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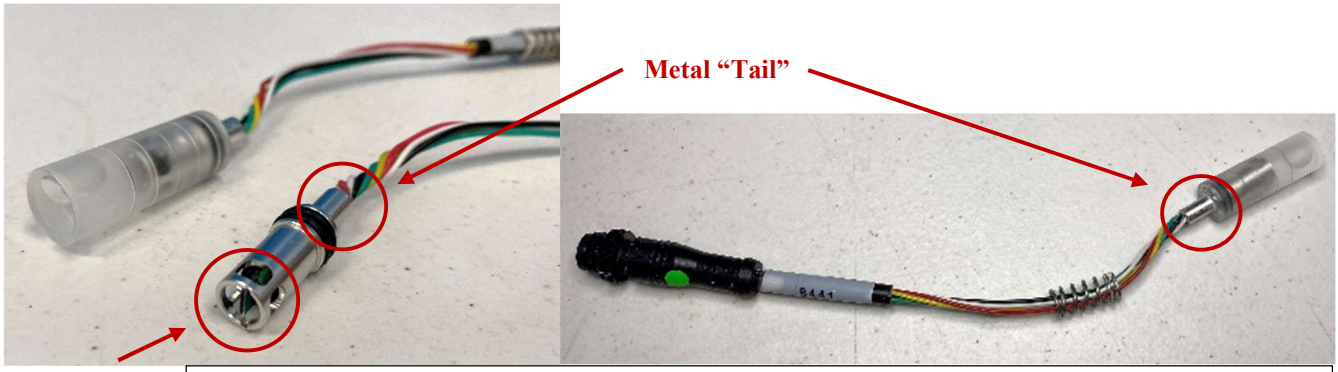
Sensor re-use and test manual for advanced users

This guide provides written instructions for removing and re-using the FloraPulse probes. We recommend watching videos below for a complete overview of the process.

Links to installation videos

1. Default installation video
2. How to remove/reuse probes
3. Installation into thick-bark trees
4. Installation into small trunks
5. [RECORD VIDEO ON SENSOR TAU TESTING]
6. [RECORD VIDEO ON SENSOR SANDING]



*Microchip should be kept wet and away from contaminants throughout removal and reinstall.

General instructions on removing, cleaning, storing and re-installing FloraPulse sensors

The FloraPulse sensor installations are generally permanent, but it is possible to remove, store and reinstall sensors. Keep in mind the sensors are fragile and can break during removal. Thus, it is best to only move sensors when necessary, and to do so very carefully.

There are 3 main reasons for removing a sensor – here is what we recommend for each.

1. **Poor installation performance.** If the sensor appears to be reading erratically or values that are too low or too high, this could be caused by issues with the installation. In this case, we recommend the sensor be removed, stored, tested in the laboratory, then re-installed in a new tree.
2. **Move to a fresh installation site for the 2nd+ season.** We have seen that, at least in some crops such as almond, the sensor becomes less responsive when used for a second season in the same installation site. We believe this happens because the install site closes off slightly during winter. For best performance, sensors should be moved to a new site each year at the beginning of the season.
3. **Storage during a cold winter.** Installed sensors can tolerate temperatures down to 0 °C (32 °F), but if temperatures go below freezing for extended periods the sensor's water will freeze and break the sensor. We thus recommend that sensors be removed and stored in regions where temperatures regularly drop below freezing. The sensor can then be re-installed in the spring.

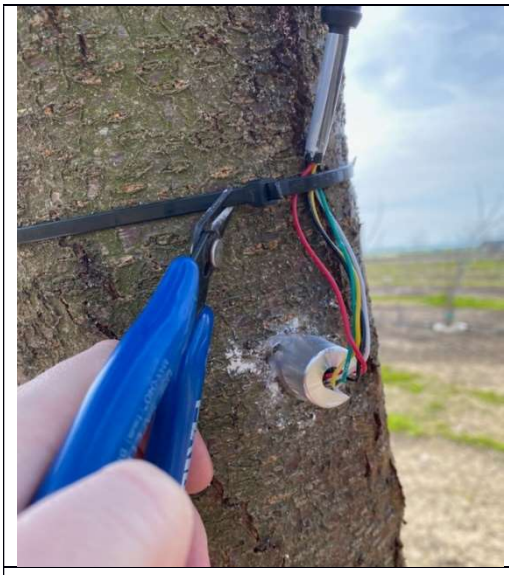
Sensor Removal Tools

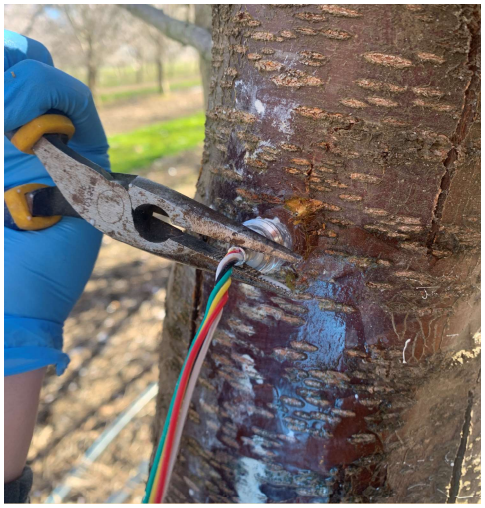
- Vise Grip
- Wire Cutter (from install kit)
- Spatula (from install kit)
- Extra Capsule
- Wash bottle
- Needle nose Pliers
- Labelled Ziploc Bag (Optional)
- Nitrile Gloves (Optional)

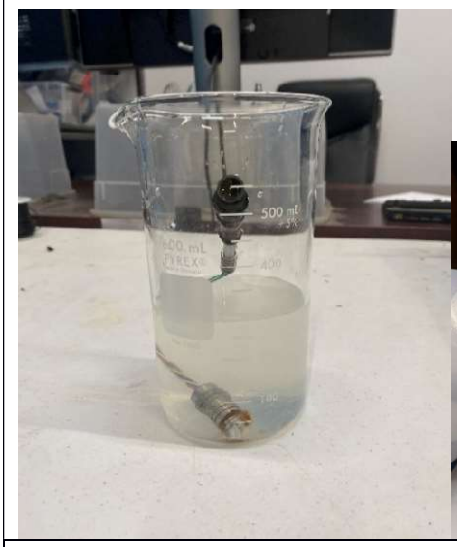
Keep these materials for reinstall

Extra sleeves, capsules and parafilm come in your install kit. After install reseal the mating compound to keep it from drying out. These supplies are used again when you reinstall, so keep track of them!

How to Remove, Clean, and Store sensors

	1. Carefully cut down the surrounding insulation/wiring.
	2. Using a napkin, clean off the excess grease and wounding gels from the install site. A clean area will help prevent contamination of the probe upon removal. You may apply water to help clean the area.
 	3. Using your hands twist off the cap. Squirting water on the threads can help loosen the cap. If necessary, use a vise grip to remove the cap. Keep the cap for the sensor reinstallation. Fill an extra capsule with water and set aside. Capsule should be filled to below halfway, leaving space for the sensor and an air gap.

	4. Once the cap is off, rinse the sleeve interior with water to loosen the dried mating compound.
 	5. To remove the probe, try pulling on the wires by hand (GENTLY! OR THE WIRES WILL BREAK) to see if the sensor is loose and will come out easily. If the sensor is stuck, use needle-nose pliers to gently pull on the metal 'tail' base of the probe and remove the sensor. DO NOT PULL ON THE WIRES WITH PLIERS!
 	6.Pull the sensor straight out, and quickly place the sensor inside the plastic capsule with water. You may want to rinse the sensor with a stream of water before capping. *KEEP SENSOR FRONT WET IN WATER AS MUCH AS POSSIBLE.

 	7. Some installs, especially older ones, can get very dry and stuck. If the sensor still won't come out, fill a container (in this case a Ziploc bag) with water. Using your vise clamp, grip the sleeve and pull the sensor and sleeve straight out together. Try to avoid moving/wiggling the sleeve because this places stress on the probe microchip. Place the sleeve and sensor inside the water-filled container, and keep it in water overnight until the sensor can be separated. Water will hydrate the dried mating compound over time and the sensor will come loose.
 	8. Leave the sensor in water overnight to loosen the excess powder, then gently rinse it using a water stream.
	9.After sensor is removed and cleaned, cap your sensor and put aside. You may choose to label the sensor with the datalogger #, port # or anything else to help keep track of where the probe should be reconnected if needed. SENSORS MUST BE KEPT IN WATER AT ALL TIMES.

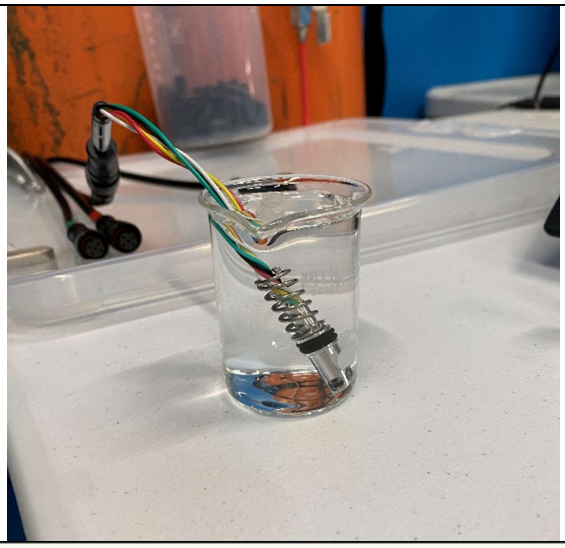
How to test the sensor in the laboratory

If desired, you may perform two tests for each sensor to verify proper functioning. Only test after the sensor has been cleared of mating compound (by leaving the probe in water overnight to loosen the dry powder).

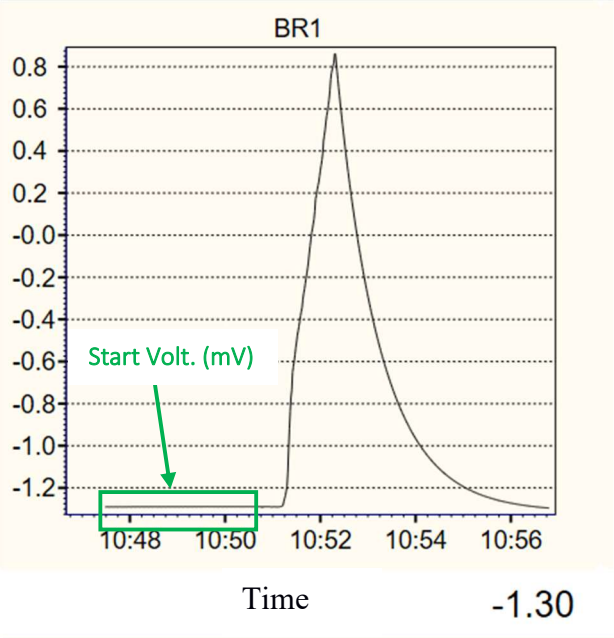
Test #1: Sensor output is stable in water

1. Place the probe sensing head in water.
2. Connect the sensor to a datalogger and measure its output for 24 hours or longer.
3. Look over the data. The sensor should measure close to zero bars, within ±1 bar, for the duration of the test. Small deviations are fine and are usually caused by temperature fluctuations. Likewise, the voltage output should be stable, and not vary by more than ±0.2 mV/V. If there are big jumps or drift in the data, the sensor is likely broken.

Test #2: Sensor response in dry air



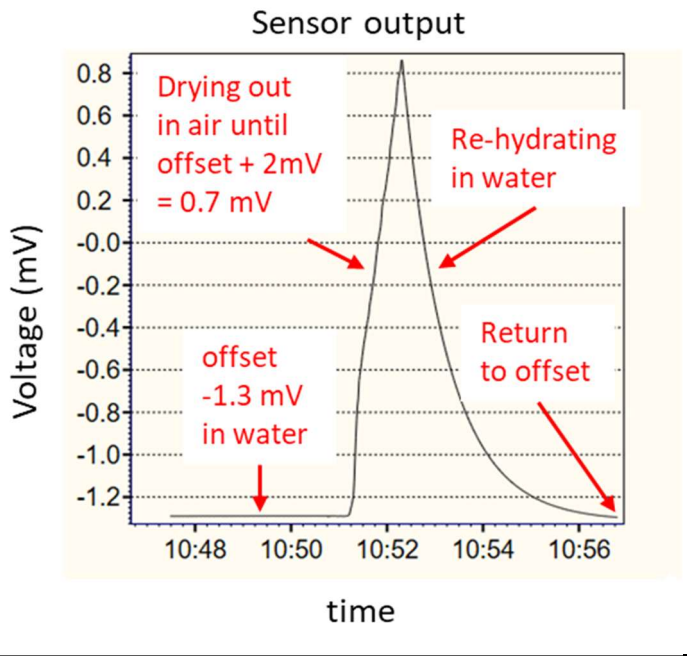
1. Place the sensor in a water container for at least an hour to let it relax (fully hydrate) and measure zero pressure. This is the offset voltage (voltage in water).



2. Measure the sensor drying out response to ensure the sensor is full of water (not cavitated). For this test, you must have a real-time readout of the sensor that refreshes at least every 5 seconds.

The readout can be completed by connecting the probe to a scientific logger (i.e., Campbell CR6, CR1000)

*Starting Voltage (Probe in Water) is approx. -1.3 mV

	Pull the sensor out of water and hold it with the chip facing up. Gently use a clean napkin to dry off the top of the chip (being careful to not contaminate it), then watch the sensor output. *wear protective gloves to avoid contaminating the sensor. *the sensor will not work if grease/contaminants get on the pores (top of the chip)
	The sensor output voltage will soon shoot up and start reading increasing tension. Wait until the sensor reads -10 bars (about offset + 2 mV) and then immediately place it back in water. This process should only take a few minutes. It's critical to carefully watch the sensor output because once the sensor starts drying out, it will cavitate within a minute or two if not quickly placed back in water. *Ending Voltage, returned to -1.3 mV after being returned to water.

Analyze the response test data to evaluate sensor performance.

The table below shows the 3 stages of the response test (measure offset, dry sensor, re-hydrate sensor), the expected 'good' behavior for each, and potential problems and solutions.

Stage	Good	Problems	Solutions
Measure offset	Sensor offset should be flat and stable.	• Large noise or random jumps. • Measured offset slowly decreasing.	• The sensor electronics are likely broken. Use a new sensor. • The sensor is still not fully re-hydrated. Wait until the line flattens out.
Dry sensor to offset+2 mV (-10 bar)	Sensor output shoots up offset+2mV in a straight line within ~3 minutes.	• Sensor output does not change during dryout (stays flat). • Sensor output increases very slowly and takes 3+ minutes to reach +2mV. • Sensor output increases, then drops sharply back to offset.	• Sensor is cavitated or nanopores are broken. Use a new sensor. • Sensor is partially blocked. Sensor re-hydration should also be slow. Try sanding the pores to increase response speed (see below). • Sensor cavitated because it dried too much (too much tension), or the pores broke. Use a new sensor.
Re-hydrate sensor	Sensor output decreases back towards offset. Voltage goes down by 1 mV within 30 minutes.	• Sensor output decreases very slowly, takes 30+ minutes to decrease by 1 mV. • Sensor output drops sharply back to offset.	• Sensor is partially blocked. Try sanding the pores to increase response speed (see below). • Sensor cavitated. Use a new sensor.

Sand sensor nanopores if needed

Sometimes sensors are slow due to contamination and it may be possible to remove this contamination by lightly sanding the pore surface. This process should only be done carefully and only when necessary because excessive sanding will eventually break the sensor.

Instructions: Pull sensor out of water and leave pore surface wet to prevent dry out and cavitation. Using a clean sanding stick, apply light pressure and abrade the chip top surface back and forth for 60 seconds, at a rate of 2 strokes per second. You should hear a scratching noise as the sanding stick abrades the nanopores to open them up. It may be necessary to rotate the sanding stick as the abrasive wears out to use fresh abrasive.

Place the sensor back in water and swish it around to rinse off sanding debris.

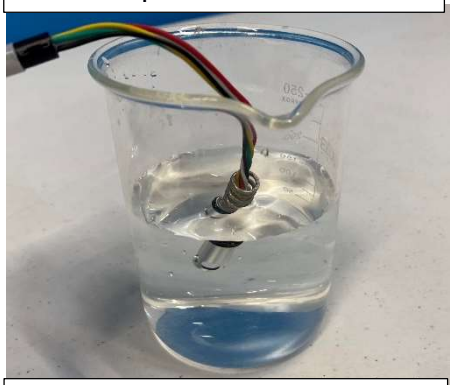
Let sensor rest for 30+ minutes in water to fully re-hydrate, then re-test for response speed as explained above (test #2).

You may repeat sanding one more time if response speed is still slow. Further sanding will not help and will eventually destroy the sensor.

*Slow sensors will still measure water potential, but their response will lag the tree water potential. Thus, accuracy will be impacted.

Buy the sanding sticks here

Sand Chip Surface



Rinse Sanding Debris

Sensor re-install

To reuse the sensor, you will need to gather the following materials:

1. Fresh mating compound. The mating syringe may dry out after sitting around for a long time. You can re-hydrate it by adding a couple of drops of water at a time and mixing until a 'syrup' consistency. **Add liquid very slowly because the mating compound will easily become too runny (and then you will have to wait for it to dry out).**
2. New sleeve. The sleeve nails always break when removed – you will need to use a new sleeve. The cap can be re-used.
3. The rest of the materials from your install kit can be re-used.

*See installation manual for full list of install tools and installation instructions.