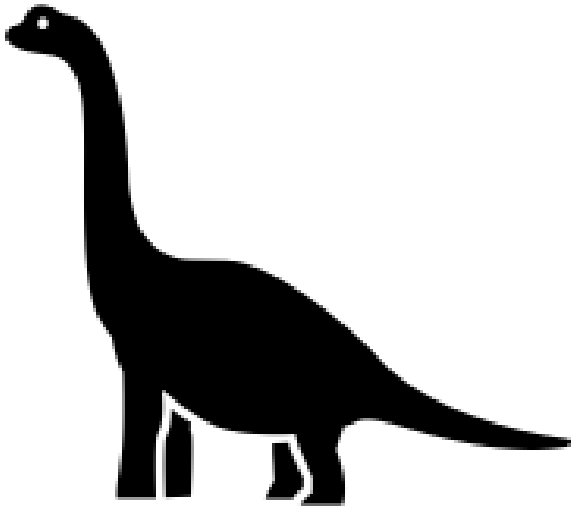
McGill Radio Lab

BRACHIOSAURUS
Assembly Manual



Felix St-Amour

Prof. H. Cynthia Chiang

McGill University Department of Physics

January 23, 2025

Contents

1 Assembly

Material

Printable circuit boards and their components (some include the part number for DigiKey):

- Printable Circuit Board (PCB)
- Single row female header pins
- Single row male header pins
- Female to female 4 pin connector (4 inches)
- DFR0654 FireBeetle 2 ESP32-E Microcontroller
- Vertical micro SD card mount (part number MSDV-2008-AKA0T01)
- Switch (part number 450301014042)
- Small Molex Connectors (x2)
- LSM6DSOX (accelerometer board)
- 3x AA batteries holder (Digikey part number 36-2487) (x2)
- HC-SR04 ultrasonic depth sensor
- Velcro

Aluminum box and attachments:

- 3/8” standoffs (x4)
- 4-40 Phillips screws (x8)
- 20 mm M3 screws (x4)
- M3 nuts (x4)
- Rubber washers (x8) DK 36-3116-ND
- O-rings, 9/16” (inner diameter) x 3/4” (outer diameter)
- Custom aluminum plate cover (for depth sensor)
- 1” U-bolts (with two lock washers and nuts)
- Metal zip tie
- Aluminium box (Hammond Manufacturing 1590WXXFL), comes with 4 watertight screws and a watertight gauge for the box

Mounting the PCB

Here is the protocol to populate the PCBs. For this, you will need a flat-head soldering iron and everything from the PCB section of the materials.

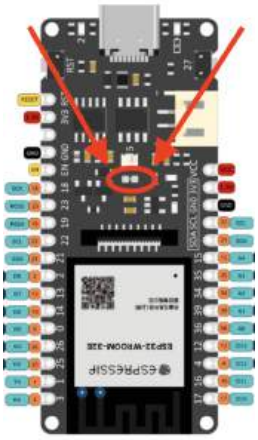


Figure 1: The RGB wire that needs to be cut is circled in red on the board.

Begin by soldering the male header pins to the accelerometer as well as the microcontroller. Note that the accelerometer only needs male header pins on the side with pins VIN, 3Vo... I2. Also note that the microcontroller has male and female pins included in the packaging. Before moving forward, ensure that the RGB wire has been stripped on the microcontroller using a knife, see Figure 1. This is extremely important for energy conservation. The end result should look as in Figures 2 and 3:

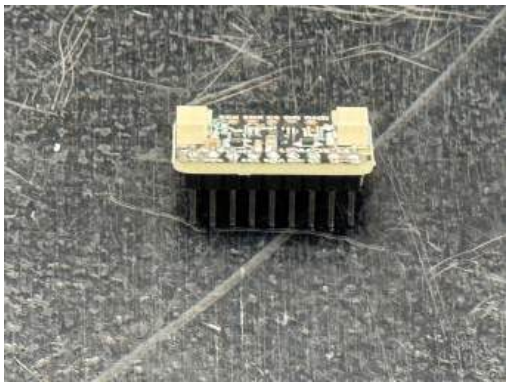


Figure 2: Acceleromater with male solder pins

The next step, soldering a few components on the PCBs, is not required to be done in any particular order, but it was found that the order given allows for simpler soldering as the

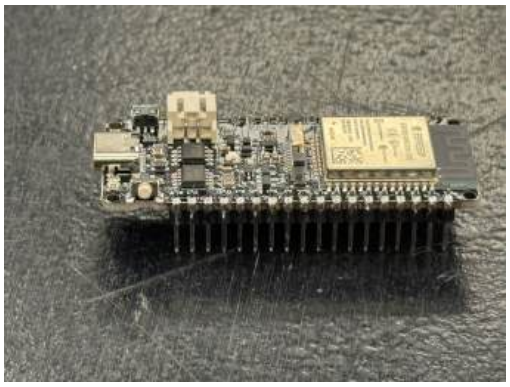


Figure 3: Microcontroller with male solder pins

board gets more crowded. It is also recommended to do this with a piece of tape in order to hold the components in place while you flip the PCB to solder the components. On the PCB:

- Solder the switch on the footprint labeled SW (the orientation does not matter)
- Solder the small molex connector to the footprints labeled BT1 and BT2. The PCB suggests soldering with the plastic pin sticking out towards the switch (in case of confusion, refer to Figure 4)
- Solder male pins to the through holes of the U1 footprint. Note that the long part of the male pins should be pointing out of the face of the PCB (the face which has a silkscreen)
- Solder female header pins to the footprint labeled U3
- Solder female header pins to the footprint labeled U2
- Solder the micro SD card holder to the footprint labeled U5. Notice that the micro SD card mount has 3 large pins forming a triangular pattern (besides the smaller pins in the center). The pins can be aligned to their corresponding hole on the PCB as to orient the micro SD card mount properly.
- Add velcro to the center of the Battery footprints

The PCB with all the components soldered to it should look as in Figure 4.

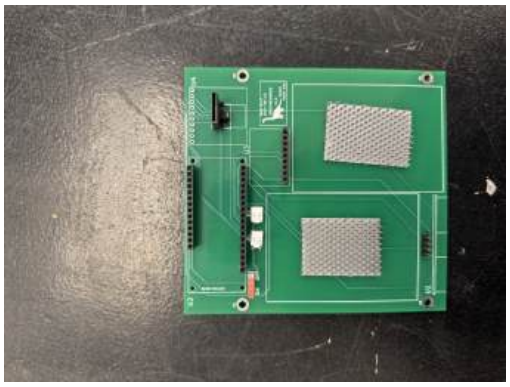


Figure 4: A PCB containing all the components that need to be soldered to it.

You can now add on the the microcontroller, accelerometer, and micro SD card to the board. For the microcontroller and accelerometer, simply push their male pins into the female pins. They should be easy to put in and remove. The current board should look like Figure 5.

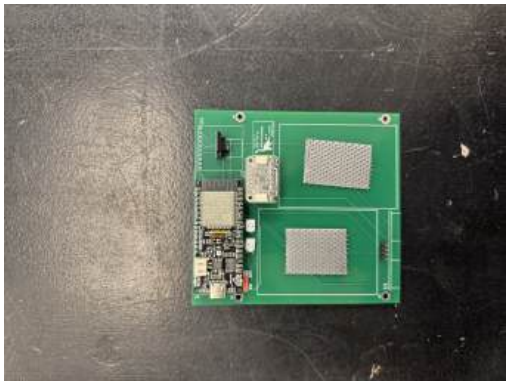


Figure 5: PCB with the microcontroller, accelerometer, and micro SD card added.

When it comes to adding the depth sensor, first connect the 4-pin female connector to the male pins on the PCB. Connect the depth sensor to the 4-pin female connector such that, if the depth sensor was directly soldered to the PCB, the transceivers (metallic cylinders) would be sticking out of the PCB, as suggested by the silkscreen layout. Figure 6 shows what this should look like.

Insert the exposed wires from the battery holders in the Molex metal crimps before inserting them in the top half of the small Molex connectors. They should be inserted in the top half of the small molex connector such that the red wire goes to + and the black wire to - (as seen on the PCB where the molex connector attach). The wires should remain in

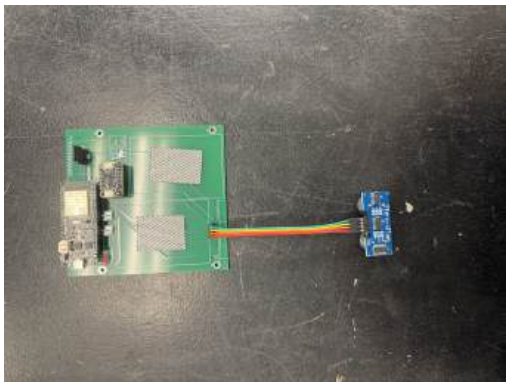


Figure 6: PCB with the depth sensor added.

the small Molex connectors when lightly tugging on them. They can now be connected to the bottom part of the small Molex connectors. Add a patch of complimentary velcro to the underside of the battery holders such that they can rest on the PCB without sliding. Figures 7 and 8 show what this looks like.

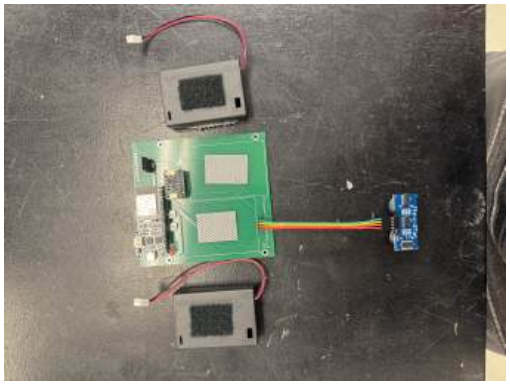


Figure 7: PCB with battery holders before being connected together.

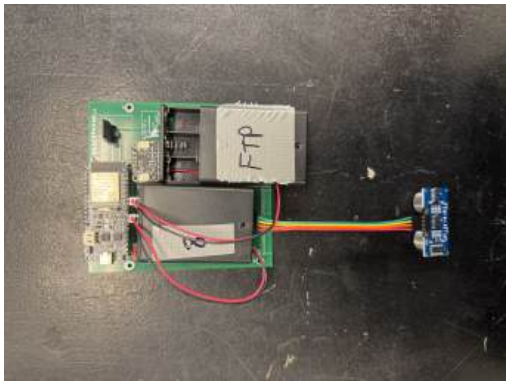


Figure 8: Fully completed PCB.

While making sure that the switch is turned to the ON position (since there is an error on the print, this means that the board is powered off), slide open the battery holders (you might need to remove the protective screw beforehand) and place 3 AA batteries in each battery holder. Only one battery holder needs to be filled in order to power the board. Removing a single battery from a battery box renders the battery box useless as no current will flow.

Preparing the box:

Mounting the PCB to the box

1. Position a PCB that is yet to be populated on the top of the aluminum box and align it where you would like the PCB to sit inside the box. Mark the position of the holes (H1, H2, H3, H4) on the box. Allow for 1 cm of space from the top and bottom as to properly fit inside the box. See Figure 9.

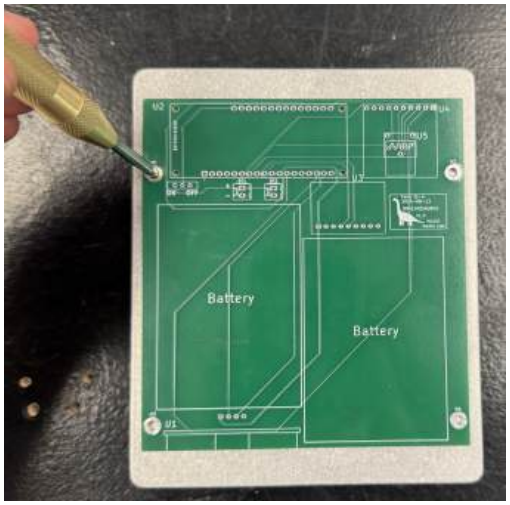


Figure 9: PCB aligned with the box.

2. With a 1/8" drill, drill the marked holes. See Figure 10.

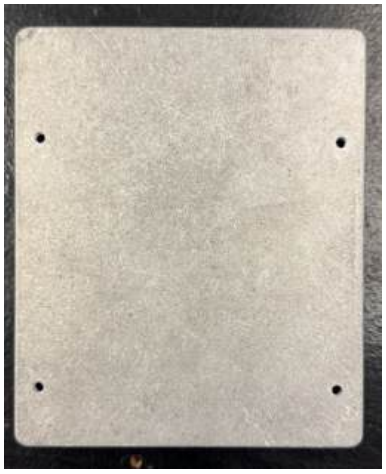


Figure 10: Box with holes drilled for the PCB.

3. Add a plastic washer on the outside of the box before screwing in the 4-40 M3 standoffs. See Figures 11 and 12.

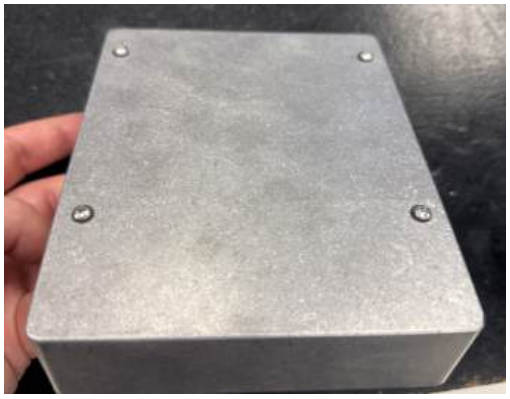


Figure 11: Underside of the box with the screw and plastic washer.

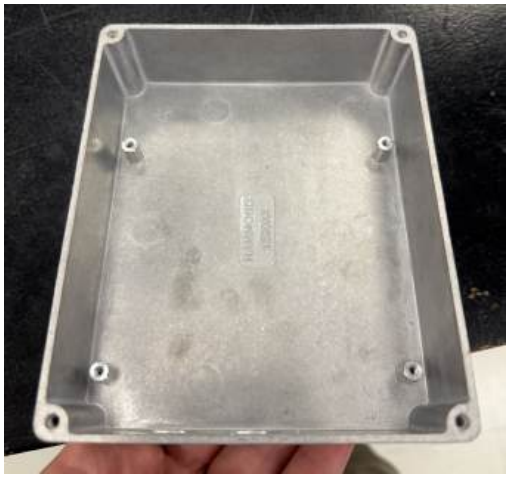


Figure 12: Inside of the box with the 4-40 M3 standoffs.

Mounting the depth sensor

1. With a 3/4" drill, drill 2 holes at the bottom of the box (where the ultrasonic depth sensor will go) with their center 1" apart (2.54cm). Preferably, scout where the holes will go using the aluminum cutout that will go over the transceivers in order to ensure that the piece will fit. See Figures 13 and 14.

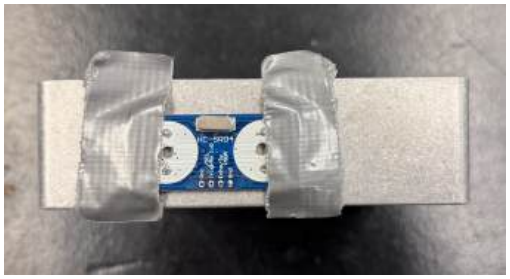


Figure 13: Holes being marked for the depth sensor.

Figure 14: Holes corresponding to the depth sensor.

2. Trim down the 4 pins protruding out of the depth sensor (on the same face as the transceivers) and place electrical tape over them. This will ensure that the pins do not come into contact with the aluminum box, shorting the ground and VCC pins.

3. Align the cutout with the holes previously drilled for the depth sensor. Mark and drill 4 holes on the box corresponding to the ones found on the cutout. See Figures 15 and 16.

Figure 15: Cutout aligned with the holes of the box.

Figure 16: Holes drilled in the box corresponding to the depth sensor and cutout.

4. Inside the box, insert the ultrasonic depth sensor to let the transceivers (cylinders coming out of the sensor) go through the holes drilled in step 1. The pins of the depth sensor should be pointing upwards. Secure the transceivers in place with O-rings. The O-rings should cover the entirety of the hole. See Figure 17.

Figure 17: Depth sensor and O-rings placed on the box.

5. Screw the cutout over the transceivers, the head of the screw should be on the outside of the box. Add a plastic seal ring and secure the screw with a nut on the inside. Since the space is tight, I suggest using pliers to hold the nut while screwing with a screwdriver from the outside. Make sure a lot of pressure is applied on the O-rings (screw as much as you can). See Figures 18 and 19.

6. Slide in the PCB. The depth sensor previously added can be connected to the board

Figure 18: Screw inserted to secure the cutout. Notice that the head of the screw is towards the outside. On the other hand, the threaded part of the screw is inside and contains a plastic washer as well as a nut to secure it.

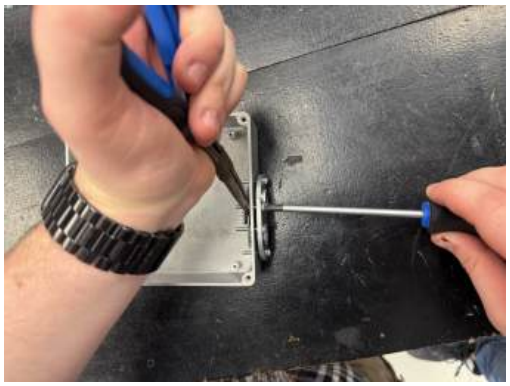


Figure 19: Suggested technique to screw in the cutout.

via the 4 pin connector. Ensure that you give the 4 pin connector a twist such that VCC goes to VCC and GND to GND. The PCB can be screwed in via the H1, H2, H3, and H4 holes. See Figure 20.

Figure 20: Completed box. The PCB is screwed into the box.

Mounting the box to the pole

1. Mark the base of a 1" U-bolt on the mounting flange. See Figure 21.

Figure 21: Marking the base of the U-bolts.

2. With a 9/32" drill (or 5/16" if it makes it easier), drill a hole through the marks made previously.

3. Insert the U-bolts in these holes with the round part pointing away from the box. Slide the pole through the U-bolt making sure that the U-bolt points up, and the depth sensor down. Fix the box on the pole using bolts tightened with a wrench (11mm). Metal zip ties can be secured to the bottom holes of the back cover in order to further secure the box. See Figure 22 for the U-bolt attachement to the back cover.

Figure 22: U-bolts added to the cover of the box.