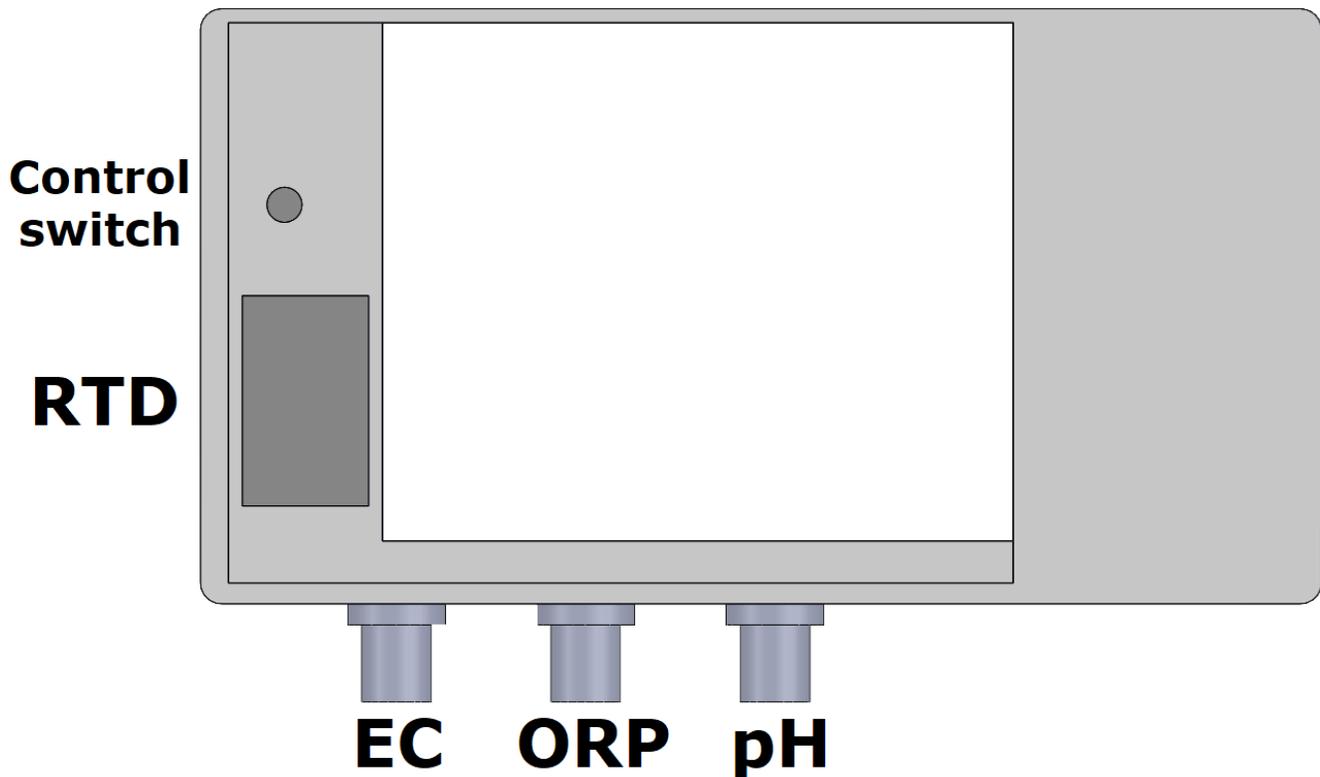


## Overview

The Water Monitor is a sensor suite that measures 4 properties of water: Temperature, pH, oxidation-reduction potential (ORP), and electrical conductivity (EC). The EC sensor may be used to estimate total dissolved solids (TDS). These measurements can be used for a number of applications. Some suggestions are laboratory, hydroponics, aquariums, swimming pools, and water-quality field work. The Water Monitor can be powered using USB-C, or using 3 AA batteries.

## Specifications

- **Dimensions:** 50 × 25 × 17(height) mm
- **Weight:** 52 grams (8oz)
- **Safe temperature range:** 0-80°C
- **pH precision:** 0.01, with a suitable sensor
- **pH Range:** 0 - 14
- **pH and ORP electrode design:** Double junction glass electrode
- **pH and ORP bulb shape:** Spherical
- **Temperature precision:** 0.03°C
- **Temperature accuracy:** 0.5°C and better
- **Compatible EC cell constants:** K=0.01, K=0.1, K=1.0, K=10 cm<sup>-1</sup>
- **Conductivity range:** 0.01 μS/cm to 1 S/cm
- **Conductivity range with K=1.0 probe:** 100μS/cm to 10mS/cm
- **Power:** USB-C, or 3 × AA batteries (included)
- **Sensor interface:** BNC Male (Accepts BNC female sensors) for pH, ORP, and EC. 3-wire screw terminals for RTD.
- **Power consumption (typical):** 500μW



## Quick start

To get started, connect the three sensors that use cylindrical connectors (BNC) to the Water Monitor. Left-to-right, with the screen facing you, and the ports at the bottom: conductivity (black sensor), ORP (teal sensor), pH (clear sensor). If not already connected, connect the temperature sensor (A 3-wire resistance temperature detector (RTD)) to screws on the left side, using a Phillips-head screwdriver; the blue terminal is on the top.

Connect power by plugging the Water Monitor into wall power, or a PC, using the USB-C Port. Press the control switch inwards to power on the device. You will see four readings. When taking measurements, unscrew the caps on the probes, and place the probes into the water you'd like to measure. If you don't need a certain measurement, you can leave that probe disconnected.

The Water Monitor can be powered over USB using its USB-C port, or using 3 AA batteries, which are included in the package. You may use rechargeable batteries, but the Water Monitor will not charge them; you must charge separately. The Water Monitor will operate for about 6 weeks on a single set of batteries.

## **Display**

The Water Monitor uses a 4.2" e-paper display. This allows it to hold an image on the display without using any power, providing a long battery life. As a consequence of the way this display operates, every few screen refreshes (eg when a reading change, or you navigate in the menu), the screen will flash white-black-white for 1-2 seconds. This is called a *full* refresh, and is normal. The readings may become blurry during refreshes where this doesn't occur. Note that a full refresh will occur once readings have stabilized.

## **Interface**

You can change settings on the Water Monitor using the 5-way control switch, located to the left of its screen. From the home page, move the stick right to enter the menu. In the menu, move the stick up or down to select different items; the selected item is indicated by a carat to its left. Press forward to access or toggle the item, and press back to go to the home page. Selecting a unit to change will toggle that unit. Selecting a calibration process will enter that calibration; instructions on screen will explain how to proceed. During a calibration, press backwards to abort, and revert to the previous calibration.

## **Update interval**

When plugged in, readings will update twice a second. To increase battery life, updates occur more slowly when on battery power. The rate of these updates is selectable using the *Update* setting in the menu. Here, you can toggle between 1 second, 5 seconds, 30 seconds, and 5 minutes. 5 seconds is the default interval. The slower the update interval, the longer the battery will last. With a 5-second interval, batteries will last approximately 2 months. Which setting you choose depends on the use case. For example, for long-term system health measurement, you may wish to set a 5 minute interval to maximize battery life.

## **Connecting to a PC**

You can connect the Water Monitor to a PC or Raspberry Pi to send its readings there, by plugging it into the PC's USB port. The easiest way to take advantage of this is by using the Water Monitor view software, available at <https://github.com/anyleaf/water-mon-app/releases>. Download the version suitable for your operating system. (Currently available for Windows and Linux), unzip, and run the resulting executable. It will then start a web server, and provide instructions on how to view readings: By entering *localhost* in a browser's URL bar on that computer, or by entering that computer's IP address, which it displays, on another device on your network, such as a mobile phone. This software is open source: You're encouraged to view the source code, and modify if you wish.

A Python library that allows access to the readings is also available: `pip install anyleaf`. This is the same library used to access the standalone AnyLeaf modules.

In addition to viewing readings using a web browser, you can access the readings using the AnyLeaf Python library: <https://github.com/AnyLeaf/anyleaf-python>. Reference the *water\_monitor.py* example (examples folder) for the code used to take readings.

You can use MyCodo to easily integrate with other sensors, and display and log readings from a Raspberry Pi. You can download and learn about MyCodo here: <https://kizniche.github.io/Mycodo/> Once set up, you can add the *AnyLeaf WaterMonitor* as an input.

## **Update rate**

When plugged in, the Water Monitor refreshes readings every second. When on battery power, the update interval is customizable, by using the *Update* setting in the menu. Setting a longer interval results in improved battery life, at the cost of slower updates. If you're monitoring long-term system health, a longer update interval allows you to go longer between battery changes. When plugged in, the user-customizable setting is ignored.

## **Calibration**

pH, ORP, and EC can be calibrated by selecting their respective calibration items in the menu. (Press forward on the control switch, select the item you wish to

calibrate using up and down, then press forward to start). Each calibration screen displays instructions on how to perform the calibration. Note that you need calibration solutions (eg pH buffers, conductivity standards etc) to initiate calibration. If you wish to revert to default calibration (and other default settings), you can select *Reset all* from the menu.

pH calibration uses either 2 or 3 points: 2-point calibration models pH as a linear relationship with probe output voltage – this is good enough for most uses. 3-point calibration account for nonlinearity in readings – this is suitable for scientific measurements. You can read about how pH calibration works from our blog article on the subject: <https://www.anyleaf.org/blog/how-to-calibrate-ph-sensors>.

EC and ORP calibration is simpler, as they each use single-point calibration. They both use a linear model between the calibration point, and 0. ORP calibration maps measured voltage to ORP voltage (They should be very similar), and EC calibration compensates for imperfections in the probe and measuring setup.

pH and ORP probes need to be re-calibrated periodically, as ion-selective probes like this drift over time. More the purpose of hydroponics or aquarium monitoring, you can calibrate once every few months. EC probes shouldn't drift over time, and you may be able to get away with never calibrating, or calibrating once for your probe.

## **Configuring conductivity (EC) probe cell constant**

The Water Monitor is available with a  $K=1.0$  ( $\text{cm}^{-1}$ ) cell constant. It's capable of working with other probes that plug into BNC ports, including ones with different cell constants. This is useful for reading conductivity at varying ranges. (See specifications above). To change cell constant, adjust the *EC* setting in the menu to toggle between  $K=0.01$ ,  $K=0.1$ ,  $K=1.0$ , and  $K=10.0$ . If this setting doesn't match your probe, EC readings will be incorrect.

## **Estimating Total Dissolved Solids (TDS)**

By setting the *EC unit* to *PPM* mode (Press the switch forward to enter the menu; down to select *EC unit*, forward to change the unit, then back to get out of the menu), total dissolved solids are approximated based on conductivity and

temperature readings. PPM is calculated as  $0.5 \times$  conductivity reading in  $\mu\text{S}/\text{cm}$ . It's adjusted by 1.95% for each  $^{\circ}\text{C}$  difference in temperature from a reference of  $25^{\circ}\text{C}$ . An increase in temperature causes a decrease in measured TDS – this is because conductivity increases with temperature. So, to get an accurate estimate of total dissolved solids, we compensate for this. Readings displayed in  $\text{mS}/\text{cm}$  or  $\mu\text{S}/\text{cm}$  aren't temperature-compensated: They're direct conductivity readings.

## Mounting

You can mount the water monitor on walls using 1 or two mounting points – eg nails, screws, and hooks. Its 2 center mounting keyholes are set up so that the left one is near center-of-gravity when batteries are installed, and the right is near center-of-gravity when batteries are not installed. For stability, it's recommended to use both mounting points when able. Using both points helps keep the display level, and provides additional support.

## Avoiding interference

The Water Monitor's sensors are sequenced so they don't interfere with each other. When a given probe isn't taking a reading, the Water Monitor uses software switches to disconnect that probe from the rest of the device. It also uses other techniques, including disabling the conductivity sensor's activation current. Stray current and electrical interference in the water from other devices will interfere with the Water Monitor's readings, so use in an electrically-noisy environment isn't recommended.

## Updating firmware

The firmware running on the Water Monitor can be updated to add features, improve performance, or fix bugs. Information on updates, and firmware downloads are available on the AnyLeaf website: <https://anyleaf.org/firmware-update>. These updates are optional, and descriptions of what they change are shown with a download link. To update, follow the instructions on that *page*. When the updater asks to press the *firmware update button*, this is accessed using a paper clip or similar device, inserted through the small hole above the control switch.

## **Troubleshooting**

If you have any questions about or trouble with your Water Monitor, please email support at [anyleaf@anyleaf.org](mailto:anyleaf@anyleaf.org)