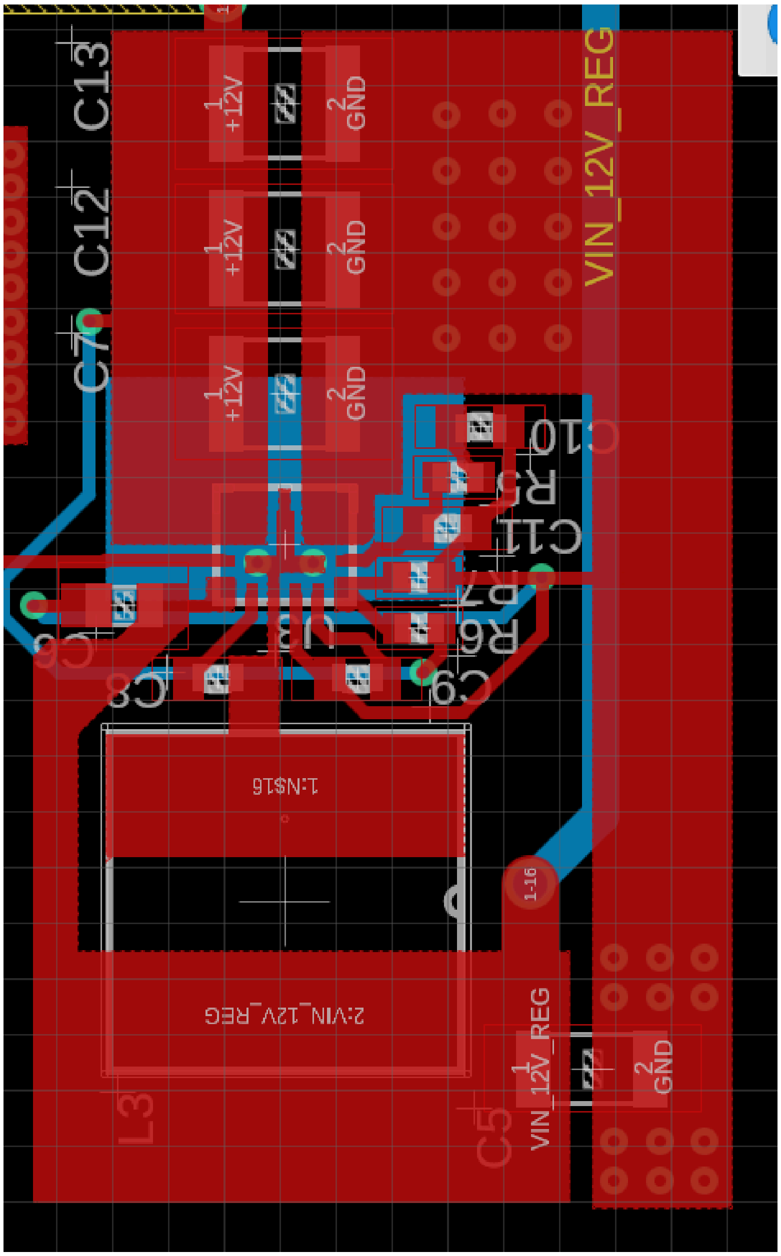


- 30mm gives enough space for the motors

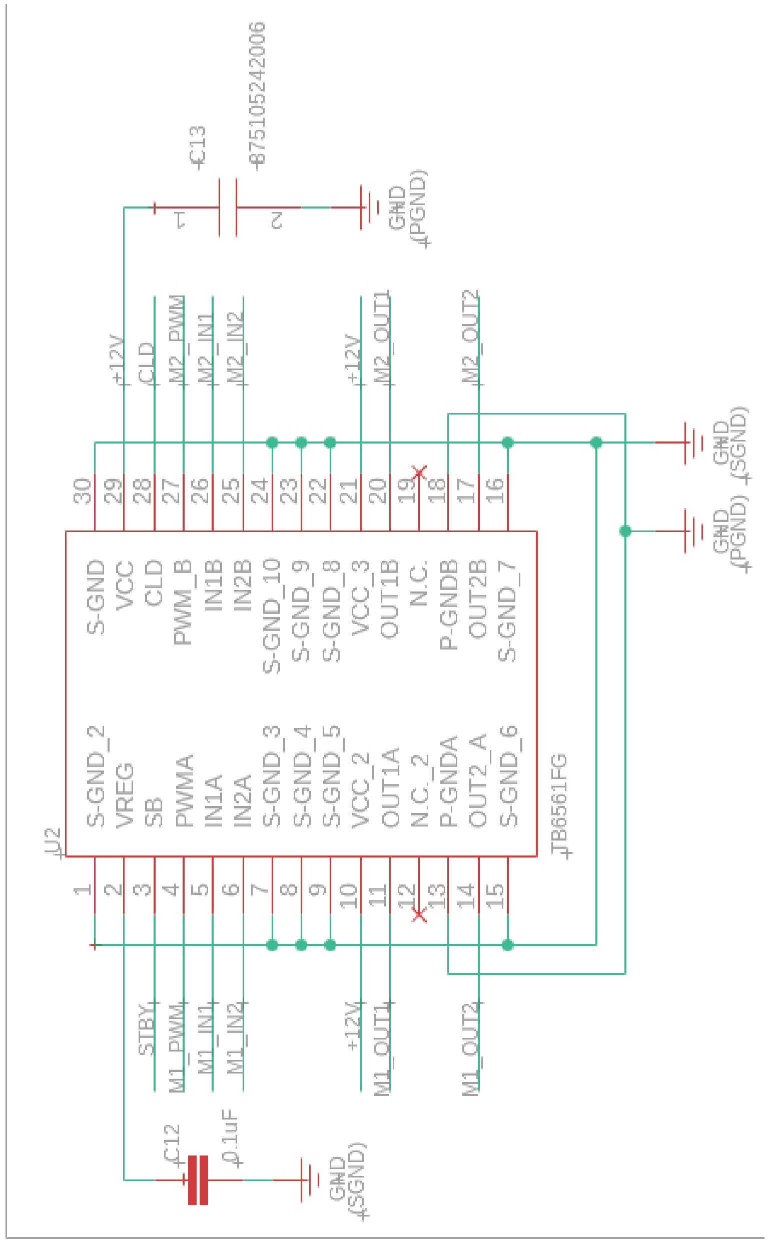
2/27/2024:


+5V
L1
C3
VIN_3.3V_REG
GND
C2
+5V
GND
U1
R1
N$4
+5V
R2
+3.3V
N$11
U2
GND
+3.3V
C4
C1
VIN_5V_REG
GND
L2
1-16

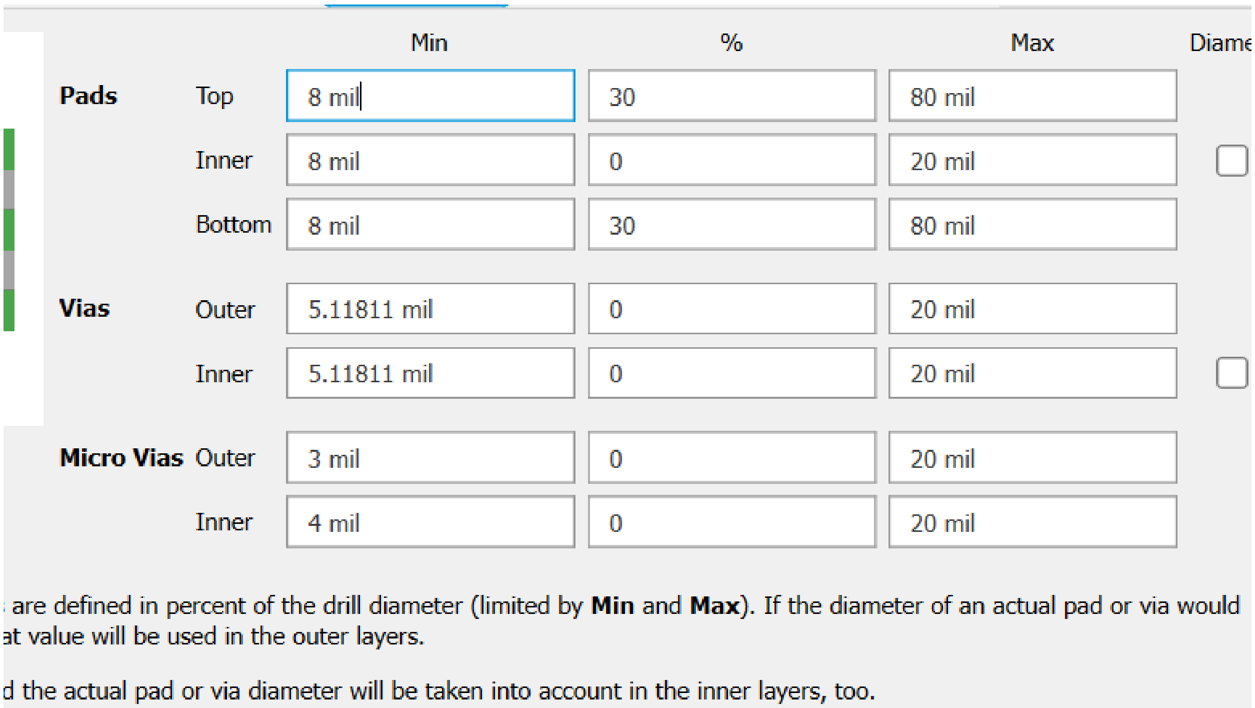

C15
R3
C16
R4
C14
U4
+3.2V
GND
N$7
VIN_3.2V_REG


C13
C12
C7
+12V
GND
VIN_12V_REG
C10
R5
C11
R7
R6
C9
C8
1:N$16
2:VIN_12V_REG
L3
C5
12V_REG
GND

2/29/2024:



3/2/2024:



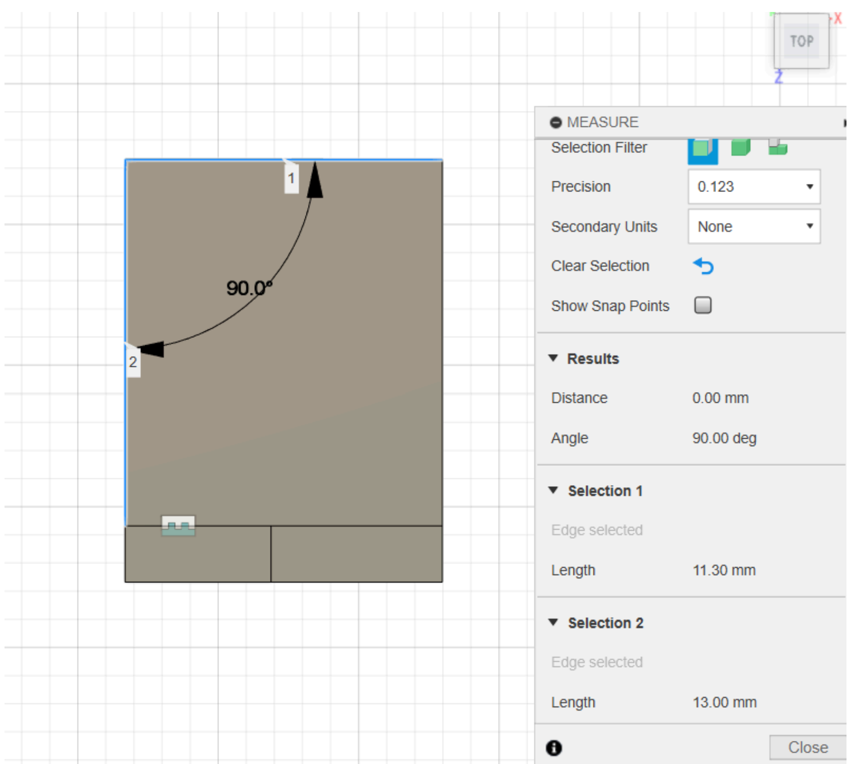
		Min	%	Max	Diame
Pads	Top	8 mil	30	80 mil	
	Inner	8 mil	0	20 mil	☐
	Bottom	8 mil	30	80 mil	
Vias	Outer	5.11811 mil	0	20 mil	
	Inner	5.11811 mil	0	20 mil	☐
Micro Vias	Outer	3 mil	0	20 mil	
	Inner	4 mil	0	20 mil	

are defined in percent of the drill diameter (limited by **Min** and **Max**). If the diameter of an actual pad or via would at value will be used in the outer layers.

d the actual pad or via diameter will be taken into account in the inner layers, too.

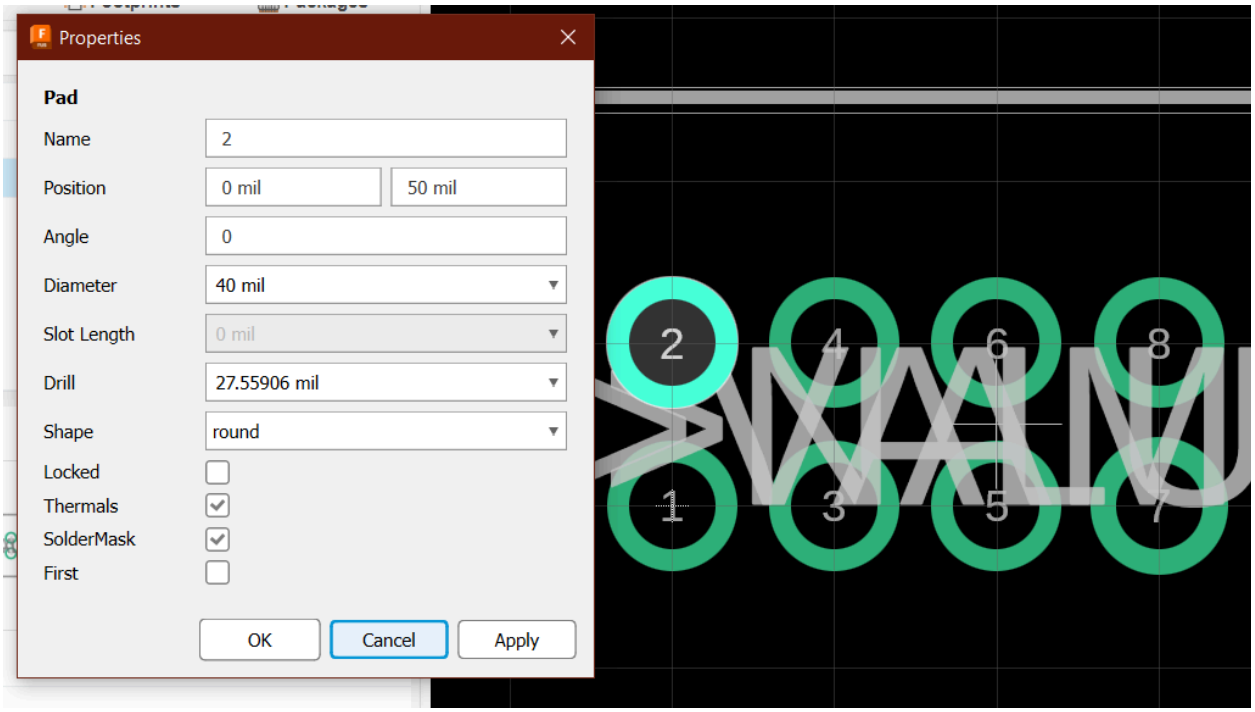
- Mcu test

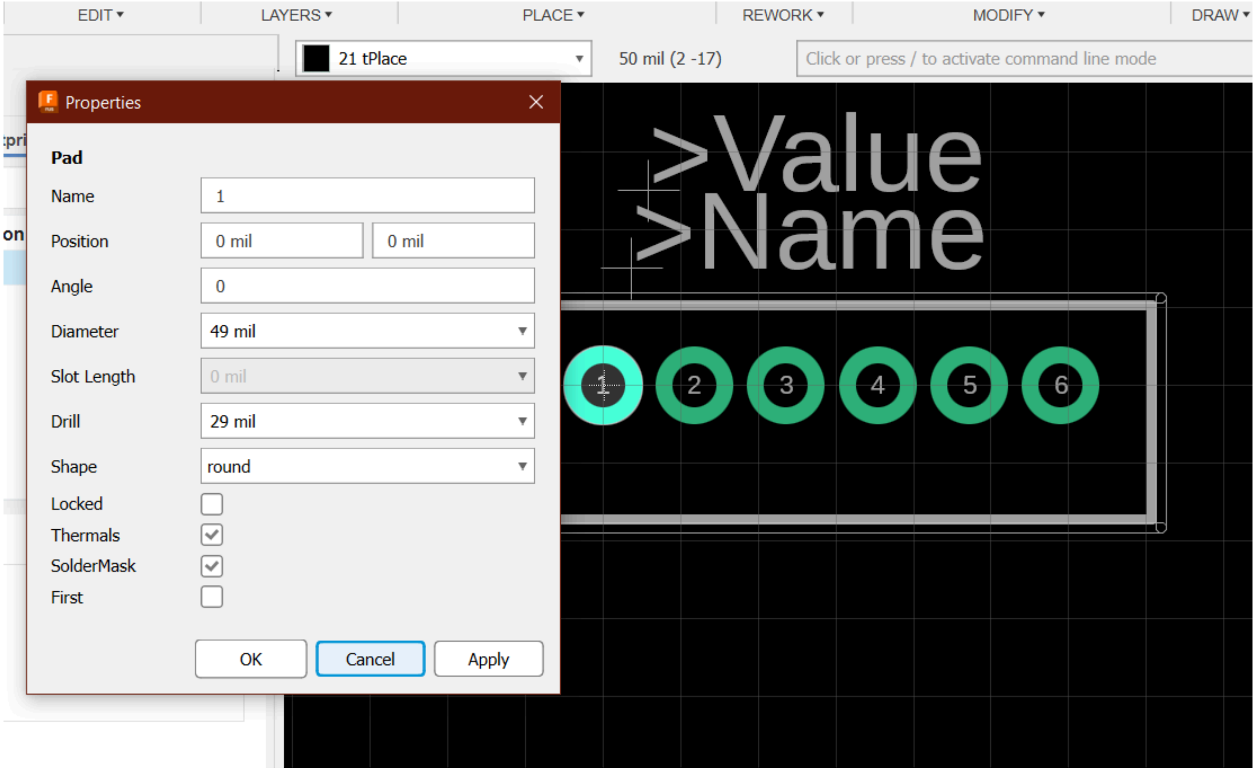
3/3/2024:

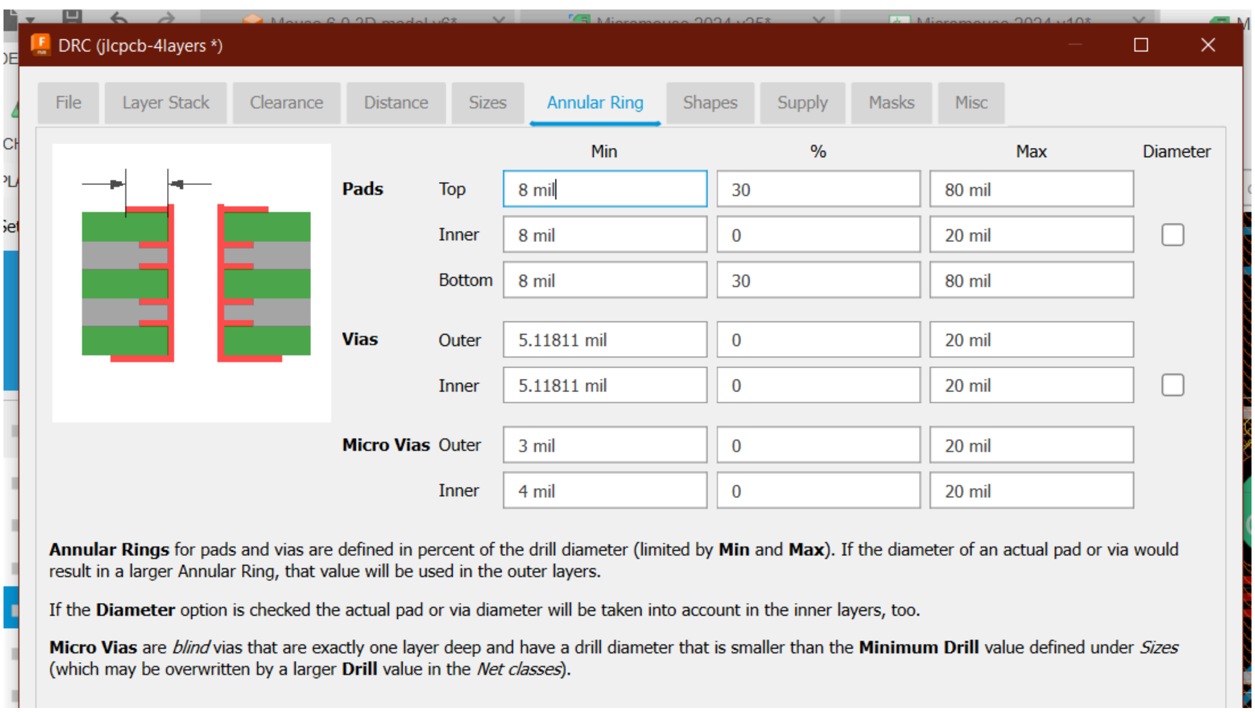


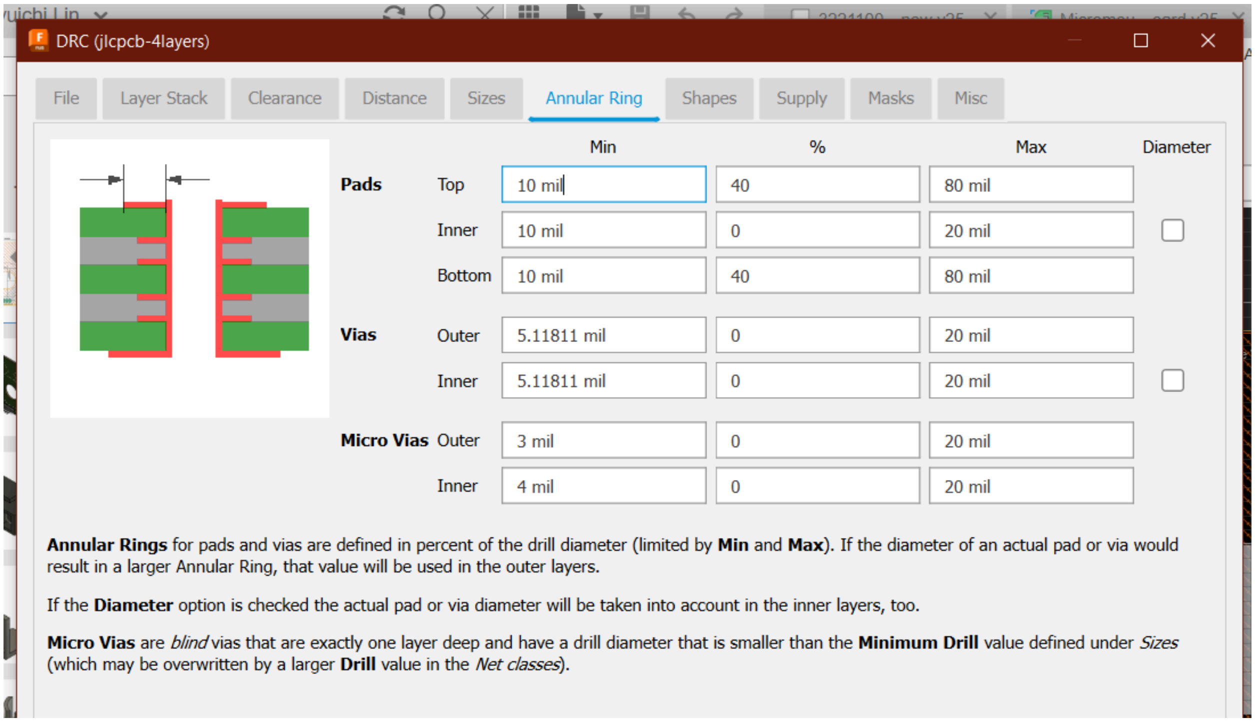
3/16/2024:

- Got feedback from layout group, have a bunch of things to update
- Vacuum fan moves, but not enough juice from 3.2V supply
- ~~Too much work to try and figure out a new regulator setup, let's just plug the vacuum directly to the battery and PWM the connection w/ a mosfet~~
    - Never mind it's just as much work to drive mosfets
- We'll contact Crazepony on Amazon and get our current rating hopefully they respond
- Until then we'll work on everything else

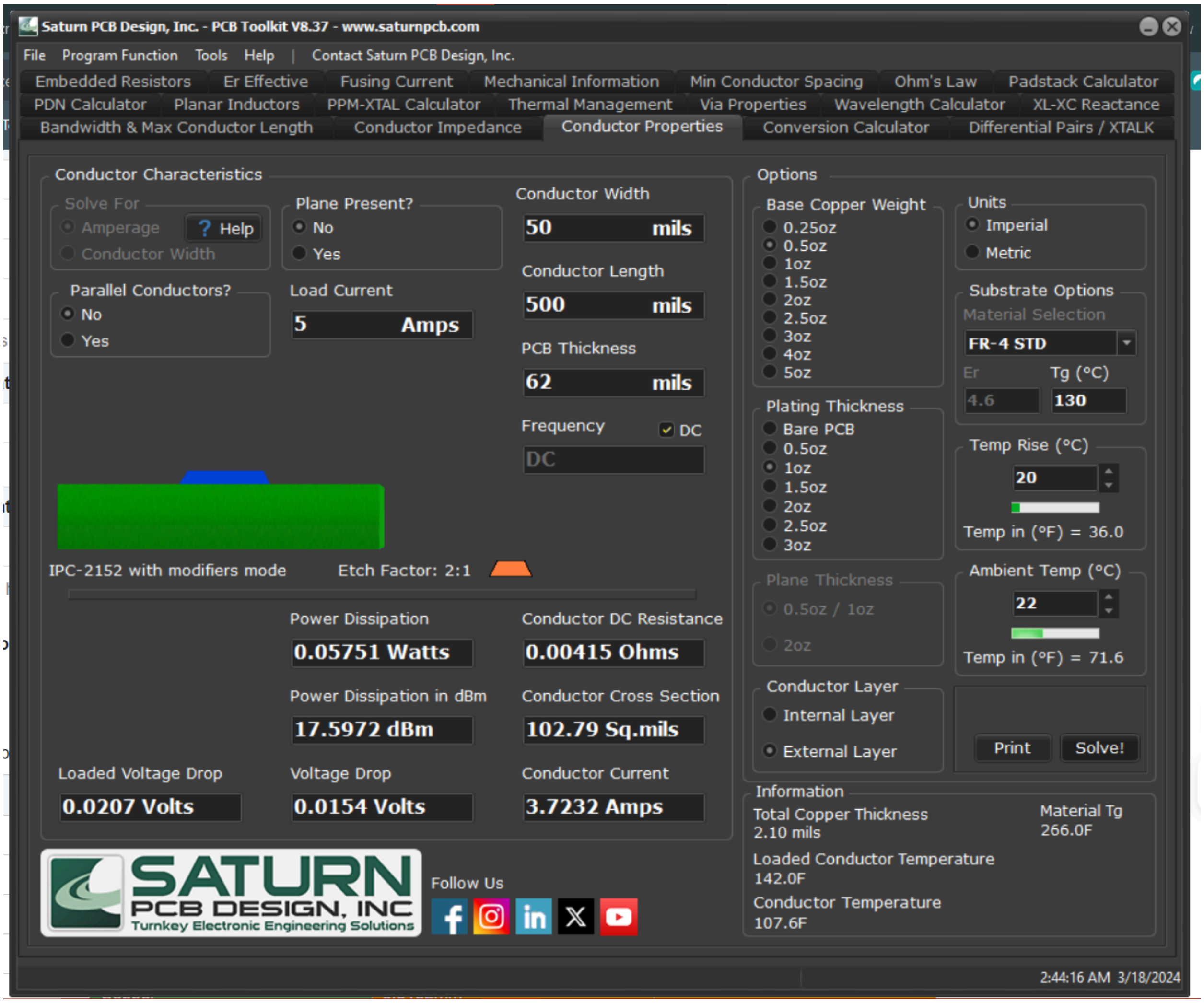



EDIT
LAYERS
PLACE
REWORK
MODIFY
DRAW
21 tPlace
50 mil (2 -17)
Click or press / to activate command line mode
Properties
Pad
Name 1
Position 0 mil 0 mil
Angle 0
Diameter 49 mil
Slot Length 0 mil
Drill 29 mil
Shape round
Locked
Thermals
SolderMask
First
OK
Cancel
Apply
>Value
>Name
1
2
3
4
5
6

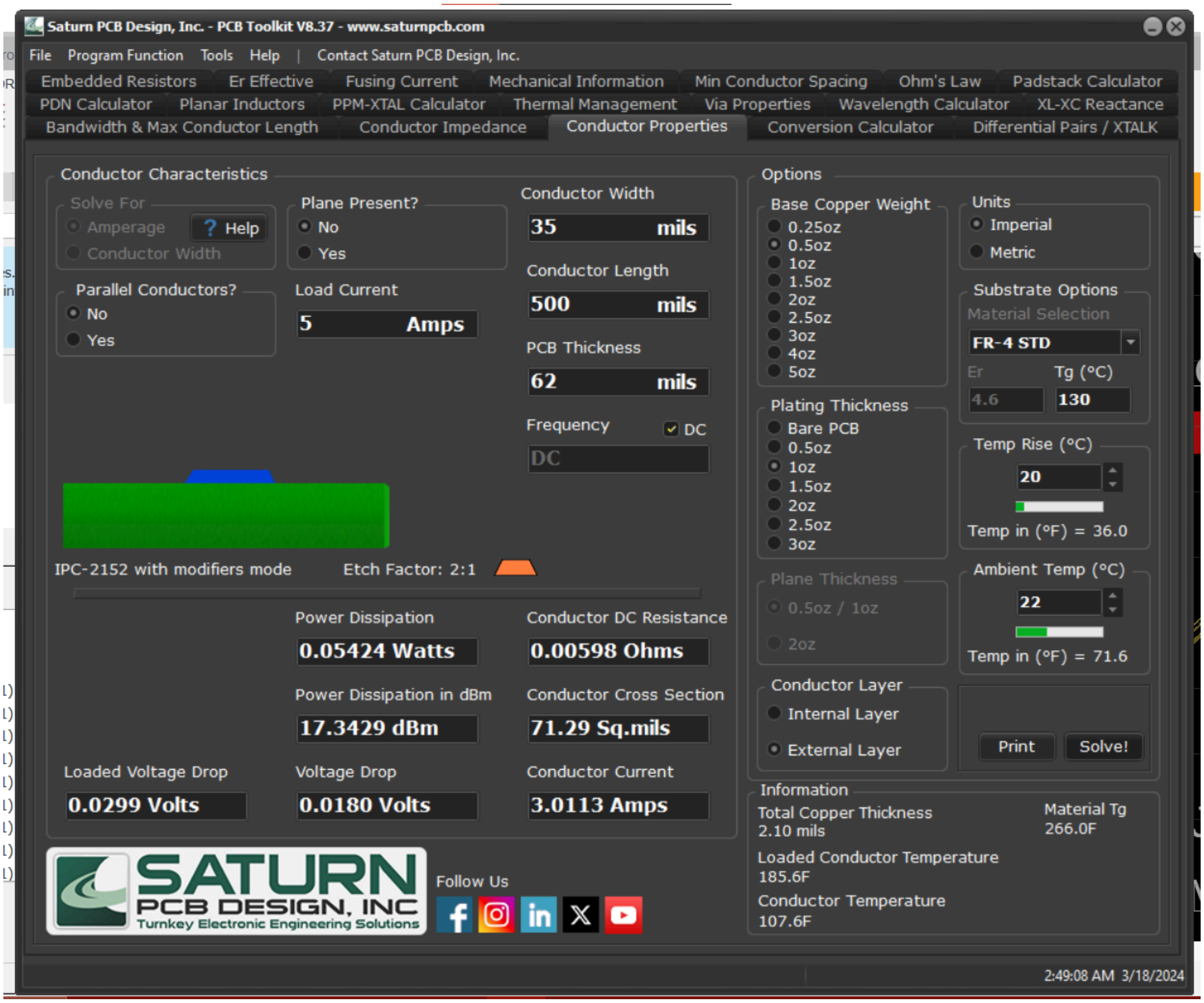

DRC (jlcpcb-4layers *)
File
Layer Stack
Clearance
Distance
Sizes
Annular Ring
Shapes
Supply
Masks
Misc
Min
%
Max
Diameter
Pads Top 8 mil 30 80 mil
Inner 8 mil 0 20 mil
Bottom 8 mil 30 80 mil
Vias Outer 5.11811 mil 0 20 mil
Inner 5.11811 mil 0 20 mil
Micro Vias Outer 3 mil 0 20 mil
Inner 4 mil 0 20 mil
Annular Rings for pads and vias are defined in percent of the drill diameter (limited by Min and Max). If the diameter of an actual pad or via would result in a larger Annular Ring, that value will be used in the outer layers.
If the Diameter option is checked the actual pad or via diameter will be taken into account in the inner layers, too.
Micro Vias are blind vias that are exactly one layer deep and have a drill diameter that is smaller than the Minimum Drill value defined under Sizes (which may be overwritten by a larger Drill value in the Net classes).


DRC (jlcpcb-4layers)
File
Layer Stack
Clearance
Distance
Sizes
Annular Ring
Shapes
Supply
Masks
Misc
Min
%
Max
Diameter
Pads
Top
10 mil
40
80 mil
Inner
10 mil
0
20 mil
Bottom
10 mil
40
80 mil
Vias
Outer
5.11811 mil
0
20 mil
Inner
5.11811 mil
0
20 mil
Micro Vias
Outer
3 mil
0
20 mil
Inner
4 mil
0
20 mil
Annular Rings for pads and vias are defined in percent of the drill diameter (limited by Min and Max). If the diameter of an actual pad or via would result in a larger Annular Ring, that value will be used in the outer layers.
If the Diameter option is checked the actual pad or via diameter will be taken into account in the inner layers, too.
Micro Vias are blind vias that are exactly one layer deep and have a drill diameter that is smaller than the Minimum Drill value defined under Sizes (which may be overwritten by a larger Drill value in the Net classes).

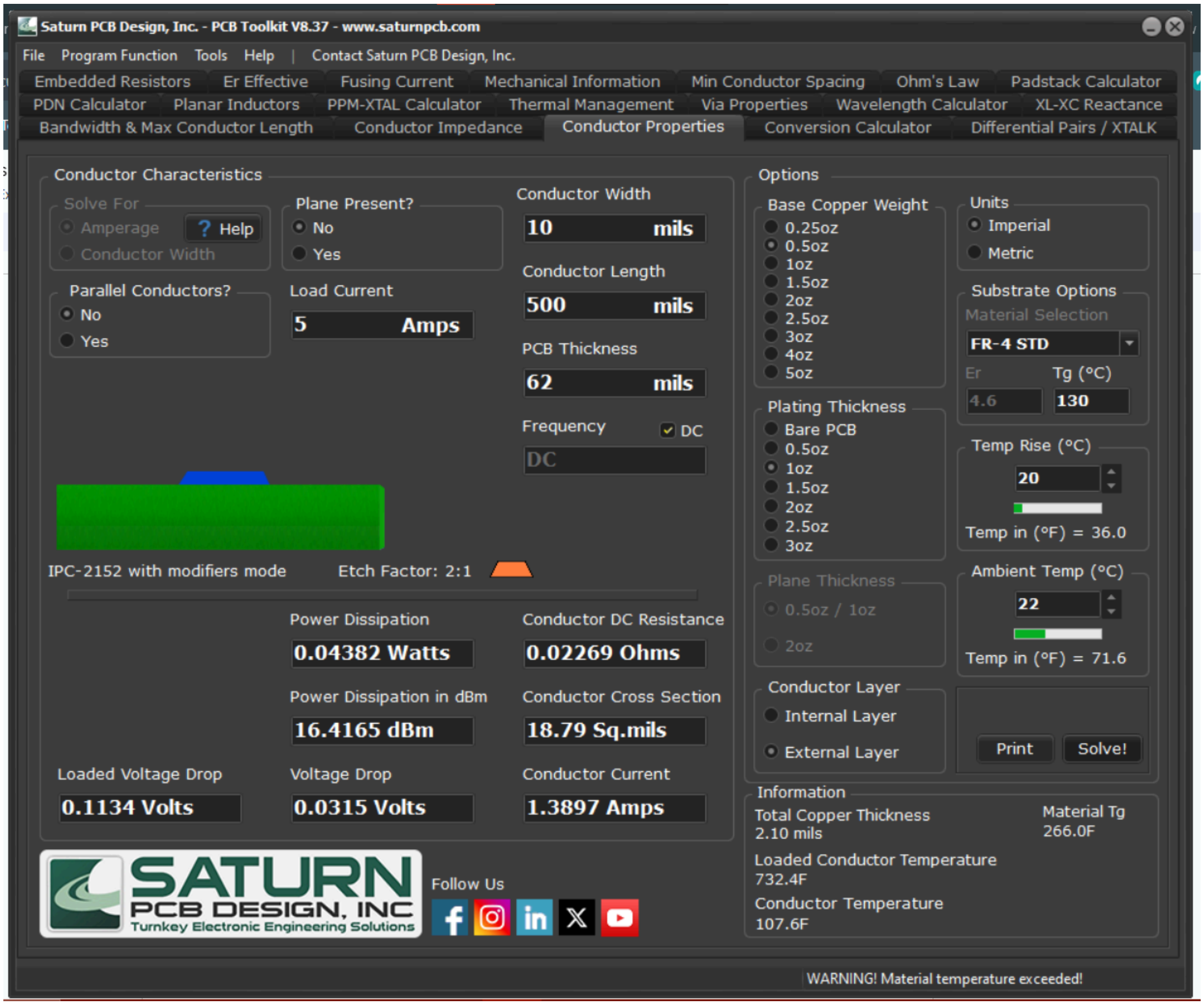
3/18/2024:



- Dang you need 50 mils for 3.7A



- 35 mils for 3A for wheel motors

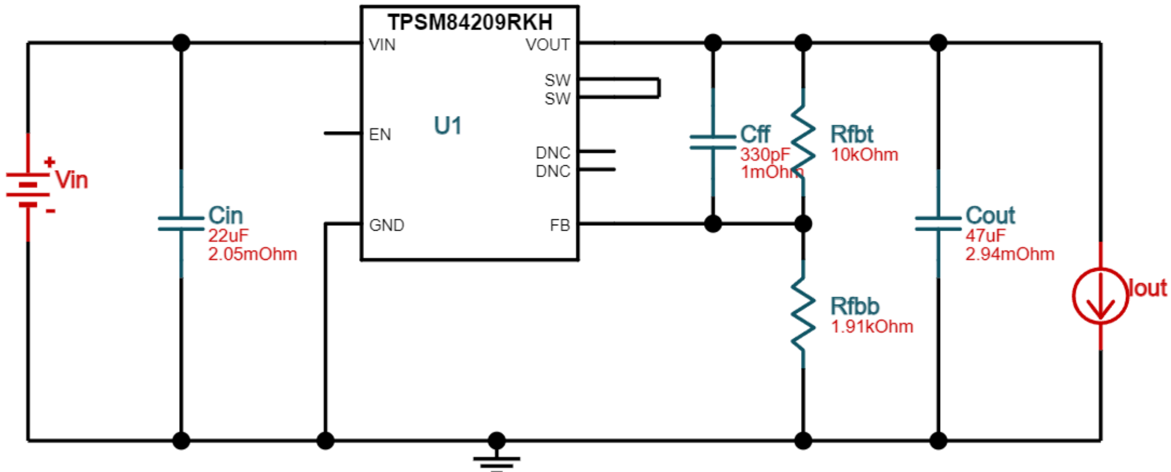


- 10 mils is plenty for power to digital components

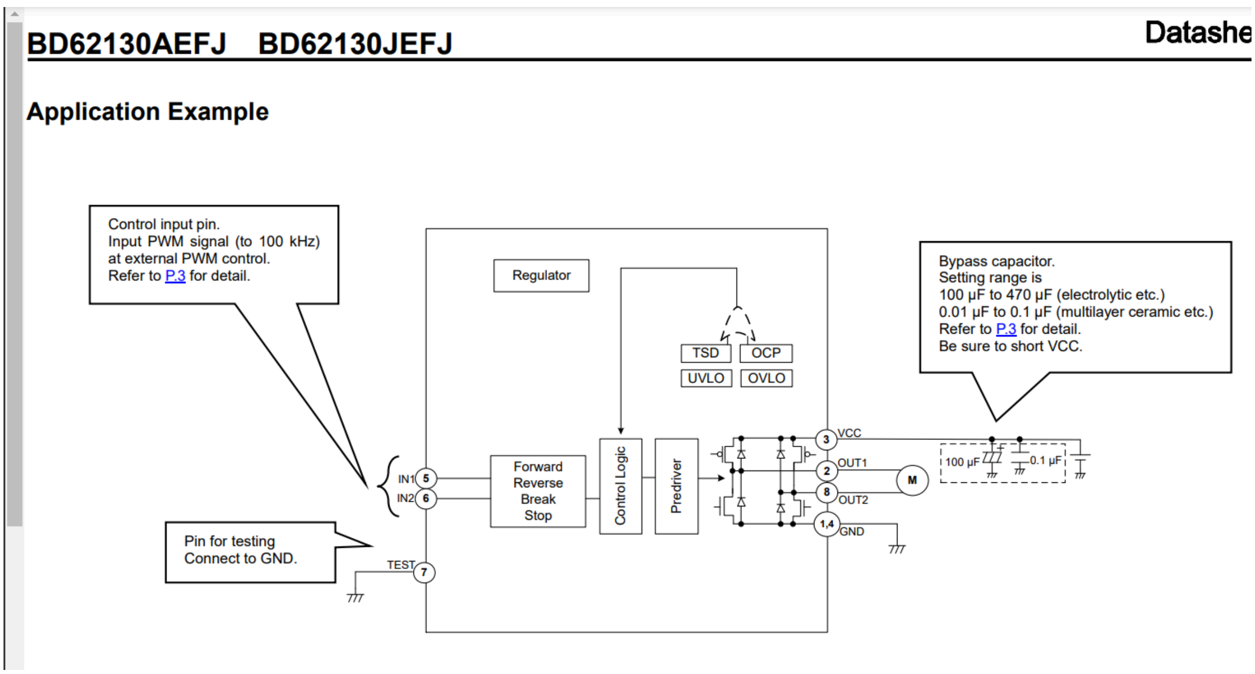
3/20/2024:
https://notblackmagic.com/projects/motor-test-stand/

- We need 2A on our 8420 vacuum motor

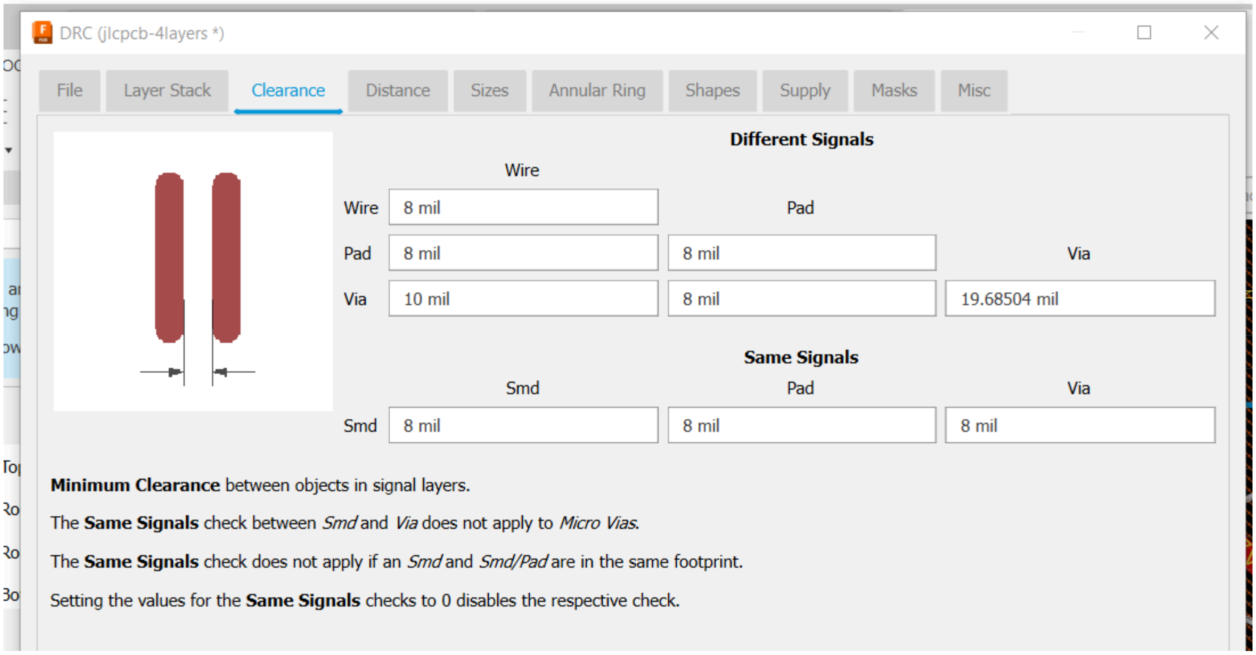
- Swapping some parts on our 1A 3.2V regulator to make it 3.7V 2A: HERE

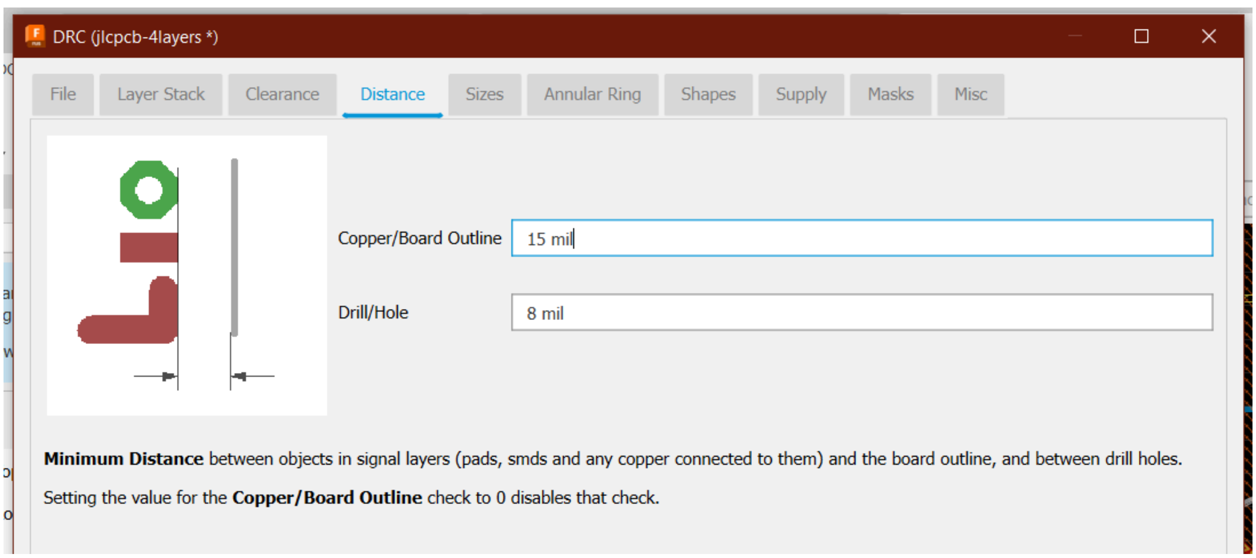


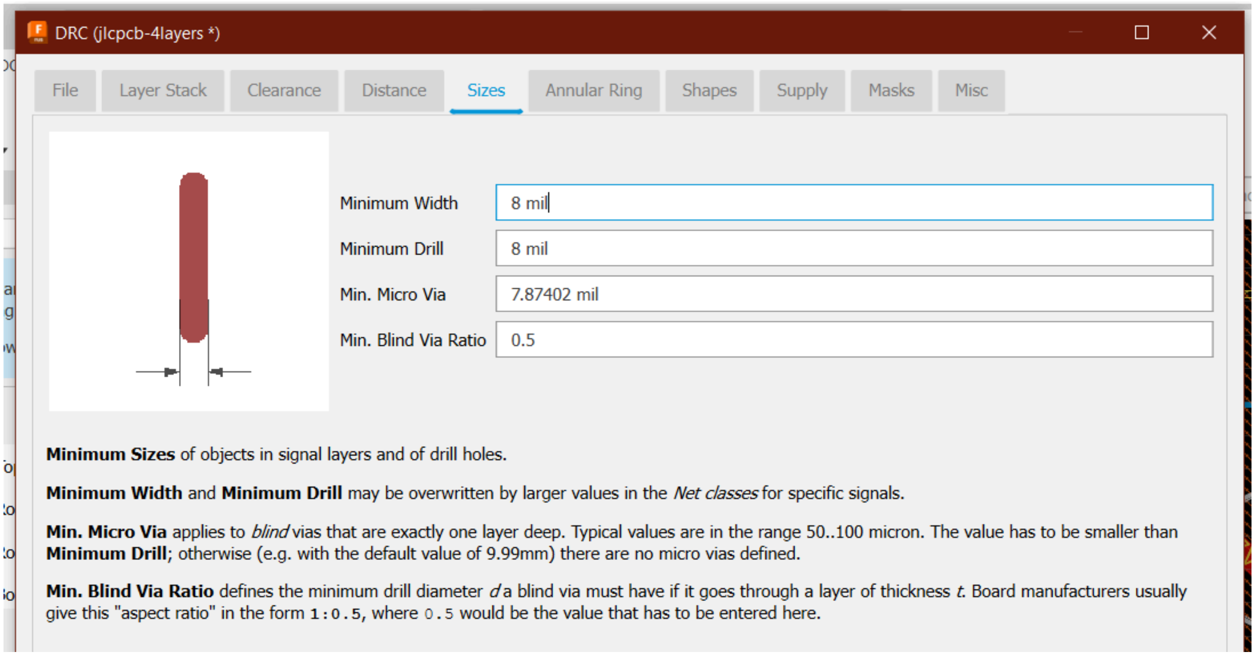
- New driver at 3A 28V supply max:

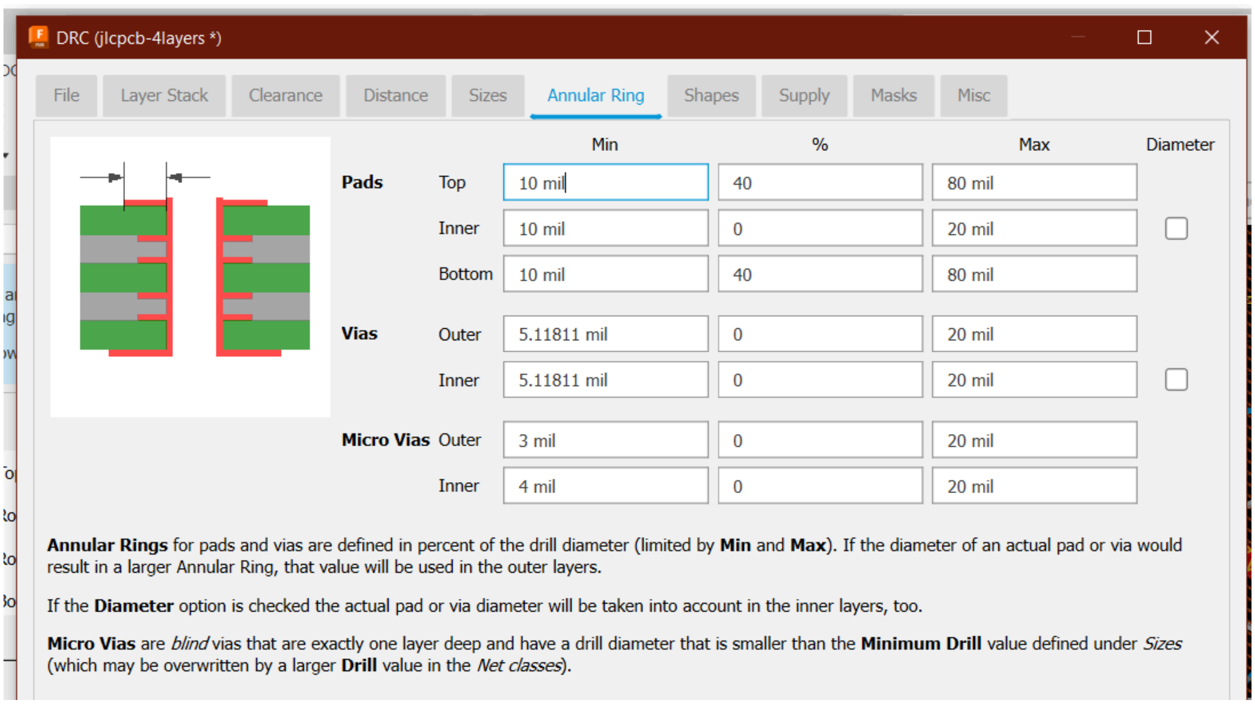


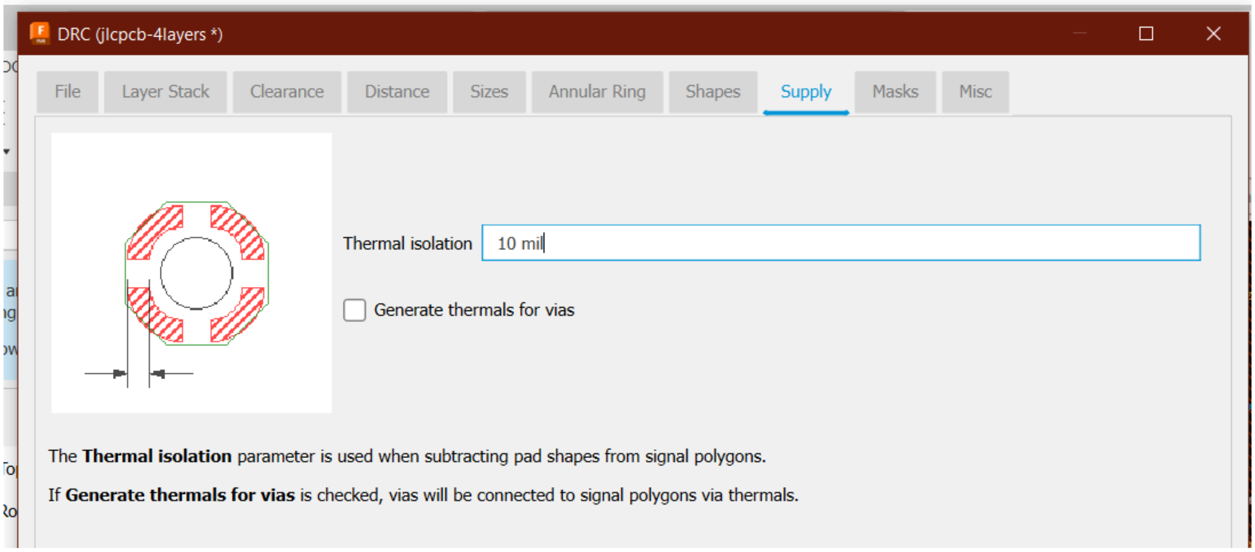
- We need a 100uF cap and 0.1uF cap

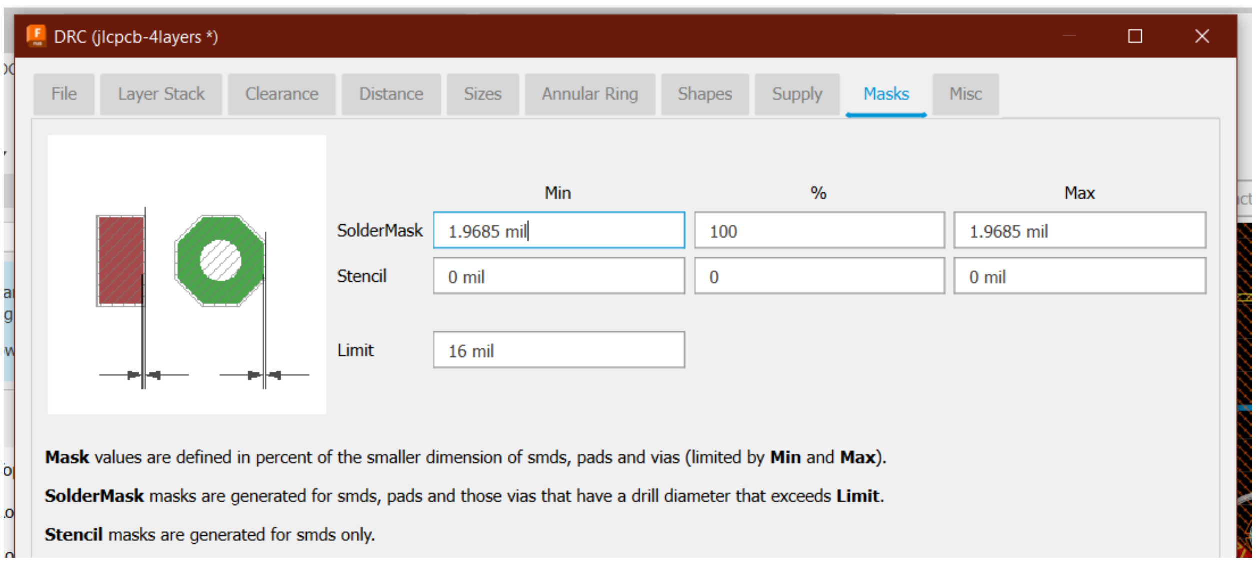

DRC (jlcpcb-4layers *)
File
Layer Stack
Clearance
Distance
Sizes
Annular Ring
Shapes
Supply
Masks
Misc
Different Signals
Wire
Wire
8 mil
Pad
Pad
8 mil
8 mil
Via
Via
10 mil
8 mil
19.68504 mil
Same Signals
Smd
Pad
Via
Smd
8 mil
8 mil
8 mil
Minimum Clearance between objects in signal layers.
The Same Signals check between Smd and Via does not apply to Micro Vias.
The Same Signals check does not apply if an Smd and Smd/Pad are in the same footprint.
Setting the values for the Same Signals checks to 0 disables the respective check.

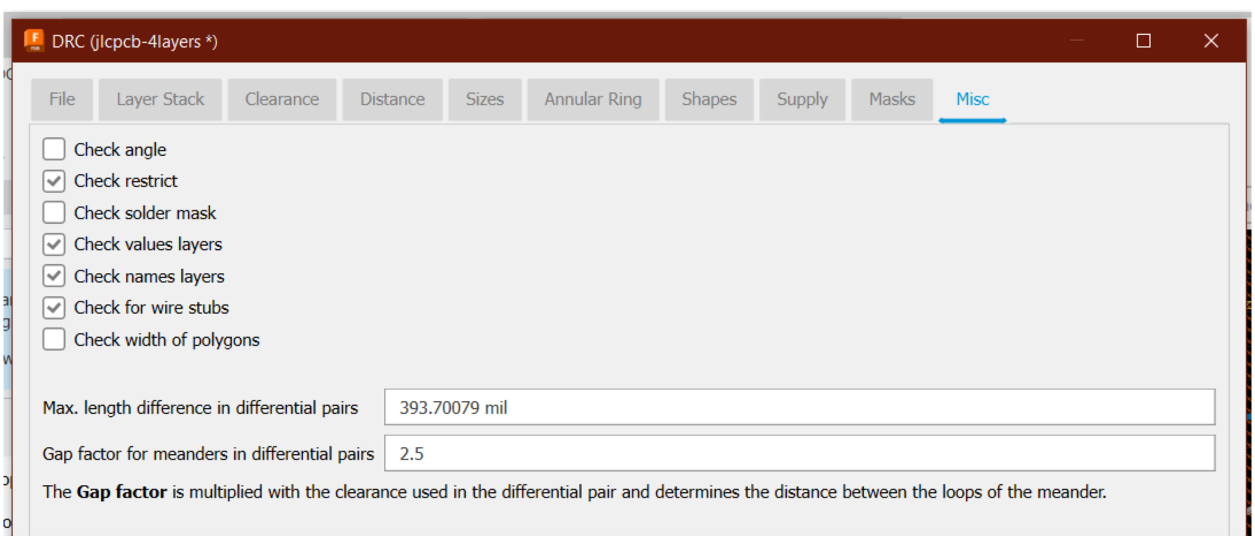

DRC (jlcpcb-4layers *)
File
Layer Stack
Clearance
Distance
Sizes
Annular Ring
Shapes
Supply
Masks
Misc
Copper/Board Outline
15 mil
Drill/Hole
8 mil
Minimum Distance between objects in signal layers (pads, smds and any copper connected to them) and the board outline, and between drill holes.
Setting the value for the Copper/Board Outline check to 0 disables that check.

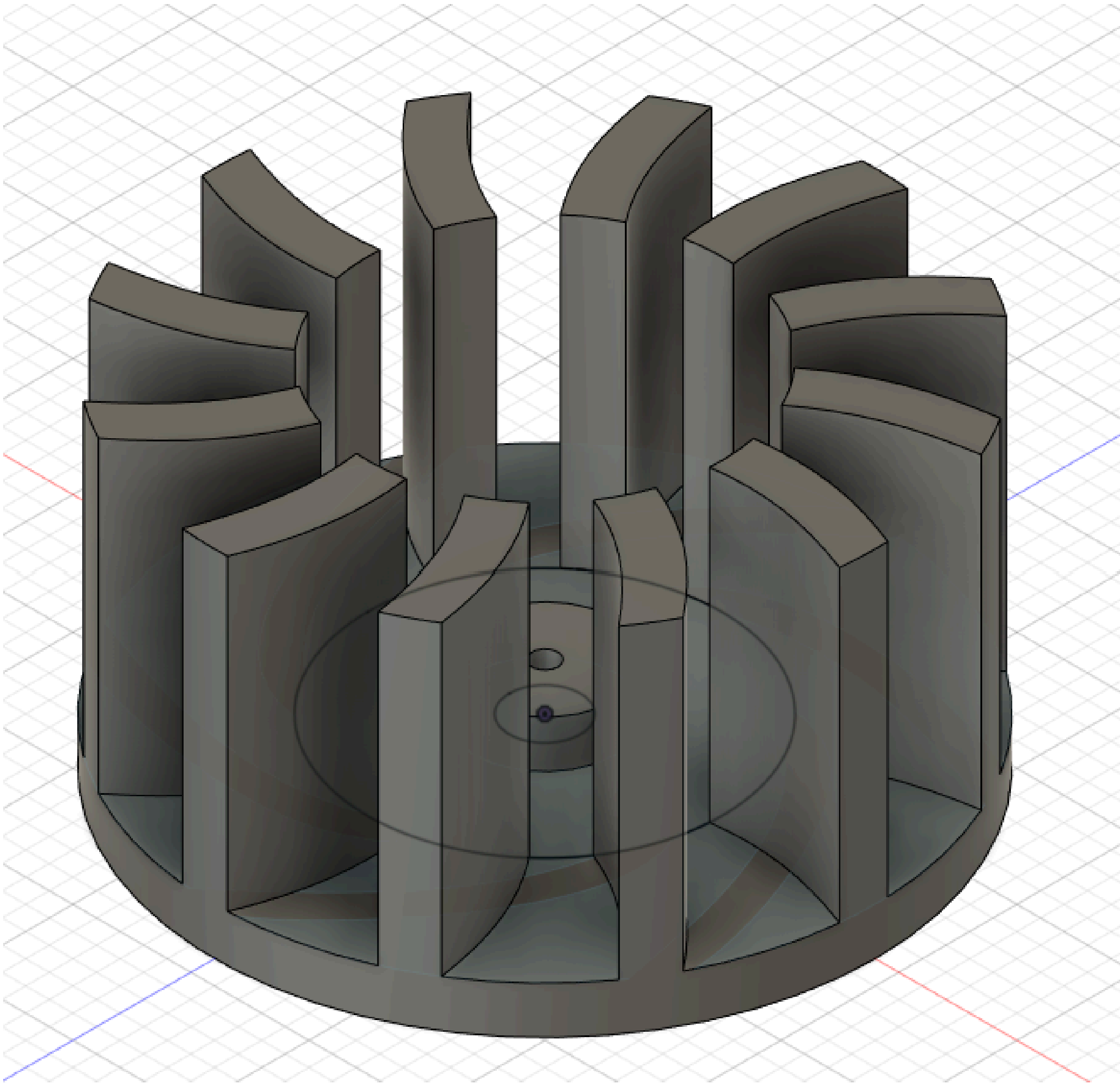

DRC (jlcpcb-4layers *)
File
Layer Stack
Clearance
Distance
Sizes
Annular Ring
Shapes
Supply
Masks
Misc
Minimum Width 8 mil
Minimum Drill 8 mil
Min. Micro Via 7.87402 mil
Min. Blind Via Ratio 0.5
Minimum Sizes of objects in signal layers and of drill holes.
Minimum Width and **Minimum Drill** may be overwritten by larger values in the *Net classes* for specific signals.
Min. Micro Via applies to *blind* vias that are exactly one layer deep. Typical values are in the range 50..100 micron. The value has to be smaller than **Minimum Drill**; otherwise (e.g. with the default value of 9.99mm) there are no micro vias defined.
Min. Blind Via Ratio defines the minimum drill diameter *d* a blind via must have if it goes through a layer of thickness *t*. Board manufacturers usually give this "aspect ratio" in the form `1:0.5`, where `0.5` would be the value that has to be entered here.


DRC (jlcpcb-4layers *)
File
Layer Stack
Clearance
Distance
Sizes
Annular Ring
Shapes
Supply
Masks
Misc
Min
%
Max
Diameter
Pads
Top 10 mil 40 80 mil
Inner 10 mil 0 20 mil
Bottom 10 mil 40 80 mil
Vias
Outer 5.11811 mil 0 20 mil
Inner 5.11811 mil 0 20 mil
Micro Vias
Outer 3 mil 0 20 mil
Inner 4 mil 0 20 mil
Annular Rings for pads and vias are defined in percent of the drill diameter (limited by **Min** and **Max**). If the diameter of an actual pad or via would result in a larger Annular Ring, that value will be used in the outer layers.
If the **Diameter** option is checked the actual pad or via diameter will be taken into account in the inner layers, too.
Micro Vias are *blind* vias that are exactly one layer deep and have a drill diameter that is smaller than the **Minimum Drill** value defined under *Sizes* (which may be overwritten by a larger **Drill** value in the *Net classes*).


DRC (jlcpcb-4layers *)
File
Layer Stack
Clearance
Distance
Sizes
Annular Ring
Shapes
Supply
Masks
Misc
Thermal isolation
10 mil
Generate thermals for vias
The Thermal isolation parameter is used when subtracting pad shapes from signal polygons.
If Generate thermals for vias is checked, vias will be connected to signal polygons via thermals.

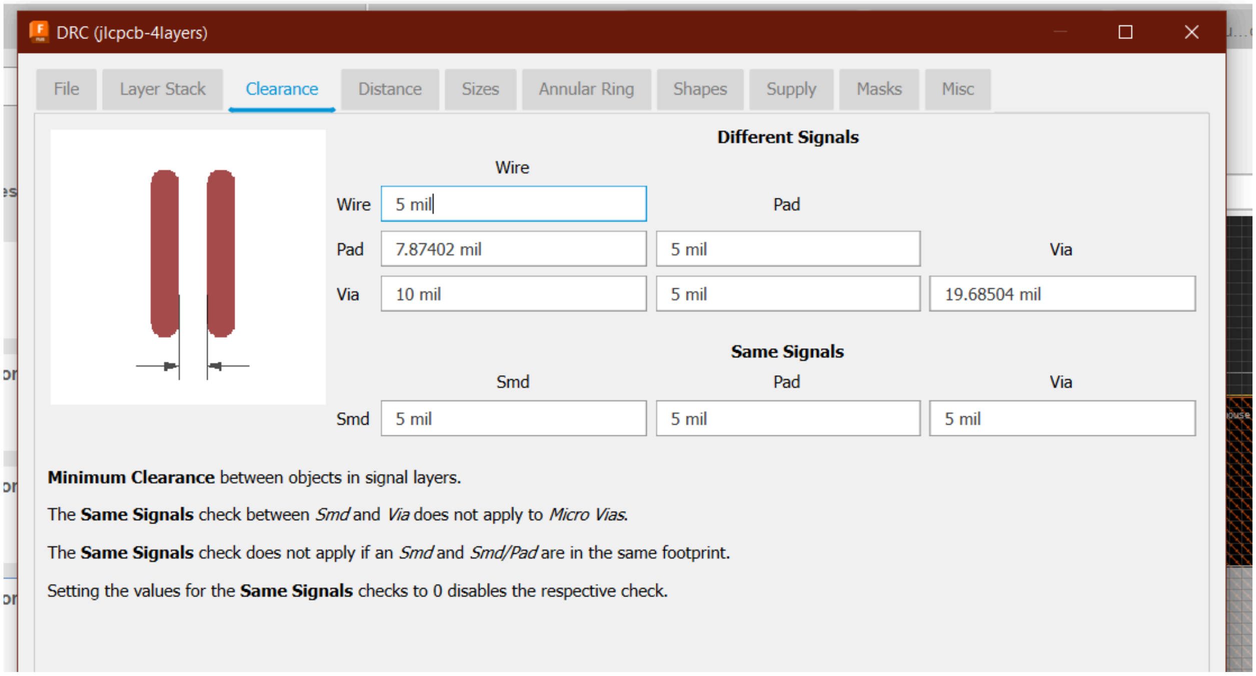

DRC (jlcpcb-4layers *)
File
Layer Stack
Clearance
Distance
Sizes
Annular Ring
Shapes
Supply
Masks
Misc
Min
%
Max
SolderMask
1.9685 mil
100
1.9685 mil
Stencil
0 mil
0
0 mil
Limit
16 mil
Mask values are defined in percent of the smaller dimension of smds, pads and vias (limited by Min and Max).
SolderMask masks are generated for smds, pads and those vias that have a drill diameter that exceeds Limit.
Stencil masks are generated for smds only.

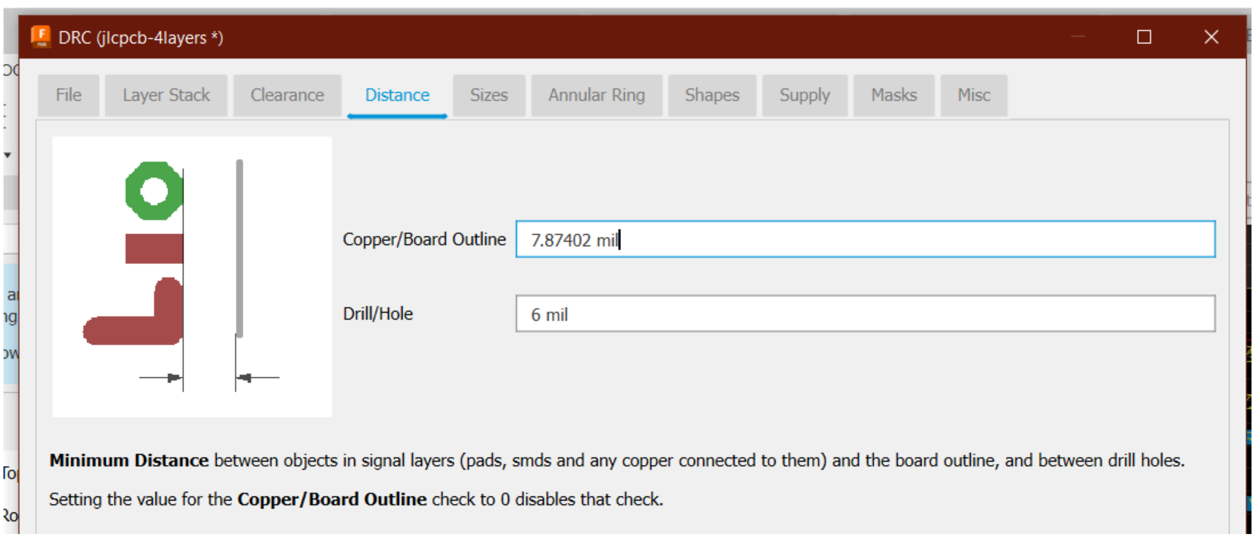

DRC (jlcpcb-4layers *)
File
Layer Stack
Clearance
Distance
Sizes
Annular Ring
Shapes
Supply
Masks
Misc
Check angle
Check restrict
Check solder mask
Check values layers
Check names layers
Check for wire stubs
Check width of polygons
Max. length difference in differential pairs
393.70079 mil
Gap factor for meanders in differential pairs
2.5
The Gap factor is multiplied with the clearance used in the differential pair and determines the distance between the loops of the meander.

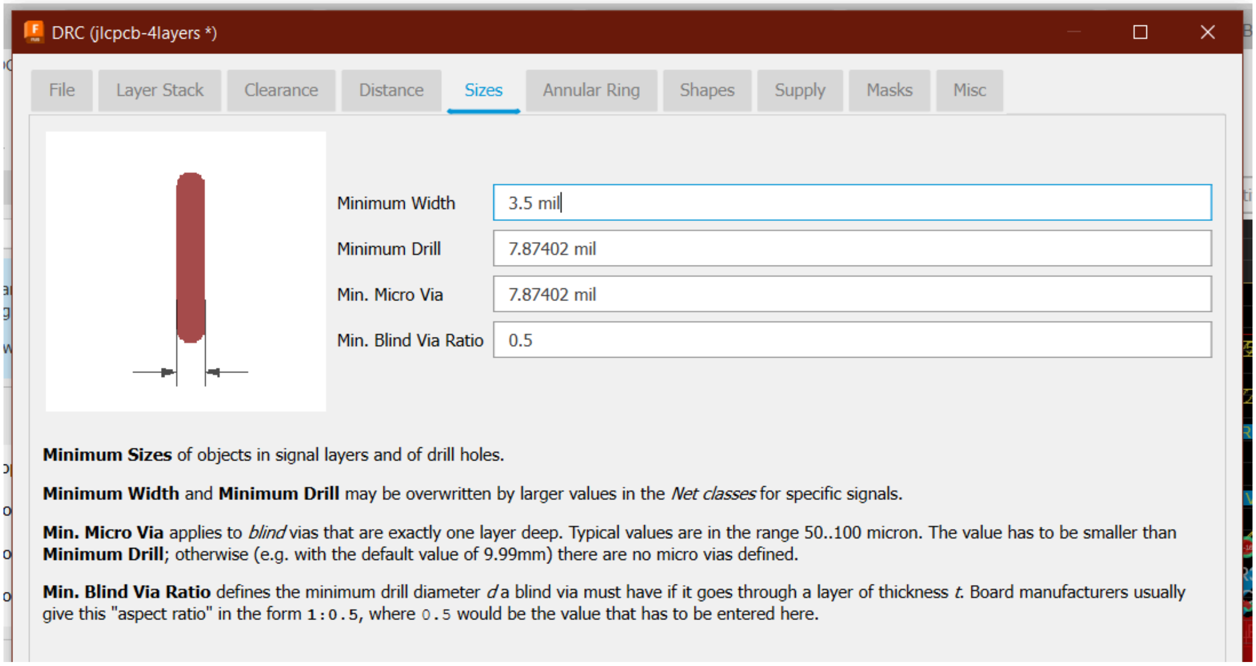


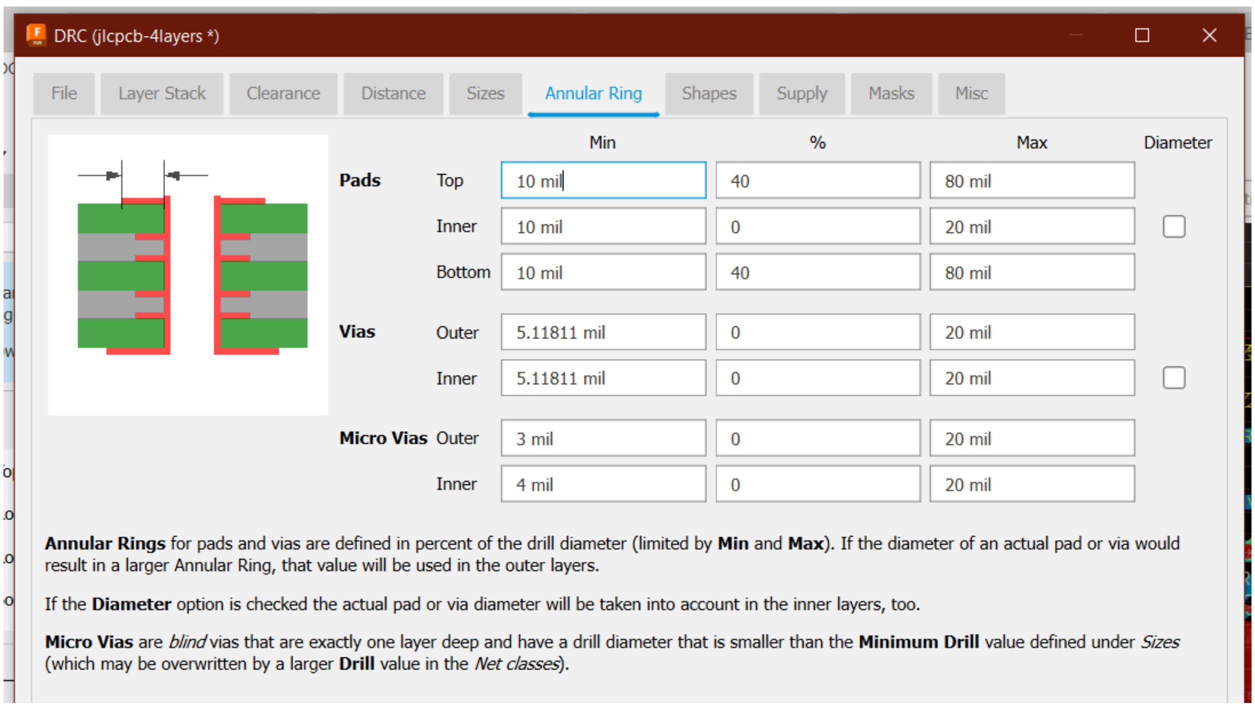
- This thing is the quietest and probably best at vacuuming?
- Let’s expand on this

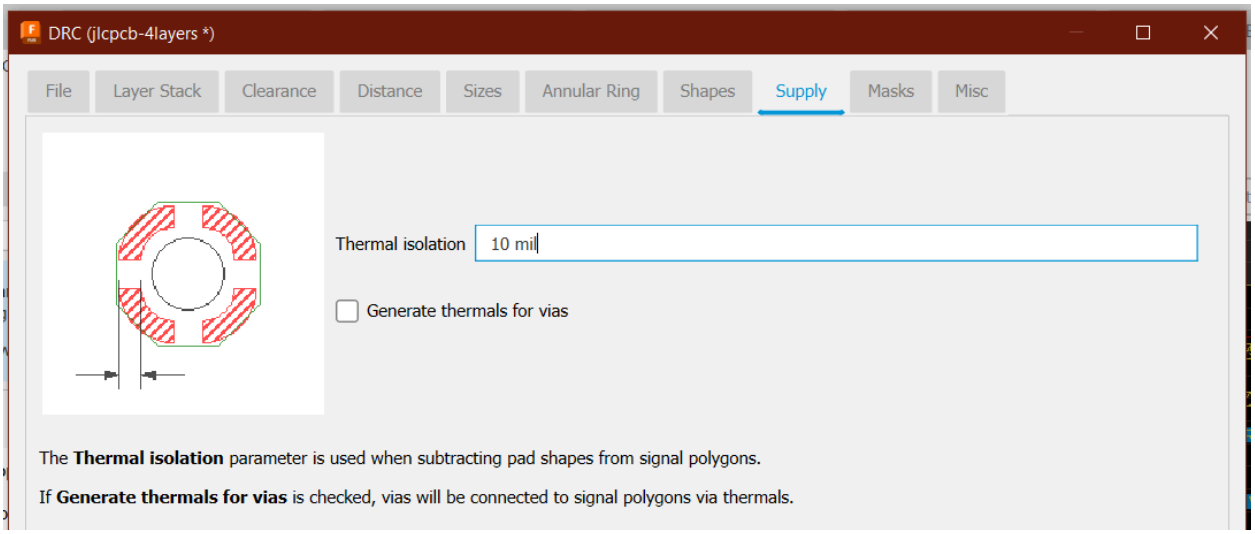
3/23/2024:

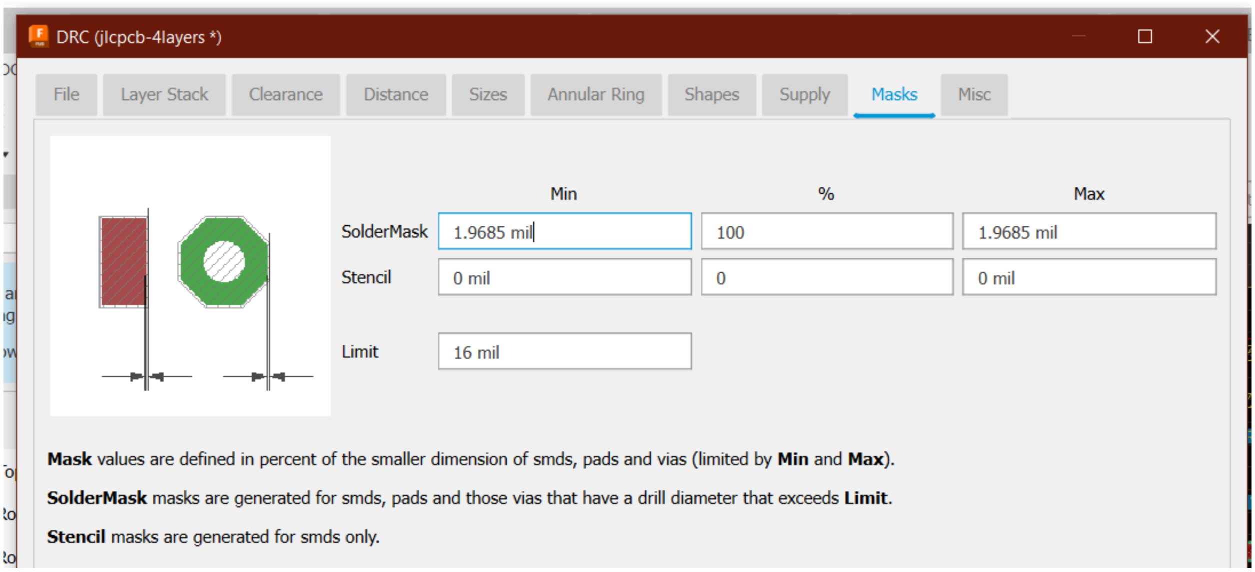

DRC (jlcpcb-4layers)
File
Layer Stack
Clearance
Distance
Sizes
Annular Ring
Shapes
Supply
Masks
Misc
Different Signals
Wire
Wire 5 mil
Pad
Pad 7.87402 mil 5 mil
Via
Via 10 mil 5 mil 19.68504 mil
Same Signals
Smd
Pad
Via
Smd 5 mil 5 mil 5 mil
Minimum Clearance between objects in signal layers.
The Same Signals check between Smd and Via does not apply to Micro Vias.
The Same Signals check does not apply if an Smd and Smd/Pad are in the same footprint.
Setting the values for the Same Signals checks to 0 disables the respective check.


DRC (jlcpcb-4layers *)
File
Layer Stack
Clearance
Distance
Sizes
Annular Ring
Shapes
Supply
Masks
Misc
Copper/Board Outline 7.87402 mil
Drill/Hole 6 mil
Minimum Distance between objects in signal layers (pads, smds and any copper connected to them) and the board outline, and between drill holes.
Setting the value for the Copper/Board Outline check to 0 disables that check.


DRC (jlcpcb-4layers *)
File
Layer Stack
Clearance
Distance
Sizes
Annular Ring
Shapes
Supply
Masks
Misc
Minimum Width
3.5 mil
Minimum Drill
7.87402 mil
Min. Micro Via
7.87402 mil
Min. Blind Via Ratio
0.5
Minimum Sizes of objects in signal layers and of drill holes.
Minimum Width and **Minimum Drill** may be overwritten by larger values in the *Net classes* for specific signals.
Min. Micro Via applies to *blind* vias that are exactly one layer deep. Typical values are in the range 50..100 micron. The value has to be smaller than **Minimum Drill**; otherwise (e.g. with the default value of 9.99mm) there are no micro vias defined.
Min. Blind Via Ratio defines the minimum drill diameter *d* a blind via must have if it goes through a layer of thickness *t*. Board manufacturers usually give this "aspect ratio" in the form `1:0.5`, where `0.5` would be the value that has to be entered here.

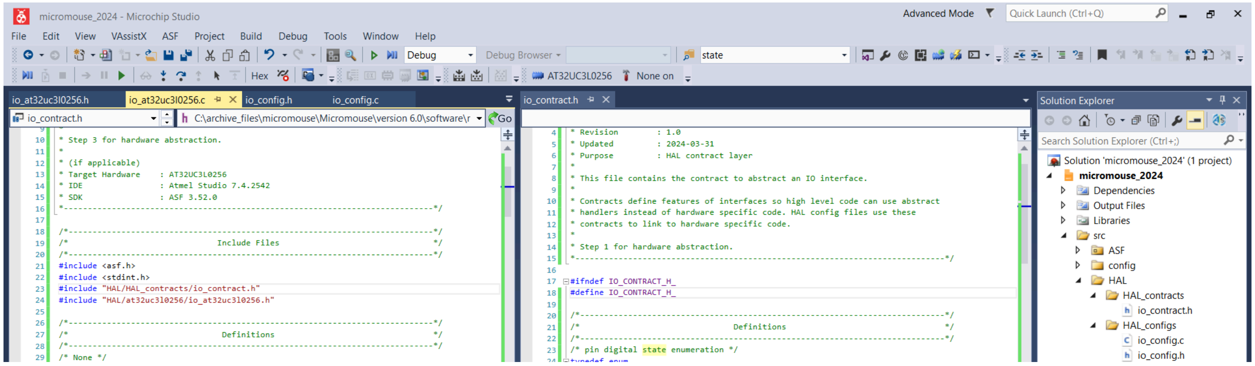

DRC (jlcpcb-4layers *)
File
Layer Stack
Clearance
Distance
Sizes
Annular Ring
Shapes
Supply
Masks
Misc
Min
%
Max
Diameter
Pads
Top
10 mil
40
80 mil
Inner
10 mil
0
20 mil
Bottom
10 mil
40
80 mil
Vias
Outer
5.11811 mil
0
20 mil
Inner
5.11811 mil
0
20 mil
Micro Vias
Outer
3 mil
0
20 mil
Inner
4 mil
0
20 mil
Annular Rings for pads and vias are defined in percent of the drill diameter (limited by **Min** and **Max**). If the diameter of an actual pad or via would result in a larger Annular Ring, that value will be used in the outer layers.
If the **Diameter** option is checked the actual pad or via diameter will be taken into account in the inner layers, too.
Micro Vias are *blind* vias that are exactly one layer deep and have a drill diameter that is smaller than the **Minimum Drill** value defined under *Sizes* (which may be overwritten by a larger **Drill** value in the *Net classes*).





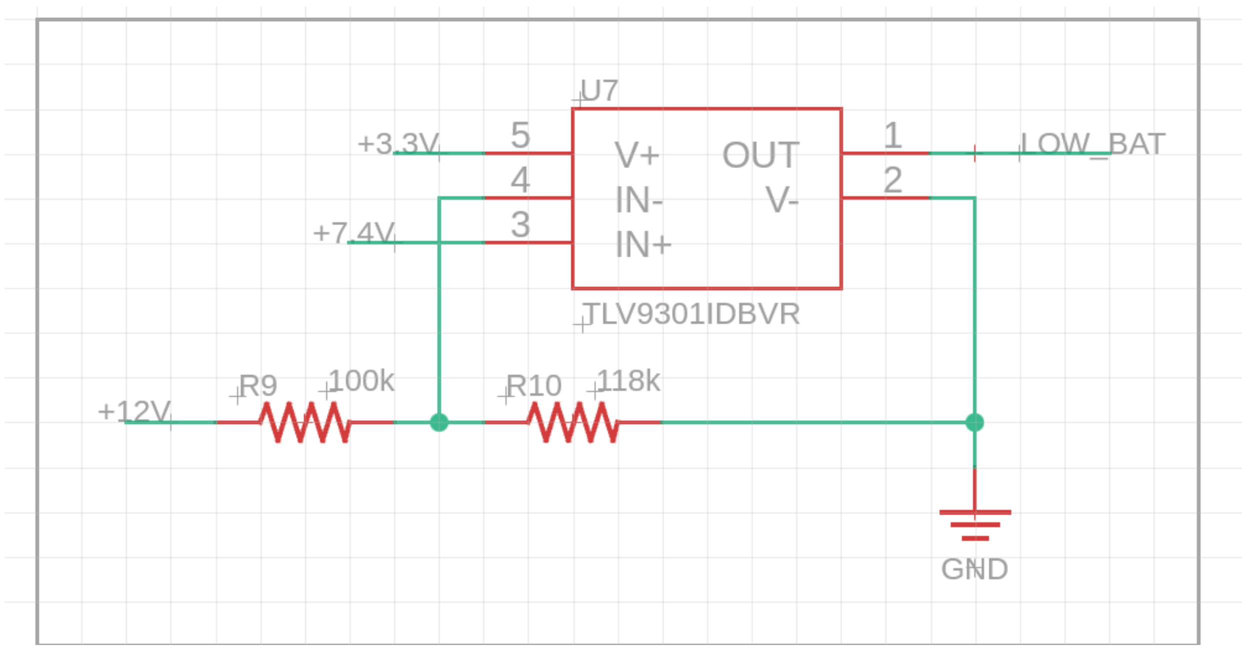
- Here are the original rules
- Alright finished taking all layout comments, gonna order PCB and missing parts

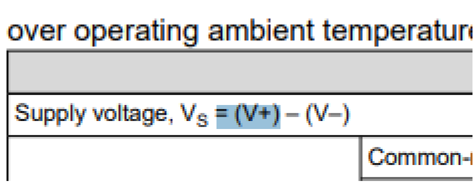
4/1/2024:



- Order of including header files matter
- If a header file you're trying to include needs other header files, then include those other header files first

4/9/2024:

- 

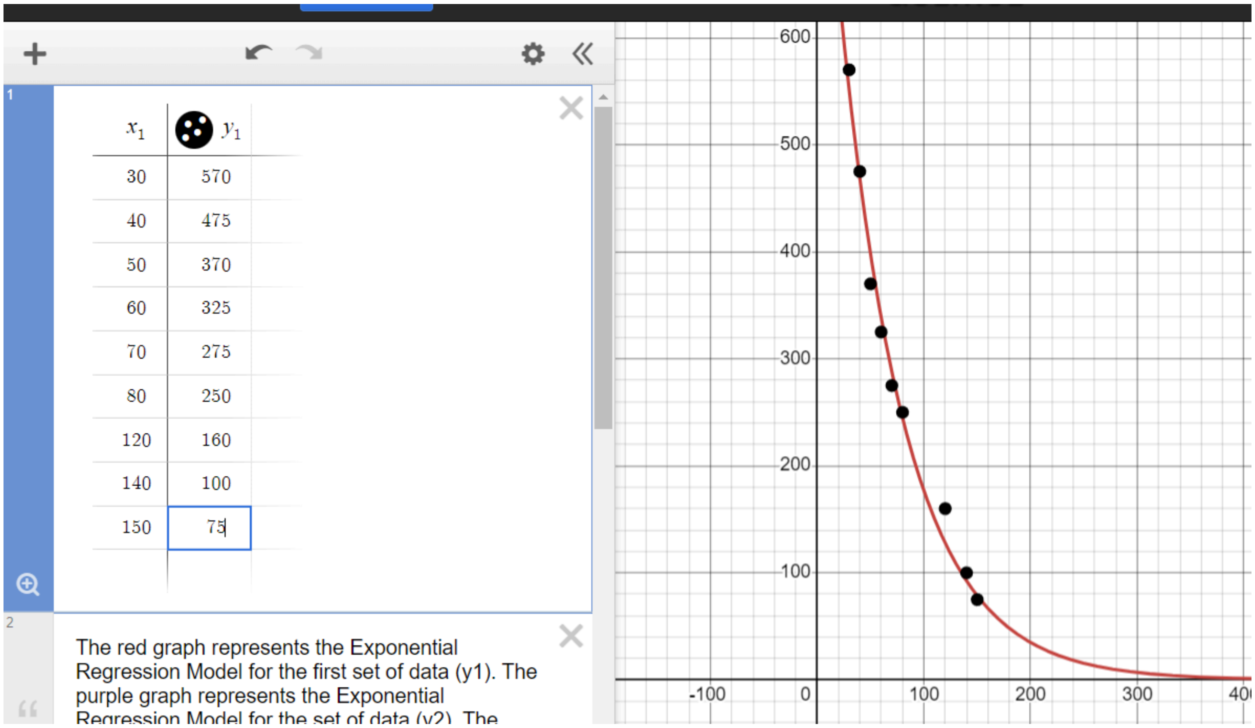
- 

- Screwed up op amp comparator circuit

- Screwed up RX/TX silkscreen probably
- Screwed up vacuum driver chip, need to look into independent gates instead

4/13/2024:

- Front IR sensor readings:
    - 3cm: 550-590 or so?
    - 4cm: 460-490 or so?
    - 5cm: 360-380 or so?
    - 6cm: 310-340 or so?
    - 7cm: 260-290 or so?
    - 8cm: 230-270 or so?
    - 12cm: 150-170 or so?
    - 14cm: 90-110 or so?
    - 15cm: 60-90 or so?



- We get a fit like this: [HERE]

- Diagonal sensors behave similarly

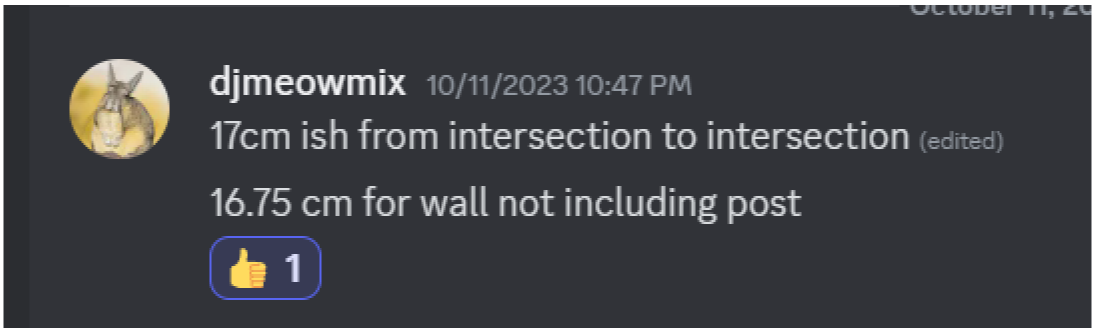
- What we need are the lowest numbers that the sensors could read given there are walls that the mouse needs to detect
- We can always comfortably read the front sensors, but we need to read the diagonal sensors before we get to the edge of the middle of the next square

- Let's use this equation to detect front and diagonal walls

- Checking for front wall can happen anytime, but let's say you can only read them after the update function has been called for the front wall presence
  - Start moving -> front check unavailable -> stop moving -> update front presence -> front check available
- Checking for left and right walls can only happen after the mouse is just about to exit its current square
  - Start moving -> left/right check unavailable -> mouse is just about to exit its square -> update left/right presence -> left/right check available

- Rotation functions
  - All wall checks unavailable upon starting movement
  - Front check available after finishing movement

        - left/right checks unavailable
- Move forward function
    - All wall checks unavailable upon stating movement
    - Front check available after finishing movement
    - left/right checks available after moving some distance



4/16/2024:
- Resetting chaotic testing
    - Print triangular spacers
        - Even w/ the wobble it might be better to deal w/ than to gradually get more friction over time
    - Get encoder count for 1 revolution
        - Recalculate encoder count for 1 square and 90 degree turns
    - Test for PD constants when there are walls on both sides first, and then move on to PD constants for single walls
        - The wobble caused by both wall PD makes mouse think there's just one wall at times

4/17/2024:
- Issues
    - Mouse isn't stopping when front wall is too close
        - Find out why loop isn't breaking in move forward pd
    - Single wall PD isn't working
        - Increase/decrease in sensor reading has to correlate to the right motor speed changes, and PD constants need to be tuned as well

4/25/2024:
- Bluetooth
    - https://www.ti.com/tool/CC2541DK-MINI#order-start-development

- https://www.ti.com/tool/PACKET-SNIFFER