DIY3 and DIY4 Pressure Transducer User Manual

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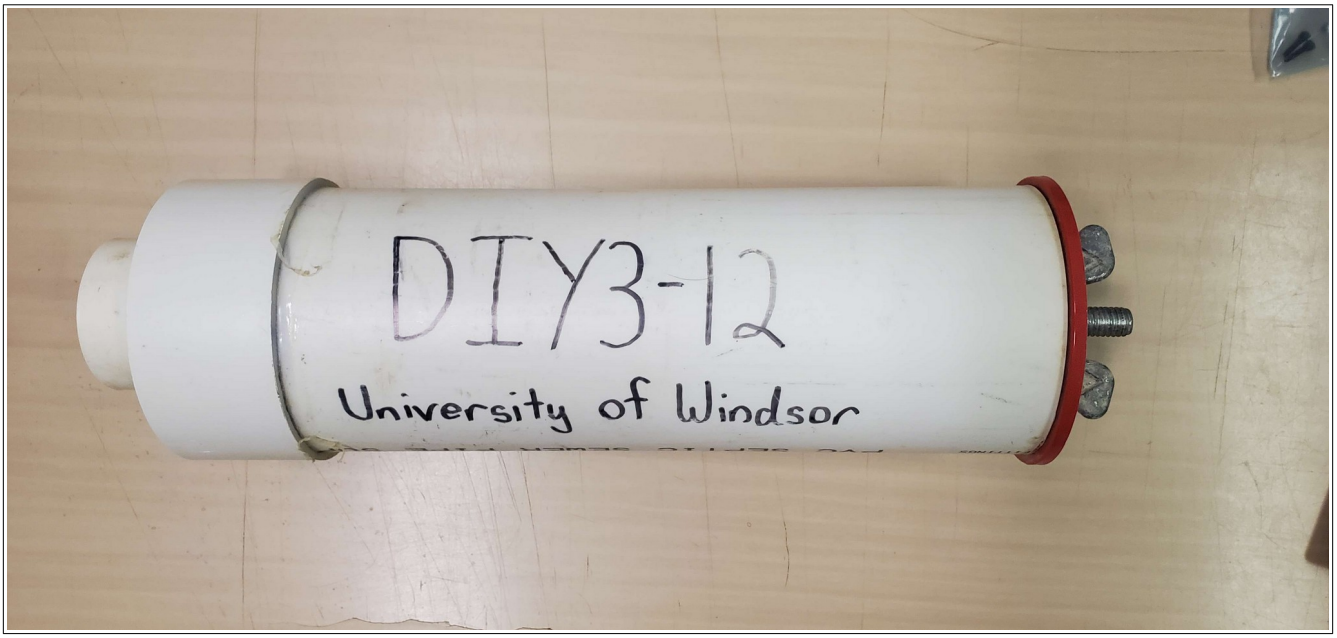


This guide explains how to prepare and deploy a DIY3 or DIY4 pressure transducer. It also gives details on capabilities, downloading data, and processing data. It does not include details on assembly of the electronics/housing or reprogramming the transducer.

Feel free to direct any questions to Ben Chittle (chittle5@uwindsor.ca).

1. Capabilities

1.1. Sampling

The transducers sample at a configurable rate of 1, 2, or 4 Hz continuously for as long as they are powered on. Each sample consists of an absolute pressure reading (millibar). An ambient temperature reading (degrees Celsius) is taken each time data is written to the microSD card (every 440 pressure samples). The sensor module is exposed at the top of the transducer. Timestamps are also recorded.

Data is stored on a microSD card in a custom raw binary format. A Python script is needed to unpack the data. See Section 5.

1.2. Accuracy

The transducers have been tested against a commercial RBR TWR-2050 pressure transducer in the lab and on several paired field deployments. Depths ranged from 0 m (atmospheric pressure) to 2 m of fresh water.

- Pressure error observed: < 1 millibar
- Temperature error observed: < 1 degree Celsius

See the Data Sheet for the sensor module used by the transducer for more information.

Note: Accuracy may drift over time and require recalibration. This has not been tested.

1.3. Battery Life

Each transducer requires 3 AA batteries and 1 CR2032 coin cell battery.

The transducers have been tested to run continuously for at least 8 months on fresh batteries, and could likely continue for much longer (perhaps over a year, though this has not been tested, and durability would likely be an issue).

Not all battery brands are equal. Duracell and Energizer brand batteries have worked well for testing and deployment in the past.

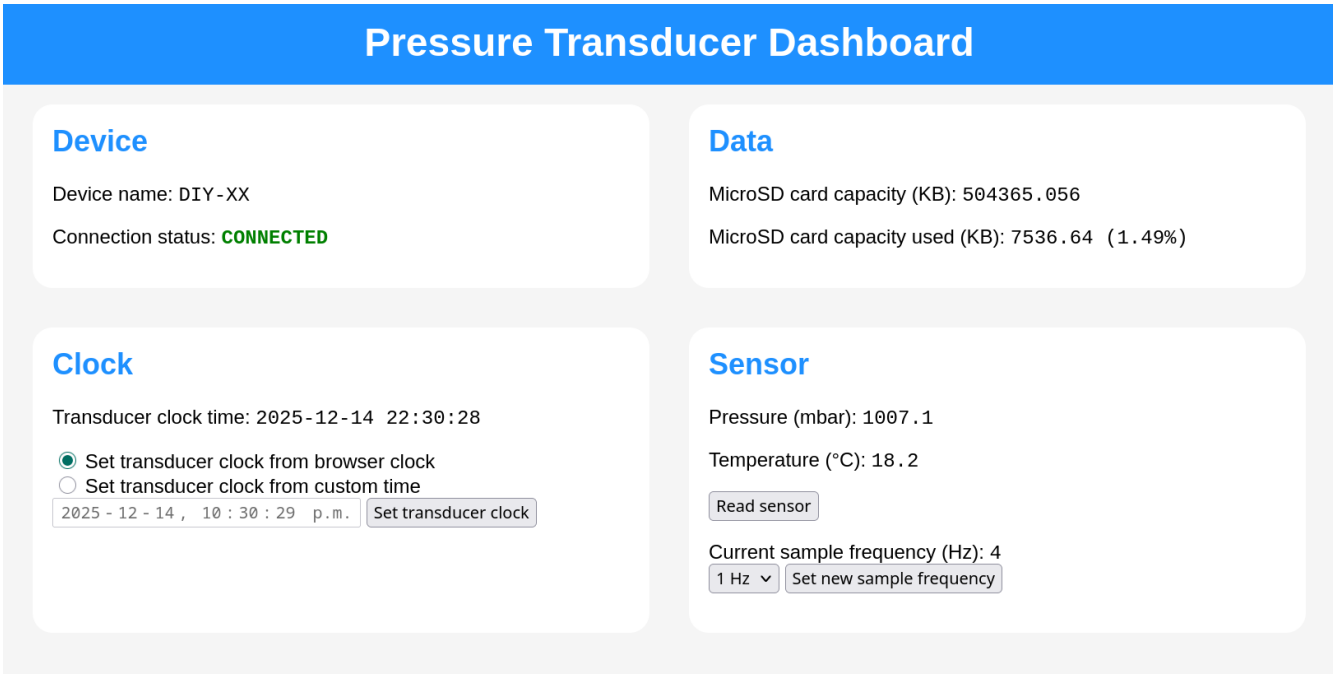
1.4. Durability

The transducers are prone to degrading during deployment. Regular check-ups are a good idea when deployed in the field to avoid data loss.

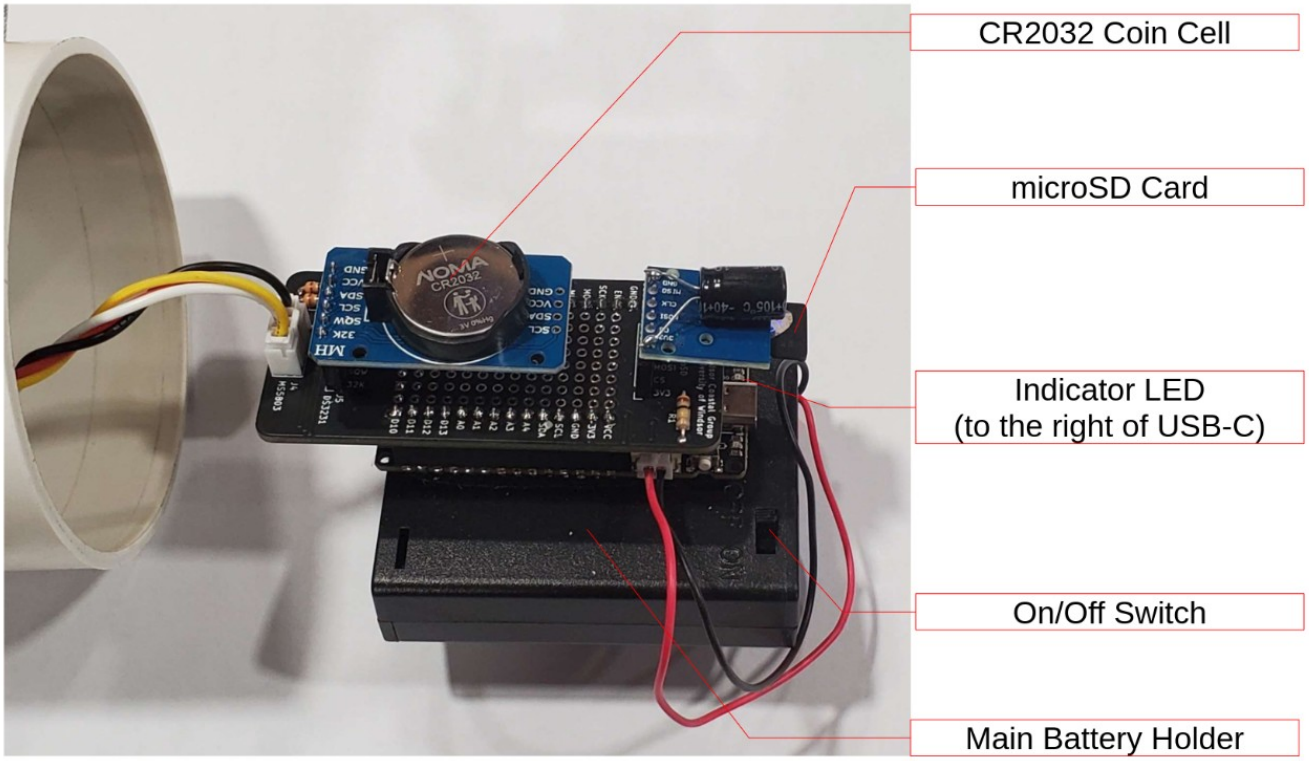
The most common issue is when the sensor module exposed at the top of the transducer becomes damaged and stops working. Existing data can still be recovered in this case, but the transducer housing will need to be replaced.

1.5. Configuration Dashboard

The transducers can be put into a configuration mode by holding a button while being powered on. In this mode, each transducer creates an open Wi-Fi access point which you can connect to from a mobile device or laptop. Once connected, you can configure the device by visiting http://dashboard.lan/ from your browser. See Section 2.5.



2. Pre-Deployment Checklist



These checks should be done in the lab in the order shown below *for each sensor* before deployment.

1. Check if main batteries need to be changed.
2. Check microSD card for old data
3. Try powering on the transducer and see if any errors are reported.
4. Check if coin cell battery needs to be changed.
5. Use the configuration dashboard to configure the transducer.

See details below.

2.1. Check Main Batteries

1. Ensure the On/Off Switch is switched off.
2. Open the battery case:
    - On the opposite side of the Main Battery Holder (as shown in the image above), locate and remove the screw.
    - Slide off the cover.
3. You can now test the batteries (if you have a battery tester or multimeter) or replace them. Ensure they are replaced in the same orientation.
    - If testing the batteries, ensure each one has a voltage of at least 1.2 V. The nominal voltage would be closer to 1.5 V. Anything under 1 V should be considered “dead” for this device.

2.2. Check microSD Card

1. Ensure the On/Off Switch is switched off.
2. Pull the card straight out from the slot. Don’t worry about touching any exposed electronics, they won’t be damaged as long as the device is off.
3. Plug the card into a computer (use an adapter if needed) and open it.
4. There should be a file called “config.txt.” **Do not delete this file**. If it is missing, it will need to be properly replaced.
5. Feel free to clear any other files on the card.
6. Eject the card from the computer and put it back in the slot on the transducer.

2.3. Try Powering On the Transducer

1. Flip the On/Off Switch to on.
2. A light next to the USB-C port should flash.
    - A solid 3 second flash followed by nothing means the device is working.
    - Otherwise, wait until a stable flash pattern is established (it may attempt to restart several times) and then see the section on diagnosing errors.
3. Turn the device off at any time by switching the On/Off Switch to off.
4. Repeat if needed.
5. After testing, check the contents of the microSD card.

- A file should have been created with a name like “DIY3-02_20230604-1527” where “DIY3-02” is the name of the sensor (as written on the housing), “20230604” is the current date in YYYYMMDD format and “1527” is the time when the file was created by the transducer in 24-hour HHMM format.
  - The file will be empty unless the transducer was able to run for more than 2 minutes (data is only saved to the card every two minutes).
  - If data was collected, you will need a Python script to unpack it. See Section 5.
- **If the date in the file name is incorrect, see the next section to change the coin cell battery. Otherwise, the transducer is ready for deployment.**

2.4. Change Coin Cell Battery

This step is only needed if files created during the previous test did not have the correct current date (e.g. if the date is in the year 2000). This indicates the onboard clock’s battery has probably died.

If the date is only off by a bit, skip to the next check to just reset the time.

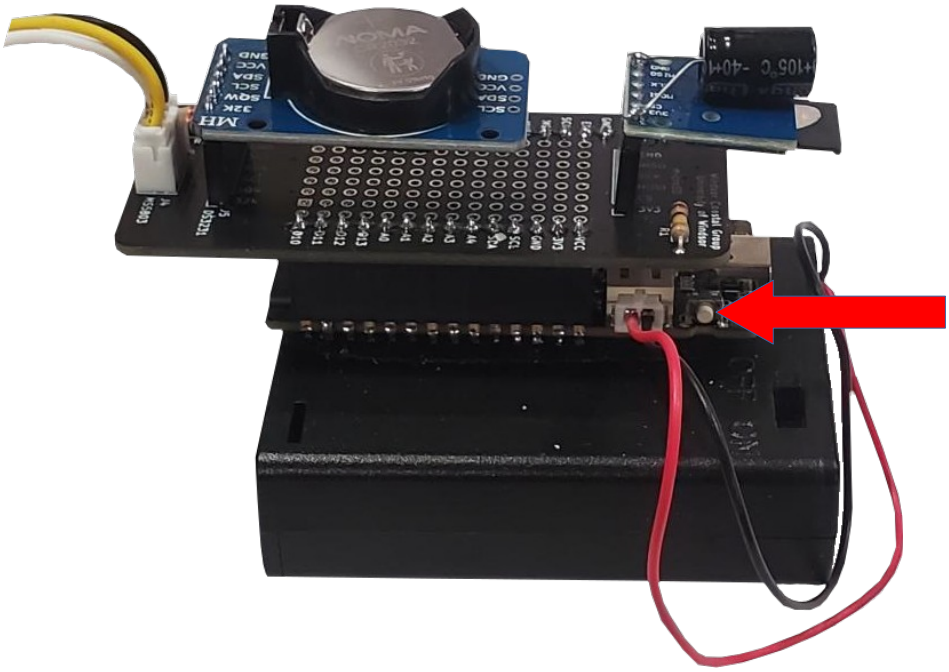
You will need a CR2032 coin cell battery.

1. Ensure the On/Off Switch is switched off.
2. (Optional) Remove the whole blue real time clock module by pulling it straight up from the board.
3. Remove the old coin cell by pulling back the metal tab / contact and trying to gently pry the battery up with a fingernail or thin tool. You can also try flipping the module upside down to see if the battery will fall out on its own.
4. Insert the new battery (positive termal facing up).
5. Reinsert the blue real time clock module onto the mainboard if you removed it. Orientation matters! It should point away from the sensor wires / white connector.
6. Set the time on the clock using the configuration dashboard (see Section 2.5).

2.5. Use the Configuration Dashboard

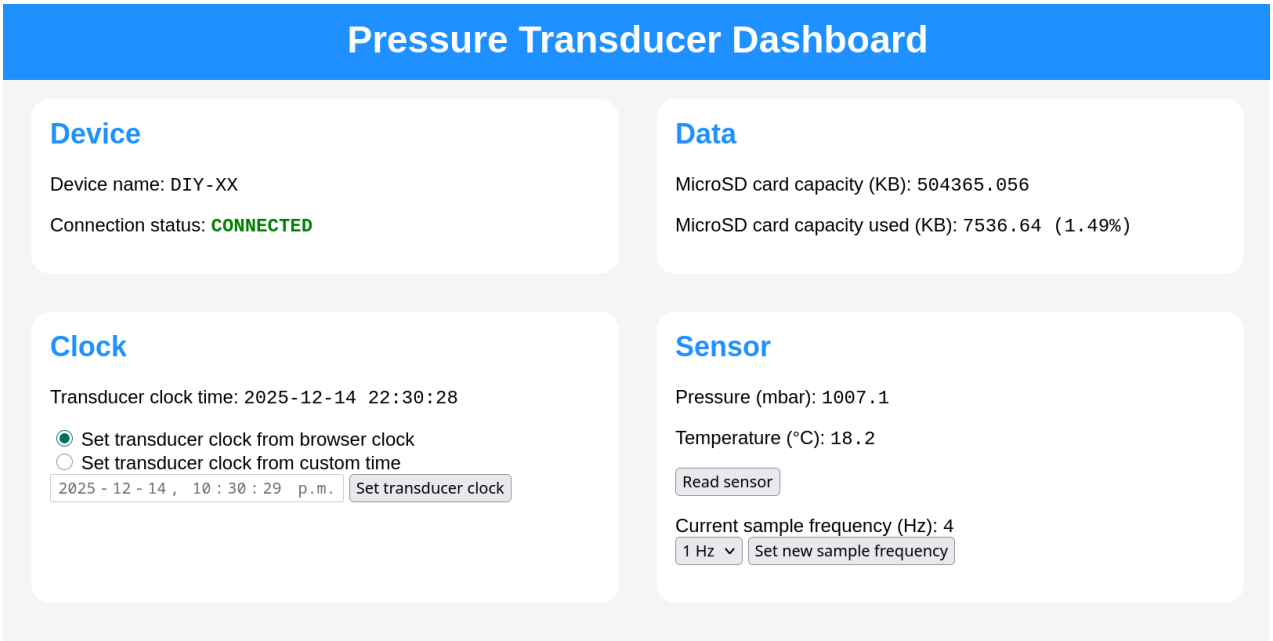
Each transducer can be put into a configuration mode. In this mode, the transducer creates its own Wi-Fi network (which you can connect to) and hosts a simple web page that you can access with your browser. On this page, you can check and configure the transducer.

1. Locate the small Dashboard Mode button. There is an identical button on the opposite side which can be used to restart the transducer while powered on, which is not what we want here.



2. With the transducer powered off, press and hold this button and continue to hold it while powering the transducer on. Release it after the green LED lights up.
3. After a moment, the green LED should begin rapidly blinking (several times per second) forever to indicate the transducer is now in configuration mode. If this doesn't happen and instead you see a fixed number of blinks, see Section 4 to diagnose errors.
4. Using a mobile device or computer, look for a new Wi-Fi network with the name of the transducer (e.g. "DIY3-05"). Connect to this network without a password.
    - You may be warned that the network has no internet connection. This is expected and you should opt to connect anyways.
5. Open your web browser and type the following in the address bar: http://dashboard.lan/
    - Make sure to type the "/" at the end, as some browsers won't recognize the ".lan" domain without it.

6. Welcome to the configuration dashboard! Here you can
    - Check and set the time on the transducer's clock.
    - Check storage used on the microSD card.
    - Check a pressure and temperature reading from the sensor.
    - Check and set the sampling frequency of the device.



7. To finish, turn off the transducer using the power switch. Try to give a second or two delay after changing a setting before turning the device off.

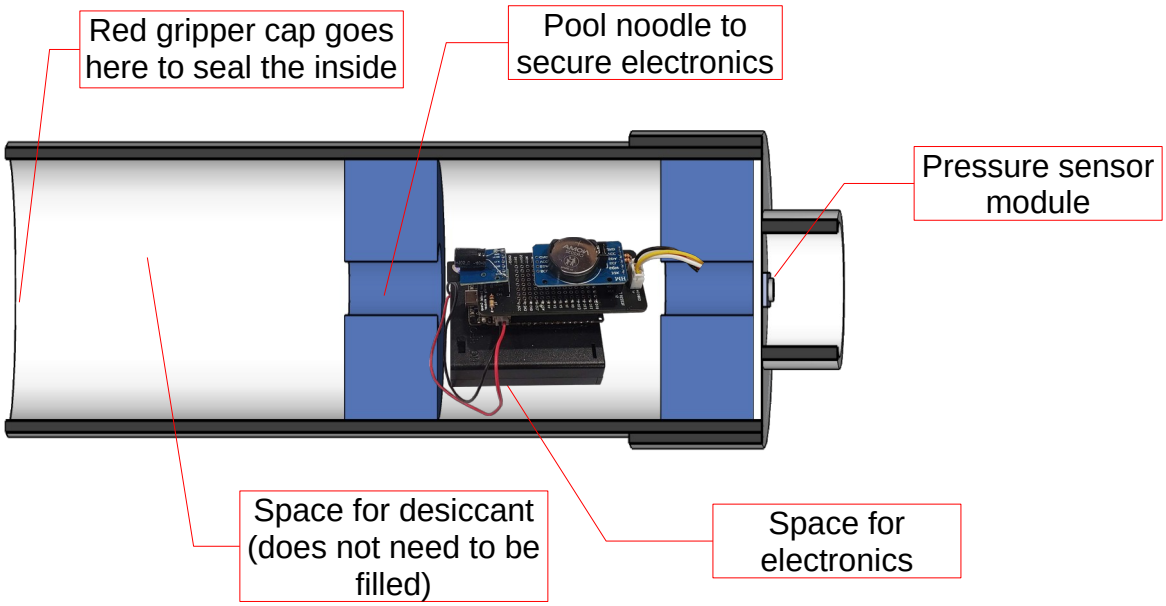
3. Deployment

The following is needed for deploying a transducer:

- Pool noodle slice and desiccant should already be in the transducer housing. (Desiccant to absorb any small amounts of moisture, pool noodle to hold the electronics in place).
- Wrench or pliers to tighten red gripper cap.
- Something to mount the transducer to and an optional buoy marker (assuming underwater deployment).

The steps to deploy a transducer follow.

1. Power on the transducer by flipping the On/Off switch to on.
    - It can also be a good idea to record the exact time (within a couple seconds) when the transducer was powered on if it becomes necessary to adjust for clock drift later.
2. Make sure you see the indicator LED next to the USB-C port turn on for 3 seconds. If any other flashing is seen, this indicates a warning or error. Try powering the device off and on again. If it continues, see Section 4.
3. Place the electronics in the PVC housing.
4. Shove the pool noodle slice above the electronics to secure them in place.
5. Place some desiccant packets on top of the pool noodle.
6. Place the red gripper cap onto the end of the housing and begin to hand-tighten it closed. Ensure the cap is flush with the housing.
7. Use a wrench or pliers to finish tightening the cap. Avoid over-tightening it! A good rule of thumb is to tighten it just until you can no longer easily loosen it by hand.
8. Deploy the transducer. Try not to jostle it around too much while mounting it.


Red gripper cap goes here to seal the inside
Pool noodle to secure electronics
Pressure sensor module
Space for desiccant (does not need to be filled)
Space for electronics

4. Diagnosing Errors

When the transducer malfunctions or otherwise encounters an error, it will endlessly flash a repeating pattern on the LED to the right of the USB-C port. This pattern consists of some number of flashes followed by a longer pause.

The number of flashes indicates the error:

1: Error communicating with the clock module

2: Error communicating with microSD card

3: (Single instance of 3 flashes, not repeating) Unable to find “config.txt” file on microSD card or the file is formatted incorrectly.

- Will cause the device to use a generic name for files instead of naming them after the device itself
- e.g. “DIY3-XX_20240520-1200.data” instead of “DIY3-12_20240520-1200.data”.
- Not a fatal error, but it will make it hard to identify which transducer produced the data when combined with others.

4: Unable to create a new file on the microSD card

5: Error communicating with the pressure sensor module

6: General malfunction

7: General malfunction

If restarting the device does not resolve an error, try the following:

- Look for any loose wires or components and set them in properly
- Ensure the microSD card is properly inserted, has a “config.txt” file in the top level directory, and is not full
- Ensure batteries are not near empty

When an error is encountered, the device will attempt to restart itself up to 3 times. If the error persists, it will continue flashing the pattern until the batteries run out. This usually means a malfunctioning transducer will be out of power by the time it is recovered in the field. The error will also be logged in a “log.txt” file on the microSD card, unless of course the error was regarding the card itself.

The most common error during / after deployment is 5 flashes if the pressure sensor module is damaged. **It is possible that the pressure sensor module malfunctions, but the transducer is unable to detect it. In this case, it will simply record junk data, which is easily recognized and filtered out later, but not able to be recovered into useful data.**

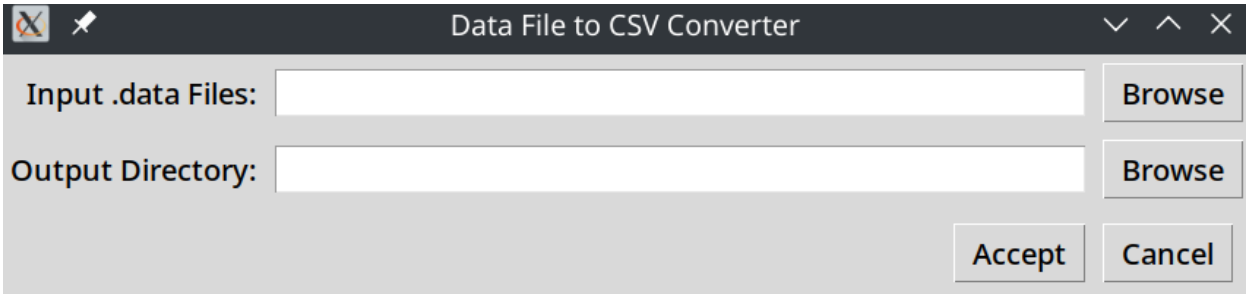
5. Downloading and Unpacking Data

For each day the transducer is active, it will create a new ".data" file on the microSD card around midnight. These files store the collected data in a raw binary format that must be unpacked by a custom Python script into the .csv format.

Before you can unpack the data, you will need a computer with Python installed. The scripts were last tested on Python 3.13.11, but would likely work on other versions.

To download and unpack data:

1. Ensure the transducer is switched off.
2. Remove the microSD card and plug it into a computer. An adapter might be needed here.
3. Copy or move all of the desired ".data" files into a new folder. Give the folder a name like "raw" and remember the file path to this folder.
    - Files are named using the timestamp when they were created (e.g. the first sample collected).
    - Data from multiple transducers can be copied into the same "raw" folder before running the script i.e. you **don't** need to create separate folders for each transducer (as long as they are all named differently).
4. Create another empty folder with a name like "unpacked".
5. Download (or copy paste) the following Python script: data_to_csv.py.
6. Run the script to launch a simple GUI where you can select input data and a folder for output data.
    - If you're comfortable with the command line / shell, you can also use the script there. Run it like "python data_to_csv.py --help" for usage info.



7. Select your "raw" folder for the input files (or select them individually), and select your "unpacked" folder for the output directory.

8. Click “Accept” to start processing. It can be a little slow as it is just vanilla Python.
9. For furher or faster processing, if you’re comfortable with Python and Pandas check out the processing_tools.py script. It can unpack data faster, and shows how to do some simple data visualization and error checking.

6. Processing Data

If you're comfortable with Python and Pandas check out the processing_tools.py script. It can unpack data faster, and shows how to do some simple data visualization and error checking.

Visualizing the data is very helpful as a first step.

Common things to watch out for:

- Occasional duplicate or missing timestamps in the data are possible and are not indicative of any faulty electronics unless they are very common.
- Random outlier spikes in pressure and/or temperature can be indicative of a faulty sensor. Any more than one or two spikes in a single data file should be investigated.
- Be aware of clock drift when comparing data from multiple sensors. Depending on when they were last calibrated, drift of several seconds to several minutes can be expected.
    - This can be countered by recording the exact time when the transducer was powered on before deployment or recovered after deployment, and adjusting all timestamps by the offset accordingly.