Issues with old 218 PDB

designing a new power distribution board for ME218
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- requires a USB battery
- 3x100mA @3.3v is limiting
  - line sensors draw 30mA each
- not enough plugs
  - old PDB has:
    - 2x 14v plugs
    - 12x 3.3v or 5v plugs
    - a majority of teams had to splice branches
- LP2950 hard to solder
  - pins too close together
- old pdb was 2.5x2.5"
  - Question: what's a good size?
    - a bit bigger is ok.
    - is a thicker PDB a problem?

probably overestimates, teams might not want individual power wires to each line sensor

looking at schematics and trying to guess how many components use each voltage

	3.3 volt	5 volt	14 volt	3.3v+5
atom	10	3	2	13
scratpack	11	3	3	14
lawn destroyer	6	4	2	10
nuttinspecial	5	4	4	9
simpbot	6	5	2	11
nimby	8	8	4	16
sealteam6	8	6	3	14
roboscrat	9	10	2	19
wacked	9	3	3	12
24t2	10	5	3	15
babygotbaxter	4	10	2	14
dumbo	7	7	3	14
MI218	8	7	2	15
CAT	10	6	2	16
todd	17	5	3	22
botx	13	7	2	20
ckp	5	4	3	9
creature	10	1	2	11
ledecky	10	2	3	12
karUR	7	4	3	11
blipperblop	10	6	2	16

usb batteries are mostly dead
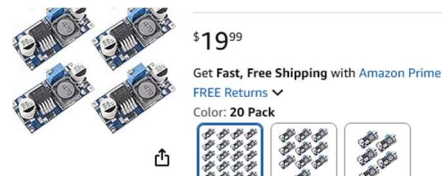we will get new usb batteries
to-220 dissipate 2-3 watts – so get hot if you pull 5-3 at enough current

Voltage Regulator Research

- DC-DC switching regulator (battery voltage down to 5 volts)

- AKA "HW-411"
- On AliExpress and Amazon they are less than a dollar each
- seems cheaper than its parts, a great deal for a buck converter module
- I used one of these to power servos last year
- 2 amps

- one issue is that the output voltage is adjustable with a knob, so students would need to set the knob to 5 volts while building the board

$19.99

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Voltage Regulator Research

- Linear regulator (5 volts down to a clean 3.3v)
  - previously LP2950
- **LD1117V33**
  - max of 800mA
  - available as through-hole TO-220 package
  - $0.35 (very similar price to the LP2950 regulators the old pdb used)
  - fixed 3.3v output
  - needs 100nF on input 10uF on output
  - says it has a current limit, but doesn't say it has short circuit protection
- **MCP1702**
  - max of 250mA
  - available as through-hole TO-92 (small) package
  - $0.5
  - if short circuited, turns off for "a short period" then restarts
- Question:
  - **what do we want the 3.3v regulators to do when they are short circuited?**
  - this is actually the most important slide, I should have researched this for longer

3
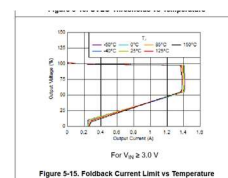
how much power can they dissipate?

most series of chips have 3.3v and 5c

lm1086 – too high dropout voltage

MCP1825s-3302e/ab

MCP1826s-3302e/ab

- **LM1117-Q1 www.ti.com/lit/ds/symlink/lm1117-q1.pdf**
  - **surface mount**

Figure 5-15. Foldback Current Limit vs Temperature

- **TLV76133DCYR, TLV76150DCYR**
  - **sot-223 surface mount**
  - **https://www.ti.com/lit/ds/symlink/tlv761.pdf**

For V$_{IN}$ ≥ 3.0 V

Figure 5-15. Foldback Current Limit vs Temperature

do we like molex plugs?

- Servos be plugged into molex plugs.
  - (they won't latch but they do fit)
  - should also plug into JST XH
    - can test when we get JST XHs to test with
    - pins are shorter so maybe no
- Question: the old PDB has 3v,gnd,5v on every plug, how attached are we to that pinout?

advantages of molex plugs – they prevent reverse connection – we have them
crimping molex is not fun,
make sure we have the right plugs
breadboard compatible
4A with 22 gauge

jst a bit easier to crimp– JST XH
             cheaper
             inline housings
             3A
             16 gauge? 22 gauge? wire

strongly consider JST to replace kk254 3 pin connectors

for motors (kk396)
             consider screw terminals
             consider screw terminals that plug into board
             Karl: use screw terminals

look up heliax – RF cable, 3 inch diameter

how should the power switches work?

Question:
The old pdb had the motors on one switch and everything else on the other switch. Now, we have more options, but what options do we want the PDB to have?

Why do switches have such low current limits?

through hole mountable ones have low limits generally

let's find switches that are rated correctly
            even if it's off-board
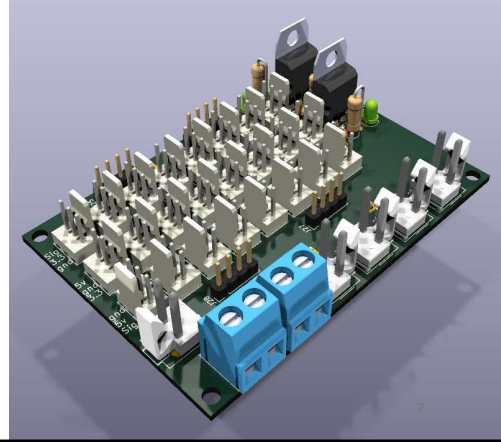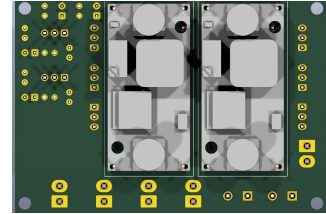
research switches
            "up-fitter switch"

PCB "design-A" (naming things is hard)

I haven't drawn traces in KiCAD yet, this is just a mockup
See readme for a list of questions I have about this design and a to do list
3d model https://github.com/joshua-8/218-pdb/blob/design-A/218-pdb.stl

- 3.15 x **2.18** inches (10% larger area, ~2x taller)
- buck converters on back
- 24 plugs + 4 14v plugs
- each row is different, see schematic
- connects signals (can stop cutting servo plugs off?)

old 3 pin can't accidentally put the wrong voltage into something

3 pin connectors for everything take more board space

don't put anything on the back, make larger if needed

put voltage monitors on some of the voltage supplies?
                    look for multi-voltage monitors
                    look for through hole monitors
                    some have current monitors
maybe pins for adding voltage monitors

add extra capacitors to servo power bus

ground trace around servo plugs to contain the noise?

maybe servos are molex and everything else is old 3-style pintout but JST XH
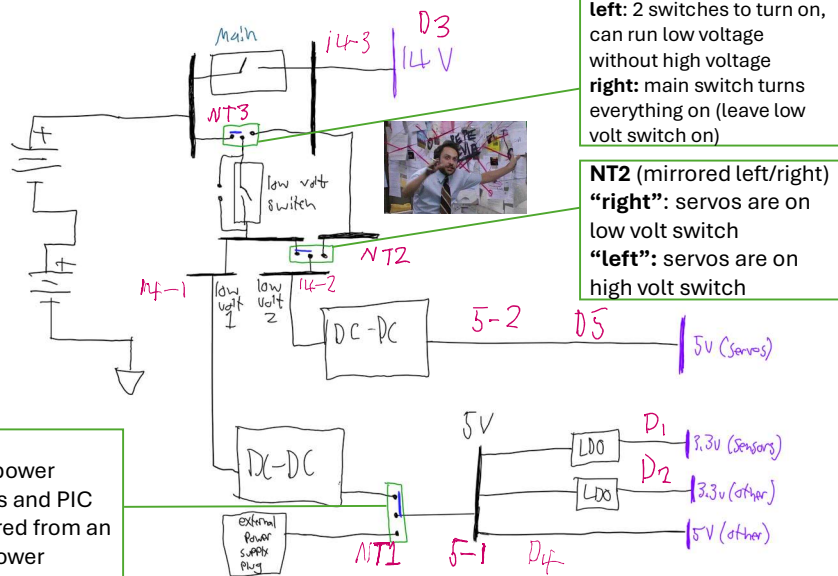
design A

"Ask me how to make your robot more complicated."
– Joshua Phelps

I'm trying to design the PDB to almost force separation between servos and sensors.

green boxes: jumpers to select what paths the power follows

better diagram on slide 7

NT3
left: 2 switches to turn on, can run low voltage without high voltage
right: main switch turns everything on (leave low volt switch on)

NT2 (mirrored left/right)
"right": servos are on low volt switch
"left": servos are on high volt switch

NT1
left: battery power
right: sensors and PIC can be powered from an external 5v power supply for benchtop testing

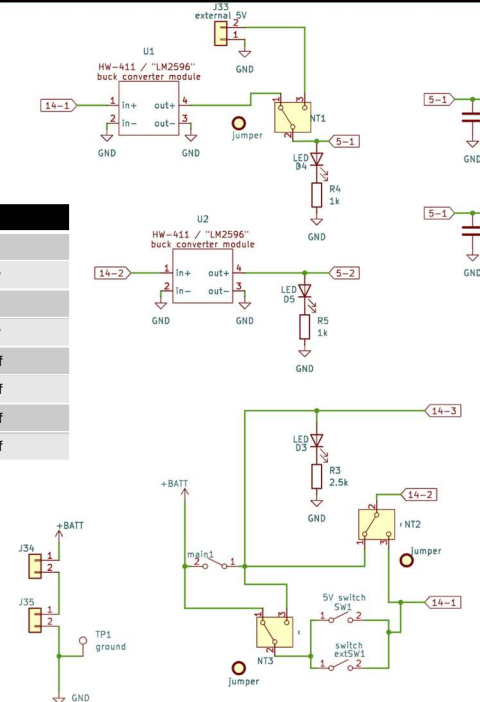| NT1	NT2	NT3	motors	servos	PIC and sensors
LEFT	LEFT	LEFT	main sw	main sw	5V sw
LEFT	LEFT	RIGHT	main sw	main sw	main sw and 5V sw
LEFT	RIGHT	LEFT	main sw	5V sw	5v sw
LEFT	RIGHT	RIGHT	main sw	main sw AND 5V sw	main sw and 5V sw
RIGHT	LEFT	LEFT	main sw	main sw	external power / off
RIGHT	LEFT	RIGHT	main sw	main sw	external power / off
RIGHT	RIGHT	LEFT	main sw	5v sw	external power / off
RIGHT	RIGHT	RIGHT	main sw	main sw AND 5V sw	external power / off

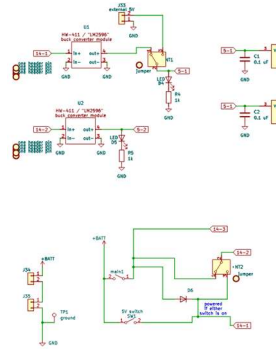NT1 is needed to turn off 3.3v regulators when setting HW411 voltage

Question: do we need all these options or are we ok with removing one (maybe NT2? changing which switch controls servos might be unnecessary)
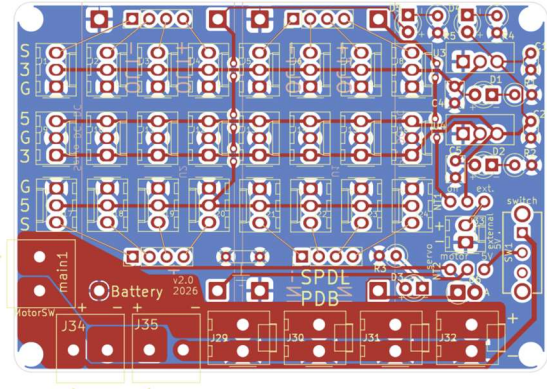
design B (small variation on design A, has different options for the switches and routes that power can take, requires a diode)
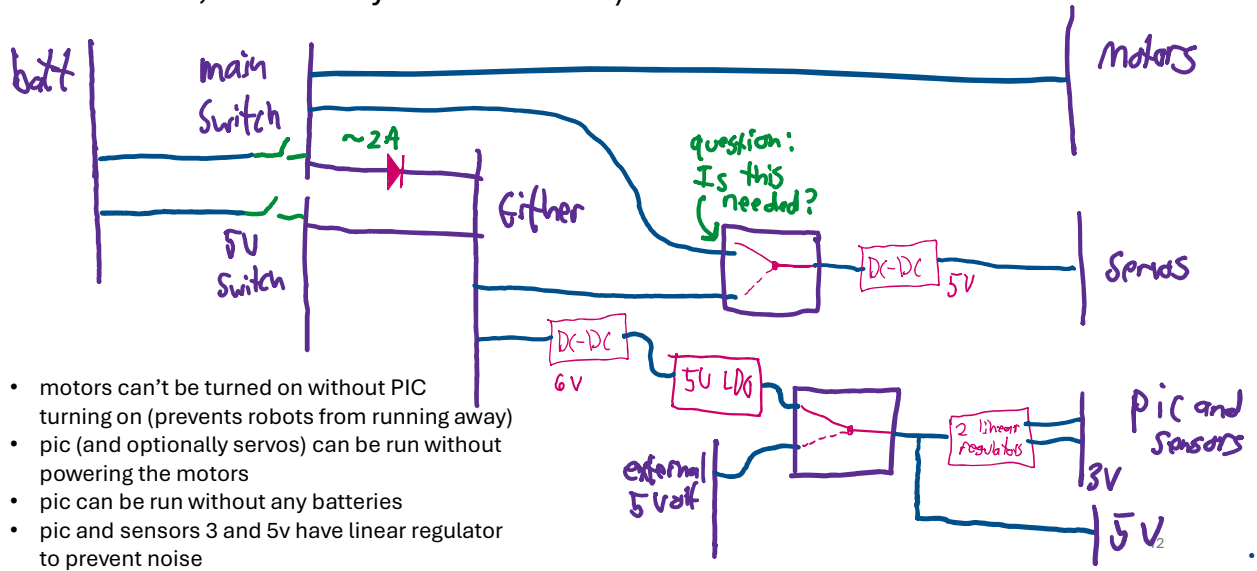
batt | main Switch | ~2A | motors

5v Switch | either | question: Is this needed? | DC-DC | Servos

DC-DC | external 5 volt | 2 linear regulators | 3V | PIC and sensors | 5V

- motors can't be turned on without PIC turning on (prevents robots from running away)
- pic (and optionally servos) can be run without powering the motors
- pic can be run without any batteries

10

B

NT1	NT2	motors	servos	PIC and sensors
LEFT	LEFT	main sw	main sw	main sw OR 5V sw
LEFT	RIGHT	main sw	main sw OR 5V sw	main sw OR 5V sw
RIGHT	LEFT	main sw	main sw	external 5V / off
RIGHT	RIGHT	main sw	main sw OR 5V sw	external 5V / off

design D/E (small variation on design B, has a 5V LDO to smooth current, E is new layout with JST XH)

- motors can't be turned on without PIC turning on (prevents robots from running away)
- pic (and optionally servos) can be run without powering the motors
- pic can be run without any batteries
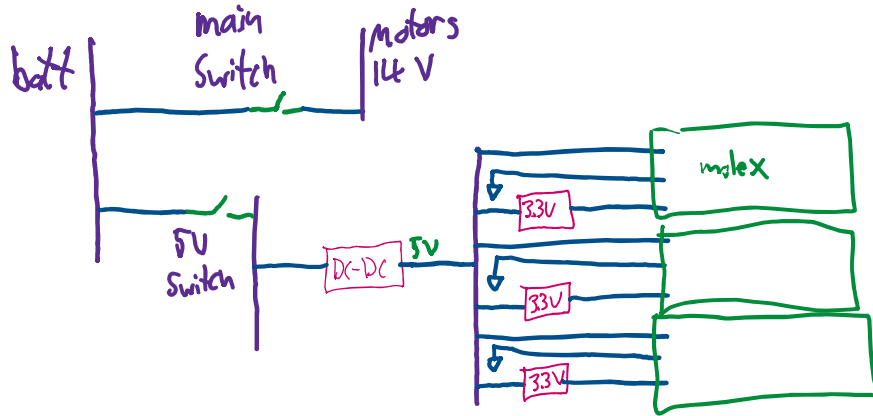- pic and sensors 3 and 5v have linear regulator to prevent noise

full robot shore power?
if we can find a barrel jack that has a switch to do the change over for us

design C

simpler, like the old PCBs, no KiCAD yet

batt

main Switch

Motors 14 V

5V Switch

DC-DC

5V

3.3V

3.3V

3.3V

molex

cost estimate

- Digikey list (everything except HW-411 regulators and PCB)
  - link (estimate, and SPDL has many of the parts in stock already)
  - $8 per board at 25 boards
- HW-411 buck regulators
  - $2 for 2 regulators (if bought $20 at a time)
- PCBs
  - JLCPCB and PCBWay estimate around $2.5 per PCB (but tariffs ☹)

- I'd estimate new PCBs can be made for $15 each

barrel jack for shore power – give you battery power

20v, 4a, $15 barrel jack supply