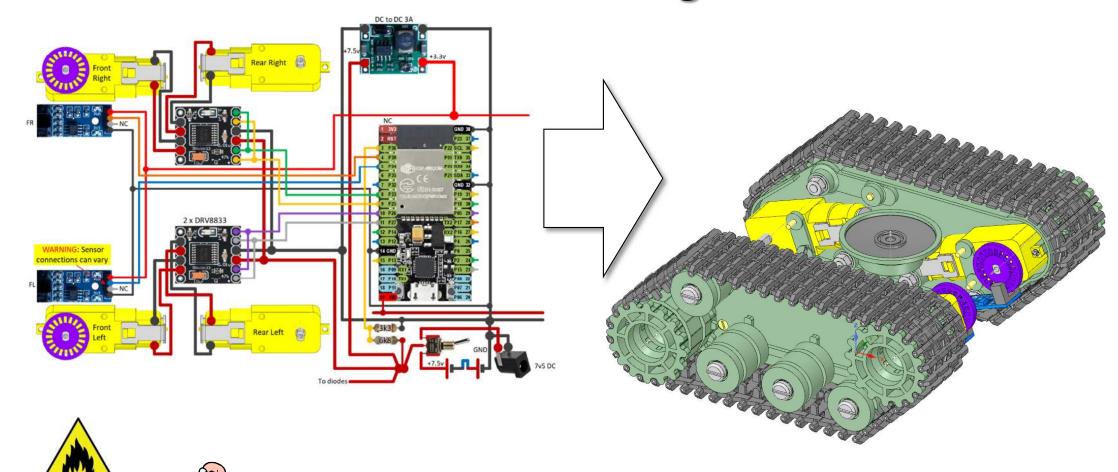
Project TankBot Mk1

Circuits & Wiring





Quite a complex project, please read through this document before starting.

Hand Tools:

Recommended:

Fine Nosed Pliers

Side Cutters

1.5 mm Drill

2.0 mm Drill

4.0 mm Drill

Needle Files

Screwdrivers

Craft Knife

Note: Not all items needed are shown here.



Tools & Materials:

Temperature controlled iron
Solder flux
Resin cored solder
Hot melt glue gun
2-part epoxy resin glue
Screw drivers
Wire wrapping tool
Wire wrapping wire 30 AWG
24 AWG stranded wire (red & black)





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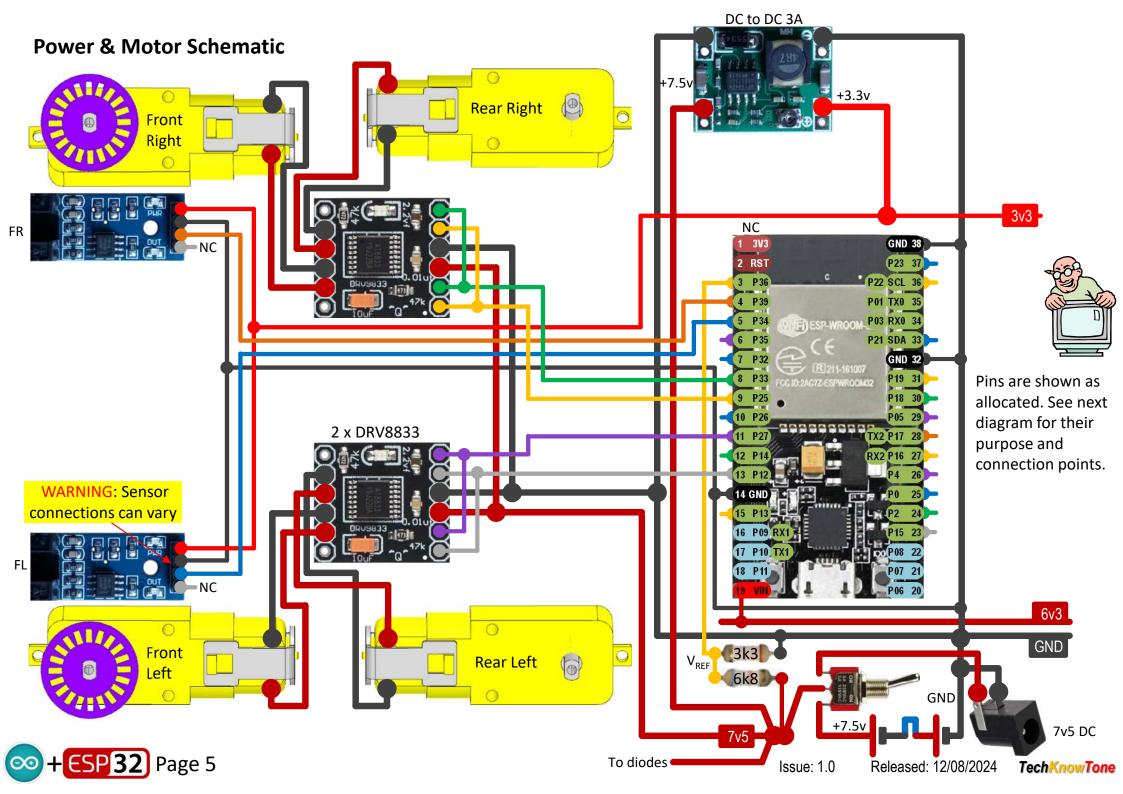
TechKnowTone

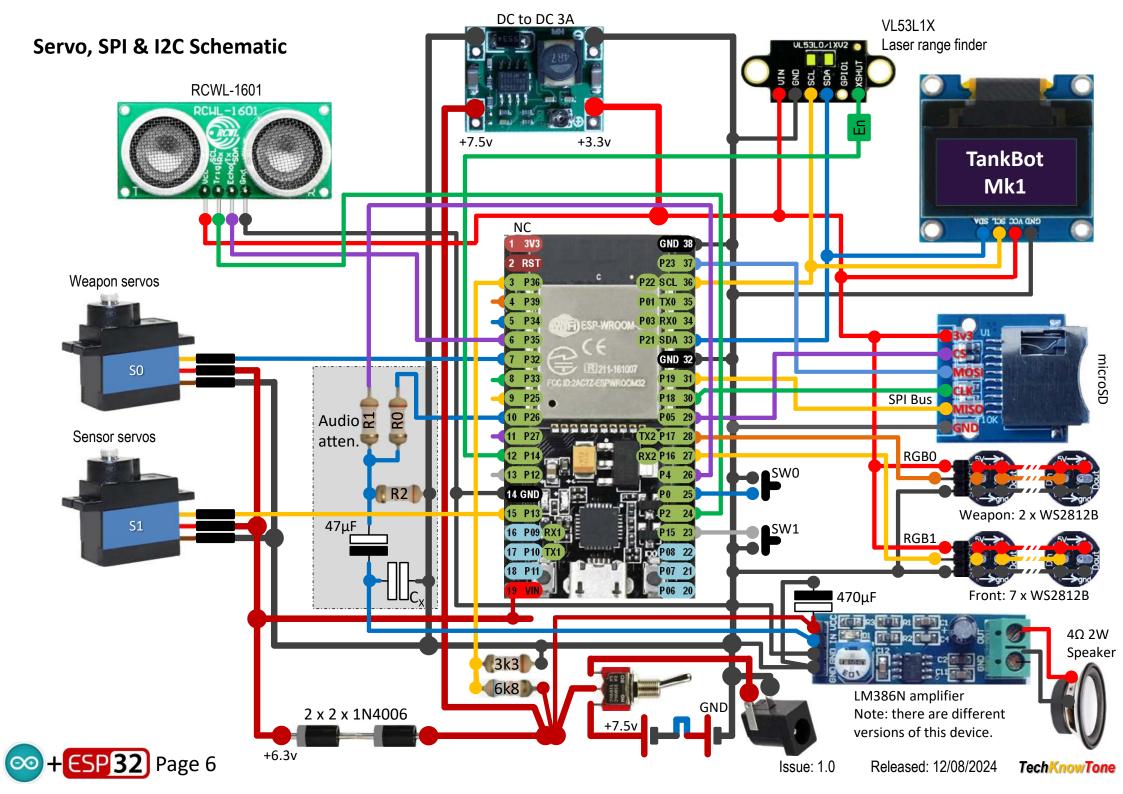
Construction - Tools:

Drills: 1.5mm, 2.0mm, 2.5mm, 3.3mm, 4.0mm M3 tap, M4 tap Screwdriver – Flat blade Screwdriver - Cross blade Side cutters M3 M5 1.5Ø 2.0Ø 2.5Ø 3.3Ø Note: 4.2Ø A 3D printer is great for making handles for small



drills and taps.





Dual H-bridge Wiring

In this design we run two H-bridge controllers in parallel in order to combined their 2A max current capability, and half their MOS-FETs on-channel resistance.

This is achieved by creating a sandwich using two controllers pcb's with 6 pin strips between them. The pins are soldered into each pcb, and the protruding longer pins are used as the connection points.

These sandwich modules are mounted in the design such that cooling airflow can circulate over the DRV8833 driver ICs.

The nSLEEP and nFAULT pins are not connected; however, the nSLEEP pin is pulled HIGH by an on-board $47k\Omega$ resistor when you bridge J2 with a blob of solder.

OUT1 O

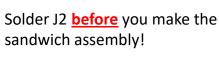
OUT2

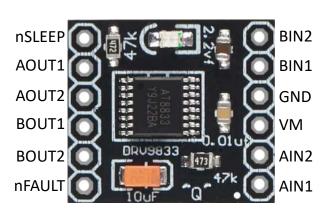
OUT3

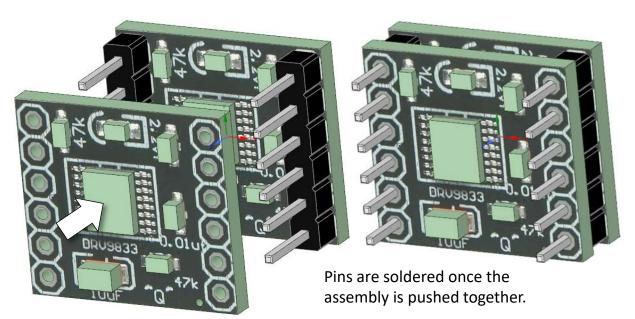
OUT4

ULT





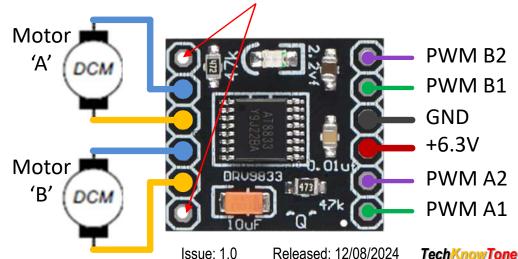




Applying a small amount of flux to the pins before soldering can improve solderability.



Crop unused SLEEP and FAULT pins after soldering.



Solder J2

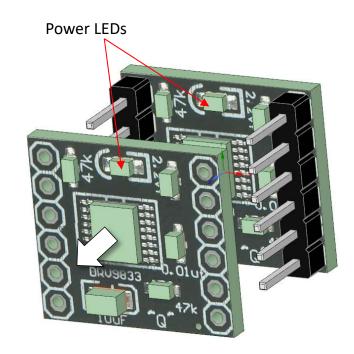
Dual H-bridge Quality Check

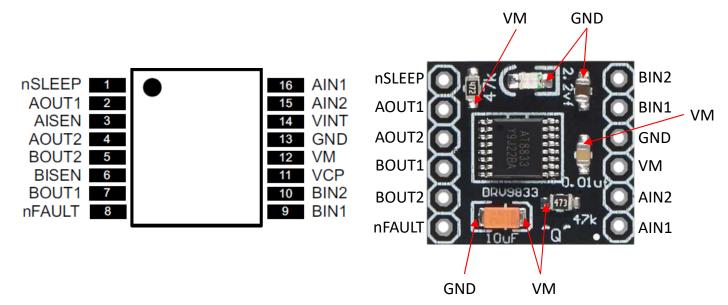
Soldering the pins to the board can be tricky, with some connections not being made. So it is best to perform a continuity check after soldering the rear board, <u>before</u> soldering the top board.

Separate the two halves of the assembly and probe between pins and points on the board, to ensure that all pins are connected to the board.

Once the top board is re-fitted and soldered, repeat these continuity tests for that board too.

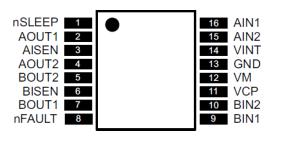
You can also briefly apply 5v power to the VM and GND pins, from an external source, to ensure that both power LEDs light up.

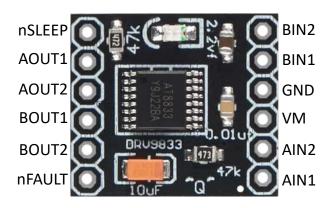




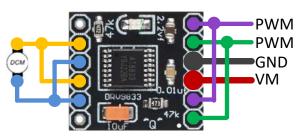


DRV8833 H-bridge Driver





Combined H-bridge.



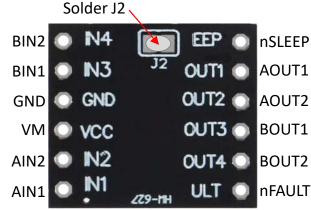
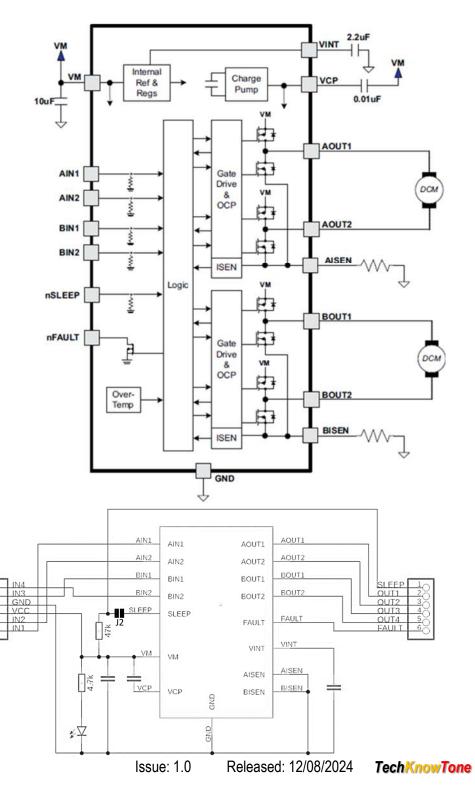


Table 1. H-Bridge Logic

xIN1	xIN2	xOUT1	xOUT2	FUNCTION
0	0	Z	Z	Coast/fast decay
0	1	L	Н	Reverse
1	0	Н	L	Forward
1	1	L	L	Brake/slow decay

Table 2. PWM Control of Motor Speed

xIN1	xIN2	FUNCTION
PWM	0	Forward PWM, fast decay
1	PWM	Forward PWM, slow decay
0	PWM	Reverse PWM, fast decay
PWM	1	Reverse PWM, slow decay

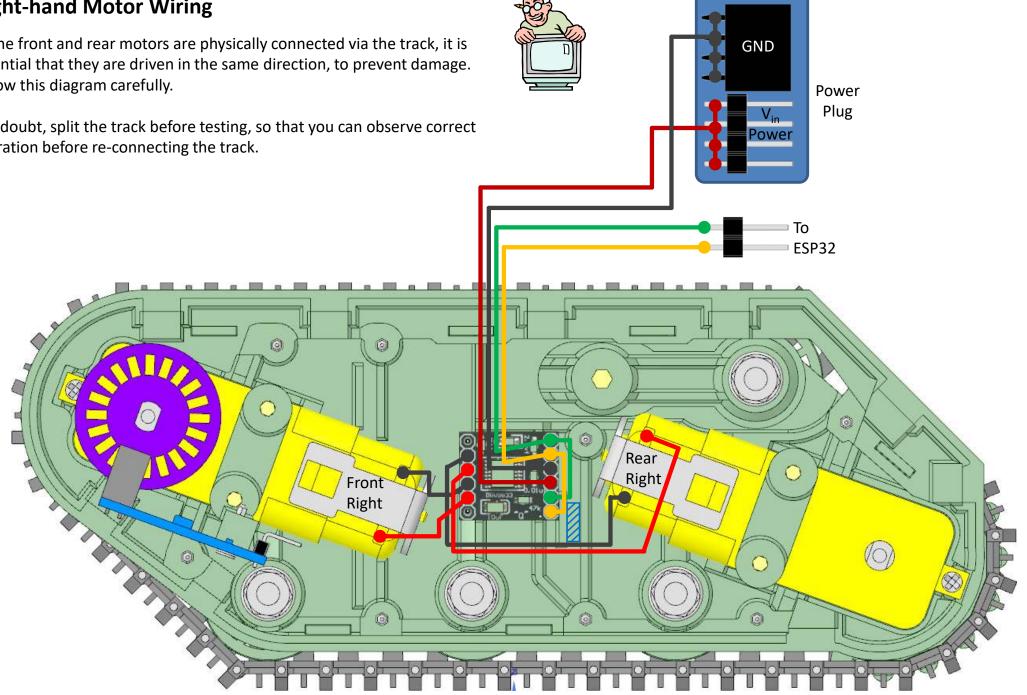




Right-hand Motor Wiring

As the front and rear motors are physically connected via the track, it is essential that they are driven in the same direction, to prevent damage. Follow this diagram carefully.

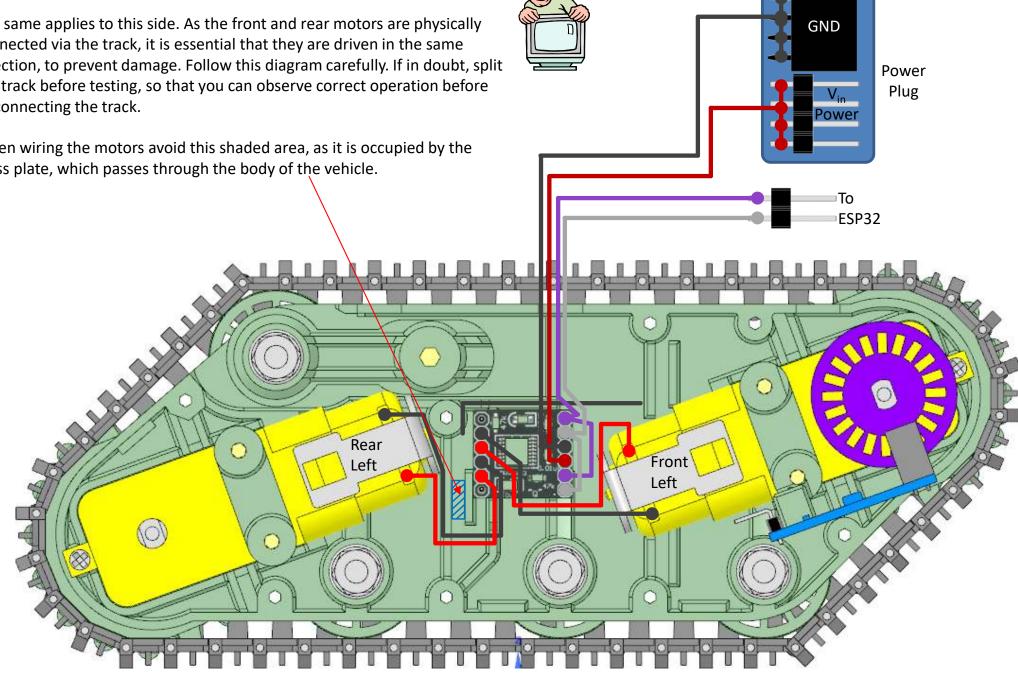
If in doubt, split the track before testing, so that you can observe correct operation before re-connecting the track.



Left-hand Motor Wiring

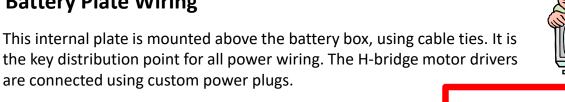
The same applies to this side. As the front and rear motors are physically connected via the track, it is essential that they are driven in the same direction, to prevent damage. Follow this diagram carefully. If in doubt, split the track before testing, so that you can observe correct operation before re-connecting the track.

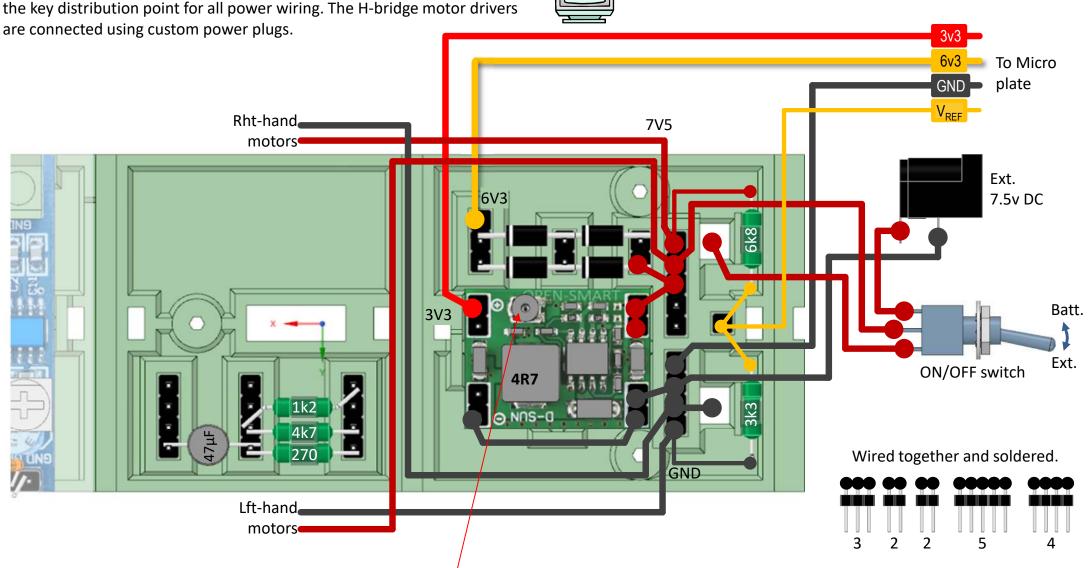
When wiring the motors avoid this shaded area, as it is occupied by the cross plate, which passes through the body of the vehicle.



Battery Plate Wiring

the key distribution point for all power wiring. The H-bridge motor drivers





Set voltage regulator output to 3.3v before connecting its output to the rest of the system.

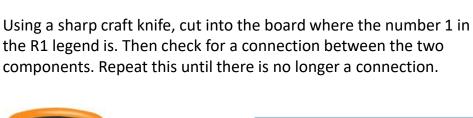
Pin strip connection points are pre-wired as connected pins, before gluing into the battery plate.



LM386 Amplifier Board

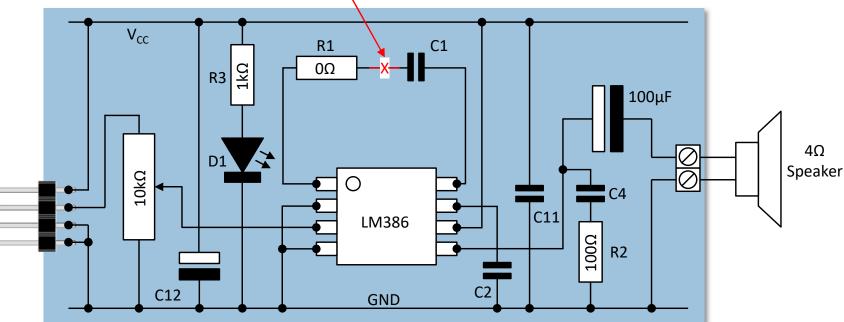
The LM386 audio amplifier is configured as having a Gain = 200. Which is much too high for our application!!!.

Fortunately we can cut a track on the pcb, which will reduce the gain to 20, and the layout of the pcb makes this relatively simple to do. The capacitor C1 has been inserted to increase the gain, and it is connected in series with a 0 ohm resistor R1, to keep the pcb single sided.



+Audio Signal in





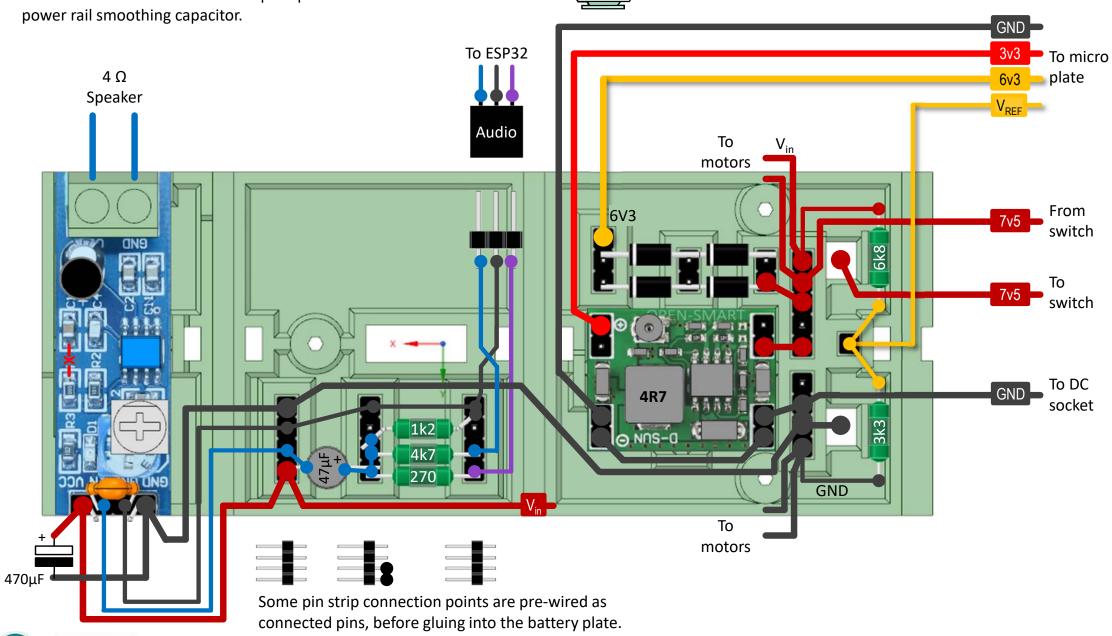
LM386 Amplifier Chip

Volume Control Preset



Battery Plate Audio Wiring

The audio amplifier is mounted on the end of the Battery plate, using a cable tie. Which also retains a $470\mu F$ capacitor beneath it. This acts as a power rail smoothing capacitor.



Released: 12/08/2024

Audio Attenuator Wiring

The audio output signal can be developed in code by either PWM signals, or from the DAC2. A simple attenuation function is provided by a pin connected to R1. If this pin is configured as an input, it will have no affect; but if it is set to an output and driven LOW it will significantly reduce the output fed to the amplifier.



In all cases the audio waveform will have fast edges and high frequency noise, which needs to be removed before feeding it into the LM386N audio amplifier. So we need to filter that HF noise using a simple low pass RC network. The audio signals also have a DC offset on them, centred around the mid-rail voltage, which needs to be removed via a in-line series capacitor, as the amplifier input expects signals to be centred on GND.

As the attenuation method used effectively changes the impedance of the circuit we will select a capacitor to suit the high output condition, when R1 is effectively out of the circuit, and the pin is an input.

The 3dB cut-off frequency of the RC network occurs when the impedance Xc == R, where the value of R is R0 in parallel with R2. This value is 956 ohms.

We calculate impedance of a capacitor as: $Xc = 1/(2 \times \pi \times F \times C)$

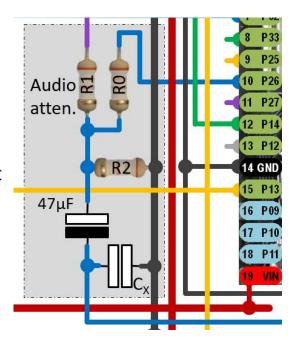
 $C = 1/(2 \times \pi \times F \times Xc)$ Re-arranging this gives:

Using a cut-off frequency of 4 kHz, calculating capacitance gives us:

 $C = 1 / (2 \times \pi \times F \times Xc) = 1 / (2 \times 3.142 \times 4E3 \times 956)$ = 41.6 E-9

We will therefore use Cx = 47 nF, as the HF audio attenuation option, and this will be attached at the terminals of the amplifier.

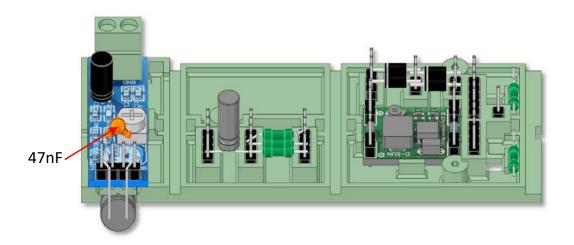




 $R0 = 4k7\Omega$

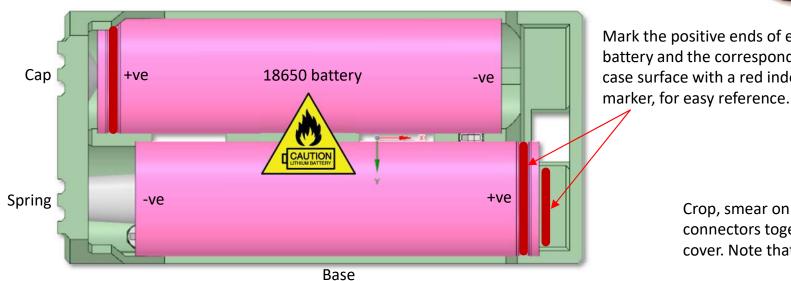
R1 = 2700

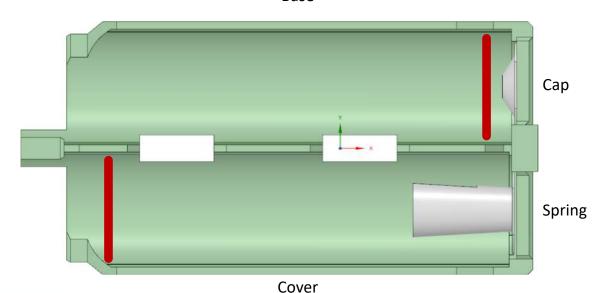
 $R2 = 1k2\Omega$



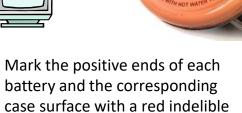
Battery Box Wiring

The cap and spring clips are glued into the base of the battery box, so that their leads protrude through the base into the battery plate. Where as the cap and spring clips in the cover are first soldered together, before being glued into the cover as one piece.

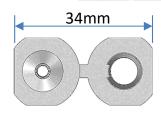




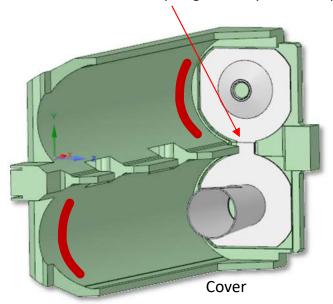








Crop, smear on flux, and solder the two connectors together **before** gluing them into the cover. Note that the spring is on top of the cap.



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Battery Box Wiring

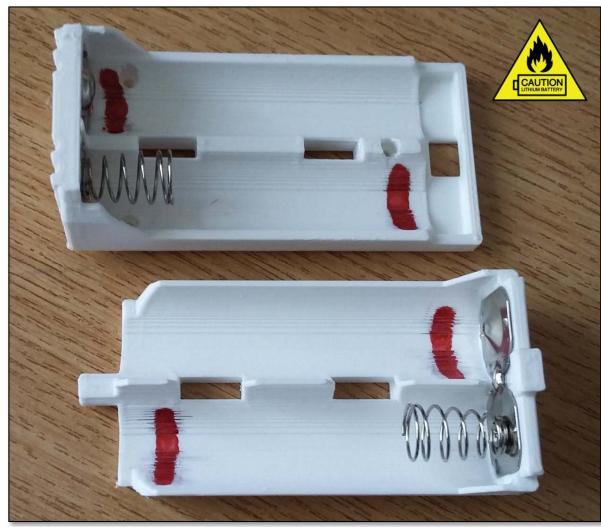
Crop and solder the spring and end cap together, ensuring that the space between them matches that of the battery holder.

The use of soldering flux will help to reduce oxidation and make the soldered joints easier. Tin both parts separately, then place one over the other and apply heat to melt them together.





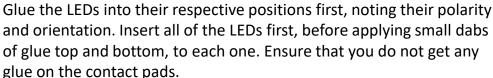
Note the markings in red, using a felt tipped pen, to ensure that you always insert the batteries the correct way round. There is no current protection in this system, so always take extreme care.

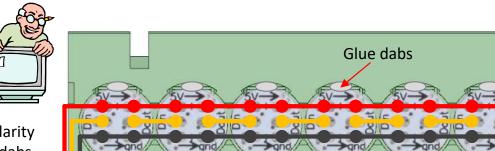


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Nose Plate LED Wiring

The RGB LED strip mounted in the Nose Plate is made up of individual WS2812B LEDs, glued into the mounting plate.

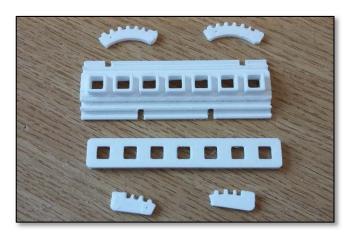


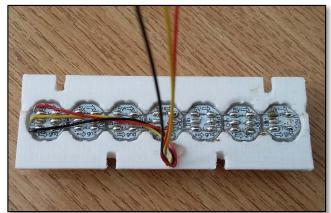


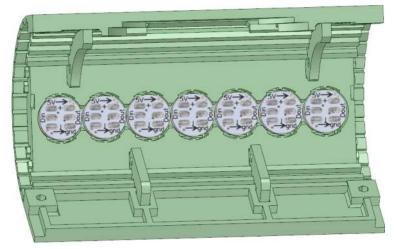
e yellow data wire is effectively broken at re this is to strip the end of the red wire first, and solder onto the chips starting at

Use wire wrap wire to make the solder connections. Note that the yellow data wire is effectively broken at each chip, to form an input and an output. The easiest way to wire this is to strip the end of the red wire first, to run the full length of the strip. Lightly smear the chip pads with flux and solder onto the chips starting at the insulated end. The data wire is attached in a similar manner, but the stripped section is longer, and after each input pad is soldered the wire is raised up, then down again to form a small loop, prior to soldering it onto the next output pad. Once all data pads have been soldered, you can then cut out the looped wire in the centre of each chip, effectively breaking the in/out connections. The black GND wire is attached in the same way as the red wire. Red and black wire length >= 27cm, yellow wire length >= 32cm, allowing for loops in the data wire.

Once soldered, you can test the strip by temporarily wire wrapping it to your ESP32 micro, and running the code in TEST = true mode. Then fold down the loose wires and group them together, either by twisting or using heat shrink sleeving. Wire the free ends to a 3 pin strip as shown. This will later connect to a plug from the Micro Plate wiring.







To micro plate

Display & Micro Power Wiring

Pre-wire and solder the pin strips as shown, then glue them into the plate, along with the socket strips for the ESP32, and the button switches. Attach the OLED display using the small strap and 2x10mm screws.

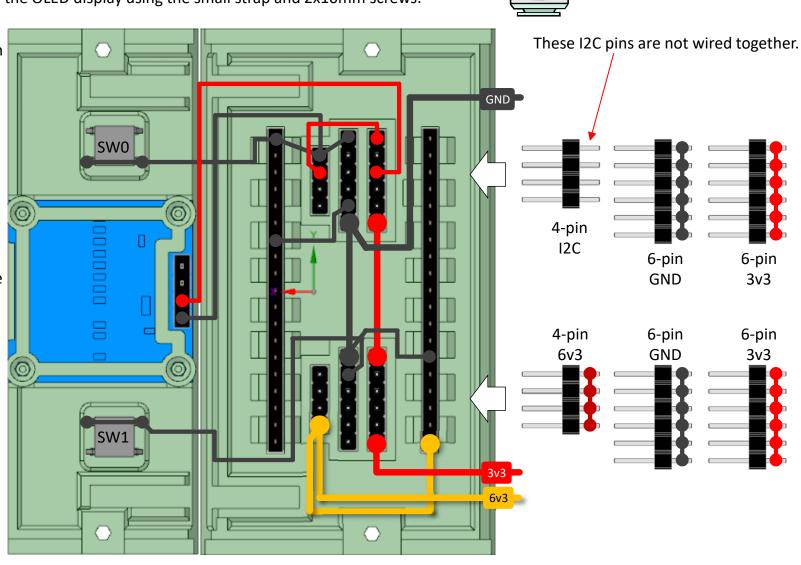


The pre-wired pin strips act as common connection points, which are easy to wire wrap to.

Start by running in these wires. The power feed in wires are soldered onto the pins, where as the other wires can be wire wrapped initially, and tested functionally, before finally soldering those connections.

A 4-pin socket is used to connect to the display, to ease maintenance tasks.





Heal Plate Wiring

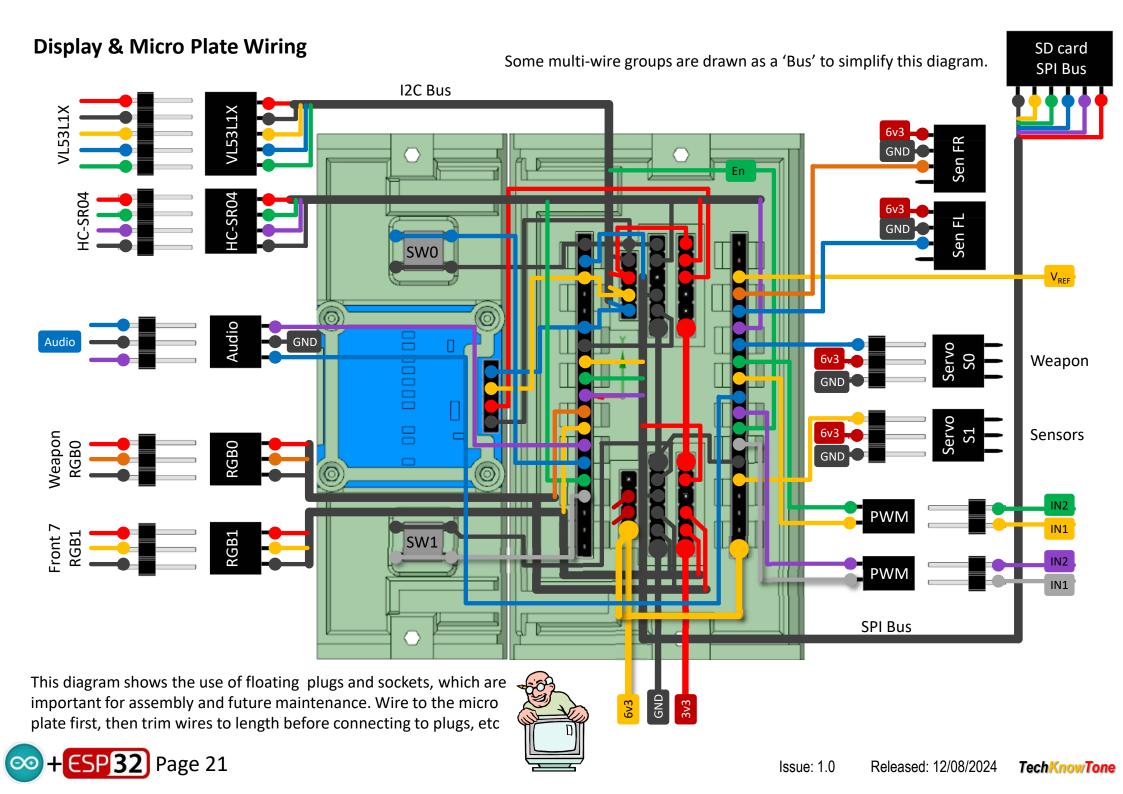
The DC power socket, toggle switch and micro-SD card reader at glued into the heal plate, prior to wiring. To micro plate DC Switch 7v5 Ext. - Batt. The toggle switch enables 0 power to be taken from either the DC power socket or the battery pack. This is useful when operating the TankBot A A A A A A on a stand, during software changes and testing. SD card 0 Bend and fold the battery wires, so that GND their developed length can be extended. This will make assembly easier.

From Battery

Positive

To Battery

Plate Terminals.



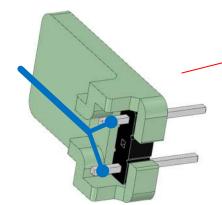
Speaker Wiring

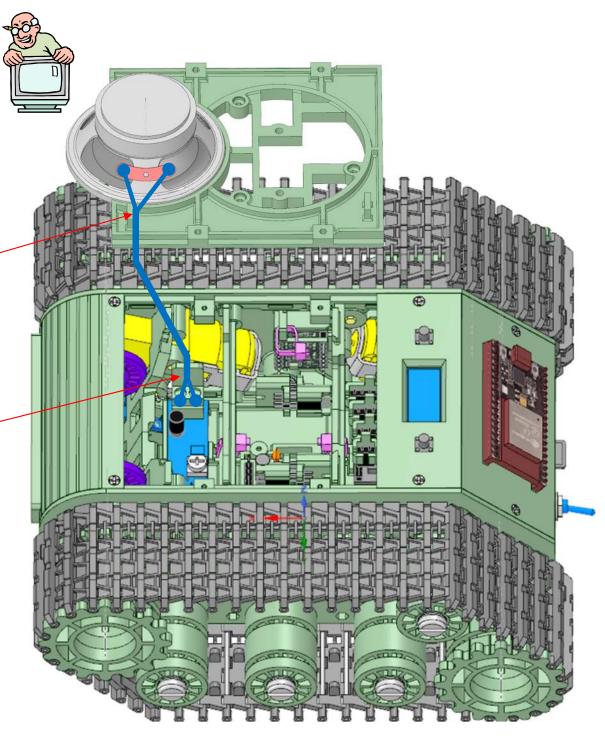
Glue the speaker into the Top Plate, with the connections orientated as shown. Allow the glue to set fully.

Wire the speaker as shown, to a 2-pin strip, which is actually 3-pin, with the centre pin removed. Solder the connections and glue the pin strip into the Amplifier Connector. This component makes it much easier to insert the pin strip connections into the amplifiers screw terminal block.

Cable tie

Wire wrap the modified 3-pin strip, and solder the connections. Then glue the strip and wires into the custom holder, which is designed to make it much easier to insert the terminals into the amplifiers terminal block.





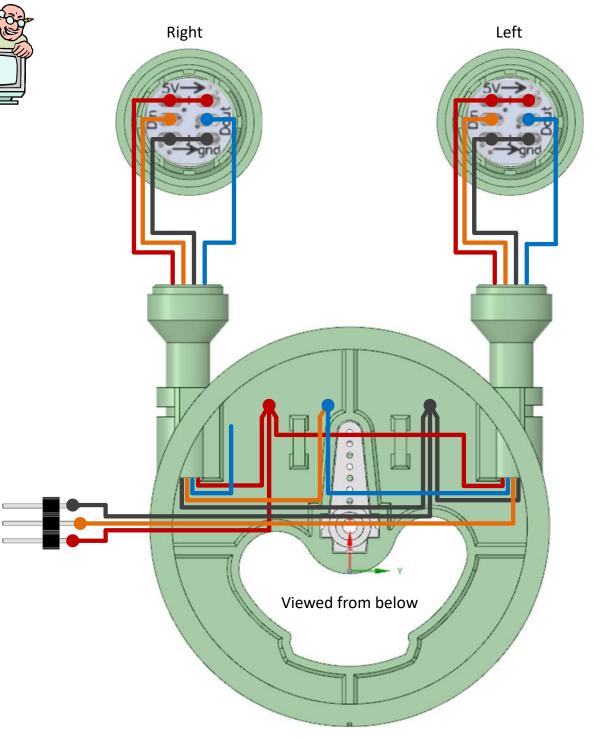
Turret LED Wiring

The weapon LEDs are wired in the same manner, as shown here, but connected inside of the turret such that the data out of the left LED (blue) is fed into the data in of the second LED (orange) on the right.

A separate lead, with a 3-pin plug, is then used to make these connections with the micro plate.

As the weapons are a glued assembly, make sure that all connections are good, as it will be impossible to access the LED wiring once the parts have been glued together.







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Turret Sensor Wiring

The range sensors are mounted in the turret, and connected to the main chassis via two multi-core cables.

Wire-wrap the 4-pin and 6-pin sockets first then feed their wires through the turret plate appearature.

Then complete each cable by attaching a 4-pin and 5-pin plug.



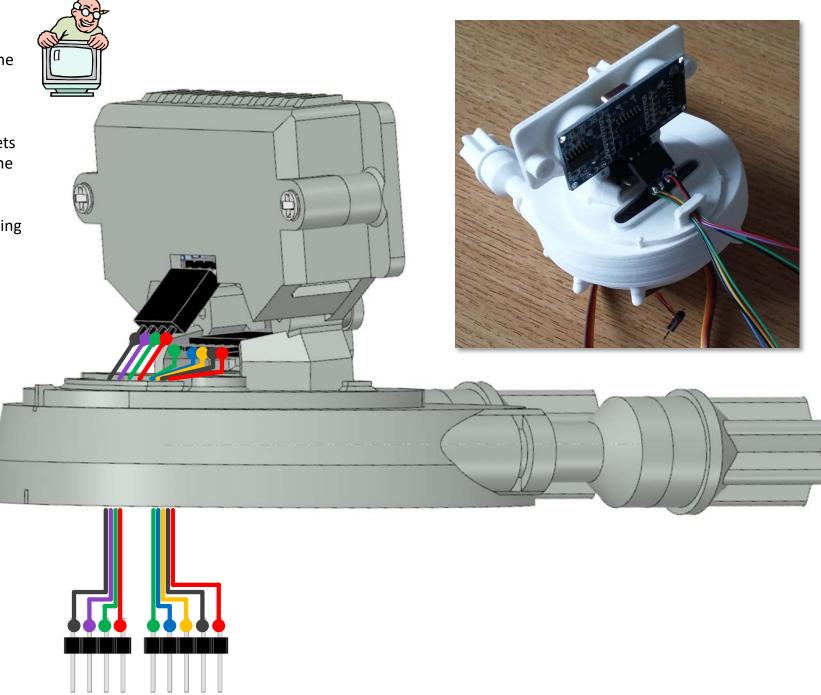


Viewed from the front



HC-SR04

VL53L1X



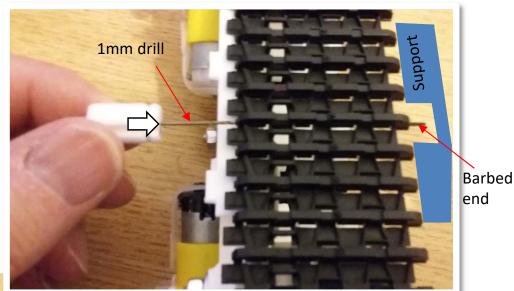


Track

To get two tracks of the required length I had to buy two sets, and split them. The fitted tracks have 52 links each, and are 405mm in length. This gives sufficient slack to connect up the track, and then tension it with the sliding adjuster. It does not need to be too tight.



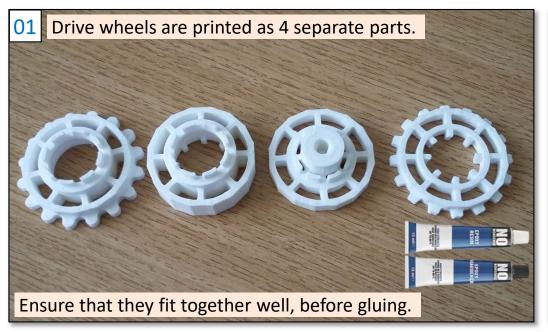
To remove a track pin, to separate the track, support it either side of the link as shown. Then apply pressure to the pin using a 1mm drill or Alen key. It is a good idea to mark the link from which the pin was removed in some way, so that in future a different pin can be removed. Thus reducing the wear caused by removing and re-inserting the same barbed pin.

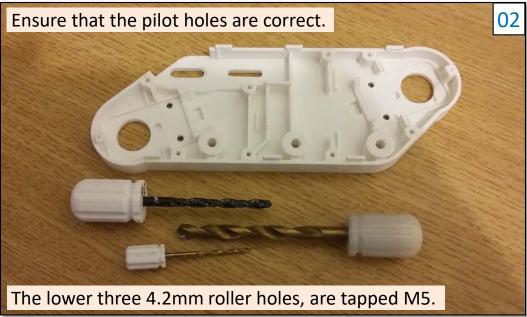


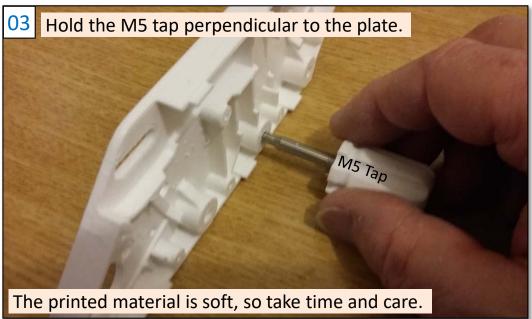


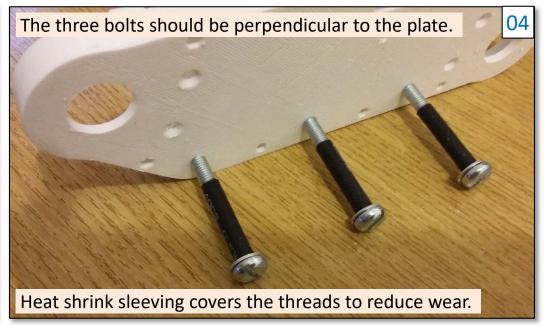


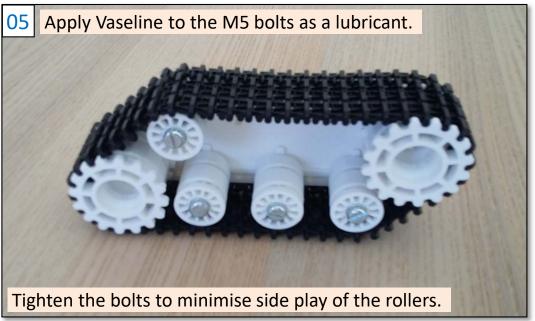
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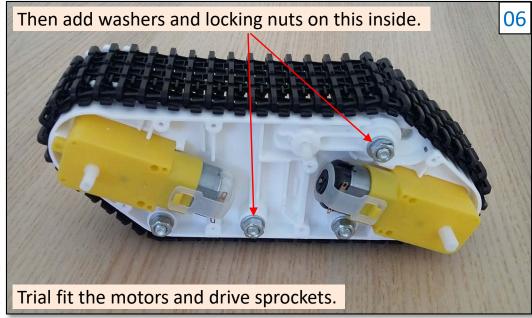


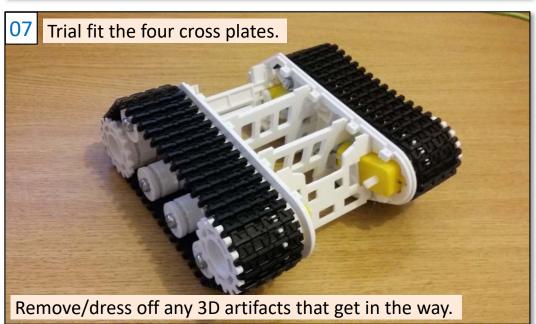


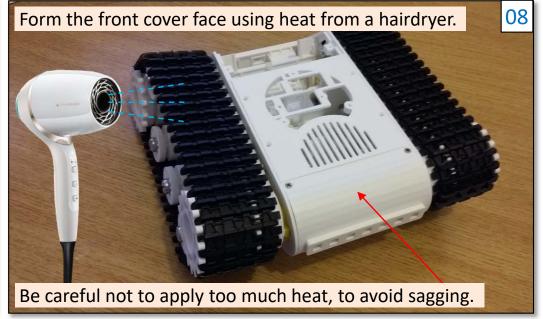


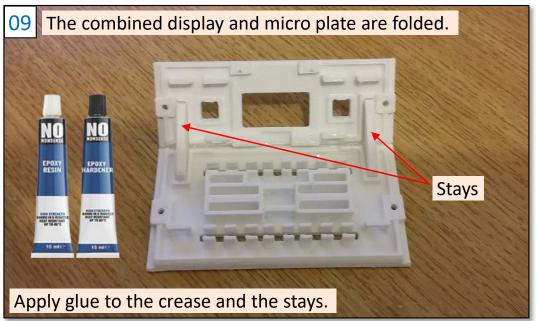


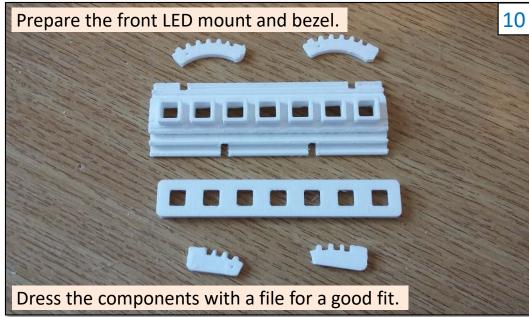


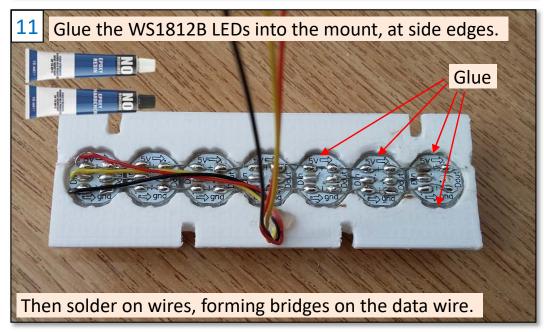


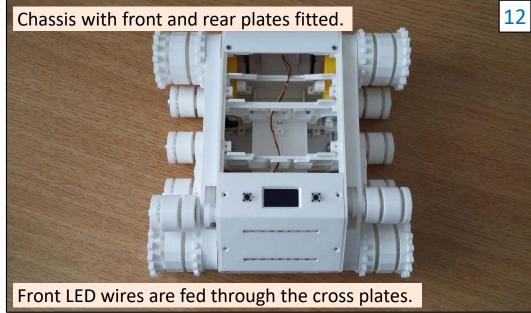


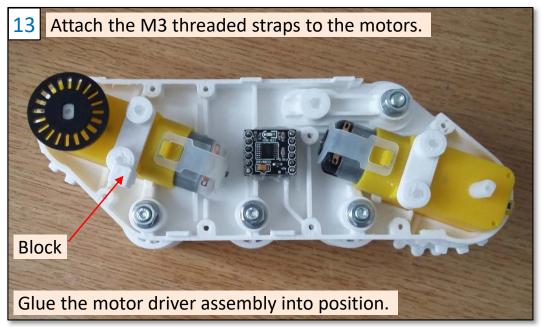


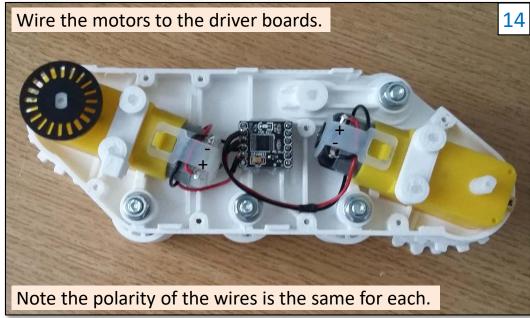


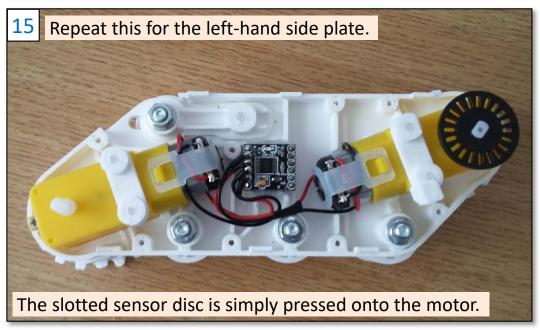


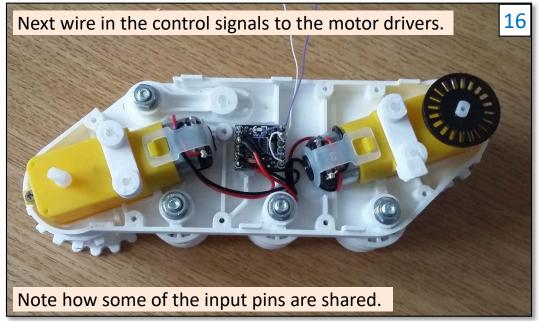


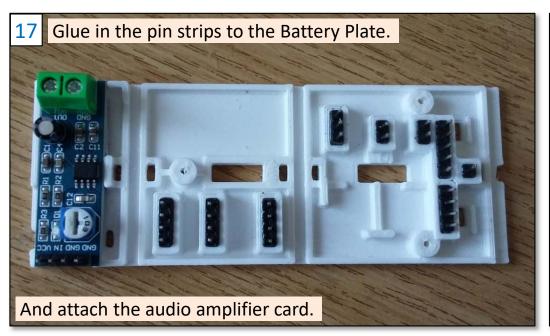


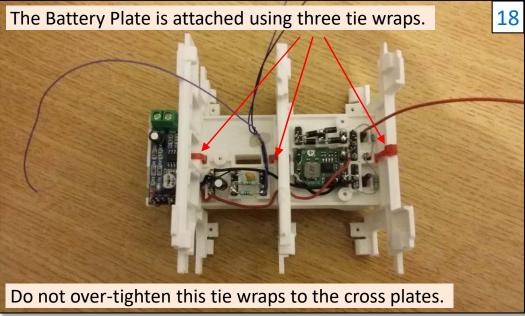


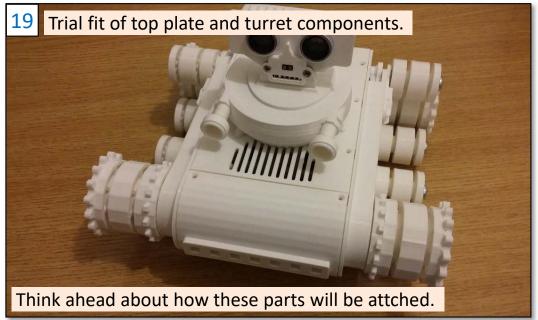


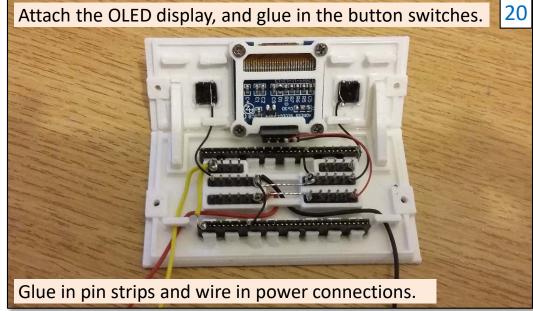


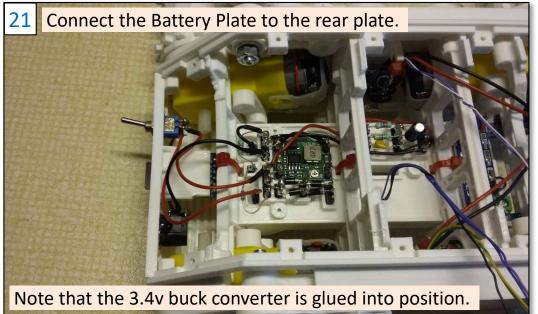


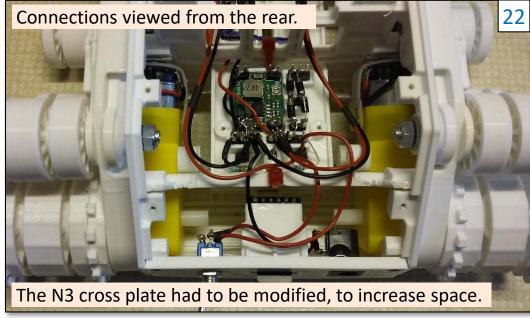


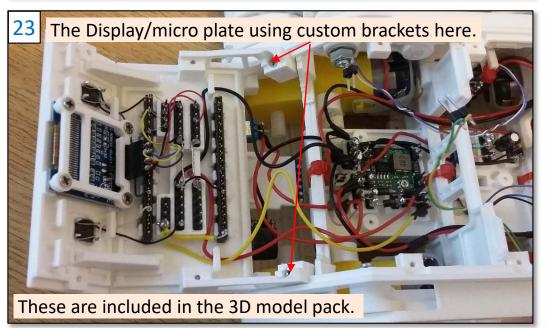


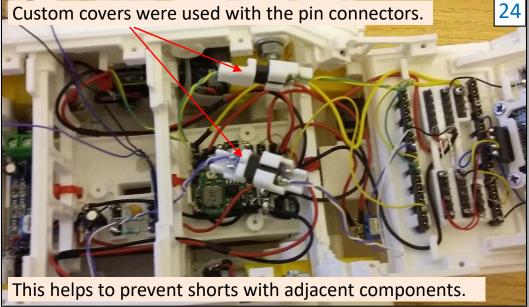


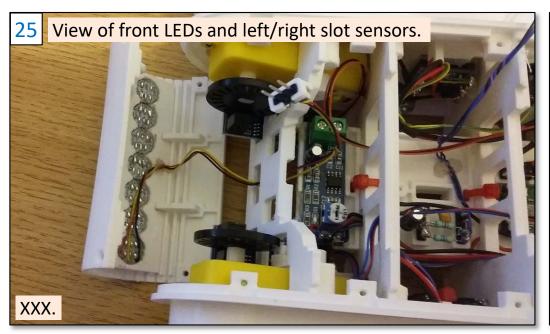


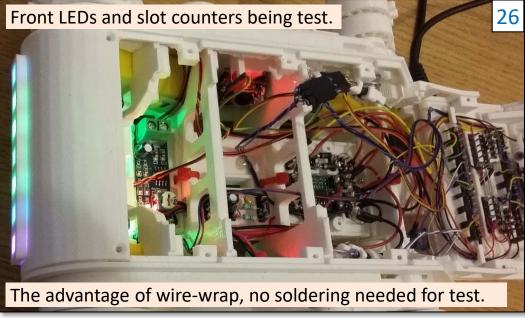


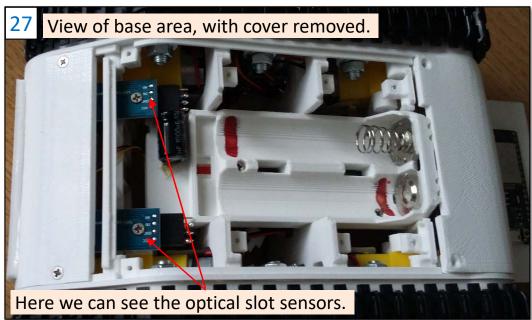


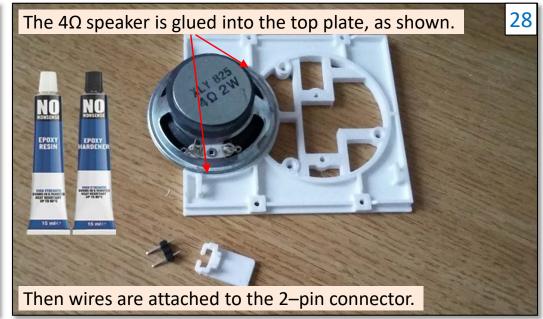


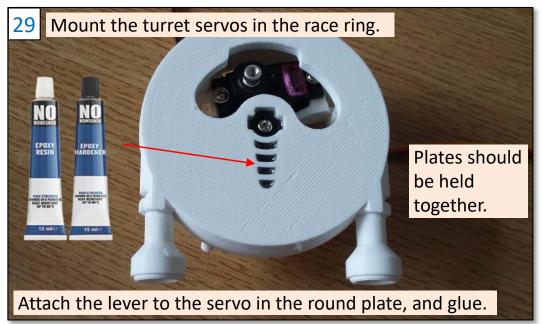


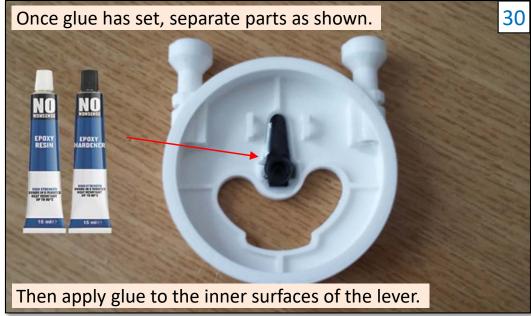


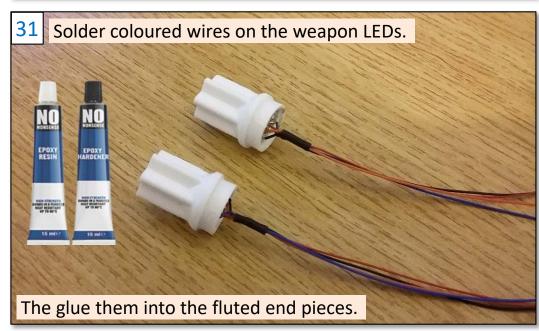


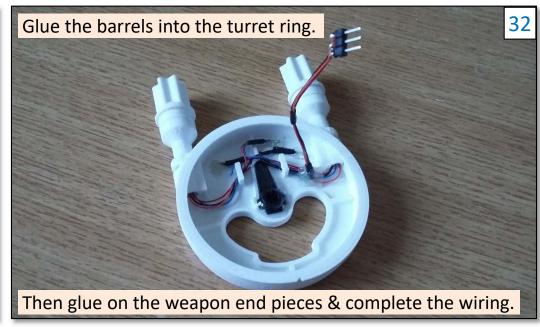


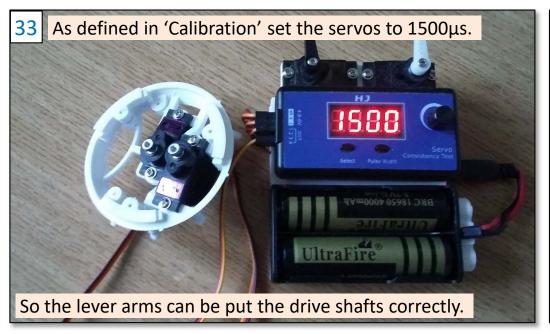


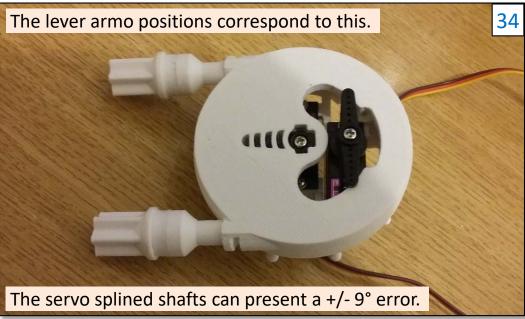


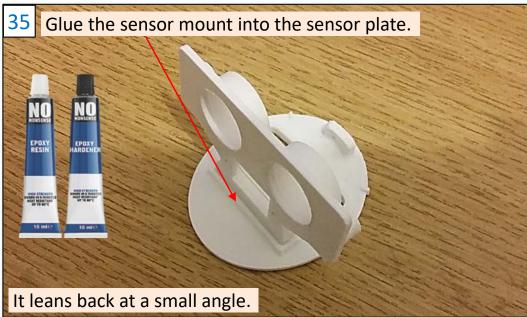


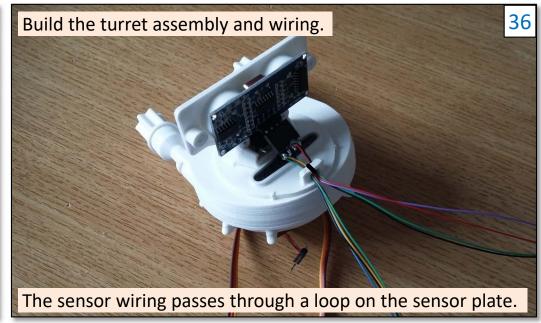


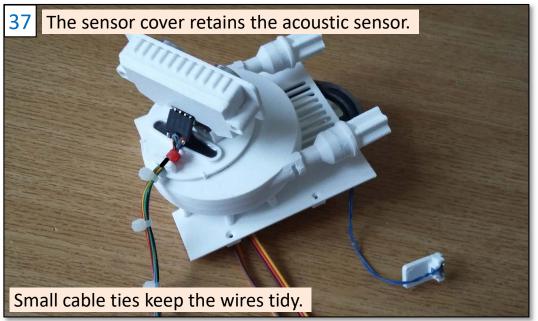


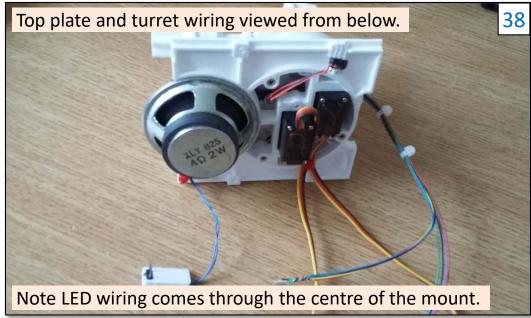


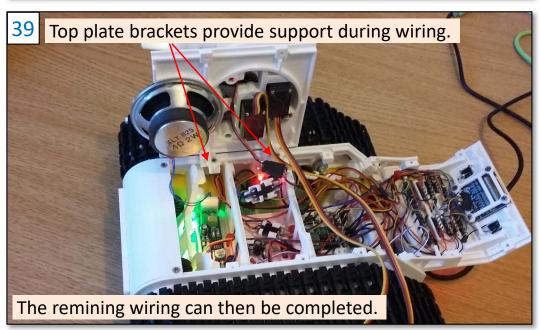


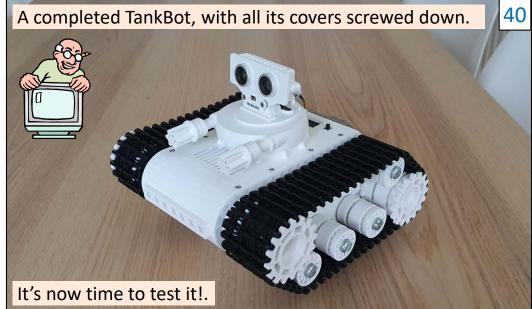












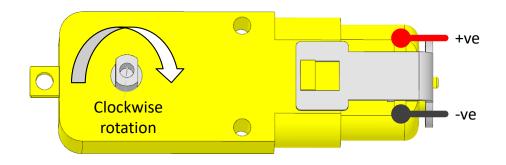
DC Motor Polarity

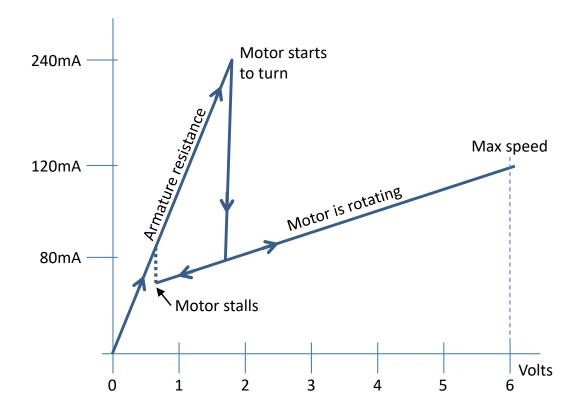
The direction of rotation of a permanent magnet DC motor is determine by the polarity of the voltage applied to its terminals. Here we see that the motor shaft on the side of the motor which has terminals, is rotating in a clockwise direction when this polarity of the voltage applied.

In an unloaded state the motor will start to rotate at around 1.8 volts. Before getting to the point of rotation, friction in the motors nylon gearbox keeps it stationary, and the stalled motor current is determined by the applied voltage and the armature resistance. Once the motor starts to turn, the current drops rapidly, due to the motors back emf cancelling some of the applied voltage.

The motor speed will then increase in a manner proportional to the applied voltage. At 6 volts I measured an unloaded current of 120 mA. Reducing the voltage will decrease the motor speed and it will be seen to still turn, below the initial starting point, as the gearbox friction is reduced once the motor is in motion.

As the voltage is further reduced the motor will once again stall, and the current will again be determined by the armatures winding resistance.







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