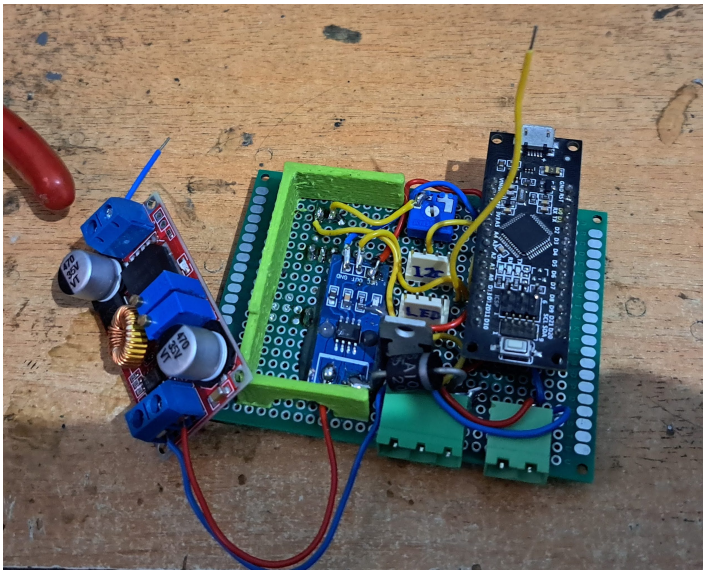
AP Tech Charger



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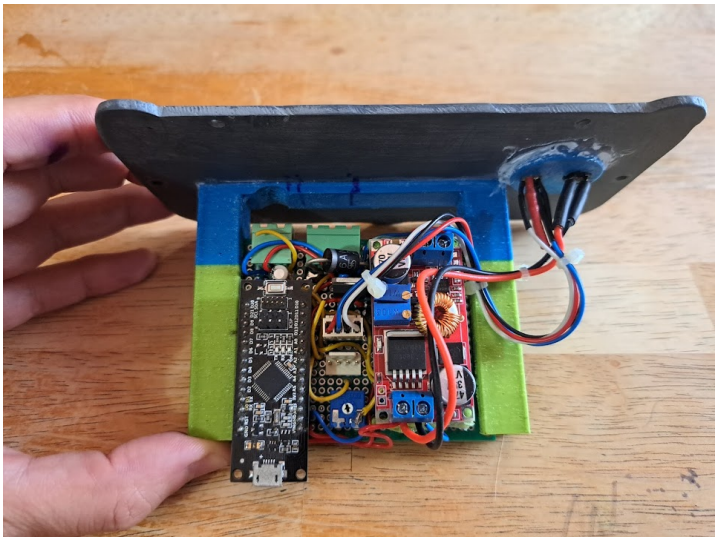

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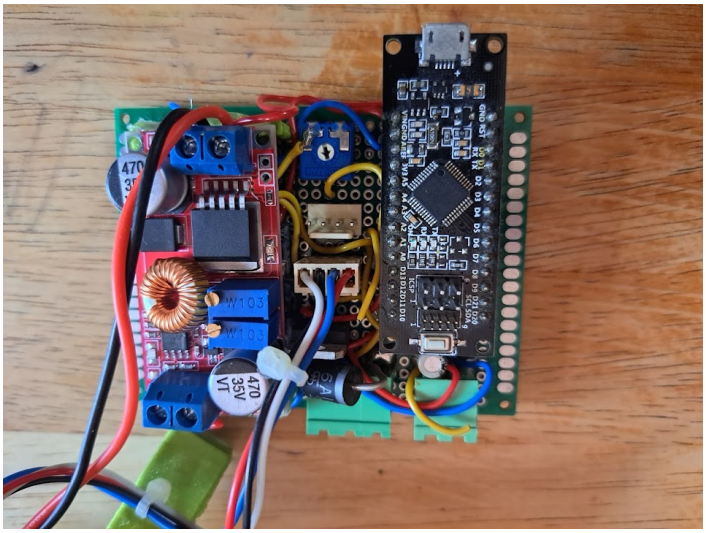

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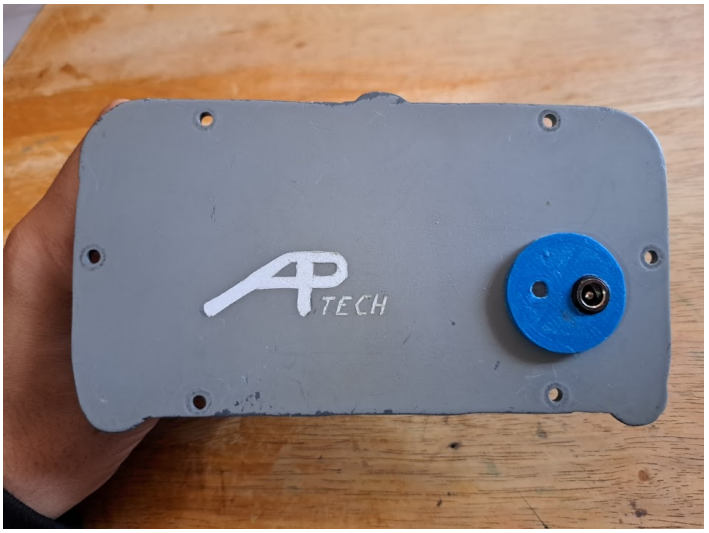

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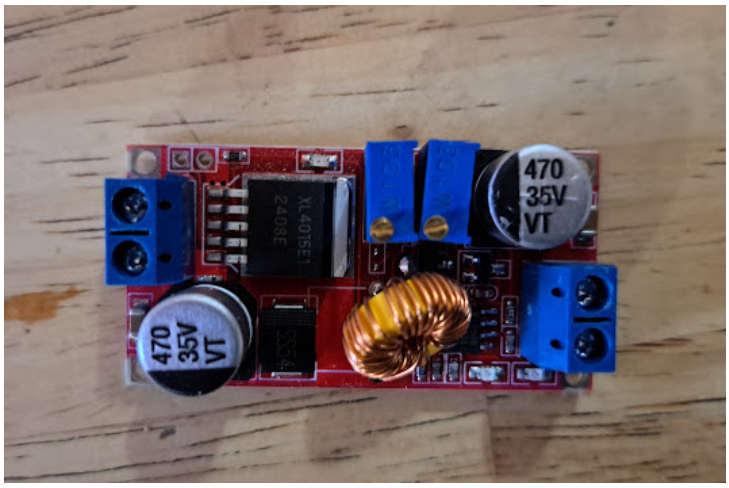
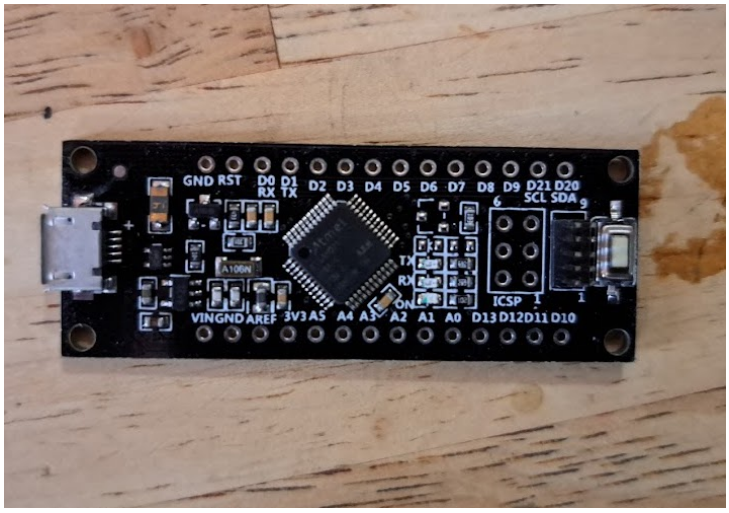
Here I show how I made a battery management system that can charge my 3 cell battery packs with an of the shelf 24v 5A transformer. the whole thing is built on a 60x80mm prototyping board and the brains of the operation is a SAMD21 based microcontroller board. The heart of the board is the red voltage and current regulating board. this is what drops the voltage coming from the 24v transformer to a voltage the battery pack can take. it is suspended over the board with a green 3D printed part (pic 1) so that I could fit more boards and components underneath. stuff like a current sensor and an optocoupler (which can't be seen since I attached it from the other side) The 3D printed part was attached to the board using super glue and after the red board was attached the to it using hot glue. The idea being that if I need to remove it for some reason the hot glue would be easer to remove. The SAMD21 chip reads the analog battery voltage through the optocoupler and a voltage divider when the device is in use. And reads the current through the current sensor when it is being charged. It displays the status of the battery through an RGB LED on the blue round panel in pic 4. This panel also has the charging jack. In the future I would like to communicate the battery state to the robot's RP2040 chip via I2C from the board. That is why there is an unoccupied 4 pin molex connector in the middle of the board. This is not the final iteration of the board. Eventually I will make a cleaner one with a custom printed circuit board from a service like PCBWay or JLCPCB.

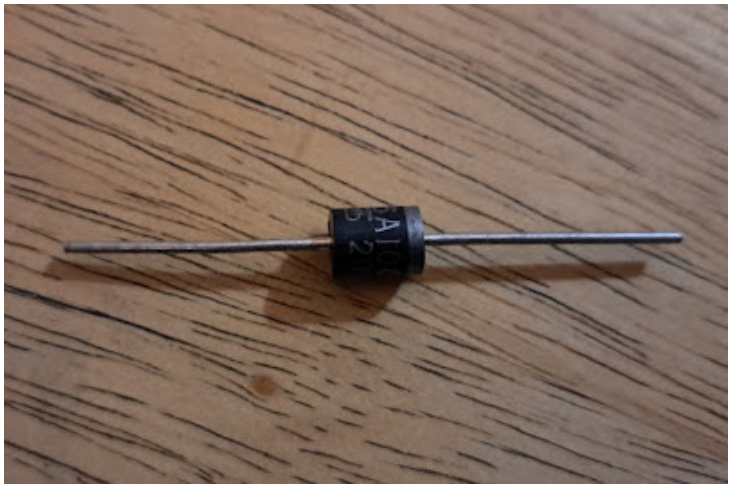


XL4015 DC to DC Buck Converter. There are different breakout boards for these but I chose these red ones on the count of their smaller size. basically these are voltage and current adjustable power supplies. that is why the two potentiometers. One is for voltage and the other is for current. it is important that they are this type, Voltage and current adjustable. I tried the norma ones where you could only adjust the voltage and they got very hot. Not good. The settings for this project should be 1.5 for the amps and 13 for the voltes.

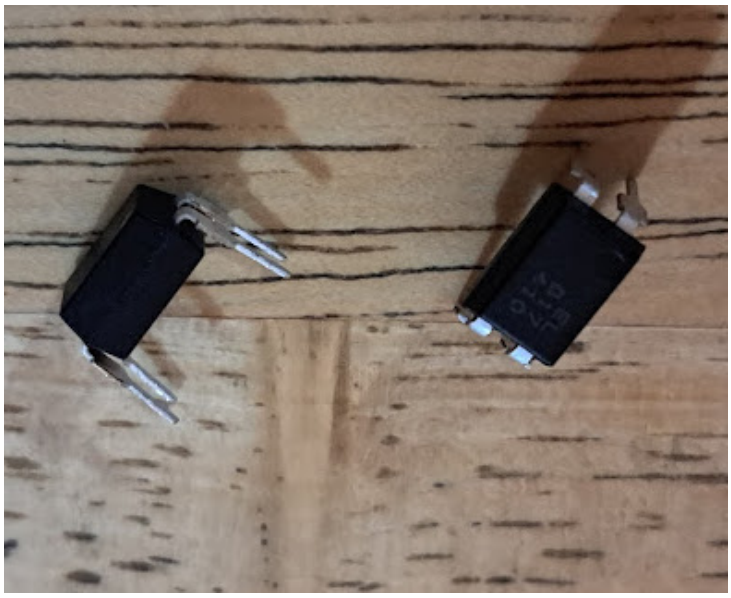


SAMD21 Breakout board. I use a WeMos one from AliExpress and I program it using the Arduino IDE. The board has analog the digital converters of which I'm using two. One for reading the battery voltage, And the other for reading the charge current from the current sensor. It also has an I2C bus which I will use to communicate with the main processor on my robot so that it can know stuff like battery level.

5A Current Sensor Module ACS712. It is important that it is the 5 amp type. AliExpress gives you a choice. 5A, 20A, and so on. originally I thought that this value meant that the chip can take 5 amps so I went for a bigger number 20 amps thinking that “the bigger the better” but no. What this number is is the sensitivity range meaning that if the current that you are measuring is smaller than 20 amps you will have trouble measuring it. Now it doesn’t say on the board that this is the 5A one. but the way you will know is that the number on the chip will end with 05B.
One thing to note about this device is that when the current is 0 the output will be 2.5v. It then goes up from there as you increase the current.

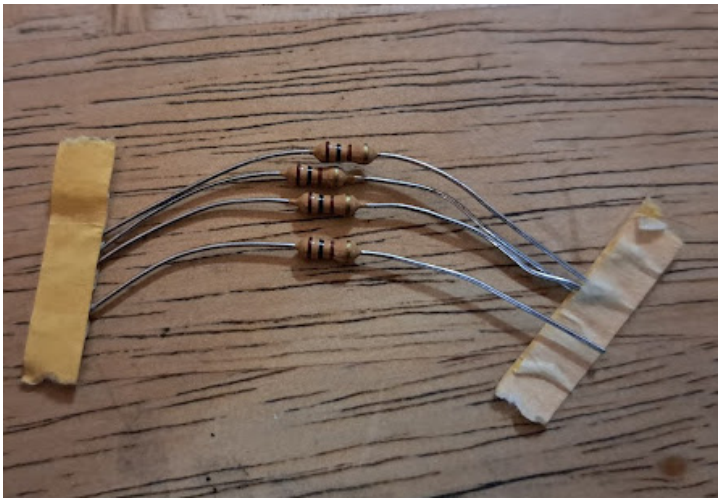


The biggest diode I could find. I don’t know the rating on it I just know that it is bigger than the normal 2.5mm wide diodes which were getting hot in this application. This diode is 7mm wide. it was still getting a bit warm but I will fix that when I create a custom PCB version of this board.

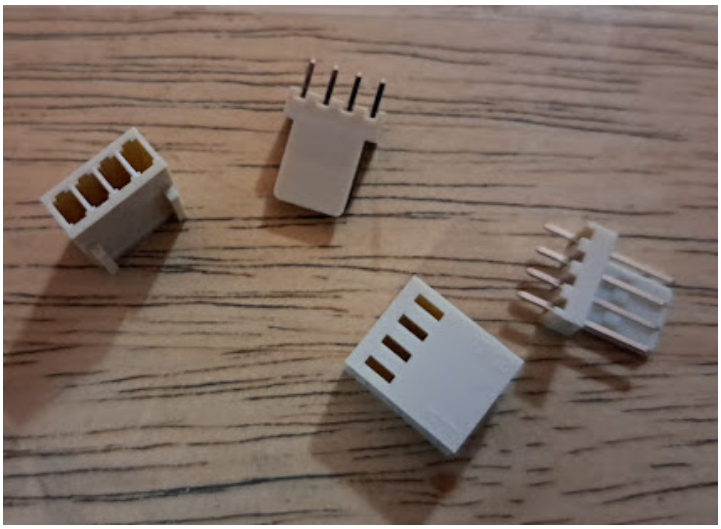


Optocoupler 817A. I got the ones you see here from a supplier close to where I live and the number is EL817. I will use this optocoupler to switch the voltage divider Off when it is not being used and On again when it is. since voltage dividers are always pulling current making them inefficient. You can also find these on AliExpress.

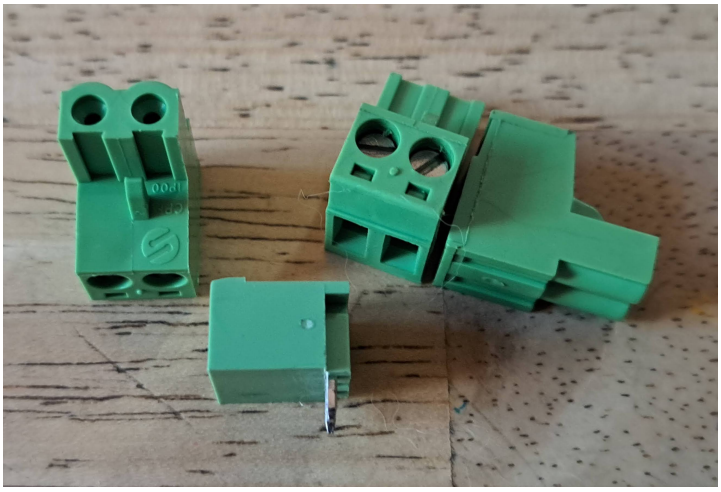
220K Potentiometer. This will be used to make a voltage divider for the battery voltage sensor.



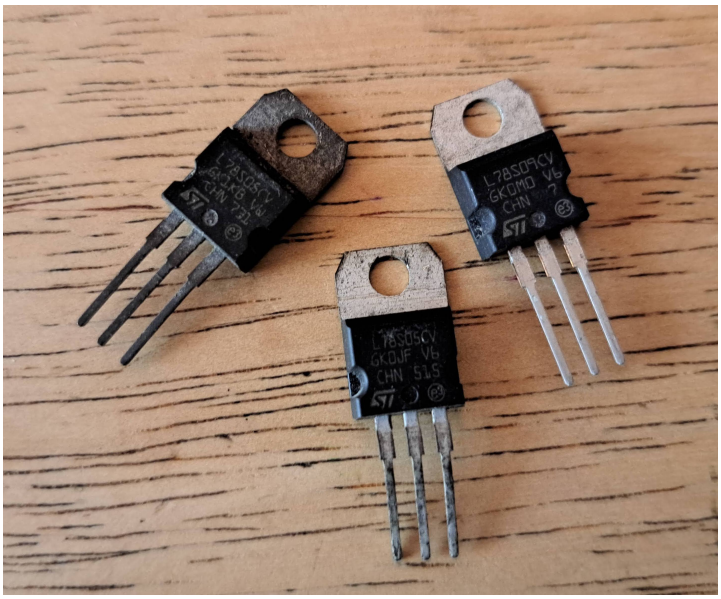
Quarter watt resistors 1K and 10K. It is always a good thing to have an assortment of Quarter watt resistors.



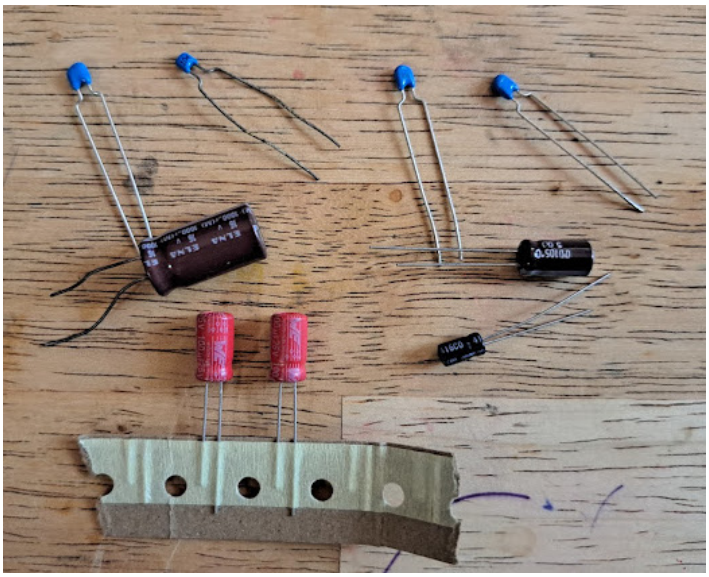
2510-AW-2.5. 4 pin type. Both the male for soldering to the PCB board and the female (plus the pins that come with them) for making the cable harnesses. In this board I'm using them for the I2C cable and the indicator LED.



KF2EDGK-5.08 Connectors. 2 pin and 3pin. these components are made of two parts. A part that solders to the PCB board. and a detachable part that you screw your wires to. I find these connectors great especially for maintenance since you can just detach your wires from the board without having them touch each other. good for safety for when working around lithium battery packs.

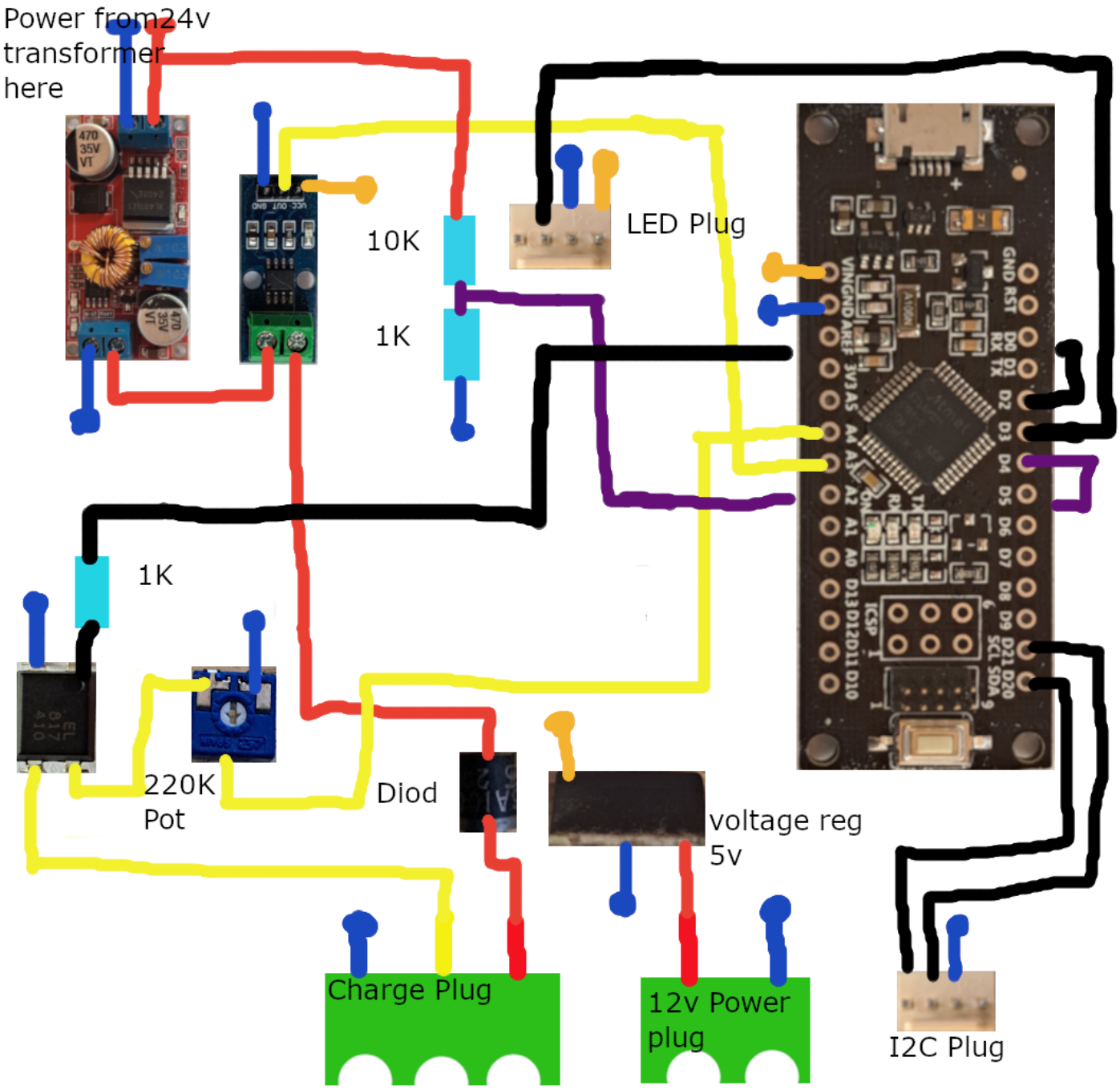


L7805 5v voltage regulator. Originally I wanted to use a DC to DC converter (more efficient) but because of board space considerations, and the fact that this is a prototype, I went with a voltage regulator. In the custom PCB version I will be using a DC to DC convertor and will be exploring giving power supplies to other boards with 5 volts from the charging board.



An assortment of capacitors. important to have. I will not go into details of what I am using in this board since I use them where ever I have to clean an analog signal or filter ripples in a power supply. And that is something that in a circuit like this you must see for yourself what cap you will need. in the custom PCB version I will have more details on capacitors.

24v transformer with barrel jack I want all of my present tech to be charged with these transformers. Even the stuff with the 6 cell battery packs when I eventually make them. Even managed to charge my 3 cell powered robots with a 19v laptop charger which is a bonus.



This is the schematic for the charge circuit. let's first see what the colour codes mean. The blue and orange lollipop like things are commons. The blue is the Ground or negative common and the orange is the 5v+ coming from the voltage regulator. Now the voltage regulator needs a capacitor on the input and on the output probably even near the components that it is supplying. The turquoise coloured rectangles are resistors with their respective values written next to them. The yellow wires are for the analog signals that will be read by the analog read of the microcontroller's inputs. One from the current sensor and the other from the voltage sensor. The purple wire is a sense wire that lets the microcontroller know when the barrel jack is in. it's connected to a voltage divider that turns the 24v of the transformer into a 3.3v logic signal for the microcontroller. The bottom white plug is for I2C but i have not used it yet. in the future I will use it to tell the robot the battery voltage and and maybe even supply 5v to all the boards on the robot. The one at the top is a status LED plug to interface with a WS2812 5mm LED. The Soul of the circuit is the XL4015 board. The power that comes out of it goes through the the current sensor and out the the big diode. The diode is there because when I tested the current with a multimeter I found that when you turn the charge off I was getting a small (in milliamperes) current going the other way and draining the battery if say the robot is inactive for weeks or months. The Optocoupler Potentiometer combo are the battery voltage sensor.

Written By: Anthony Pirotta.
For: AP tech Robots, Hand held devices, And other products.
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Revised:
Notes:
Disclaimer: AP tech and Anthony Pirotta are not responsible for any fires, explosions, damage or death occurring after someone uses these instructions. Making lithium batteries is a risky activity and one that you and only you are responsible for. Also before following these instructions it is best to have prior electrical, electronics, And soldering knowledge and experience.