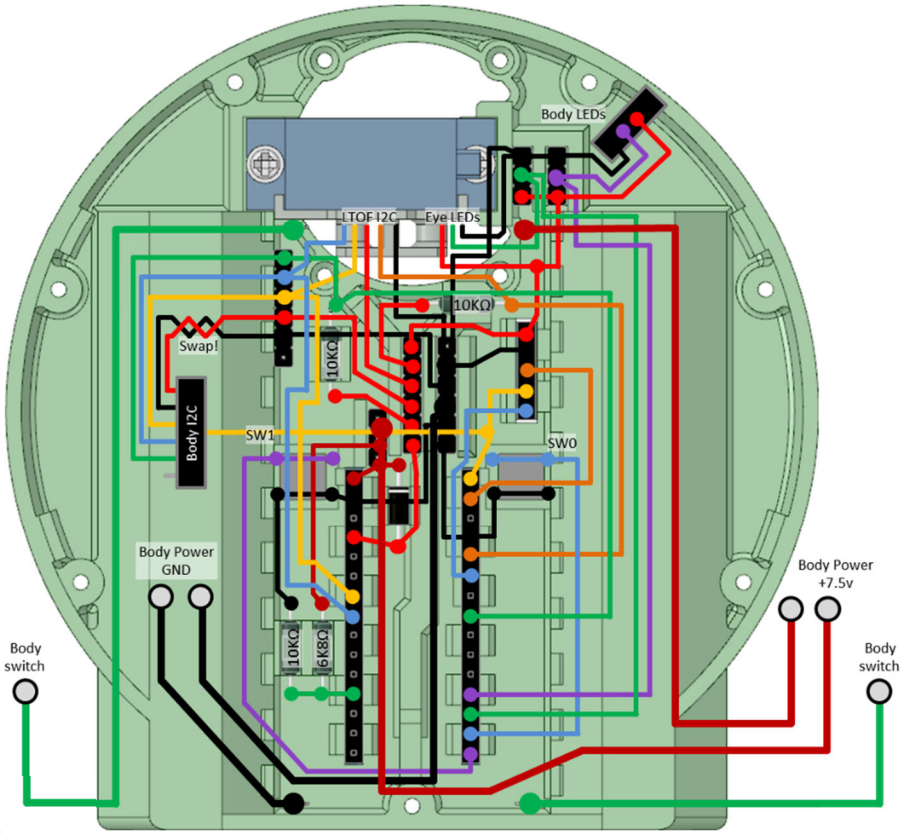
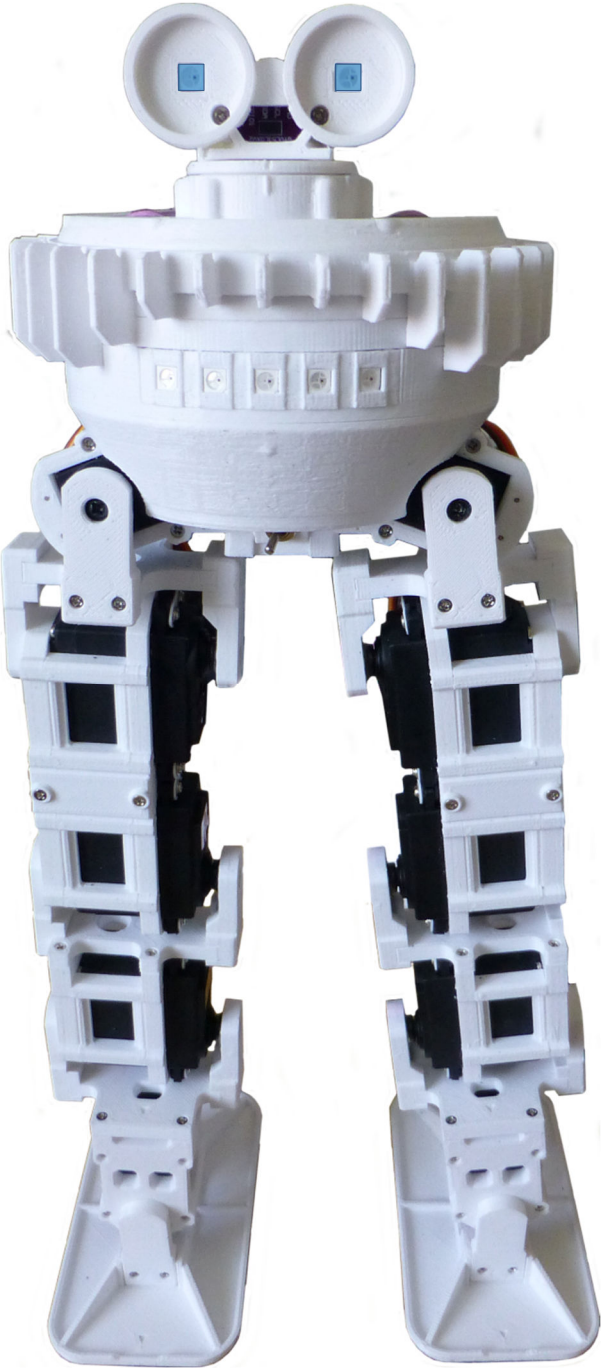
Biped Droid

Circuits & Wiring

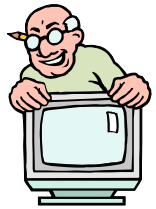




ARDUINO OPEN-SOURCE COMMUNITY

Issue: 1.1 Released: 08/12/2025 TechKnowTone

CAUTION



Lithium batteries can be extremely dangerous, if not handled and cared for properly. This design does not include any form of current limiting circuit, like a fuse. So, care must be taken to ensure that the wiring guidelines are followed accurately, that checks are made for short-circuits, and that battery polarities are marked, and they are inserted the correct way round. Failure to do so, could result in an explosive fire.

Charging Practices: Always remove batteries from your project to charge them. Use a charger, designed for the battery used, and from a trusted supplier. Choose a flat, non-flammable surface to charge on, away from flammable materials. Never leave unattended when charging. Don't charge overnight. Monitor charging to ensure charge characteristics are as expected. Only pair batteries with similar characteristics. Do not overcharge, or leave charging for prolonged periods. This increases the risk of damage and fire.

Battery care & maintenance: Stop using a battery if it is swollen, damaged, dented or leaking. Never charge a damaged battery. Never allow a Lithium battery to discharge below 3.2 volts, as cell damage will occur. Avoid extreme temperatures. Do not charge or store batteries in very hot or cold environments. Don't cover batteries whilst charging, as this can trap heat, causing overheating.

In case of fire: Get out and stay out. If a fire starts, leave immediately, and call the fire brigade. For low voltage Lithium batteries, water is a safe extinguisher.

Built-in Monitoring: Most of my project designs include code, and circuitry, to monitor battery voltage, whilst in use. This code then seeks to alert the operator, when the battery has reached a critical low voltage, before shutting down power consuming circuitry; including the micro. Time should therefore be spent on calibrating this feature, as a precaution, for good battery management and maintenance.

Carefully dispose of batteries that damaged, or discharged below their critical voltage.

Hand Tools:

Fine Nosed Pliers
Side Cutters
M3 Tap
M4 Tap
1.5 mm Drill
2.0 mm Drill
Needle Files
Screwdriver
Craft Knife

Note: Not all items are shown here.

Issue: 1.1 Released: 08/12/2025 TechKnowTone

Tools & Materials:

Temperature controlled iron
Solder flux
Resin cored solder
6mm adhesive copper tape
Screw drivers
Wire wrapping tool
Wire wrapping wire 30 AWG

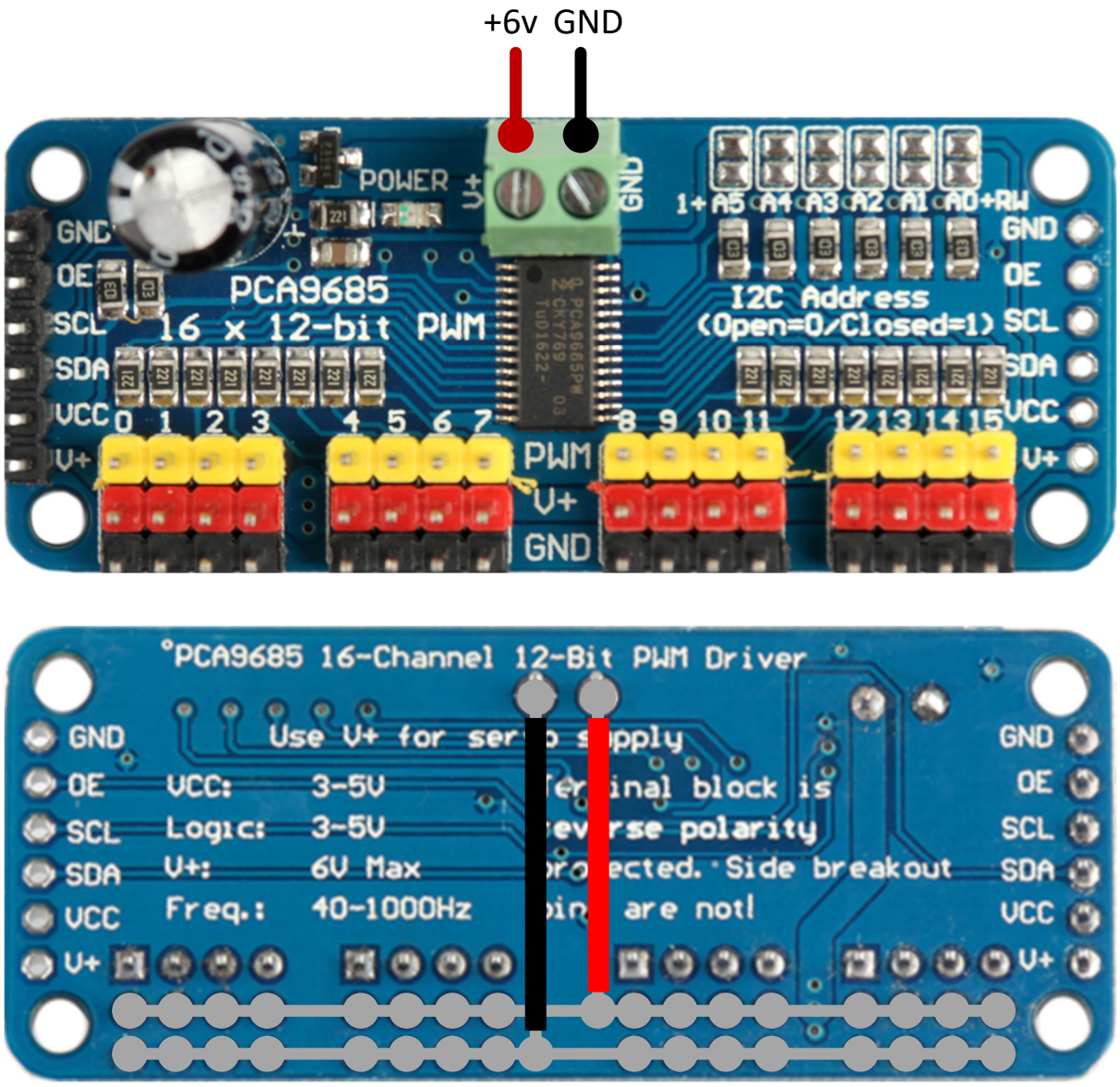
PCA9685 power lines

It is recommended that the GND and V+ lines on the PCA9685 are strengthened using insulated wire if significant currents are to be draw from this pcb. This modification needs to be done in advance of assembling your robot.

The assignment of servos to PWM channels has been done symmetrically in such a way as to ease the cable runs to the servos in each leg. See a later slide that details this.

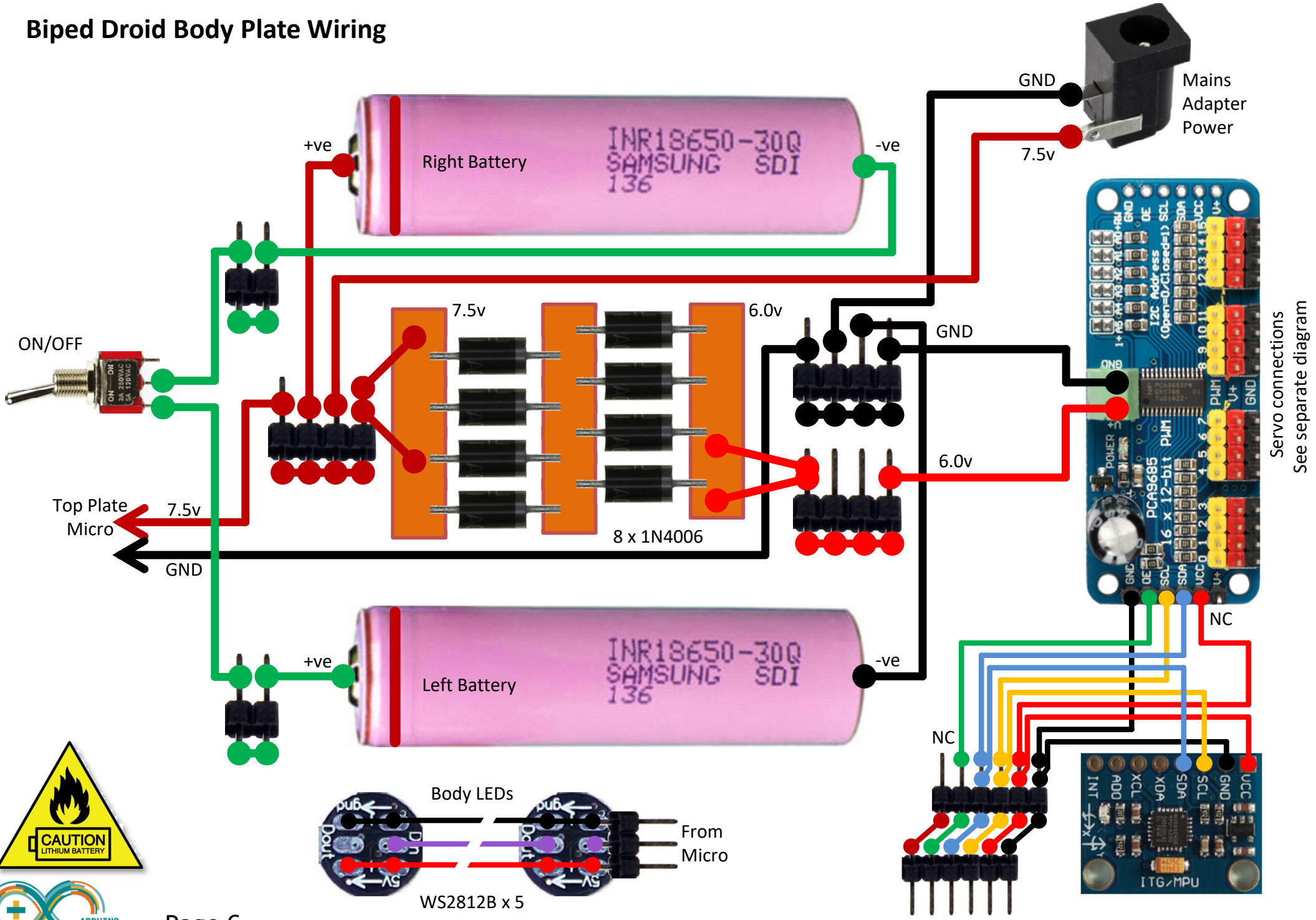
Only 11 of the 16 available channels have been used in this project, leaving scope for additional servos, used in arms, etc.

The interface to the board is serial I2C bus. If more than 16 channels are needed then more PCA9685 boards can be connected in series, by simply extending the I2C bus and changing the default address of each board that is added.



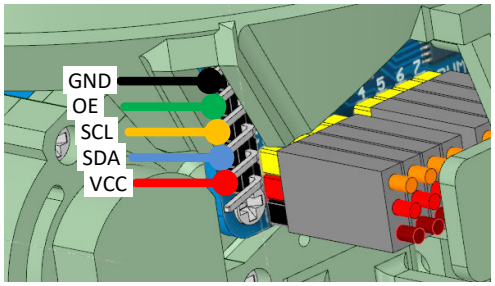
Issue: 1.1 Released: 08/12/2025

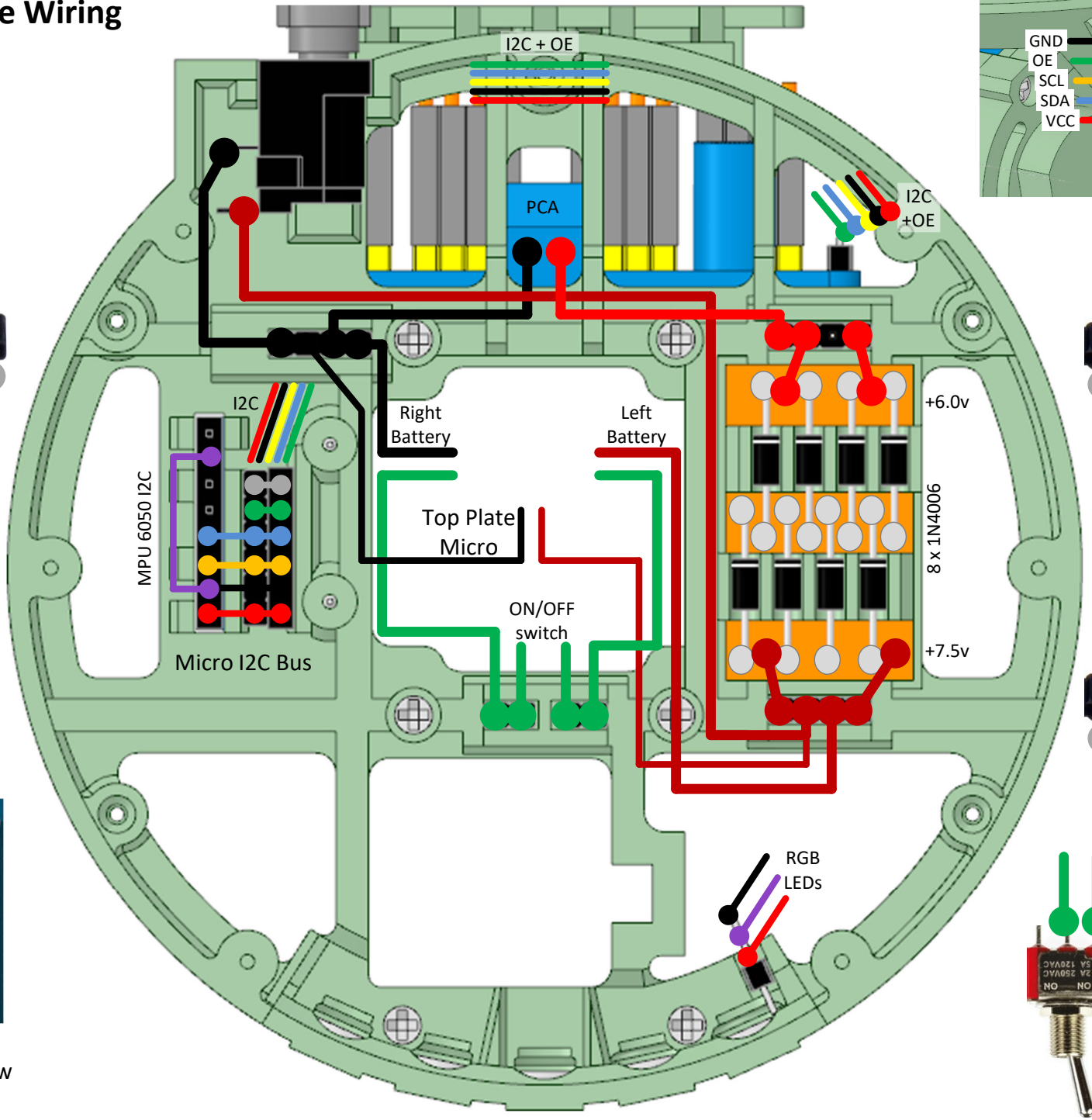
Biped Droid Body Plate Wiring

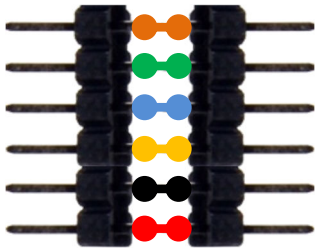


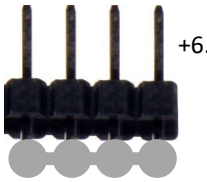
Issue: 1.1 Released: 08/12/2025 TechKnowTone

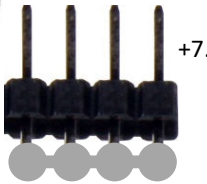
Biped Droid Body Plate Wiring

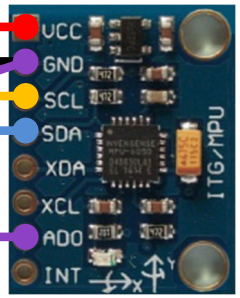






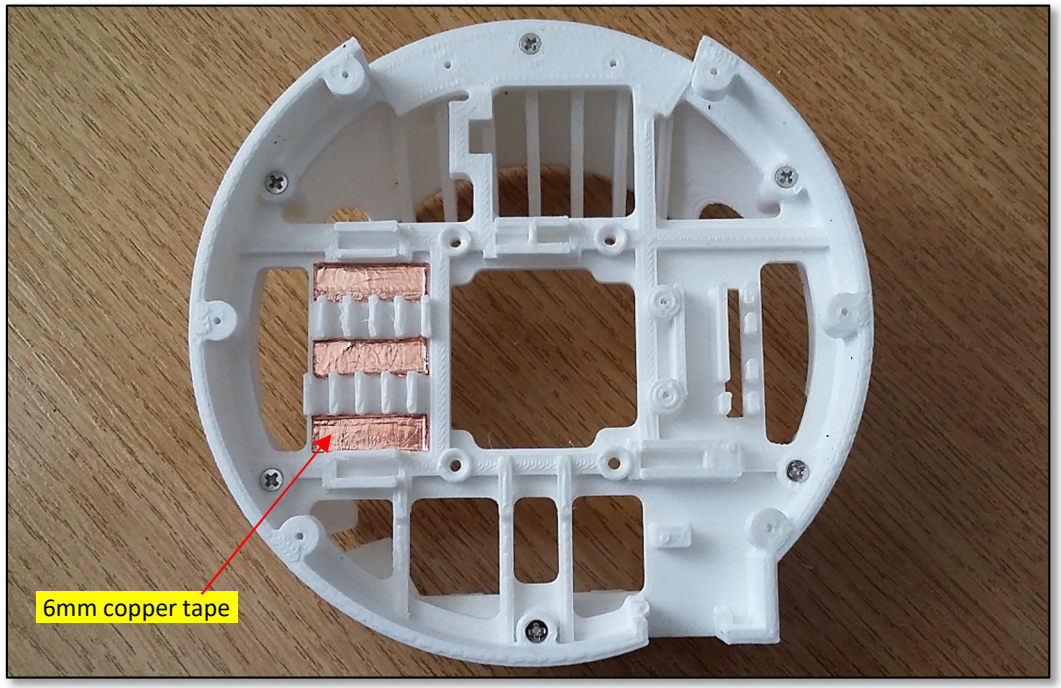


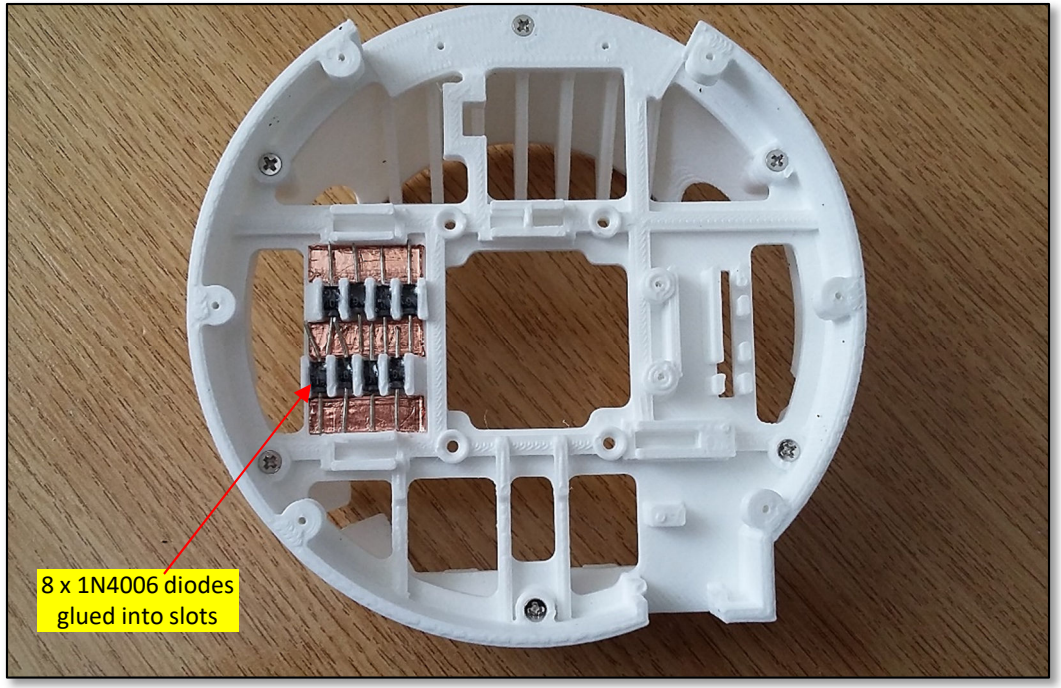


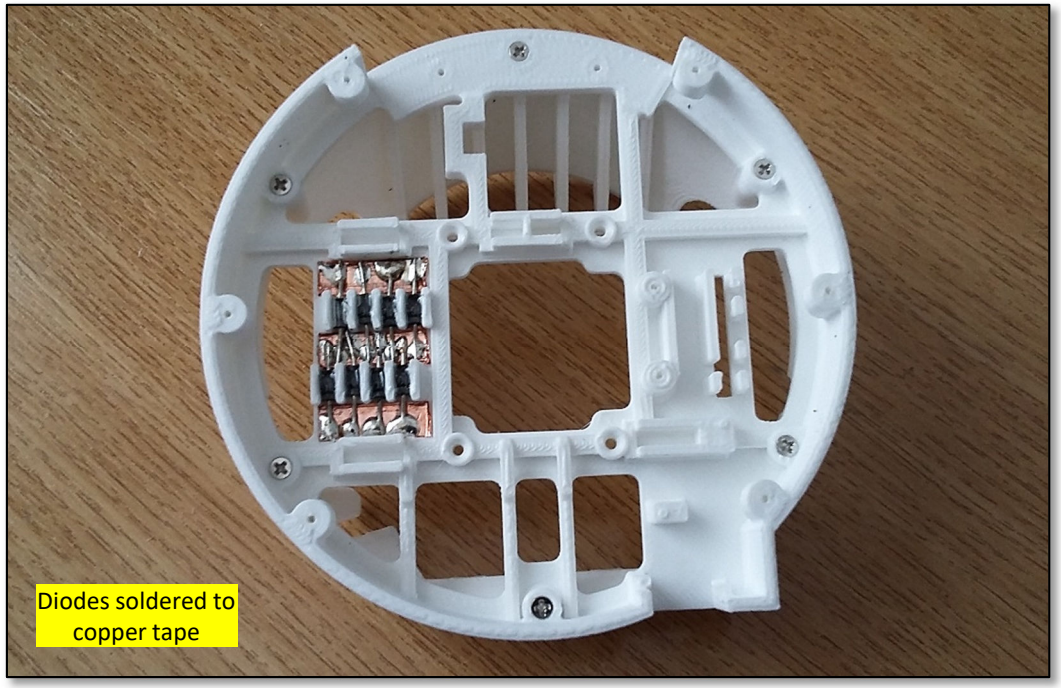


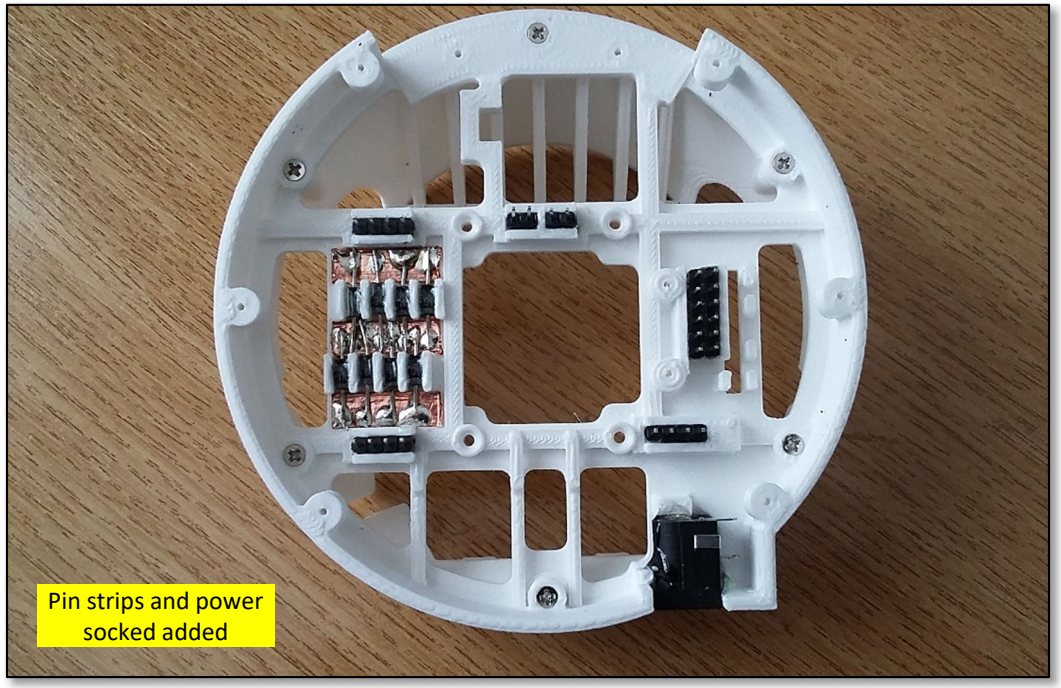
MPU6050
Viewed from below

Issue: 1.1 Released: 08/12/2025 TechKnowTone

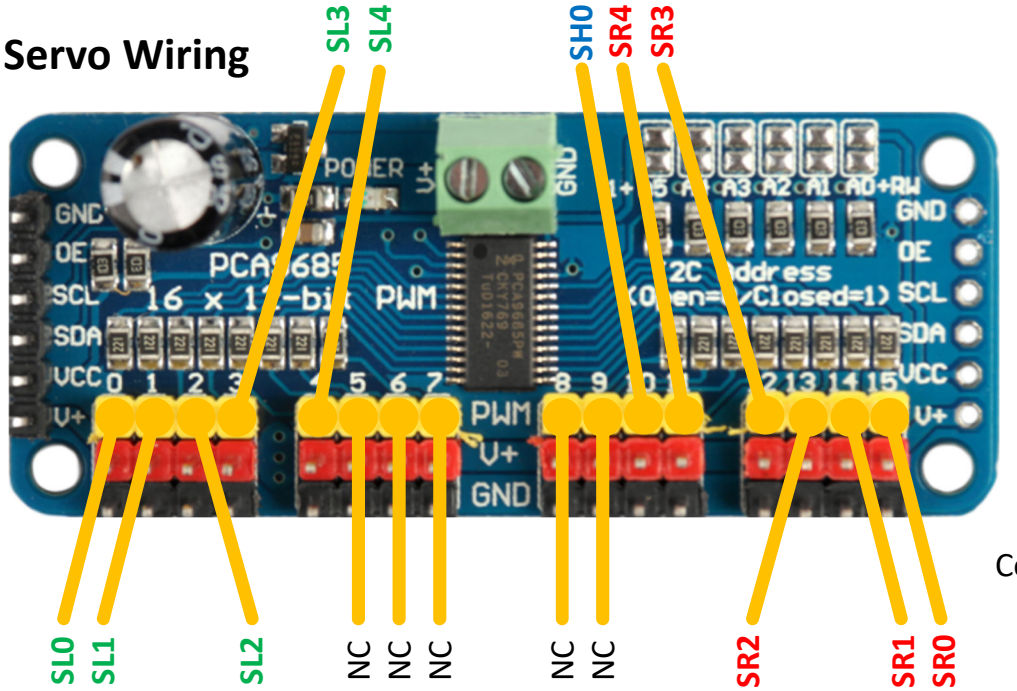

6mm copper tape

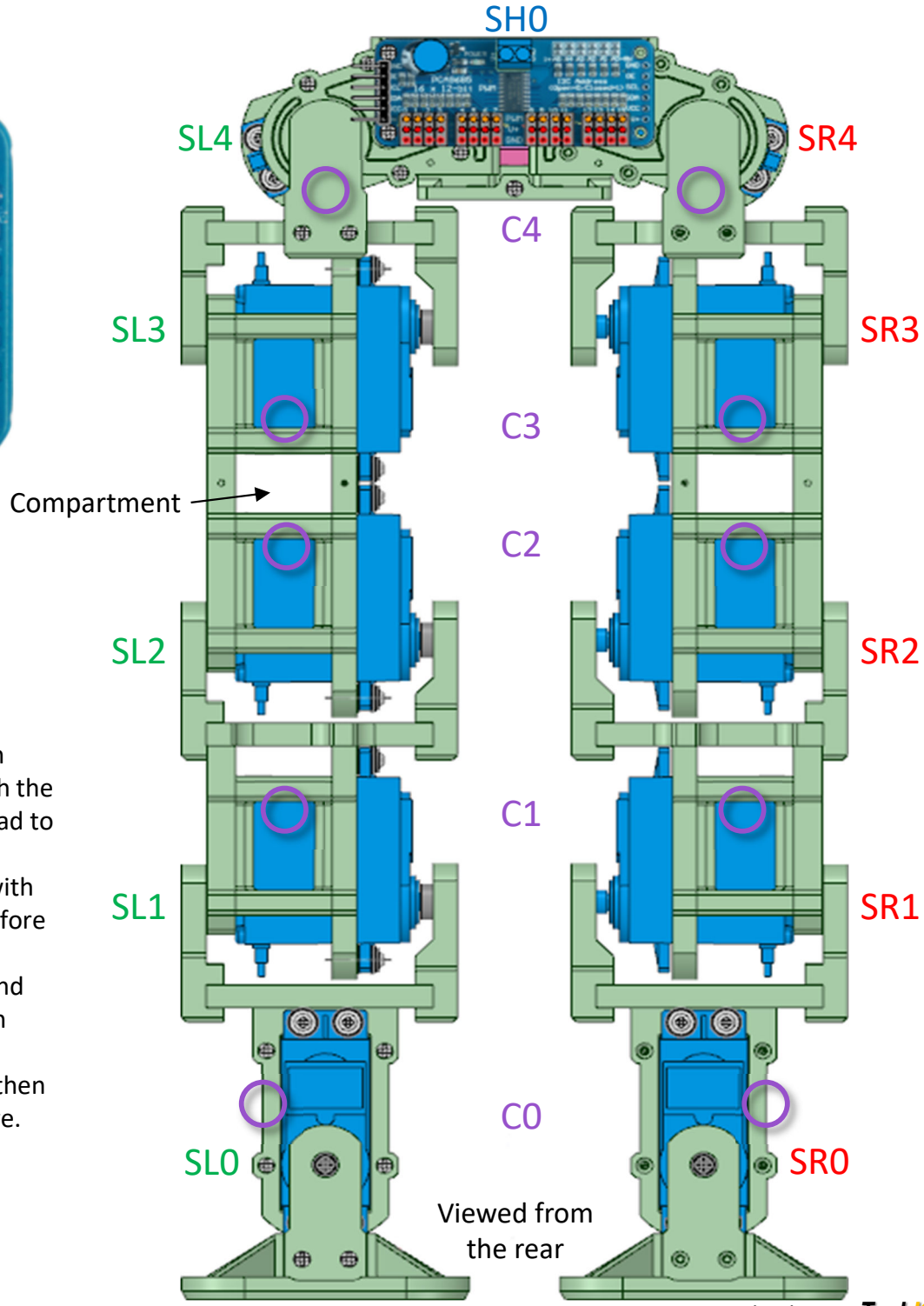

8 x 1N4006 diodes
glued into slots


Diodes soldered to
copper tape


Pin strips and power
socked added

Servo Wiring





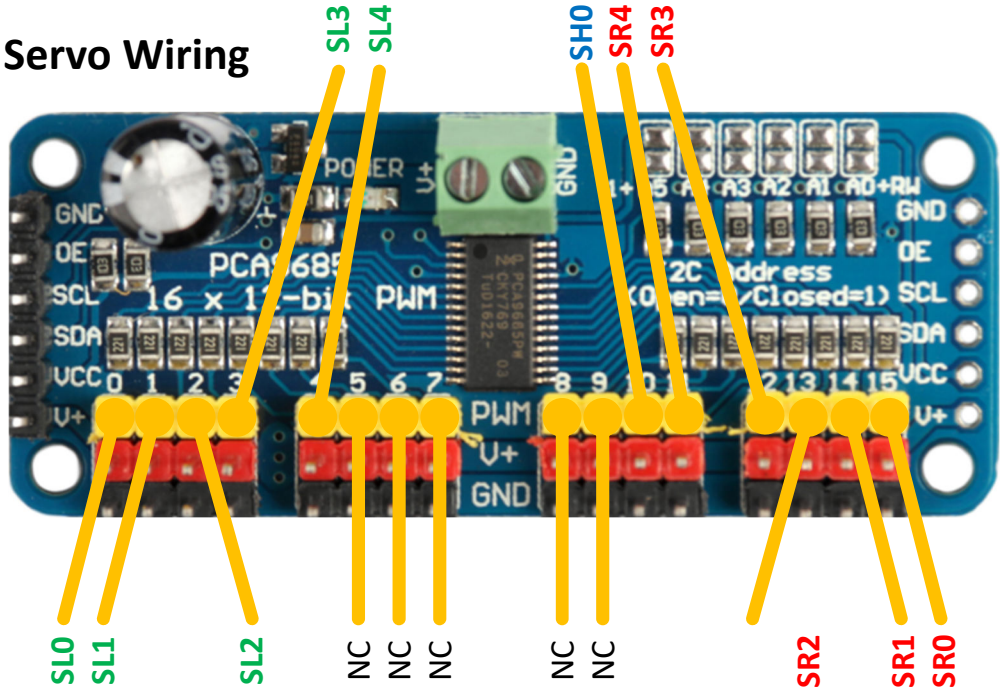
Wiring order:

1. Fit the front compartment covers.
2. Place the robot face down on a flat surface.
3. Pass SL0 lead through the 3 clips (C0,C1,C2) before attaching the 100mm extension cable. Then pass that lead through clip C4. Then pass SL1 through the 4 clips (C1,C2,C3.C4). Manipulate the left foot and knee joint to pull SL0 lead to its maximum extension. Now tie SL0 to SL1 between clips C1 and C2.
4. Pass SL2 leader through the 3 top clips (C2,C3,C4). Bend the knee joint with the foot as far forward as possible to pull on the leads, then tension SL2 before applying cable ties.
5. Bring the SL3 lead down through clip C3, loop it into the compartment and then back through clips C3 and C4. The compartment acts as a space within which spare cable length can be gathered and hidden from view.
6. Lead SL4 will pass over the servo and under the body to the top centre, then out through the back of the body to connect to the driver board from above.
7. Repeat these steps for the right-hand side servos SR0 to SR4.

Also view the photo on the following slide

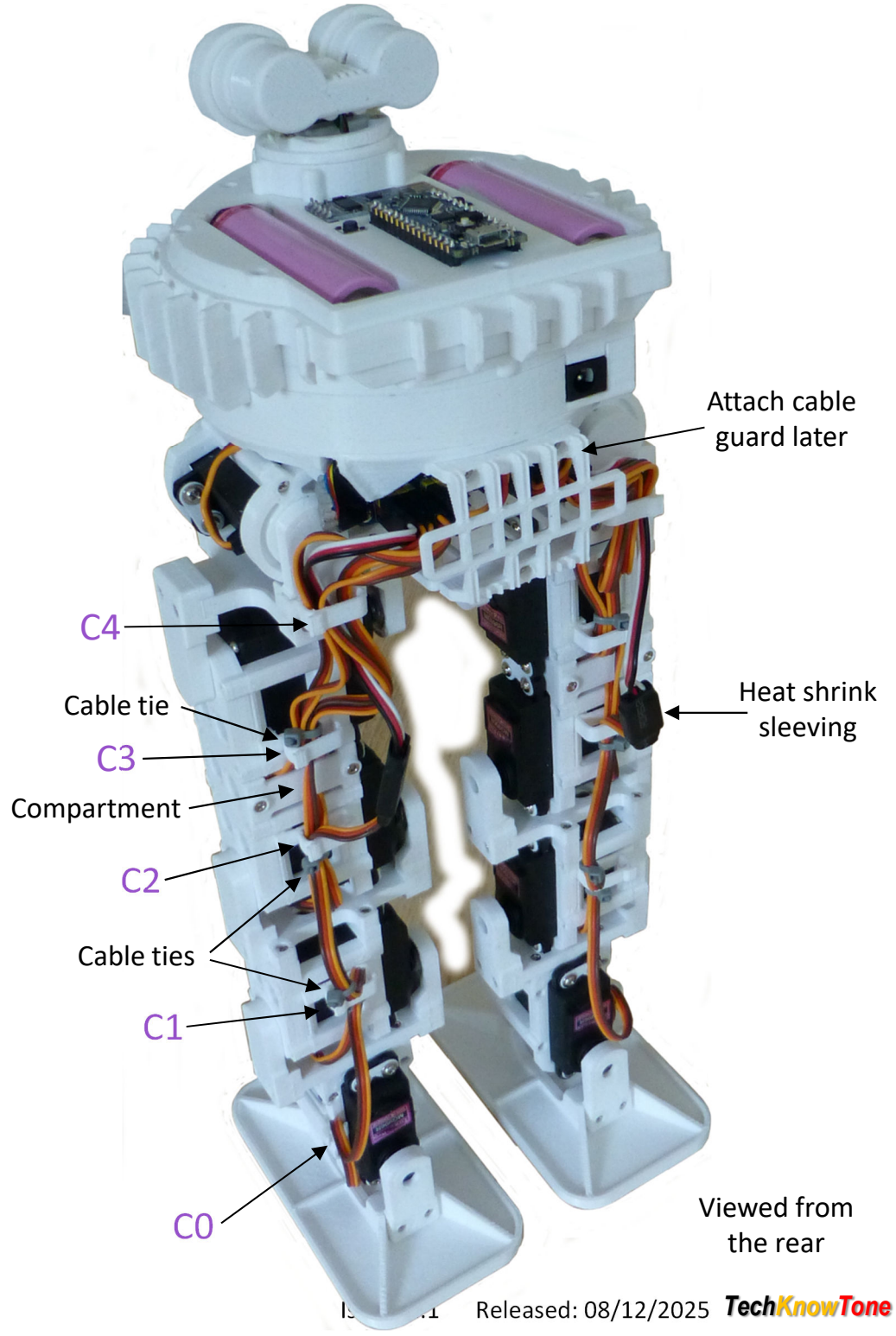
Issue: 1.1 Released: 08/12/2025 TechKnowTone

Servo Wiring

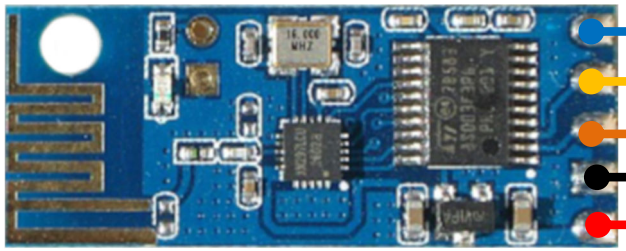


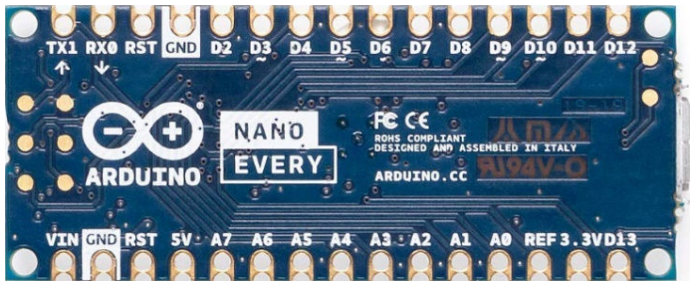
Wiring order repeated:

1. Place the robot face down on a flat surface.
2. Pass SL0 lead through the 3 clips (C0,C1,C2) before attaching the 100mm extension cable. Then pass that lead through clip C4. Then pass SL1 through the 4 clips (C1,C2,C3.C4). Manipulate the left foot and knee joint to pull SL0 lead to its maximum extension. Now tie SL0 to SL1 between clips C1 and C2.
3. Pass SL2 leader through the 3 top clips (C2,C3,C4). Bend the knee joint with the foot as far forward as possible to pull on the leads, then tension SL2 before applying cable ties.
4. Bring the SL3 lead down through clip C3, loop it into the compartment and then back through clips C3 and C4. The compartment acts as a space within which spare cable length can be gathered and hidden from view.
5. Lead SL4 will pass over the servo and under the body to the top centre, then out through the back of the body to connect to the driver board from above.
6. Repeat these steps for the right-hand side servos SR0 to SR4.
7. Fit the rear compartment covers to hide the excess cables once you are happy with the slack in the cables, when the legs are bent over.

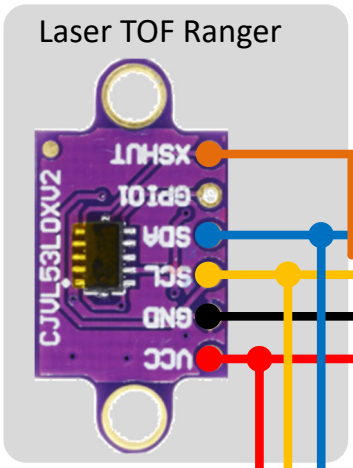


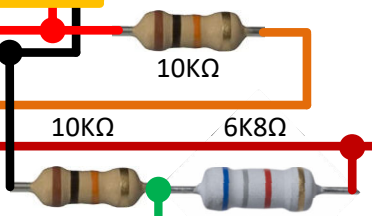
Biped Droid Top Plate Circuit



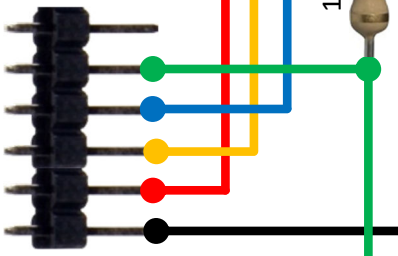


NANO EVERY underside view

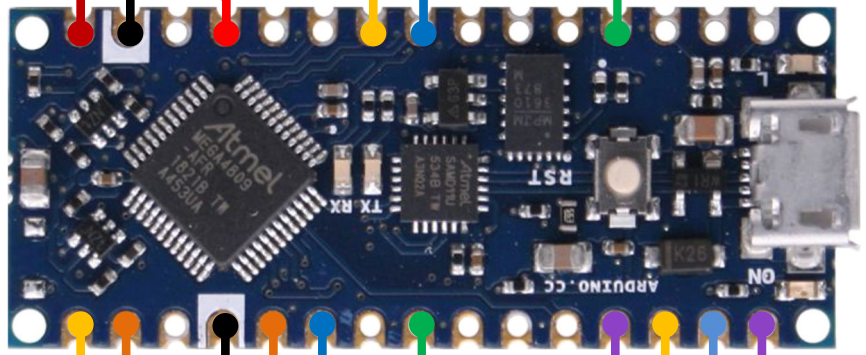


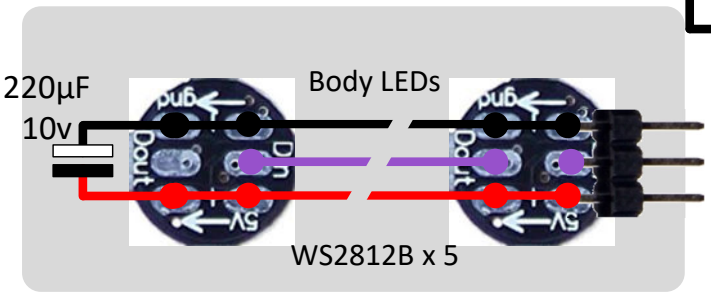


To Body power connections

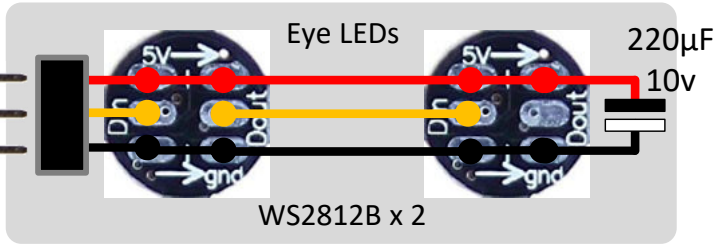


Body I2C Bus



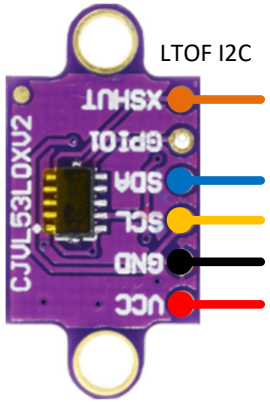


WS2812B x 5

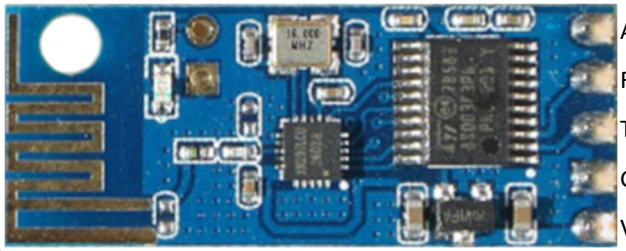


WS2812B x 2

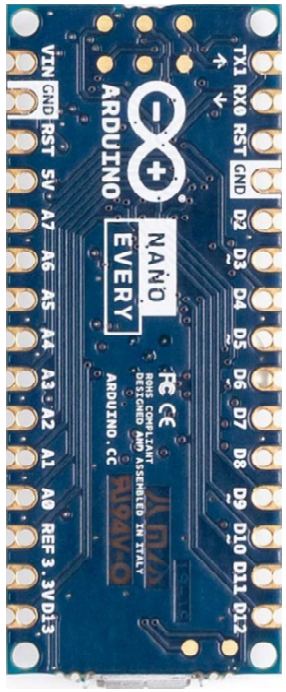
Biped Droid Top Plate Wiring

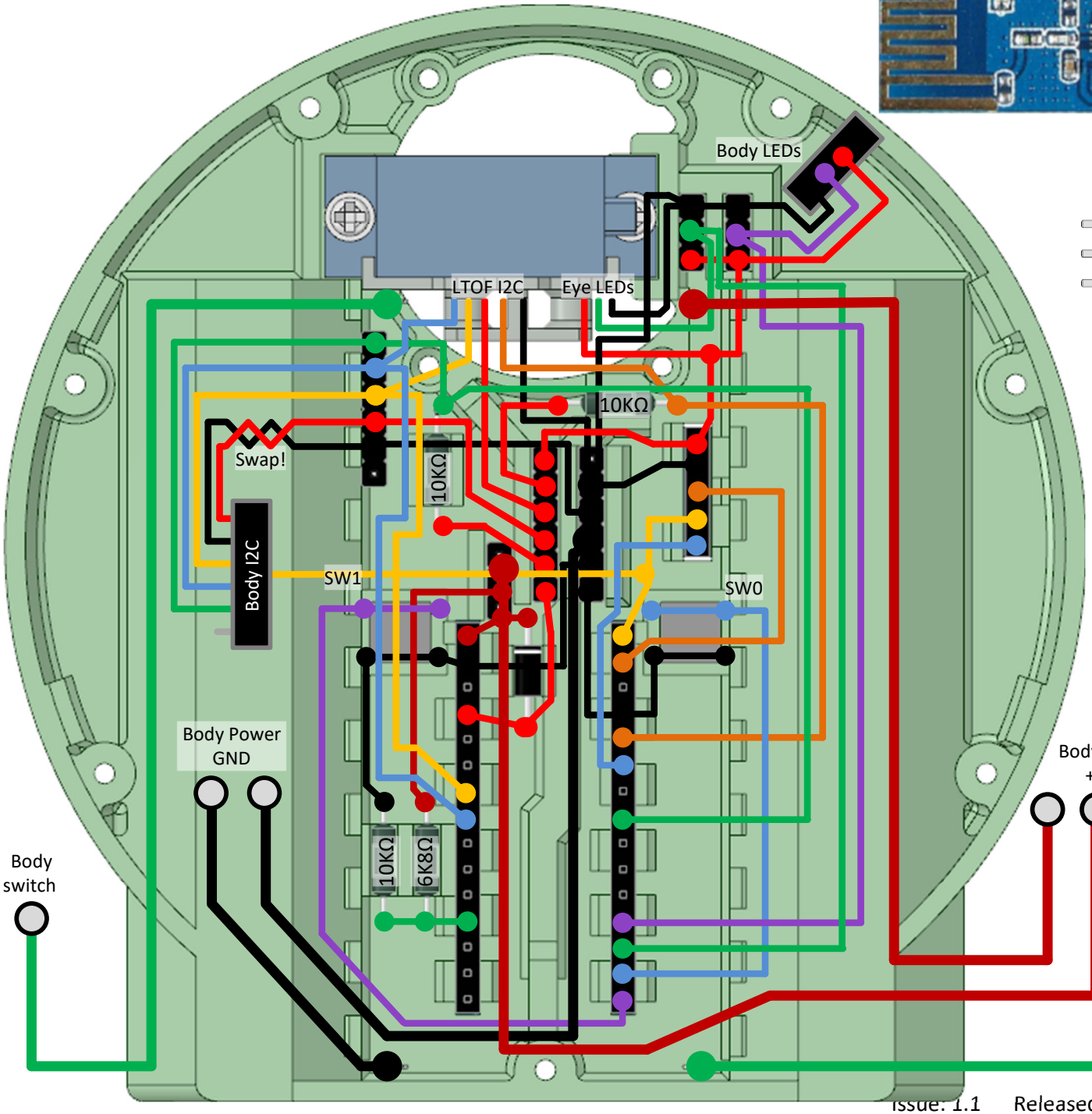


Top view

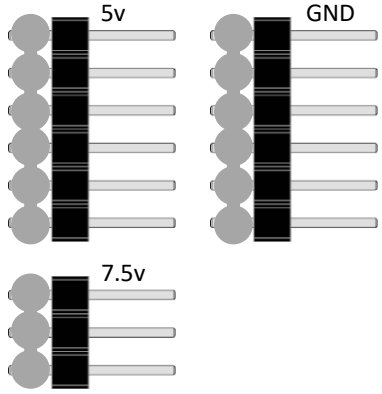


Underside view

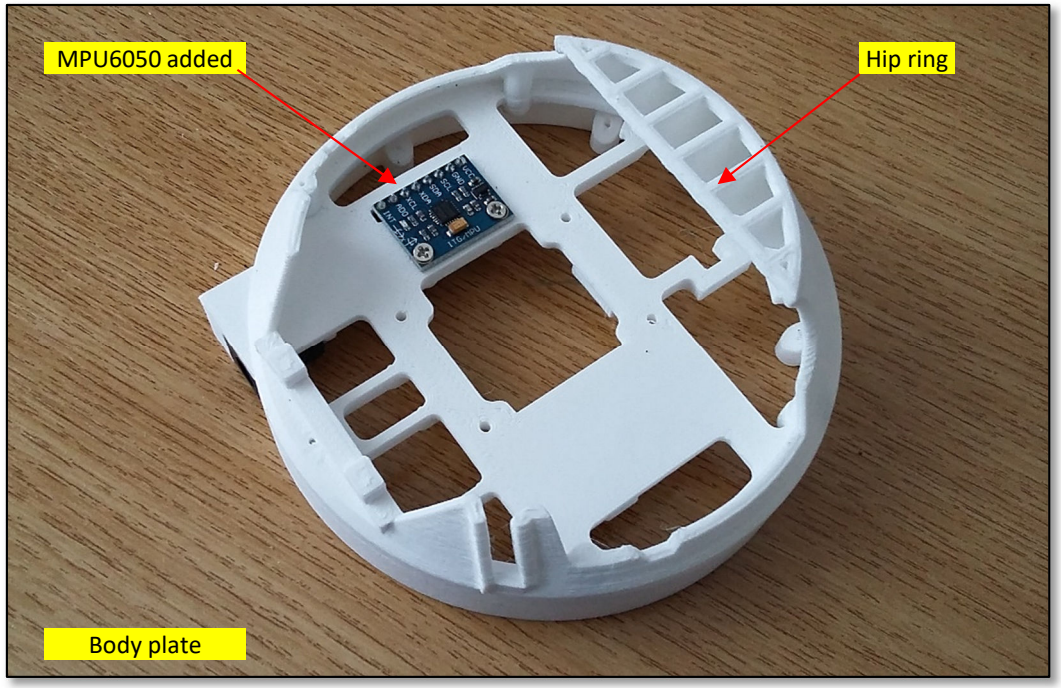


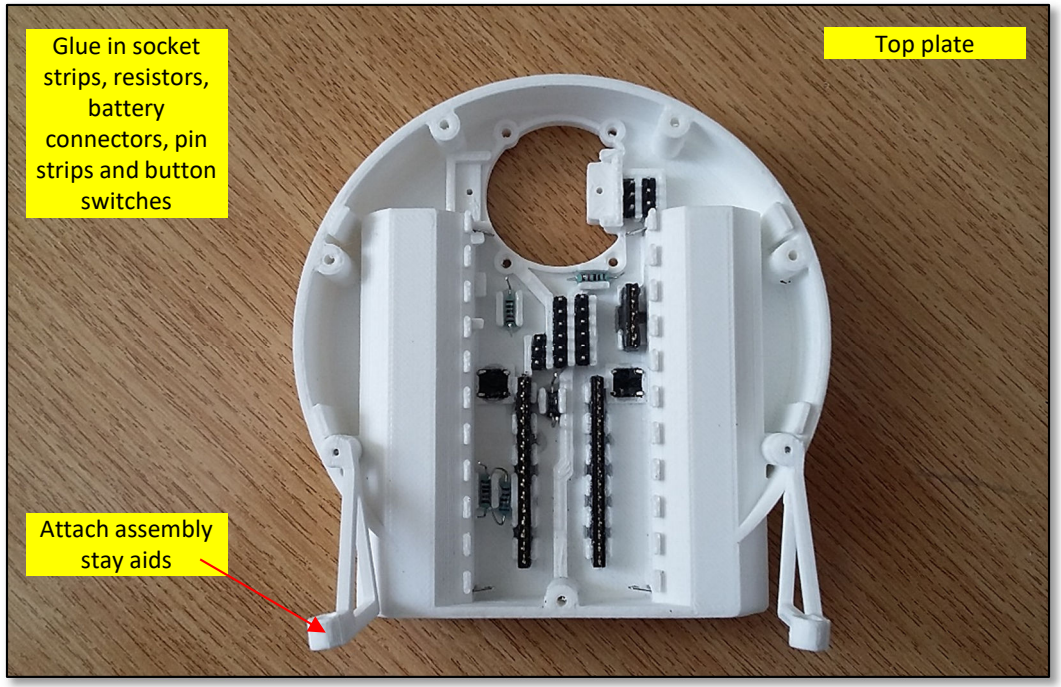


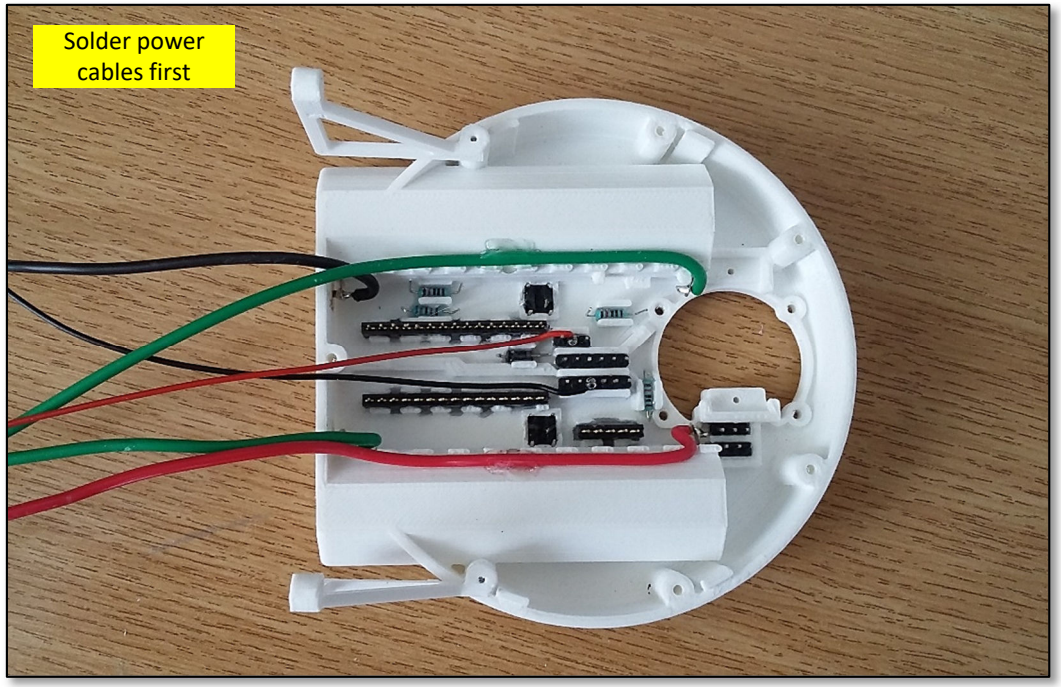
Neopixel Buses

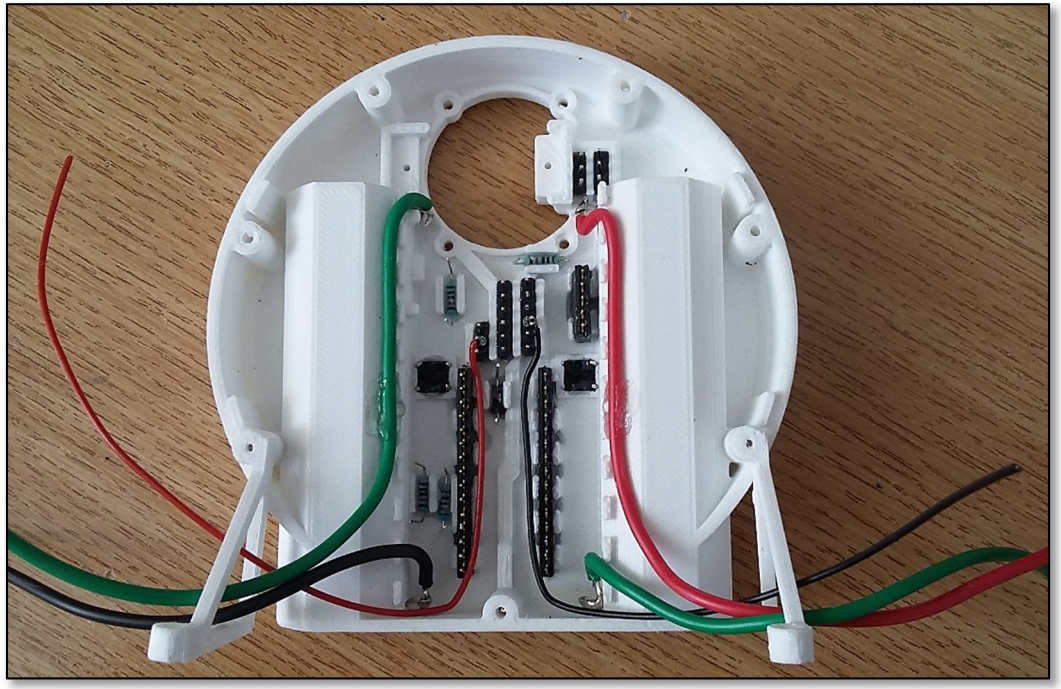


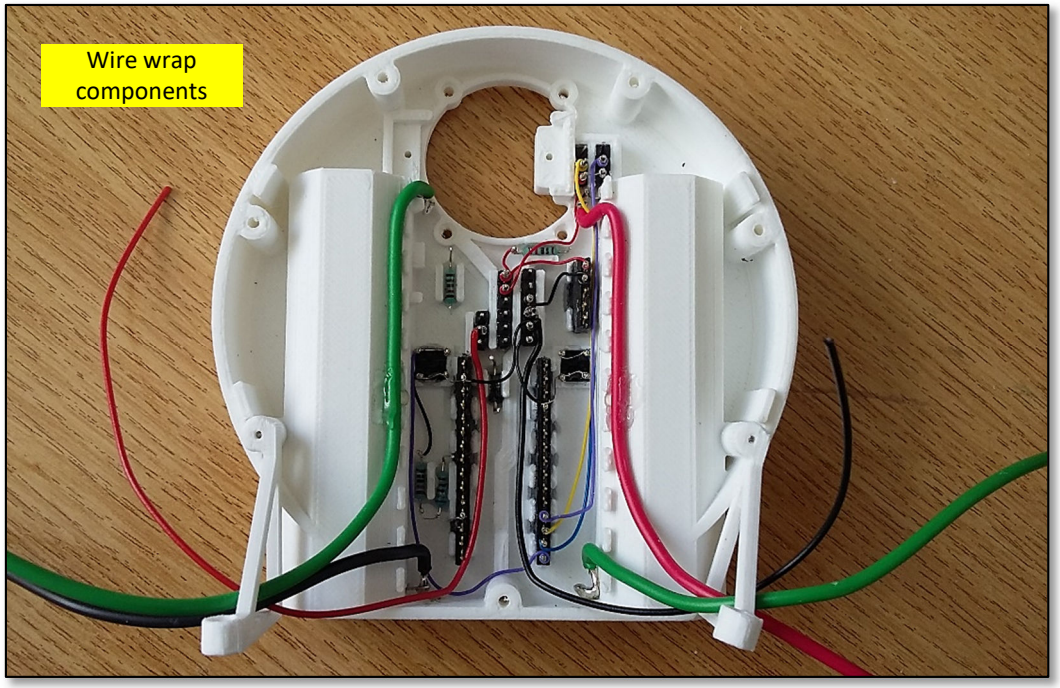
Issue: 1.1 Released: 08/12/2025

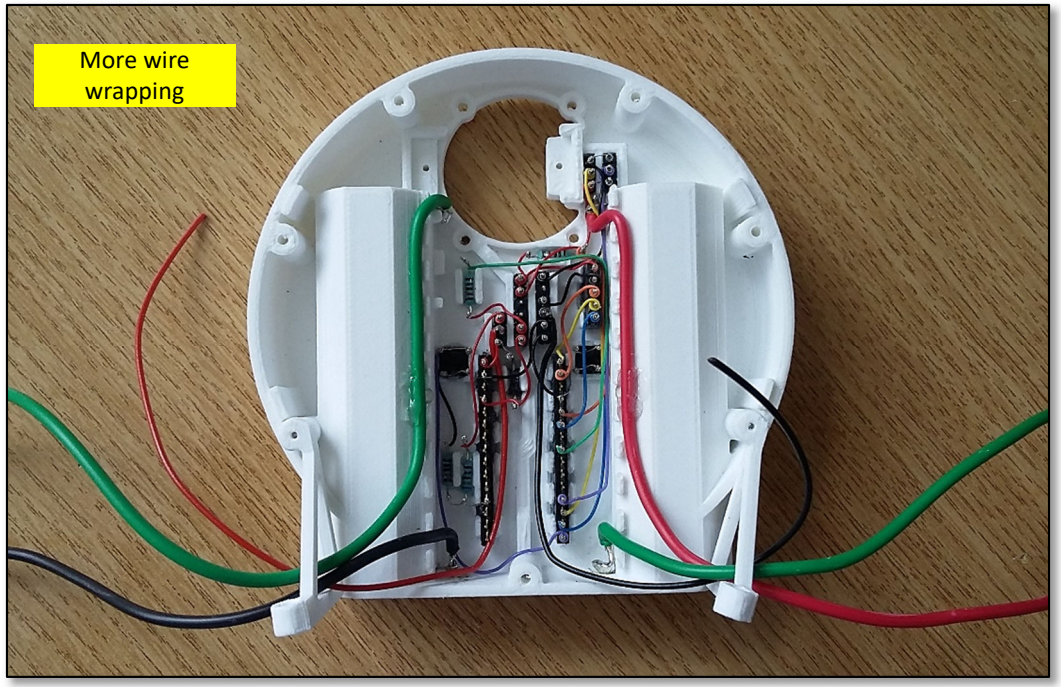

MPU6050 added
Hip ring
Body plate

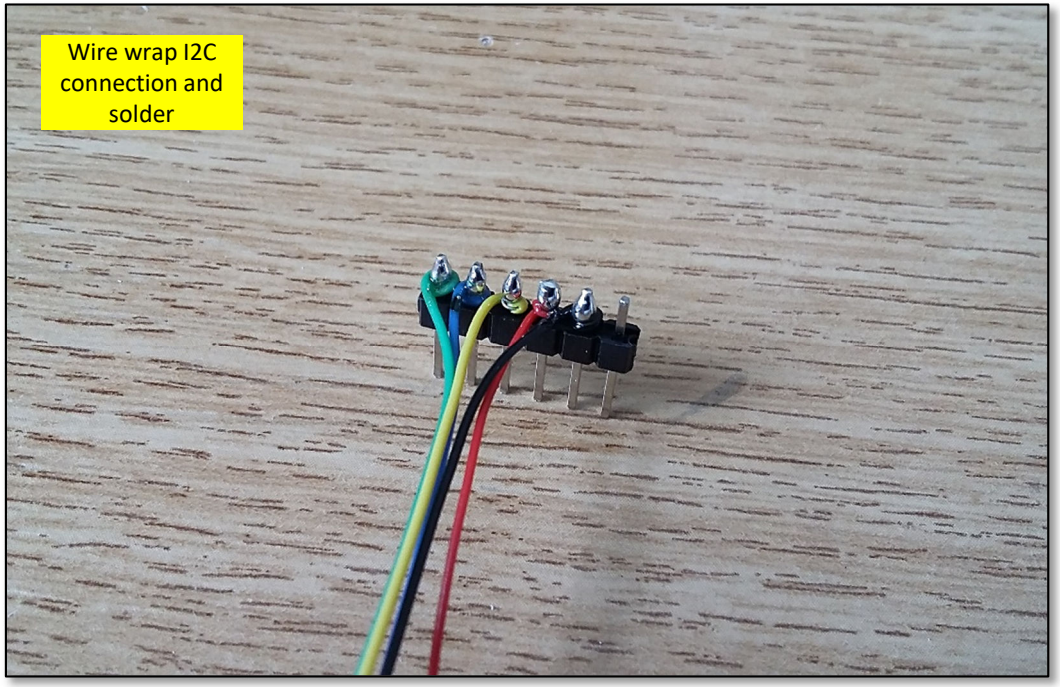

Glue in socket strips, resistors, battery connectors, pin strips and button switches
Top plate
Attach assembly stay aids

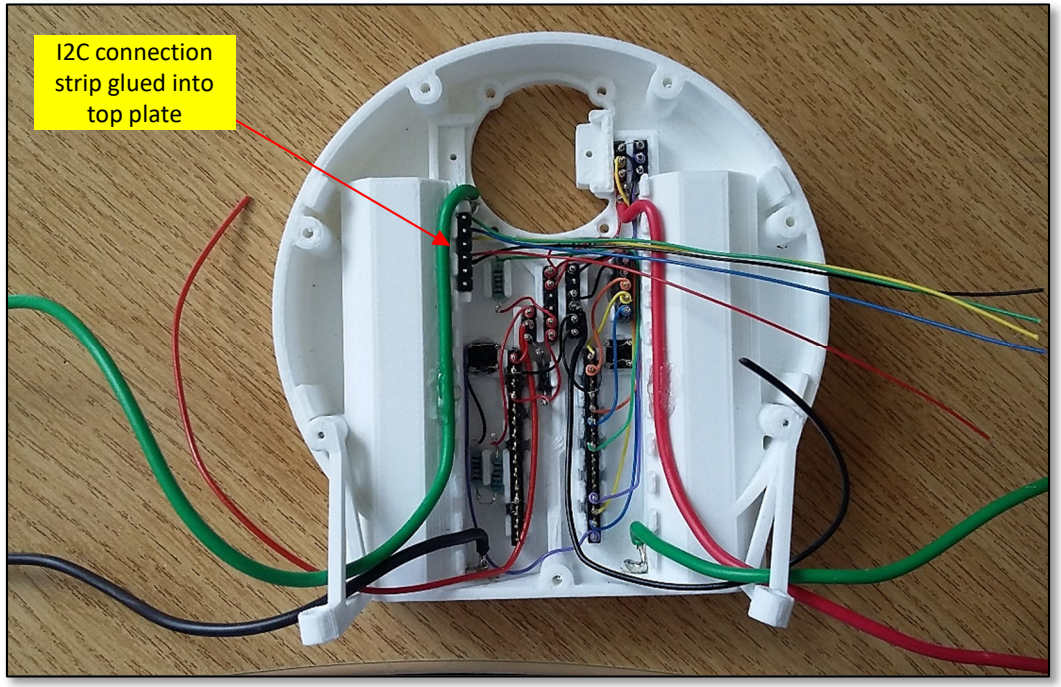

Solder power cables first

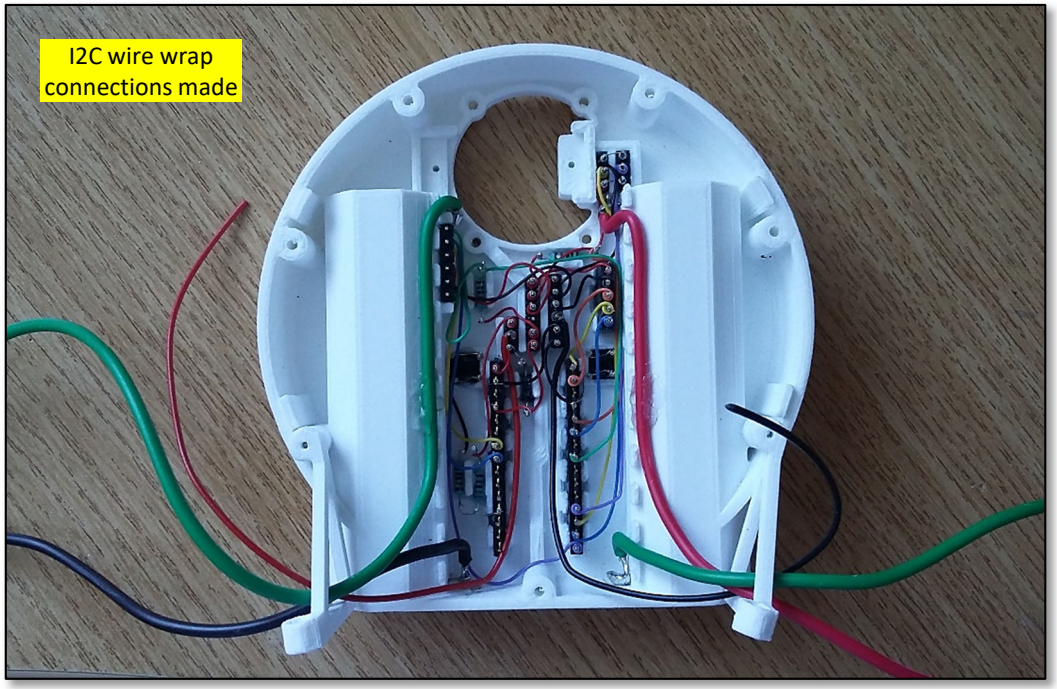


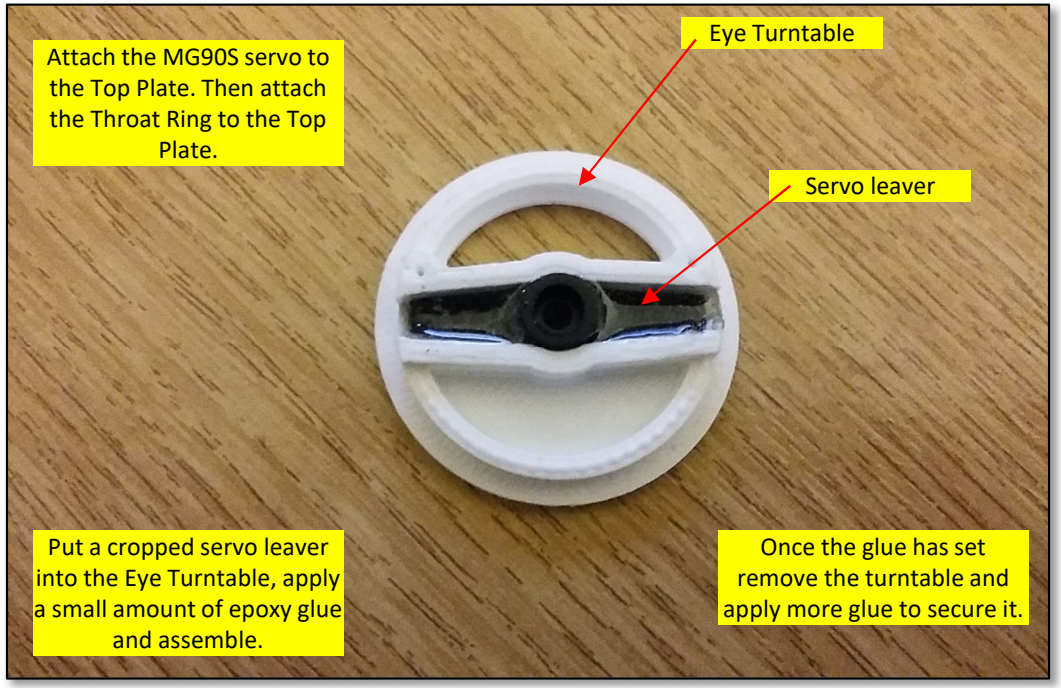

Wire wrap components

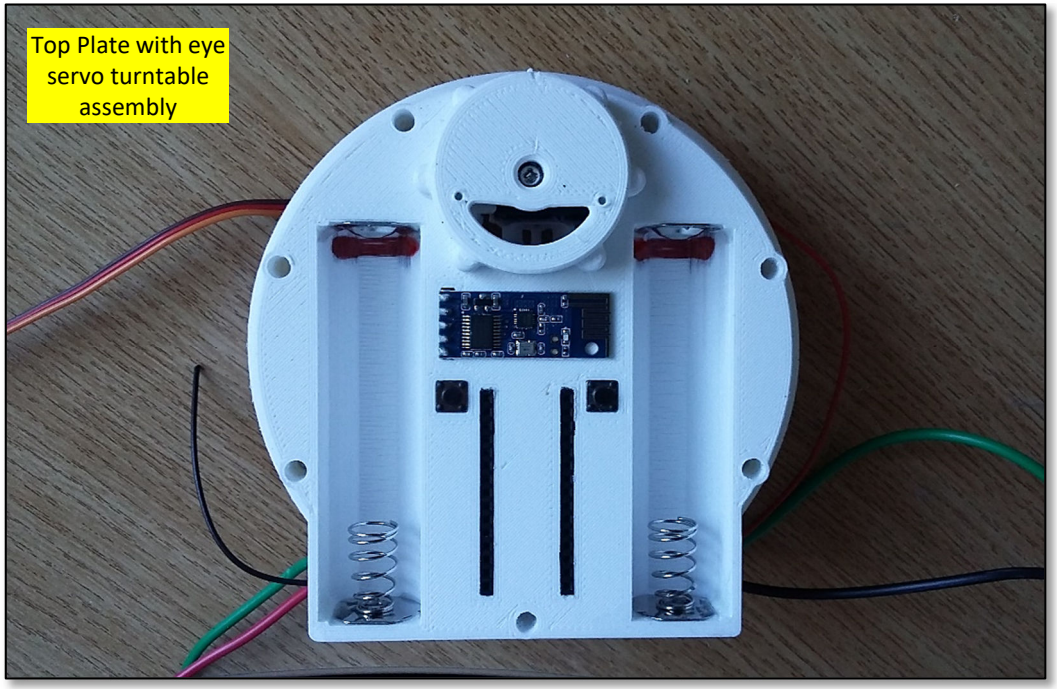

More wire wrapping

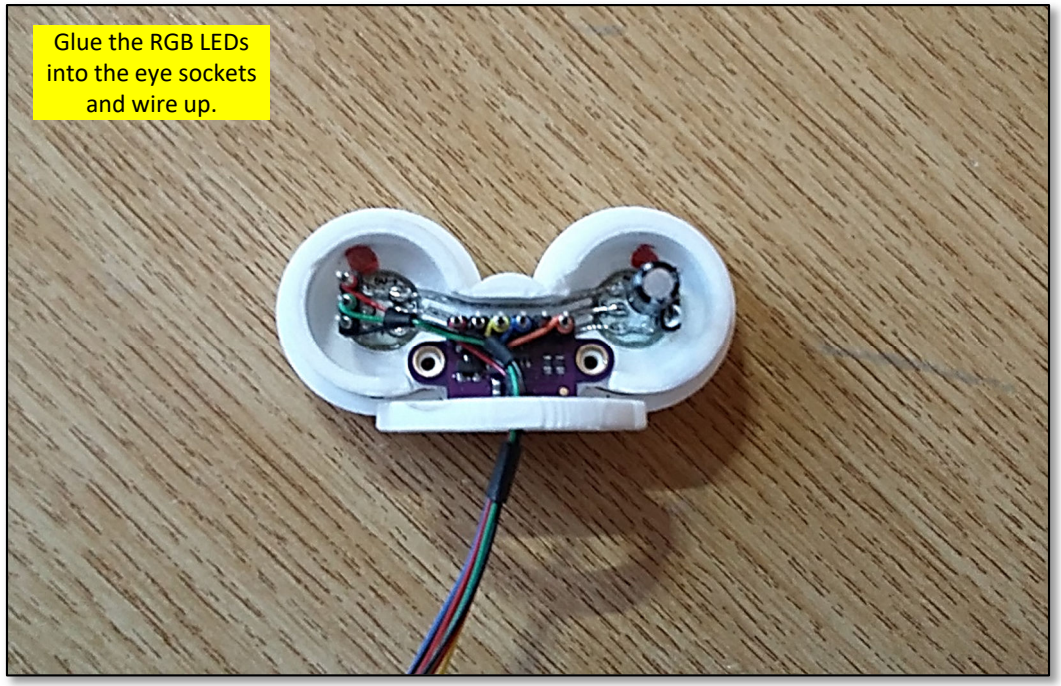

Wire wrap I2C connection and solder


I2C connection strip glued into top plate

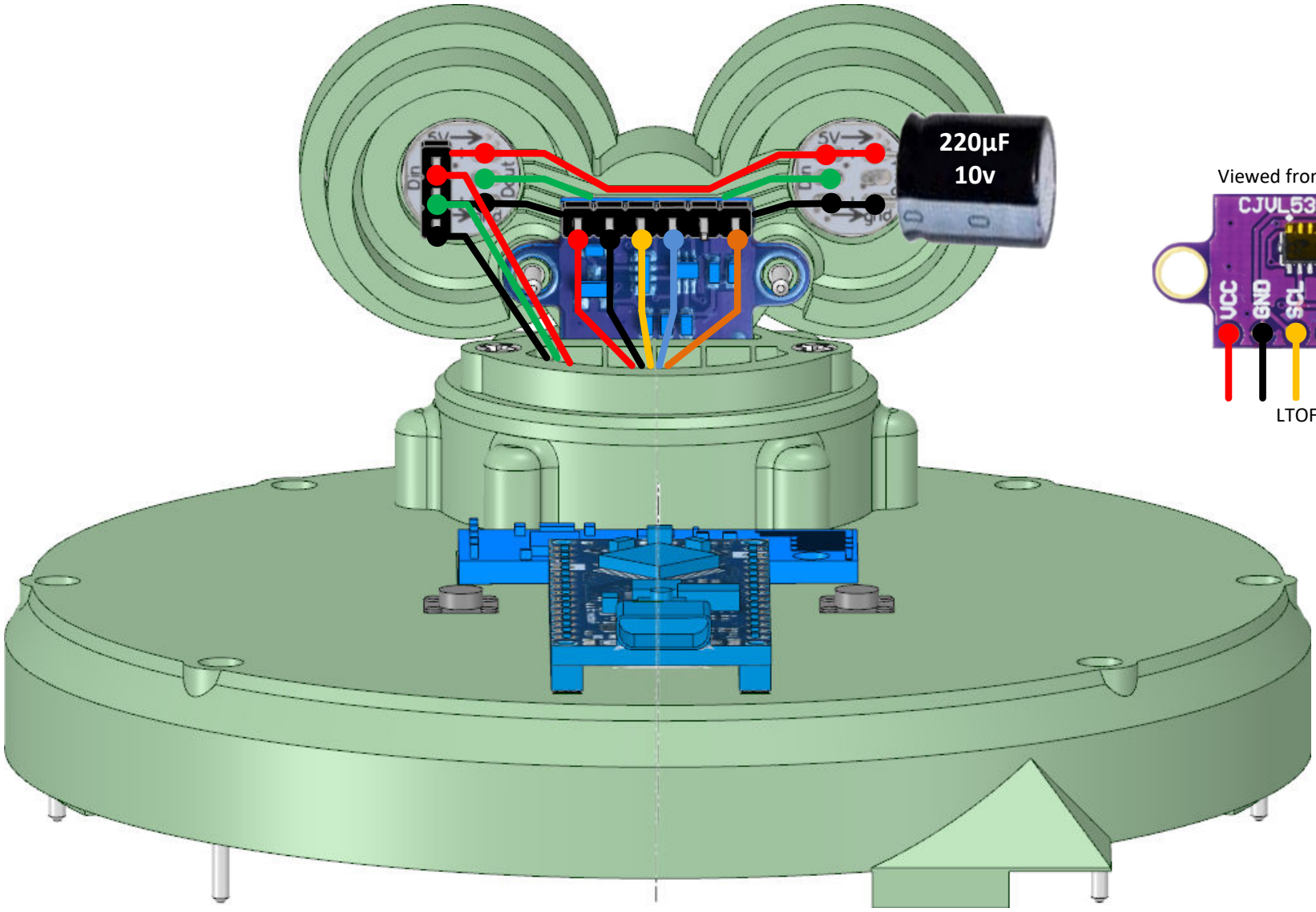

I2C wire wrap connections made


Attach the MG90S servo to the Top Plate. Then attach the Throat Ring to the Top Plate.
Eye Turntable
Servo leaver
Put a cropped servo leaver into the Eye Turntable, apply a small amount of epoxy glue and assemble.
Once the glue has set remove the turntable and apply more glue to secure it.


Top Plate with eye servo turntable assembly

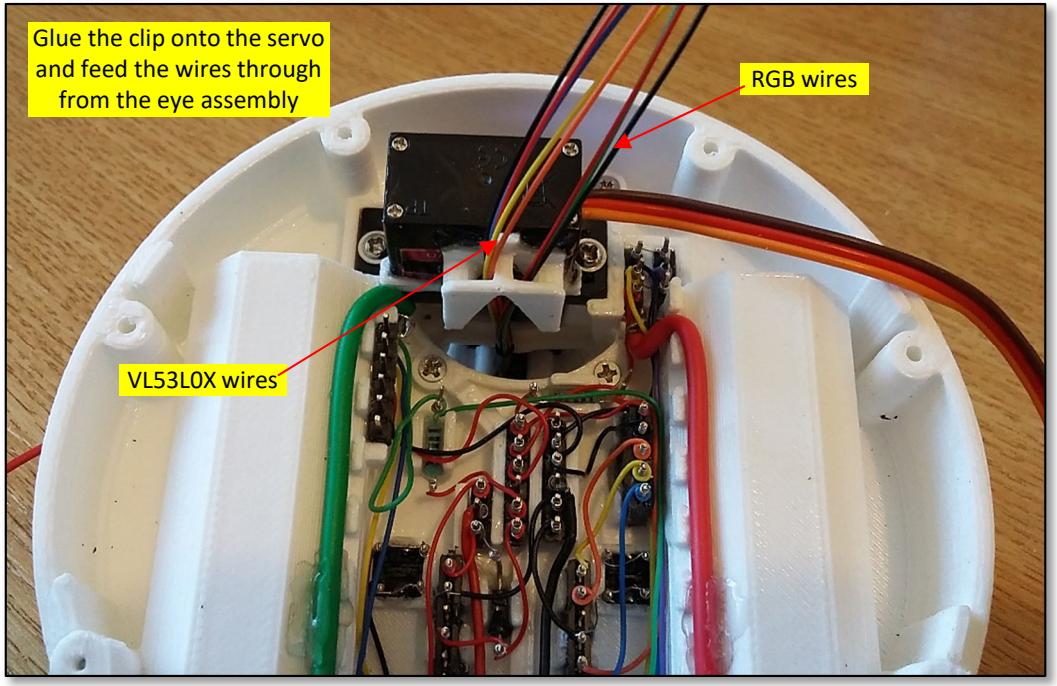

Glue the RGB LEDs into the eye sockets and wire up.

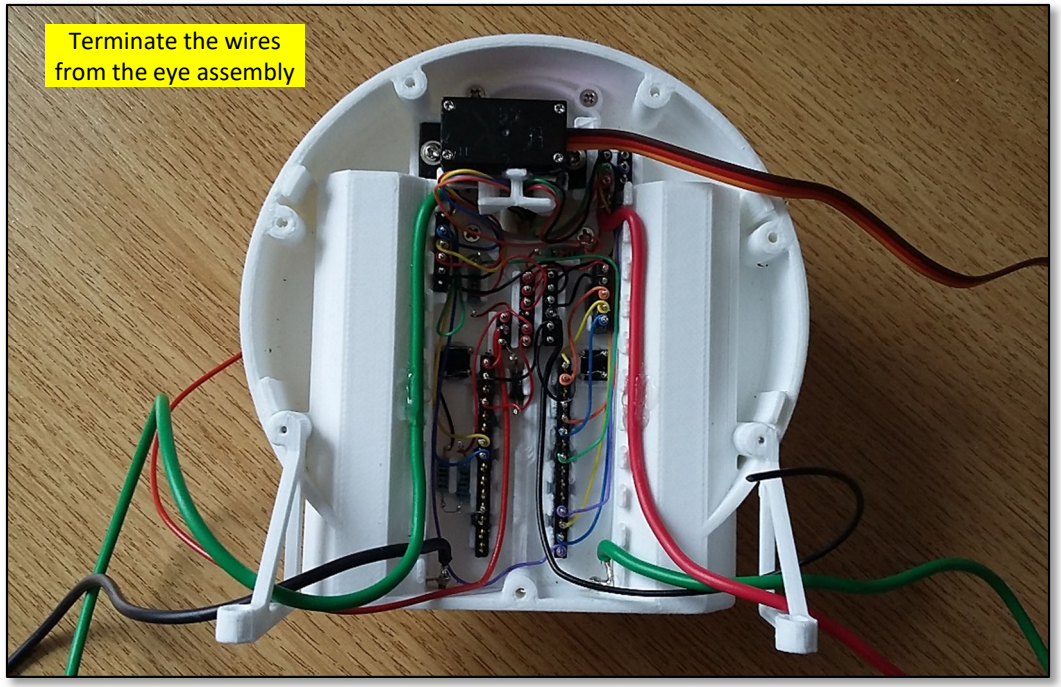
Biped Droid Head Wiring

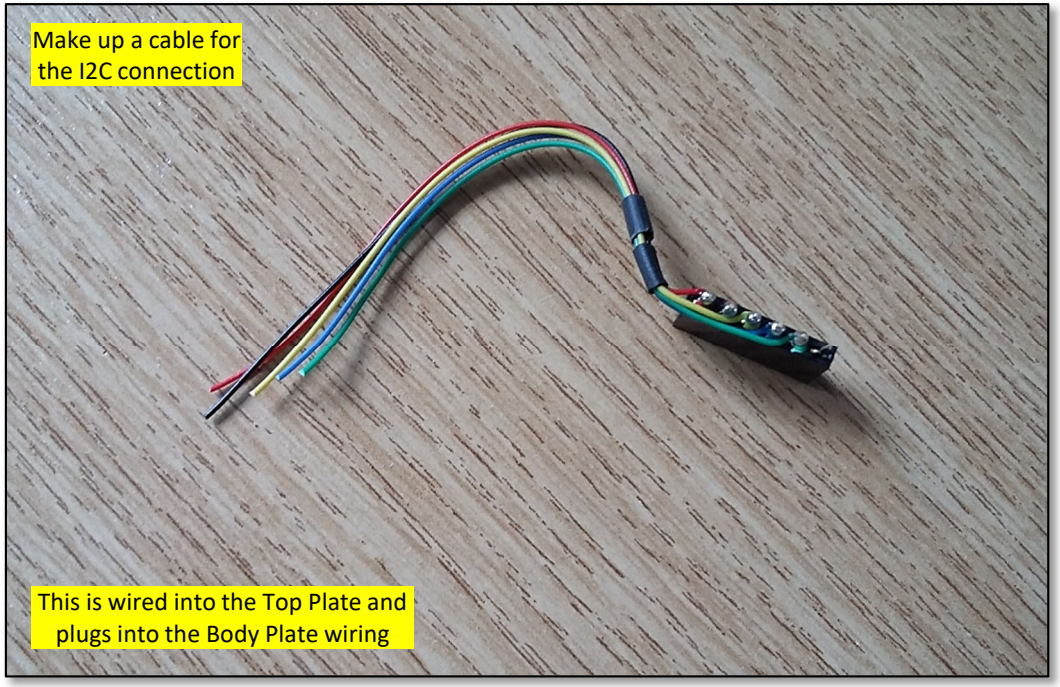


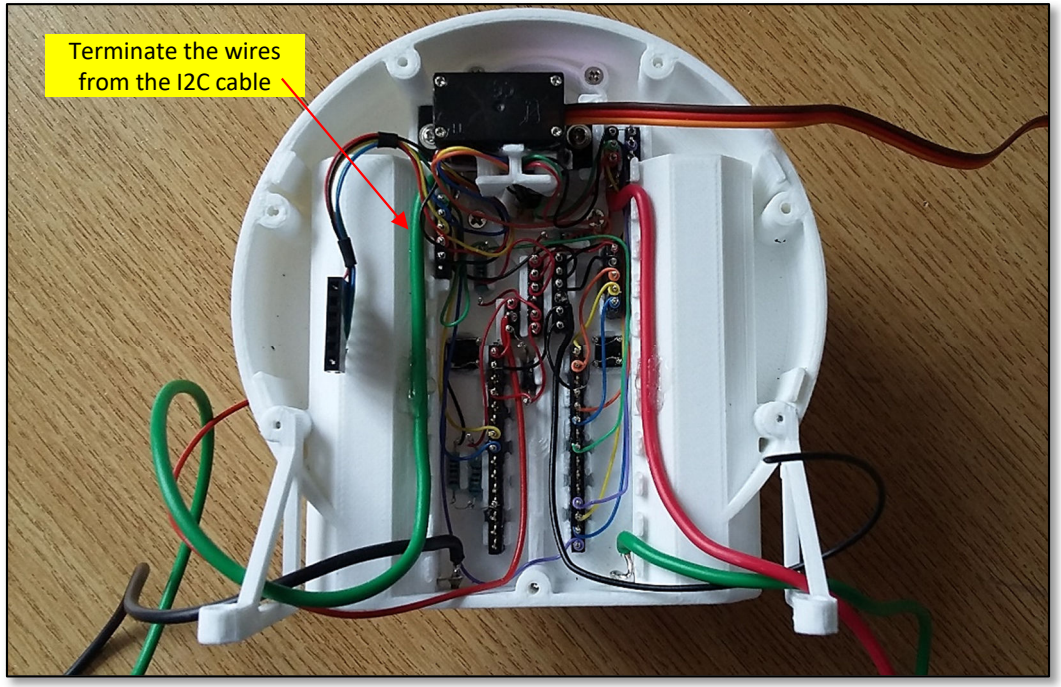
Viewed from the front

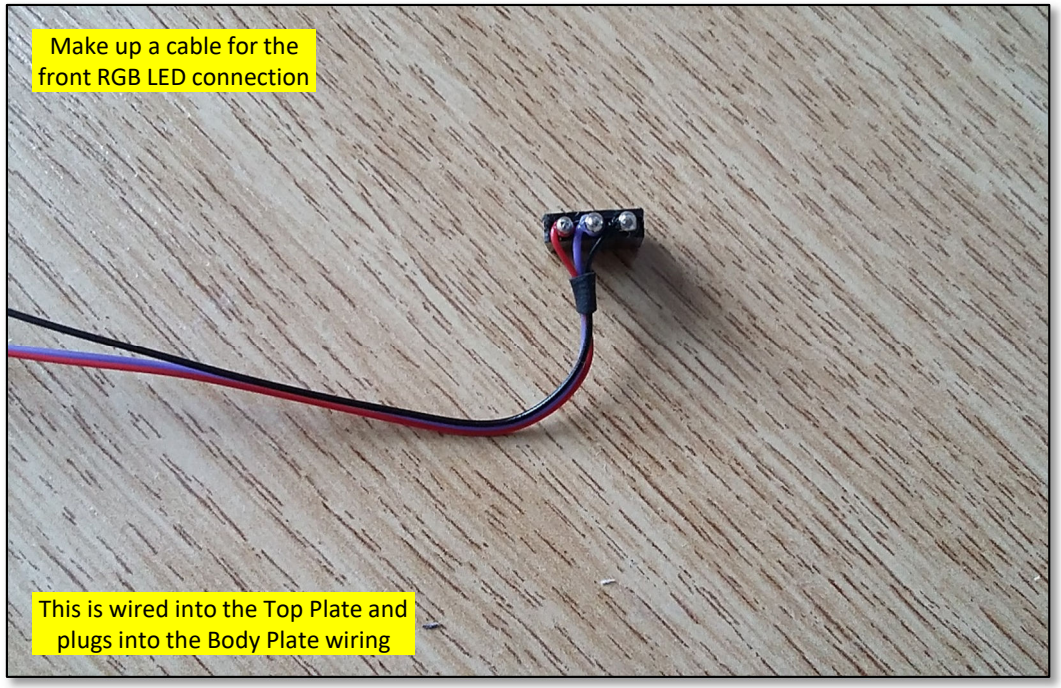
LTOF I2C

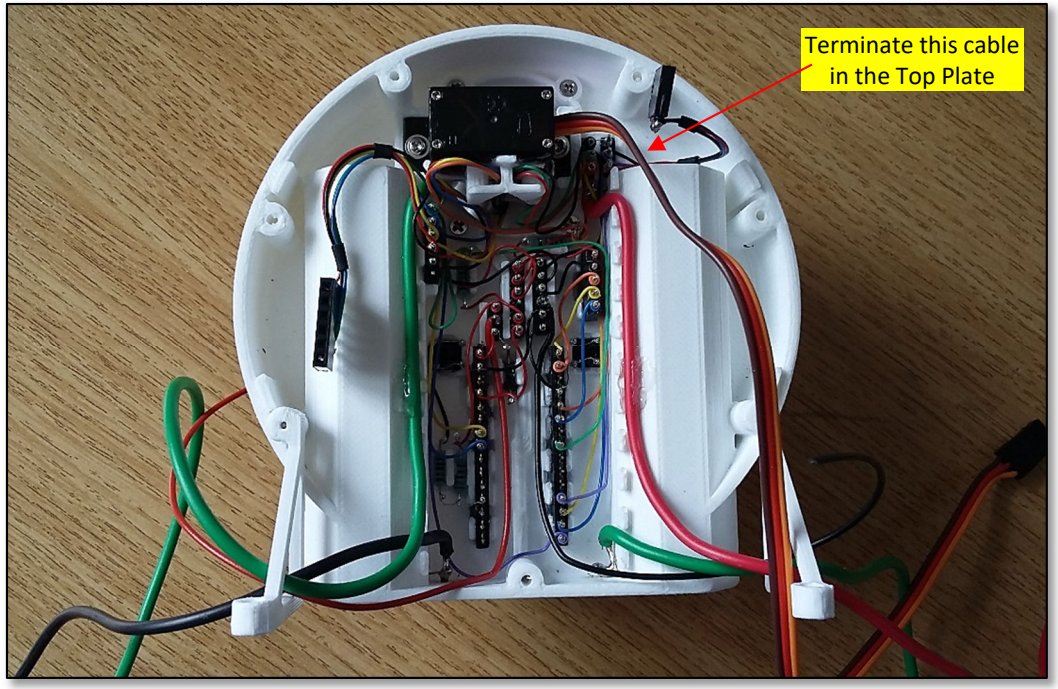

Glue the clip onto the servo and feed the wires through from the eye assembly
RGB wires
VL53L0X wires

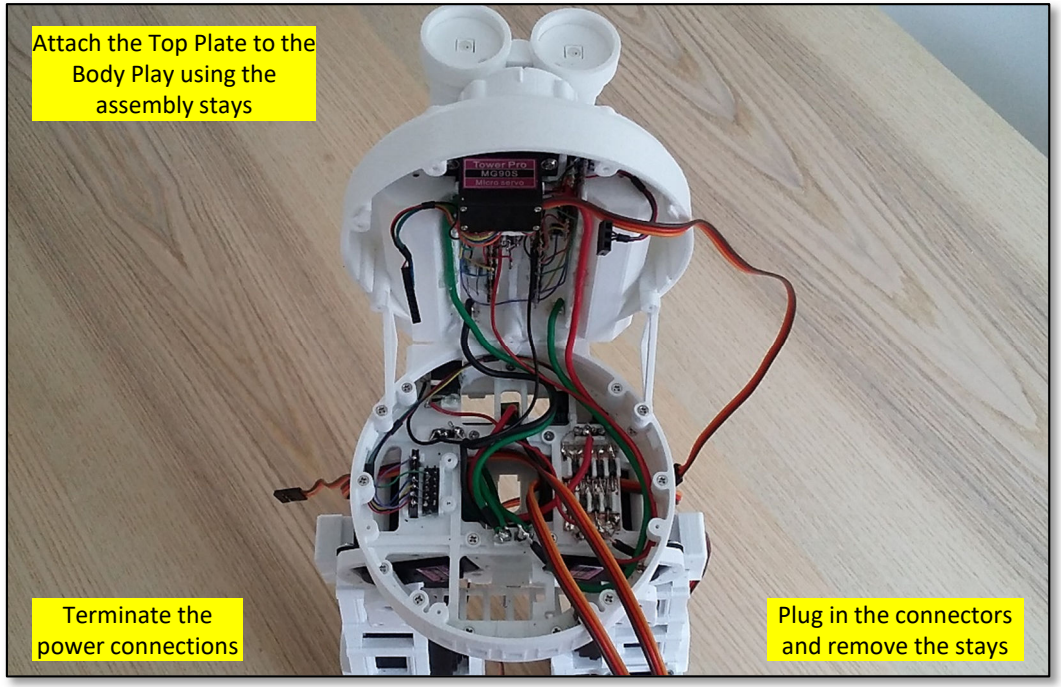

Terminate the wires from the eye assembly

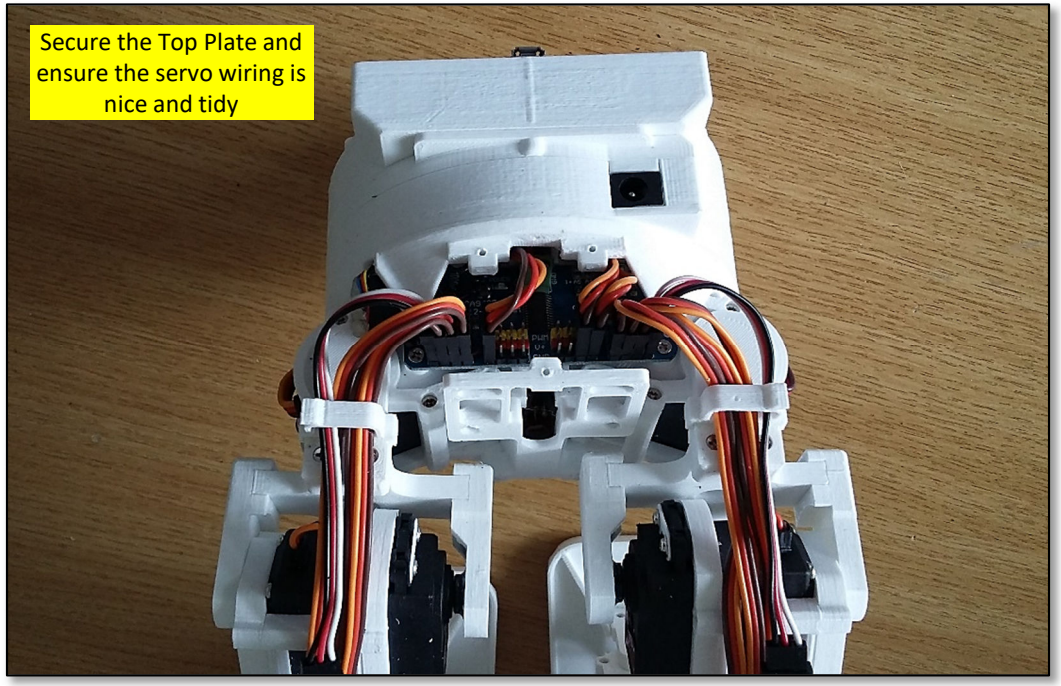

Make up a cable for the I2C connection
This is wired into the Top Plate and plugs into the Body Plate wiring


Terminate the wires from the I2C cable

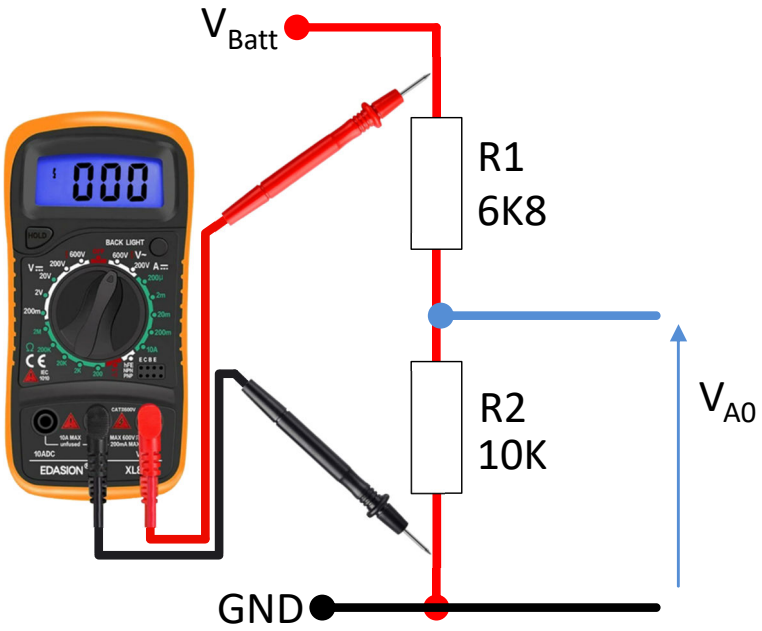

Make up a cable for the front RGB LED connection
This is wired into the Top Plate and plugs into the Body Plate wiring


Terminate this cable in the Top Plate


Attach the Top Plate to the Body Play using the assembly stays
Terminate the power connections
Plug in the connectors and remove the stays


Secure the Top Plate and ensure the servo wiring is nice and tidy

Battery Monitor (Protection)



$$V_{A0} = \frac{V_{Batt} \times R2}{R1 + R2} \qquad V_{A0D} = \frac{V_{A0} \times 1023}{5}$$ voltage read by 10-bit ADC

$$V_{A0} = \frac{V_{Batt} \times 10K}{16K8} \qquad V_{A0D} = \frac{V_{Batt} \times 0.5952 \times 1023}{5}$$

$$V_{Batt} = \frac{V_{A0D} \times 5.0}{608.9}$$

$V_{FSD} = 8.4v$ @ $V_{A0} = 5v$

Two cells in series gives a nominal 7.4v constant discharge voltage. To prevent damage, stop using once the following conditions are reached:

3.60 + 3.00 = 6.60v (one battery fades early)
3.30 + 3.30 = 6.60v (both batteries fade together)

Hence $V_{A0D} = 540$ @ $V_{Batt} = 6.60v$

The code will shut down when the value drops to 540.