

# Solid State Replacement Tack Sensors

## Manufacturing Instructions

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*\*\*\*See photos at end of packet for reference throughout manufacturing\*\*\**

1. Have the latest version of the PCB manufactured. [pcbway.com](http://pcbway.com) is a good source.
  - A .zip archive of the files the manufacturer will want is on github:  
\UTS-2017-Windows\CAD\PCB\Vx\_x\_xMFG
2. Order parts from BOM on Drive:  
<https://drive.google.com/drive/folders/0B76Is89DhFVzSlpCSkRFT1pZRWc?usp=sharing>
  - The parts from Amazon might change price so it may be worthwhile to check other Amazon listings.
  - Check to see what the Olin Blind Sailing Research Team already has.
3. Manufacture Bracket and TrackStop from \UTS-2017-Windows\CAD\Bracket
  - Make sure to chamfer the slot where the shock cord will go. Use a mill drill, then file afterward to remove any tiny burrs.
  - Make sure that a #10-32 screw slides easily into the other slot. You may need to file the slot slightly depending on the condition of the end mill used.
  - Screw a #10-32 x 7/16" screw into the tapped hole in the bracket very tightly.
4. Print the latest version of the box liner: \UTS-2017-Windows\CAD\Vx\_x
  - Support material is a good idea to help with the curve on the bottom, just make sure to remove it completely after it's printed.

## 5. Solder the PCB.

- Solder the resistors first, as some of them are hard to access after other components are installed.
  - Resistor values are as follows:
    - R1 – 1.43K $\Omega$
    - R2 – 499 $\Omega$
    - R5 & R6 – 750 $\Omega$
    - R7 – 1.58K $\Omega$
    - R9 – 4.02K $\Omega$
    - R10 – 10K $\Omega$
    - R11 – 4.99K $\Omega$
- LED colors are as follows:
  - BATT – Blue
  - PORT – Red
  - STBD – Green
  - BAL – Yellow
- Solder in female headers for the Arduino and for the serial breakout to the left of the Arduino.
- Solder male headers onto the Arduino and accelerometer, if necessary. Solder the accelerometer directly onto the board and clip the headers on the back with diagonal cutting pliers (the steel headers will ruin small flush cutters).
  - Do not solder on the 2x6 ICSP header on the top of the Arduino. If the Arduino came with it already attached, you may want to desolder it to get more clearance in the box.
- Make sure that the ON position for the DIP switch is to the right.
- To connect the battery snap, thread the wires through the holes from top to bottom, then bring the ends up from bottom to top and solder them on the top of the board. Once they are soldered, pull the slack out. Try to minimize soldering time so the insulation doesn't melt.
- The other components should be self-explanatory.

6. Prepare the box.

- Remove the Pelican sticker.
  - Peel the sticker up slowly, then remove residue by repeatedly sticking and pulling off a piece of duct tape.
  - You could probably also use a rag and a solvent, but duct tape seems to work fine. Sometimes the sticker just comes off cleanly.
- Use a hacksaw to cut the loops off the box at the top and bottom. Then use a sharp knife to shave the remaining edges perfectly flush with the box.
- Separate the liner and gasket.
  - Remove the liner from the box and place it upside down on a cutting mat.
  - Use a very sharp snap knife or x-acto knife to carefully cut around the gasket from the back.
  - You should be left with a border a little under ¼” wide.
  - Be very careful not to cut into this gasket, especially at the corners.
  - Put the gasket back in the groove in the box.
  - Discard the other box-shaped piece you are left with.
- Drill the box:
  - Use an existing jig or print a new one:  
\\UTS-2017-Windows\CAD\Vx\_x\TackHoleJig.sldprt
  - All the holes drilled with the jig should be ⅛”.
  - Press the jig firmly onto the top end of the Pelican case (the end that you removed the more complicated loop from; also the top when the box opens like a book).
  - At the top of the box, drill all four holes (two on the end, one on the back, and one on the side).
  - Move the jig to the other end of the box.
  - On the bottom end of the box, drill only the two holes on the end.
  - Remove the jig, switch to a ¼” drill bit, and drill out the hole on the side.
  - Use a knife to remove the ridge on the back that is adjacent to the hole on the back.
    - You only need to remove about 1” of it right in the middle of the box, but it is important that it be perfectly flush so the cord grip will sit flat.
  - Drill out the hole in the back to ¼”, then switch to a step bit and drill it to ½”.

## 7. Populate the box.

- Install the switch.
  - Clip off the two leads on one end of the switch as close to the body of the switch as possible with diagonal cutting pliers.
  - Install female connectors on the ends of four pieces of flexible stranded wire about 2.5" long.
    - For consistency, use a red pair and a yellow or white pair.
  - Push the connectors into the plastic housing so that with the tab pointing down, the red pair is on the left.
  - Solder the other ends of the wires to the switch so that with the clipped leads pointing up, the red pair is on the right two terminals as observed from the bottom of the switch.
  - Remove the nut but leave the O-ring on the switch, squeeze a small amount of silicone sealant around the hole on the inside, push the switch through with the clipped terminals toward the top of the box, and tighten the nut on the outside.
  - Make sure the nut is very tight and the body of the switch is parallel to the box.
- Install the mounting loops.
  - It's important that the switch goes in before the top loop.
  - Use a file to file down one end of one of the loops so it fits through the circle in the end of the carabiner.
  - Check that the hole spacing of the loops lines up with the holes you drilled. The holes in the loops will probably be slightly wider set. If this is the case, use a vice or large pair of pliers to bend the loops slightly so they align with the holes in the box.
  - Put a small dab of silicone sealant on the inside and outside of each of the holes on the ends of the box.
  - Bolt both loops on, making sure that the carabiner is on the top and the opening faces the back of the box.
  - Use a washer and locknut on each bolt.
  - Tighten firmly.
- Install the cord grip.
  - Remove the O-ring from the cord grip.
  - Put a small amount of silicone sealant around the large hole in the back on both sides
  - Put the cord grip through the hole and tighten it firmly with a wrench or pliers.
- Install the liner.
  - Print out a serial number label and stick it on the back of the liner, just below the curved indentation at the top.
    - The label should read:

OLIN COLLEGE 20yy  
S/N xx.xx.xx.xxx
    - Where the serial number is the PCB version number (xx.xx.xx) followed by the unit number (xxx),
    - And yy is the year.
  - Cut about 2" of double sided foam tape and stick it below the label in the middle of the liner.

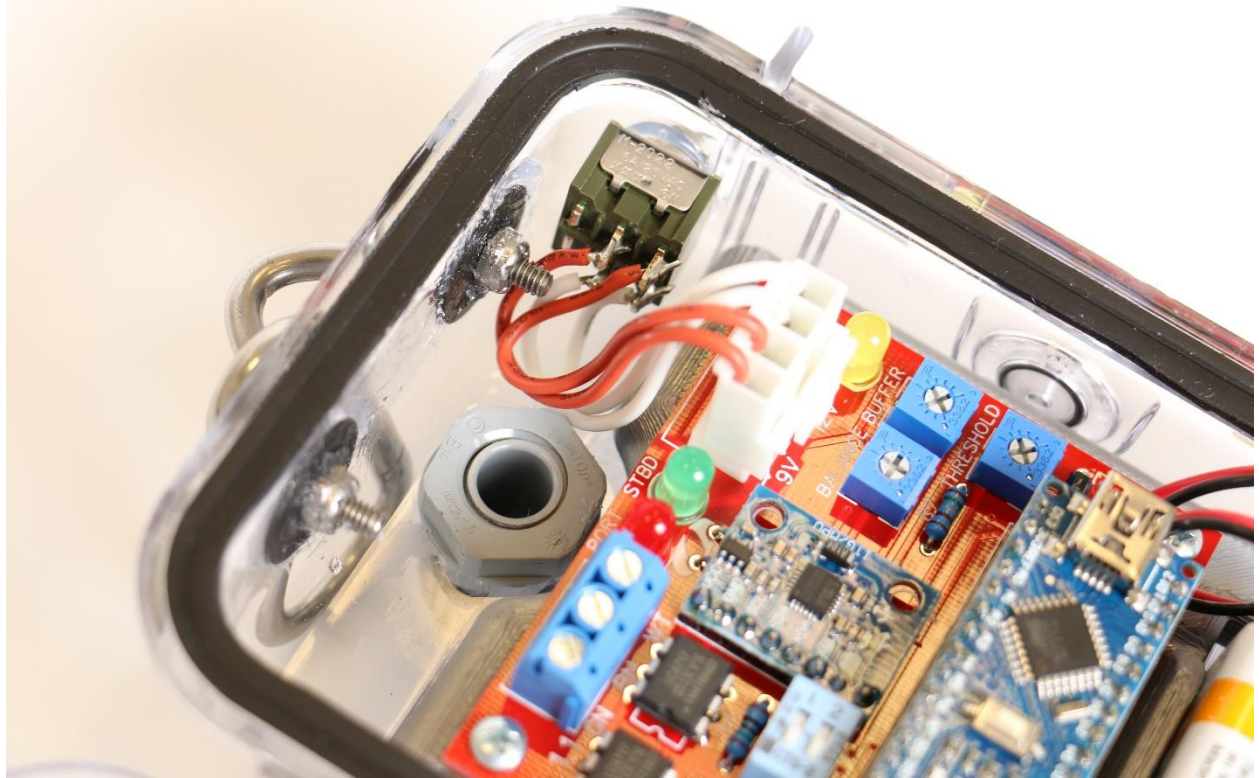
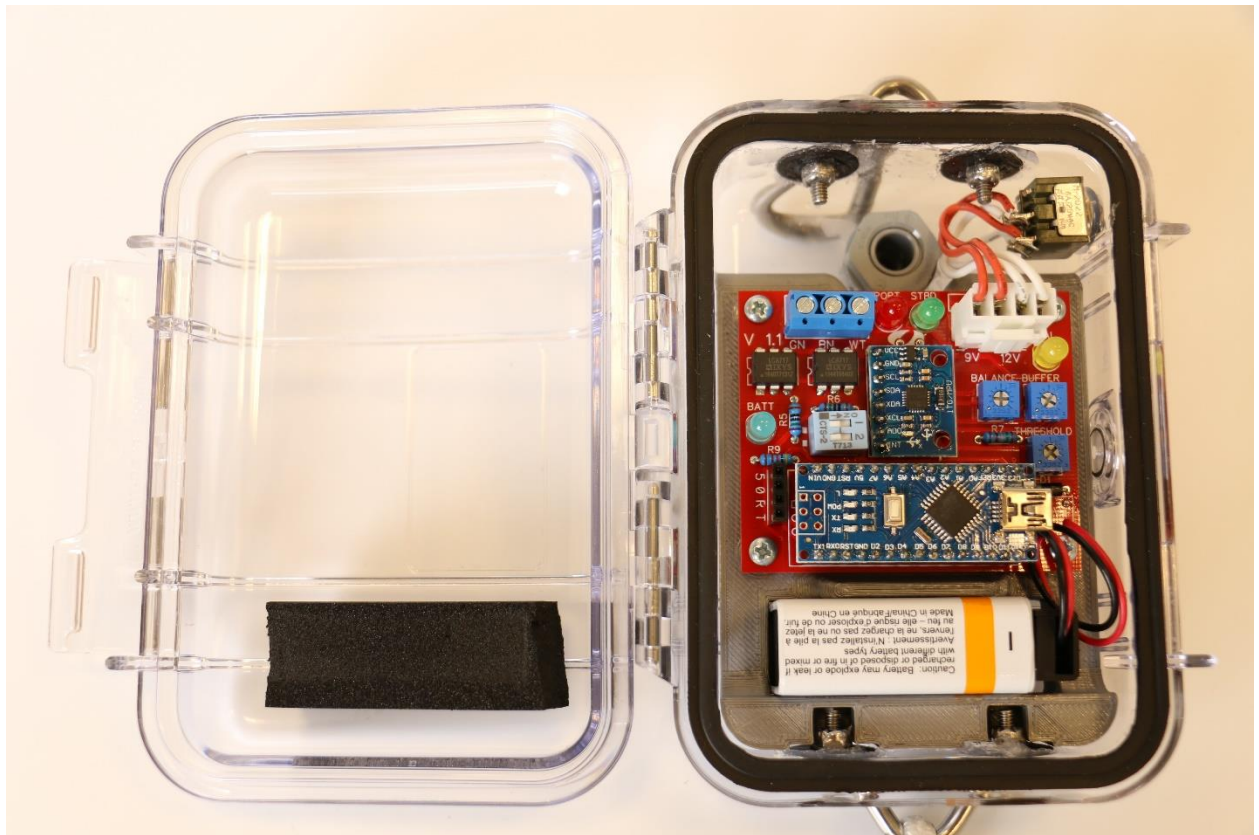
- Press the liner firmly into place, making sure it is all the way at the bottom of the box before sticking the adhesive.
- Mount the board to the liner using four tap screws.
- Plug the switch cable into the board and tuck the wires out of the way.
- Attach the battery clip to a battery and, starting with the wires sticking up out of the clip, give the battery a 360 degree roll in the direction of the bottom of the box and put it in its slot with the wires coming out on the right. This will put a nice loop in the wires that should prevent them from getting caught in the lid.
- Cut a 2" piece of thick adhesive foam and attach it to the inside of the lid so that it holds the battery in place when the lid is closed.
- Tie a 6' piece of elastic cord to the bottom loop using a scaffold knot: [https://www.youtube.com/watch?v=b\\_VU4KOBn5A](https://www.youtube.com/watch?v=b_VU4KOBn5A)
  - Melt the ends of the elastic with a lighter.

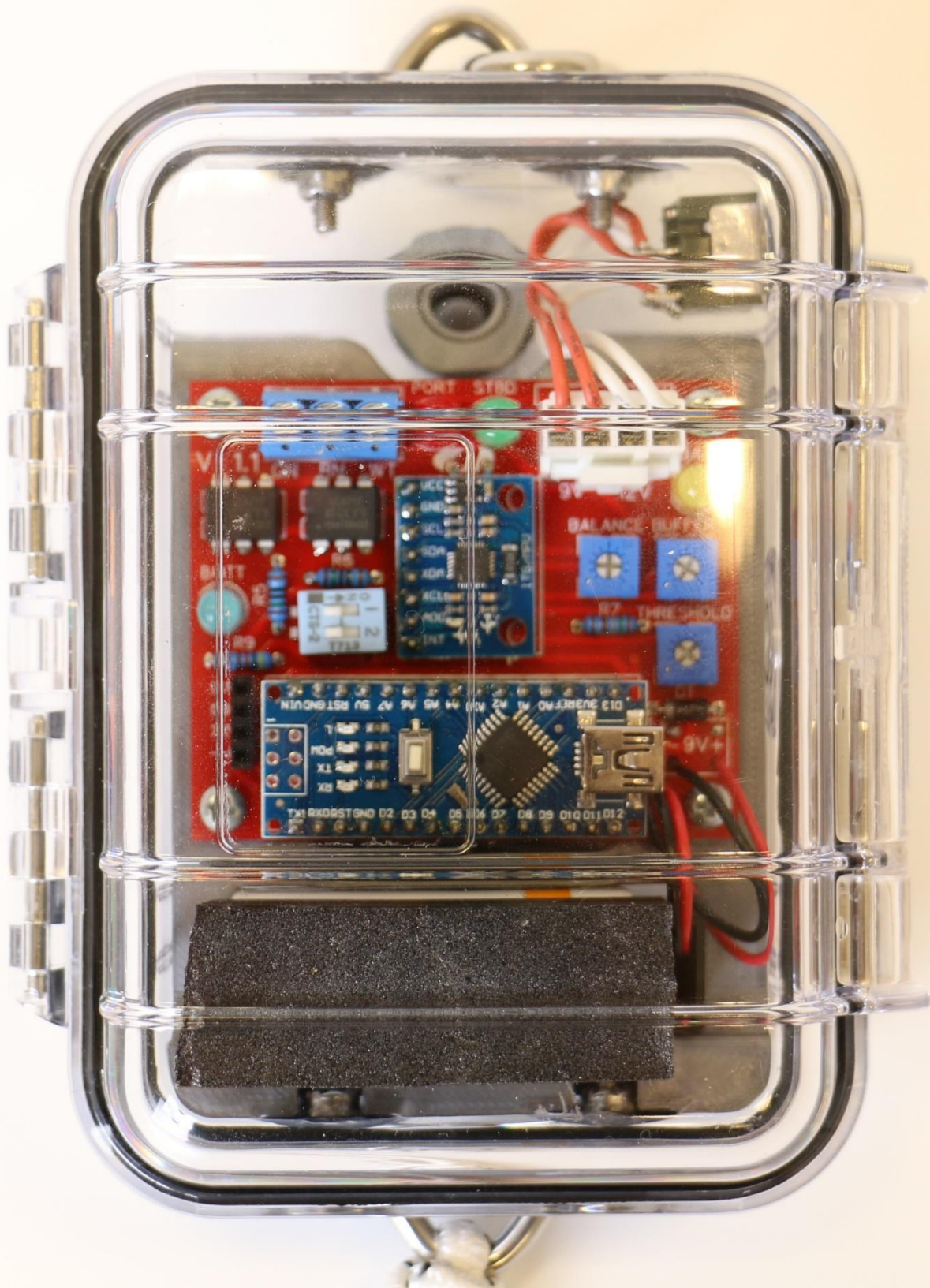
#### 8. Program the sensor.

- Install the Arduino IDE and download the code from github:  
\UTS-2017-Windows\Code\TackSensor\TackSensorPCBVx\_x
- Comment out `#define OUTPUT_SERIAL`
- Uncomment `#define CALIBRATE`
- Upload the code and open the serial monitor.
- The Arduino should be outputting a stream of numbers. If it is not, press the reset button on the Arduino.
- Hold the box vertically by pushing it against something like a door frame.
- Note the approximate value being printed on the serial monitor.
- Enter this value into the code for `BAL_CORRECT`
- Unplug the Arduino from the computer (this is important) and turn the sensor on with the switch on the side.
- Enter the correct values for `DIV_HIGH`, `DIV_LOW`, and `REG_OUT` in the code by measuring the voltage between the Arduino pins indicated in the comments.
  - Important: measure the voltages directly on the Arduino pins, not on the battery or battery connections.
- Enter all four of these values, the serial number, and any other relevant information into the database on Google Drive.
- Comment out `#define CALIBRATE`
- Uncomment `#define OUTPUT_SERIAL`
- Upload the code again.

#### 9. Test.

- With a fresh battery installed, the blue light should come on.
- With DIP switch 1 in the OFF position:
  - Holding the sensor against a door frame or vertical object should cause the yellow light to come on.
  - Tilting the sensor left should cause the green light to come on, and tilting it the same amount right should cause the red light to come on.







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