EcoSniffer specification sheet and user manual

April 2025

1 Specification sheet

The Aquacolor EcoSniffer is a plug-and-play platform featuring a flow-through sensor that delivers timestamped raw data for real-time water quality monitoring. Designed for research, industrial, and environmental applications, it integrates seamlessly with Aquacolor's spectrophotometric nitrate and algae sensors and supports local and cloud storage. This provides users with transparent data that can be tailored to specific analyses, suitable for regulatory reporting and operational use

Figure 1 shows the footprint of the flow-through sensor system.

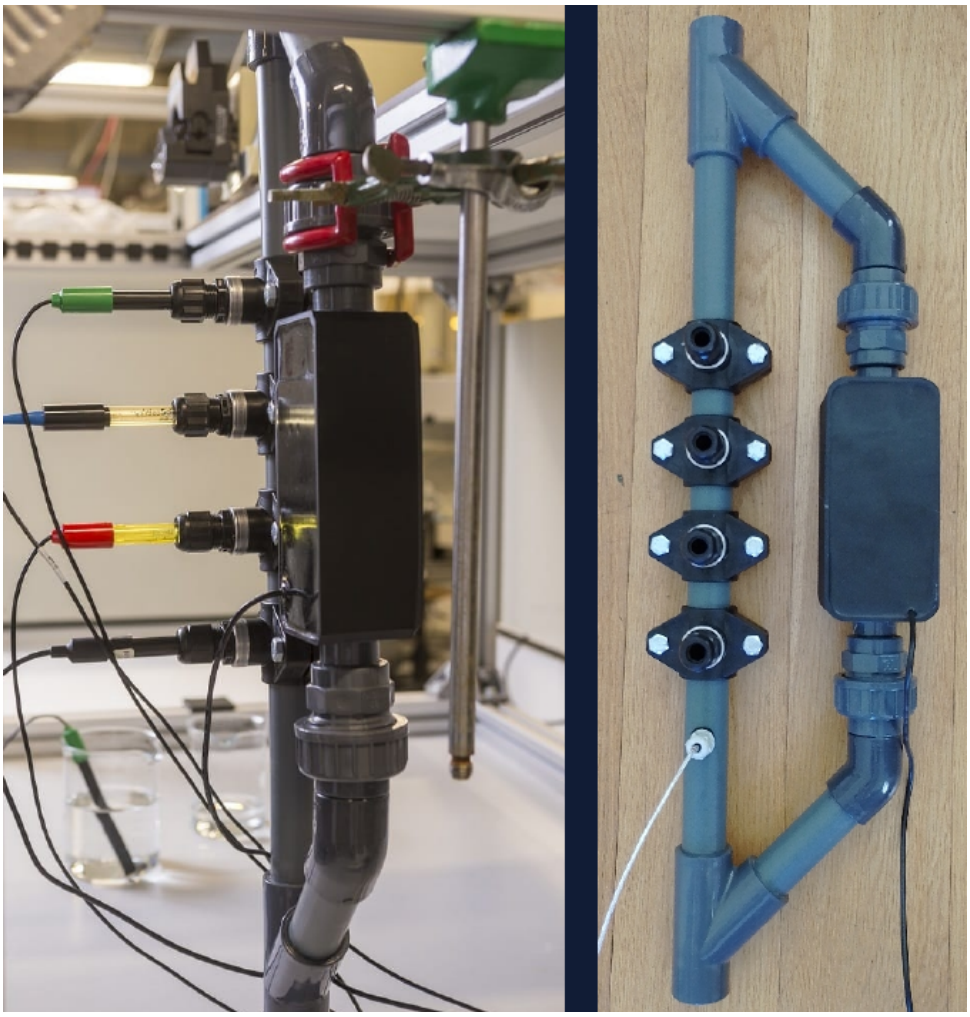

Figure 1: *The EcoSniffer with 32 mm PVC connectors and PC-based data logger.*

1.1 Measurement capabilities and output

- **pH sensor**: Measures pH in the range of 0.001 to 14.000 (extendable to −1.600 to 15.600) with an accuracy of ±0.002. Supports temperature compensation (default 25 °C).
- **EC sensor**: Measures electrical conductivity (EC) from 0.07 to 500,000 µS/cm with an accuracy of ±2% of reading. Also supports TDS (ppm), salinity (ppt), and specific gravity readings. Logged values are conductivity.
- **ORP Sensor**: Measures oxidation-reduction potential (ORP) from −1020 mV to +1020 mV (extendable to −2040 mV to +2040 mV) with an accuracy of ±1 mV.
- **DO sensor**: Measures dissolved oxygen (DO) from 0.00 to 100.00 mg/L or 0 to 350% saturation with an accuracy of ±0.05 mg/L and resolution of 0.01. Supports temperature, salinity, and pressure compensation.
- **Temperature sensor**: Measures temperature from −5 to 80 °C with an accuracy of ±0.1 °C and resolution of 0.001 °C.
- **Spectrophotometric channels**: Transmission at 255 nm, 280 nm, 400 nm, 461 nm, 520 nm, 640 nm.
- **Nitrate sensor (optional)**: Measures transmission at 235 nm for nitrate quantification, 280 nm for natural organic matter (NOM) correction, and 400 nm, 461 nm, 520 nm, 640 nm for turbidity and chromophores correction. Includes resin temperature measurement for environmental correction. Transmission values adjusted to 10 mm optical path length.
- **Algae sensor (optional)**: Measures fluorescence at 461 nm (chlorophyll-a, green algae, emission at 685 nm) and 590 nm (phycocyanin, blue-green algae, emission at 650 nm), with transmission at 400 nm, 461 nm, 520 nm, 640 nm for humic acids and turbidity correction. Provides 299 spectral channels (340 to 850 nm, 1.7 nm sampling interval, 15 nm FWHM resolution). Includes resin temperature measurement for environmental correction. Transmission values adjusted to 10 mm optical path length.
- **Raw output**: A CSV file where each line represents a single measurement, containing the timestamp and corresponding raw data, stored locally and optionally backed up to a cloud service with private servers located within the EU.

1.2 Applications

- **Drinking water safety**: Delivers raw data on UV absorbance, turbidity, redox potential, and nitrate levels (via Aquacolor's nitrate sensor) to detect early signs of water quality deterioration, supporting reliable protection of public health and regulatory compliance.
- **Wastewater treatment insights**: Supplies high-quality raw data from electrochemical and spectrophotometric sensors to support wastewater treatment plant (WWTP) analysis. Facilitates advanced modeling of nitrification and denitrification (nitrogen conversion processes) through sensor fusion and machine learning, enabling improved effluent quality and energy-efficient operations.
- **Academic and research excellence**: Provides raw, unprocessed data for sensor fusion and scientific studies, avoiding restrictive black-box algorithms. Validated by Wetsus for cutting-edge water quality research and EU projects, it's ideal for universities and research institutes seeking transparent, flexible data.

- **Nutrient removal modeling**: Integrates seamlessly with Aquacolor's nitrate sensor to deliver precise raw data for modeling nitrogen-related processes, supporting enhanced nutrient removal efficiency in wastewater treatment.
- **Algae monitoring and control**: Combines with Aquacolor's spectrophotometric algae sensor, using fluorescence and transmission spectra to provide raw data for monitoring algae presence and assessing water quality, enabling proactive management of algal blooms in surface waters and treatment processes.
- **Advanced Oxidation Processes (AOP)**: Supplies raw spectrophotometric and electrochemical data to estimate oxidative stress (OX), supporting improved degradation of pharmaceutical residues and pesticides for cleaner effluents.
- **Proactive surface water monitoring**: Provides raw data on UV-C disinfection effectiveness, algae presence (via Aquacolor's algae sensor), and turbidity for raw water intake monitoring, supporting a consistent, high-quality water supply for drinking water production.
- **Robust flow-through design**: Features a durable flow-through sensor with 32 mm PVC connectors, designed for reliable operation in demanding field and lab environments. Its rugged construction ensures long-term performance, while easy maintenance and cleaning via pulsed flow through the sensor minimize downtime and ensure consistent data quality.

Unlike conventional sensors with proprietary algorithms, the EcoSniffer, paired with Aquacolor's nitrate and algae sensors, delivers raw, customizable data for full control and flexibility. Contact us at info@aquacolorsensors.nl to explore how the EcoSniffer can elevate your water quality monitoring.

1.3 Physical specifications

- **Dimensions**: 710 mm × 210 mm × 110 mm, see figure 1. For the foot prints of the optional nitrate sensor and algae sensor, see figure 2.
- **Connectors**: 32 mm PVC
- **Material**: Spectrophotometric sensor with a 25 mm quartz tube, connected via screw connectors to 32 mm PVC piping for flow-through operation.

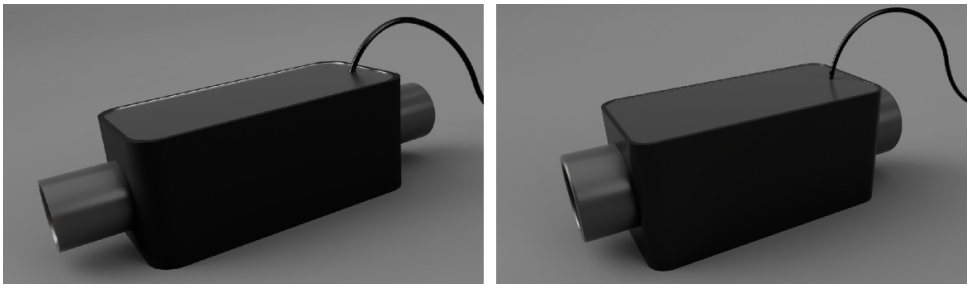

Figure 2: *Figure 2. Footprints of the optional Nitrate Sensor, 70 mm (height) × 80 mm (width) × 170 mm (length), 25 mm PVC connectors and the Algae Sensor, 95 mm (height) × 80 mm (width) × 170 mm (length), 50 mm PVC connectors.*

1.4 Power and connectivity

- **Power**:
  - Energy-efficient: 15 W, 230 V AC
- **System**:
  - Debian 12 PC with GUI, offering local and optional cloud logging, exceptional stability, no license cost, no unplanned updates, user customization through open-source design, strong community support, and robust security features for reliable operation.
- **Connectivity**:
  - USB connectivity for the standard, nitrate, and algae spectrophotometric sensors, ensuring a straightforward and reliable setup for high-precision optical measurements.
  - Dedicated color-coded BNC connectors for the electrochemical sensors (pH, EC, ORP, DO) and temperature, simplifying identification and connection for users in field or lab settings.
  - LAN/Wi-Fi support, enabling flexible data transfer and remote access to measurements, complementing the local storage in CSV files and optional cloud storage on private EU-based servers.

2 Field validation and system walkthrough

Since early 2024, Wetsus has implemented five EcoSniffer systems, acquired for use in PhD research and EU-funded projects focused on real-time and inline monitoring of drinking water in the Netherlands and Portugal. Following extensive field validation, both the systems and the associated cloud service have proven to be robust and reliable.

In close collaboration with Wetsus, this has led to the development of a practical, user-friendly plug-and-play solution that supports process optimization, model validation, and early warning applications. Among the available modules, the Aquacolor UV VIS transmission sensor is the most advanced, enabling complex water quality analysis through sensor data fusion.

The following sections walk through the user interface, data format, embedded manuals, and integrated command line tools for sensor calibration.

2.1 Data output format and example

The data produced by the EcoSniffer are stored locally and, if the cloud logging option is enabled, also on secured private cloud servers located within the EU. The logging frequency can be configured up to once per minute.

Each output line includes the timestamp, temperature, raw amplitudes, transmission values, and electrochemical readings in the following format:

```
1    date time, unix time, resin temperature, $Unique_id_code,
2    A255, A280, Adark, A400, A461, A520, A640,
3    T255, T280, T400, T461, T520, T640,
4    temp, ORP, pH, DO, EC
```

Where:

- **date time, unix time**: Date and time in ISO format, followed by the Unix timestamp.
- **resin temperature**: Temperature of the optical sensor's encapsulation resin in °C.
- **$Unique_id_code**: Unique identifier of the sensor.
- **A255, A280, Adark, A400, A461, A520, A640**: Raw amplitudes in arbitrary units at each wavelength, including the dark measurement.
- **T255, T280, T400, T461, T520, T640**: Transmission values adjusted to a 10 mm optical path length (the sensor's optical path length is 22 mm.
- **temp, ORP, pH, DO, EC**: Temperature and electrochemical sensor values: temperature (°C), oxidation-reduction potential (mV), pH (—), dissolved oxygen (mg/L), and electrical conductivity (µS/cm).

A real life output example (note that the single line is split into 3 lines for lay-out reasons and that the the Unique_id_code string was anonimized):

```
2025-04-19 22:26:11,1745094371,$Unique_id_code,ID_ACS_unit5_batch1,
16.31,24770,22877,0,3520,16170,30894,17368,0.939310,0.932836,
0.885035,0.953761,0.957262,0.960206,17.045,82.77,7.257,4.74,277.0
```

2.2 Login screen

After startup, the user is presented with the EcoSniffer desktop environment based on a stable Debian 12 operating system. The Aquacolor_logger application is available directly on the desktop. This application is used for data acquisition from the EcoSniffer and any connected Aquacolor sensors.

Figure 3: *Login screen showing the Debian 12 desktop with the Aquacolor_logger application icon magnified. Clicking the icon will start the aqua_logger's GUI.*

The logger software automatically detects all connected sensors and adapts the structure of the output file accordingly. The first line of the output CSV file always lists the connected sensors and defines the meaning and order of the values in each subsequent line.

2.3 Lab control panel

When clicking the Aquacolor_logger application icon on the desktop, a browser window opens with the Lab Control Panel. This interface allows the user to start continuous measurements and to send calibration or configuration commands to each connected sensor. It also enables access to EEPROM settings where applicable.

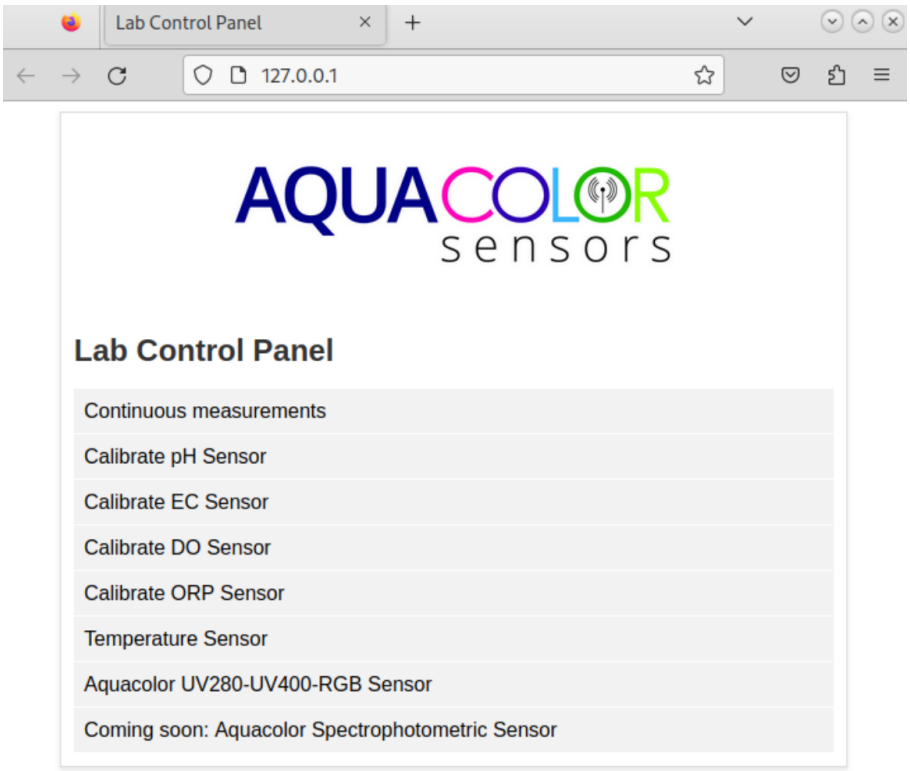

Figure 4: *Lab Control Panel as shown in the Aquacolor_logger application.*

The contents of the Lab Control Panel may differ between installations, as the available menu items are configured according to the specific needs of the customer, the available spectrophotometric sensors and new software features. All items in the control panel are clickable and designed to be self-explanatory.

2.3.1 Continuous measurements

Clicking on *Continuous measurements* in the Lab Control Panel opens the data logger control interface, as shown in Figure 5. The user can define the time interval between measurements (in seconds, with a minimum of 60) and optionally enable data upload to the cloud server.

After pressing *Start Script*, the user receives confirmation that the logging script has been initiated. From that moment on, data are continuously recorded to a uniquely named CSV file. The filename includes the exact timestamp corresponding to the moment the script was started (see example on the right side of the desktop in Figure 5).

The script will keep logging measurements at the defined interval until the user stops it by clicking *Stop Script*. No further action is required.

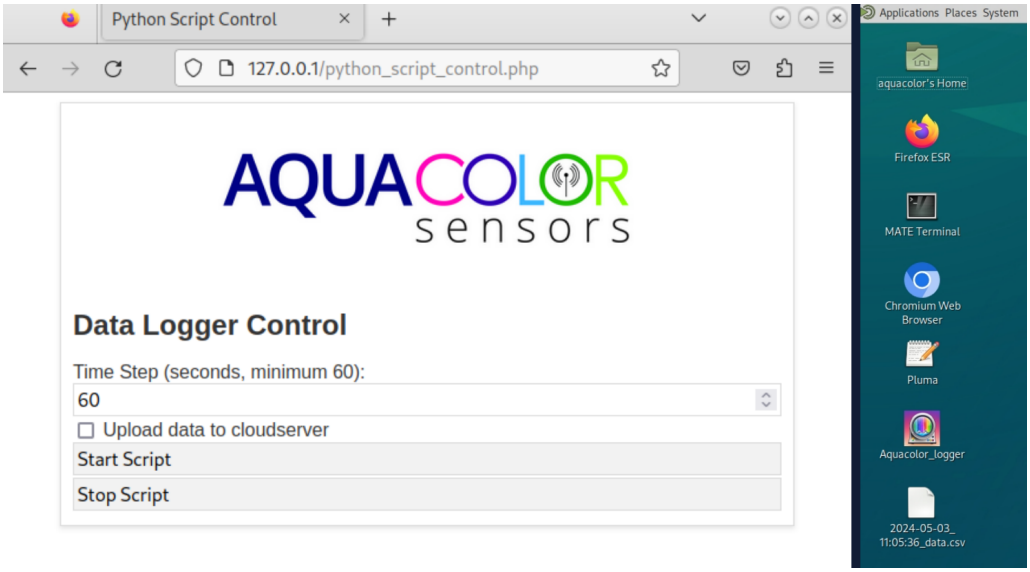

Figure 5: *Continuous measurements menu for defining logging interval and enabling cloud upload.*

2.3.2 Calibrate pH sensor

Clicking on *Calibrate pH Sensor* in the Lab Control Panel opens the pH calibration and settings interface, as shown in Figure 6. This screen provides a brief explanation of how to perform a two-point calibration using pH 4 and pH 7 buffer solutions. It includes a command input line, a response line, and a short quick reference at the bottom of the screen for more advanced use.

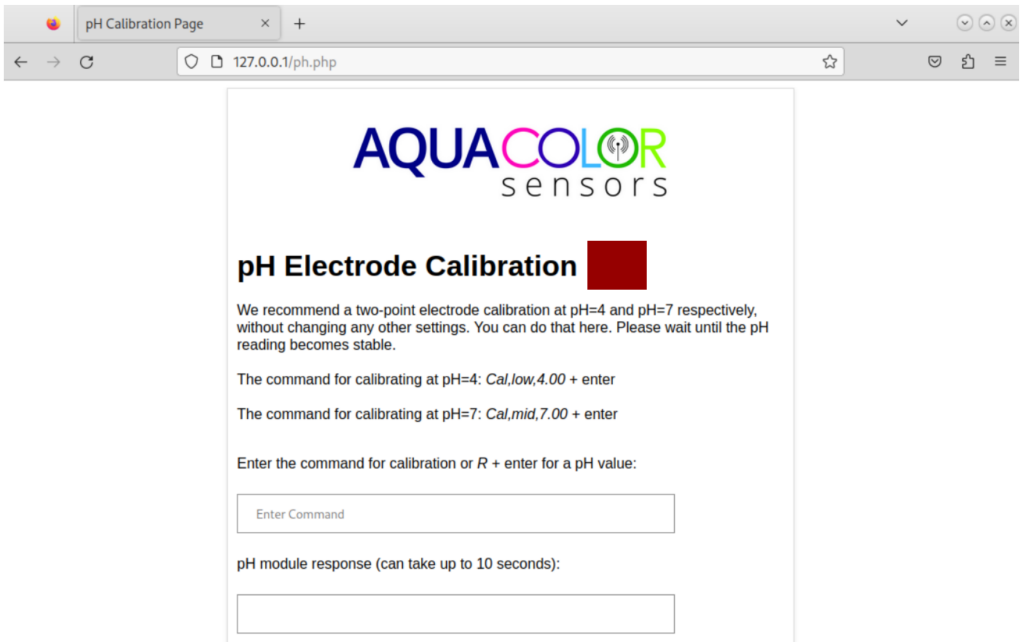

Figure 6: *Calibration interface for the pH sensor module, including command input and response lines.*

The recommended calibration procedure is:

- Allow the pH reading to stabilize in pH 4 solution, then enter: `Cal,low,4.00`
- Rinse the electrode, place it in pH 7 solution, allow it to stabilize, then enter: `Cal,mid,7.00`

2.3.3 Calibrate EC sensor

Clicking on *Calibrate EC Sensor* in the Lab Control Panel opens the calibration interface for the electrical conductivity (EC) sensor. This interface allows the user to perform a single-point calibration using a standard solution with a known conductivity value, typically 12880 μS/cm.

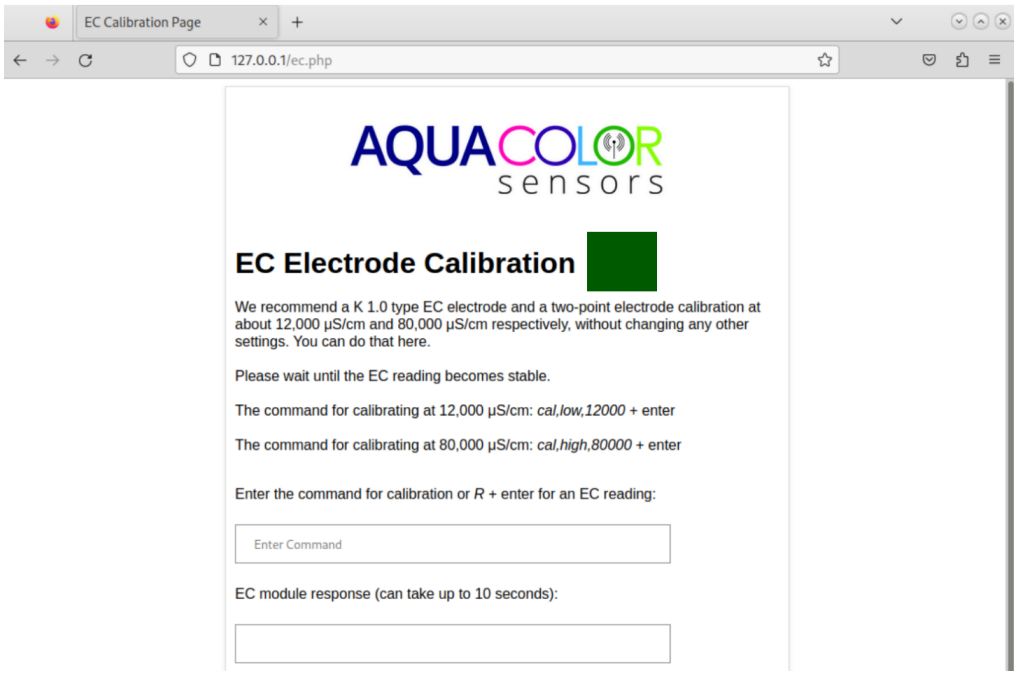

Figure 7: *Calibration interface for the EC sensor module, including command input and response fields.*

The recommended procedure is:

- Wait until the EC reading becomes stable in the calibration solution.
- Enter the command: `Cal,12880`

For expert users and advanced calibration options, refer to the EC quick reference manual in the appendix.

2.3.4 Calibrate ORP sensor

Clicking on *Calibrate ORP Sensor* in the Lab Control Panel opens the calibration interface for the ORP sensor, as shown in Figure 8. This screen allows the user to perform a single-point calibration using a buffer solution with a known ORP value, typically around 200 mV.

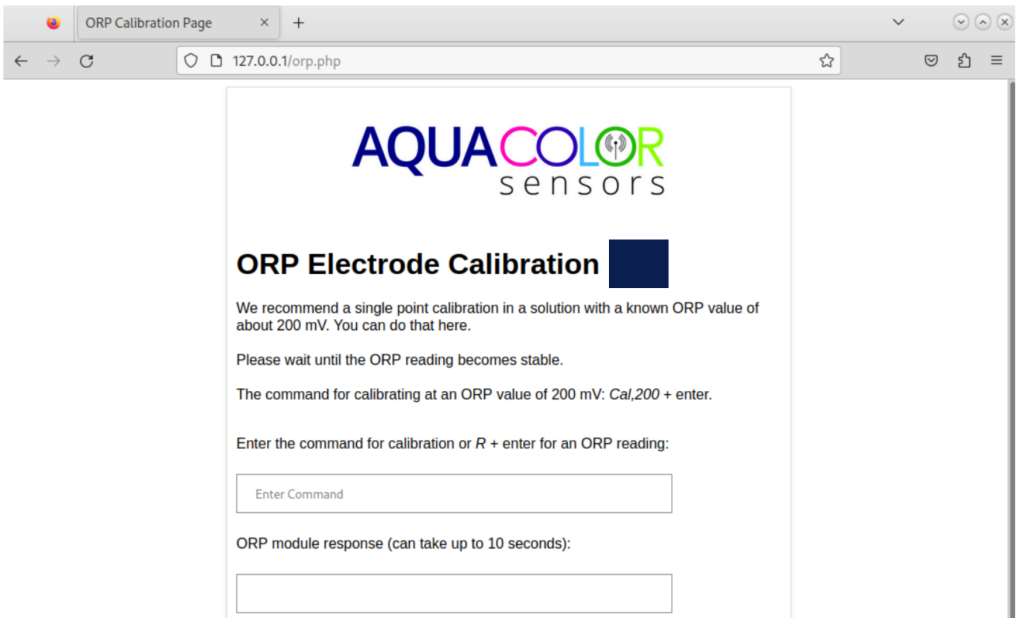

Figure 8: *Calibration interface for the ORP sensor module, including command input and response fields.*

The recommended procedure is:

- Wait until the ORP reading becomes stable in the calibration solution.
- Enter the command: `Cal,200`

For advanced settings or expert calibration options, refer to the ORP quick reference manual in the appendix.

2.3.5 Calibrate DO sensor

Clicking on *Calibrate DO Sensor* in the Lab Control Panel opens the calibration interface for the dissolved oxygen (DO) sensor, see also figure 9. This screen allows the user to perform either a zero-point or atmospheric calibration using appropriate reference solutions.

The recommended calibration procedure is:

- For zero calibration: place the sensor in a zero DO solution and enter: `Cal,0`
- For atmospheric calibration: ensure the sensor is exposed to air-saturated water, then enter: `Cal`

For advanced configuration and calibration commands, refer to the DO sensor manual in the appendix.

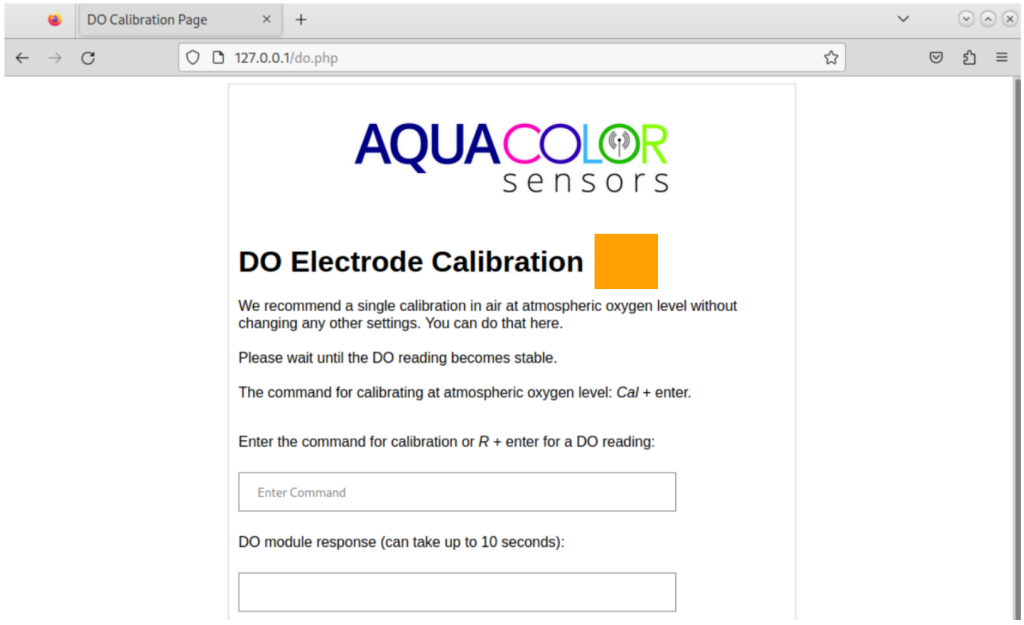

Figure 9: *Calibration interface for the DO sensor module, including command input and response lines.*

2.3.6 Calibrate temperature sensor

Clicking on *Calibrate Temperature Sensor* in the Lab Control Panel opens the interface for the temperature sensor, see figure 10. This sensor typically does not require calibration. However, a single-point offset calibration can be applied if desired.

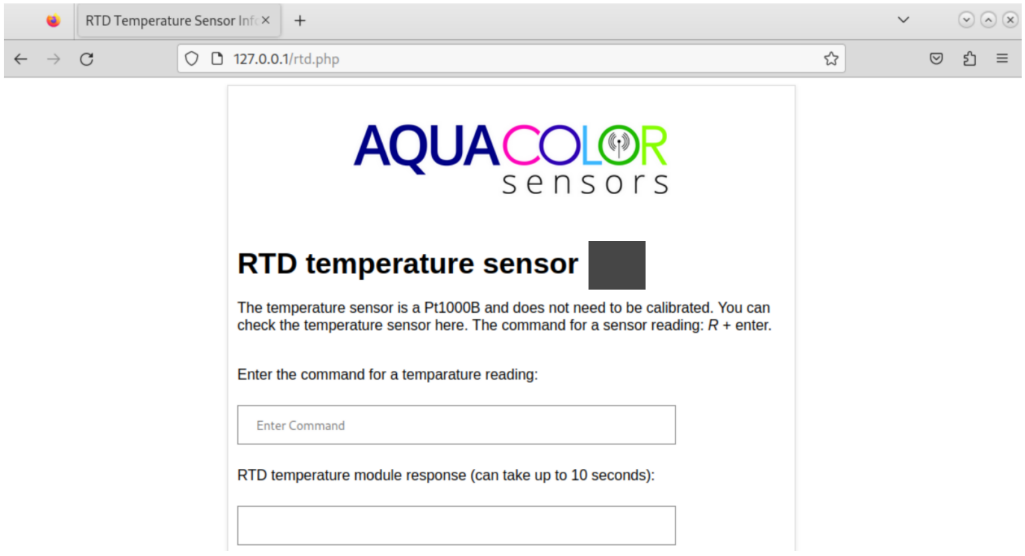

Figure 10: *Interface for the temperature sensor module. Calibration is optional and limited to offset adjustment.*

The optional calibration procedure is:

- Place the sensor in a temperature-controlled bath or reference point.
- Enter the known value using: `Cal,100.0` (for example, if the known temperature is 100.0°C)

For full command reference and advanced usage, see the temperature sensor manual in the appendix.

2.3.7 Calibrate T255–T640 transmission sensor

Clicking on *Calibrate T255–T640 Sensor* in the Lab Control Panel opens the interface for calibrating the multi-wavelength transmission sensor. This sensor measures light transmission at six wavelengths: 255 nm, 280 nm, 400 nm, 461 nm, 520 nm, and 640 nm.

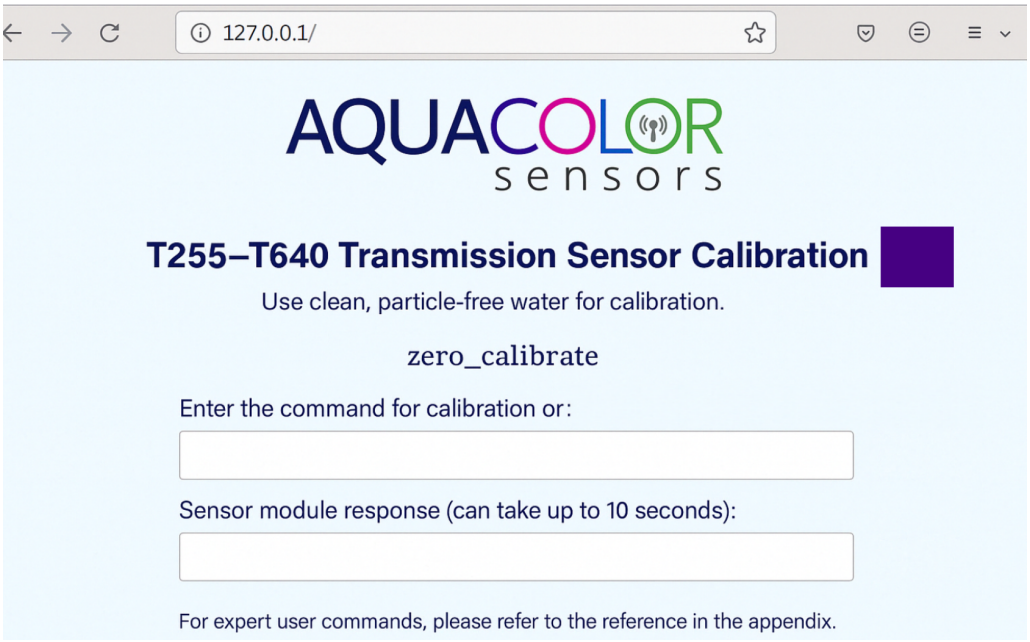

Figure 11: *Calibration interface for the T255–T640 transmission sensor.*

The calibration is performed using clean, particle-free water as background, such as demineralized water. If desired, zero calibration can also be performed against another background water source. The following command sets the current matrix as reference and adjusts all six channels such that their transmission equals 1.0:

- `zero_calibrate`

Once calibrated, the sensor provides raw and normalized transmission values for all six wavelengths. No further configuration is required for standard use.
For advanced use (e.g., adjusting LED intensity or measurement delay), refer to the expert command set of the Aquacolor transmission sensor in the appendix.

Company Info

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Appendix — Expert use manuals for the sensor modules in the Aquacolor EcoSniffer

This appendix contains the original quick reference manuals for expert use of the connected sensors. These documents are included for completeness and cover advanced configuration options, diagnostics, and EEPROM-level commands. No additional explanation is provided here.

Following manuals are available, each distinguishable by background color:

1. pH sensor
2. EC sensor
3. DO sensor
4. ORP sensor
5. Temperature sensor
6. Aquacolor UV255-UV280-UV400-RGB sensor

Quick Reference: pH Sensor

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Core Info

- **Range:** 0.001–14.000 (default), extendable to –1.600–15.600.
- **Accuracy:** ±0.002
- **Temp Compensation:** Default 25 ℃, set via `T,x`
- **Interface:** USB (virtual COM), 9600 baud, 8N1, ASCII.
- **Power:** 5V USB, 22 mA

Basic Use

- `R` – Read current pH value (response in 800 ms)
- `C,1` – Start continuous readings (1/s)
- `C,0` – Stop continuous mode
- `Sleep` – Enter low power mode
- `i` – Device info

Calibration

Use calibration solutions of pH 7, 4, and 10. Wait for stable readings before issuing commands.

- `Cal,mid,7.00` – Mid-point calibration

- `Cal,low,4.00` – Low-point calibration
- `Cal,high,10.00` – High-point calibration
- `Cal,clear` – Clears all calibration
- `Slope,?` – View calibration quality

Advanced

- `T,25.0` – Set temperature compensation (℃)
- `pHext,1` – Enable extended range
- `Name,MySensor` – Set device name (max 16 chars)
- `Export` – Dump calibration settings
- `Import,x` – Load calibration to new device

Notes

- Do not let water touch the SMA or USB connector.
- For stable calibration: issue commands only after readings stop drifting.
- Recalibrate every 8–12 months or if readings degrade.

LED Indicators

- **Green:** Standby
- **Cyan:** Blinks when a reading is taken or data is sent
- **Red:** Command not understood
- `L,0` – Turn off LED (optional)

Quick Reference: EC Sensor

April 2025

Core Info

- **Range:** 0.07–500,000 µS/cm (probe-dependent)
- **Accuracy:** ±2% of reading
- **Readings:** Conductivity, TDS (ppm), Salinity (ppt), Specific Gravity
- **Interface:** USB (virtual COM), 9600 baud, 8N1, ASCII
- **Power:** 5V USB, 35 mA

Basic Use

- `R` – Read current EC/TDS/SAL/SG value (600 ms)
- `C,1` – Start continuous readings (1/s)
- `C,0` – Stop continuous mode
- `Sleep` – Enter low power mode
- `i` – Device info

Calibration

Always start with `Cal,dry` (probe out of solution).

- `Cal,dry` – Dry probe calibration
- `Cal,84` – Single point (any value in µS/cm)

- `Cal,low,12880` – Low point (e.g., 12,880 µS/cm)
- `Cal,high,80000` – High point (e.g., 80,000 µS/cm)
- `Cal,clear` – Clear all calibration
- `Cal,?` – Show calibration status

Advanced

- `T,25.0` – Set temperature compensation (℃)
- `K,1.0` – Set probe cell constant (K value)
- `TDS,0.54` – Set TDS conversion factor (0.01–1.00)
- `Name,MyEC` – Set device name
- `Export` – Dump calibration
- `Import,x` – Load calibration to new device
- `O,EC,1`, `O,TDS,1`, `O,S,1`, `O,SG,1` – Enable outputs

Notes

- Dry calibration is always required.
- Shake probe to release air bubbles before calibration.
- Wait for stable readings before sending calibration commands.

LED Indicators

- **Green:** Standby
- **Cyan:** Blinks when a reading is taken or data is sent
- **White:** Blinking = “Find” mode
- `L,0` – Turn off LED (optional)

Quick Reference: ORP Sensor

April 2025

Core Info

- **Range:** -1020 mV to +1020 mV (extended: -2040 mV to +2040 mV)
- **Accuracy:** ±1 mV
- **Read Time:** 800 ms
- **Interface:** USB (FTDI virtual COM), 9600 baud, 8N1
- **Power:** 5V USB, 37 mA max
- **Ingress Protection:** IP62

Basic Use

- `R` – Take a single ORP reading (response in 800 ms)
- `C,1` – Enable continuous readings (1 per sec)
- `C,0` – Disable continuous readings
- `i` – Device info
- `Sleep` – Enter low power mode

Calibration

Use any known ORP standard (e.g. 225 mV). Wait for stable readings before sending:

- `Cal,225` – Calibrate to 225 mV
- `Cal,clear` – Clear calibration
- `Cal,?` – Check if calibrated

Advanced

- `Export` – Dump calibration string
- `Import,n` – Load calibration into new device
- `ORPext,1` – Enable extended range (±2040 mV)
- `Name,MyORP` – Set device name (16 chars max)
- `Factory` – Reset to defaults
- `Status` – View voltage and last restart cause

LED Indicators

- **Green:** Standby
- **Cyan:** Blinks when a reading is taken or data is sent
- **Red:** Command not understood
- **White:** Blink rapidly in `Find` mode
- `L,0` – LED off `L,1` – LED on

Notes

- Do not allow water to enter USB or SMA probe connector.
- A connector short may cause pinning at ±1020 mV but is reversible.
- Recalibrate every 8–12 months or if performance degrades.
- Wait for reading stability before calibration to prevent drift.

Quick Reference: DO Sensor

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Core Info

- **Range:** 0.00–100.00 mg/L, 0–350% saturation
- **Accuracy:** ±0.05 mg/L, Resolution: 0.01
- **Temp/Salinity/Pressure Compensation:** Supported
- **Interface:** USB (virtual COM), 9600 baud, 8N1, ASCII
- **Power:** 5V USB, 22 mA

Basic Use

- `R` – Read current DO value (response in 600 ms)
- `C,1` – Start continuous readings (1/s)
- `C,0` – Stop continuous mode
- `Sleep` – Enter low power mode
- `i` – Device info

Calibration

Wait for readings to stabilize before issuing commands.

- `Cal` – Calibrate to atmospheric oxygen (9.09 mg/L)
- `Cal,0` – Zero-point calibration (0 DO solution)

1

- `Cal,clear` – Clear all calibration
- `Cal,?` – Show calibration status (0, 1, or 2)

Advanced

- `T,20.0` – Set temperature (℃)
- `S,50000` – Salinity in µS
- `S,35,ppt` – Salinity in ppt
- `P,101.3` – Pressure in kPa
- `Name,MyDO` – Set device name
- `Export` – Dump calibration
- `Import,x` – Load calibration
- `O,mg,1` – Enable mg/L output
- `O,%,1` – Enable % saturation output

Notes

- Calibrate only after readings stop drifting.
- Use Zero DO solution for low-point calibration.
- Recalibrate every 8–12 months or if readings degrade.

LED Indicators

- **Green:** Standby
- **Cyan:** Blinks when reading is taken or data is sent
- **White:** Blinking = “Find” mode
- `L,0` – Turn off LED (optional)

Quick Reference: Temperature Sensor

April 2025

Core Info

- **Range:** –126.000 to 1,254.000 °C
- **Accuracy:** ±0.1 °C (sensor dependent)
- **Resolution:** 0.001 °C
- **Interface:** USB (virtual COM), 9600 baud, 8N1, ASCII
- **Power:** 5V USB, 22 mA

Basic Use

- `R` – Read current temperature
- `C,1` – Start continuous readings (1/s)
- `C,0` – Stop continuous mode
- `Sleep` – Enter low power mode
- `i` – Device info

Calibration

The EZO-RTD does not require calibration for normal use. Optional single-point offset calibration:

- `Cal,100.0` – Calibrate to known temperature

- `Cal,clear` – Clear calibration
- `Cal,?` – Show calibration status

Advanced

- `S,385` – Set RTD type (e.g., 385 for PT-1000)
- `Name,MyTemp` – Set device name
- `Export` – Dump calibration
- `Import,x` – Load calibration to new device

Notes

- Accepts 2, 3, or 4-wire RTD sensors
- Offset calibration shifts result but does not affect internal sensor accuracy
- Recalibration not usually required unless using extreme precision

LED Indicators

- **Green:** Standby
- **Cyan:** Blinks when a reading is taken or data is sent
- **White:** Blinking = “Find” mode
- `L,0` – Turn off LED (optional)

Quick Reference: T255–T640 Transmission Sensor

April 2025

Core Info

- **Wavelengths:** 255, 280, 400, 461, 520, 640 nm
- **Calibration:** Zero-point using background water matrix
- **Optical path length:** 22 mm (transmission normalized to 10 mm)
- **Interface:** USB (virtual COM), 9600 baud, 8N1, ASCII
- **Power:** 5V USB, 150 mA

Basic Use

- `single` – Perform one measurement cycle
- `continue` – Start continuous measurements
- `stop` – Stop continuous measurements
- `i` – Sensor info

Calibration

Calibrate with clean, particle-free water to set current matrix as baseline (transmission = 1.0):

- `zero_calibrate` – Sets transmission baseline for all wavelengths

Advanced

- `T255_intensity,x` – Set LED intensity (0–255)
- `T255_intensity,x` – Set LED intensity (0–255)
- `rgb_intensity,x` – Set RGB LEDs intensity (0–255)
- `deltat,x` – Set interval (ms) for continuous mode, min 5000
- `settings` – Show current intensity and timing settings

Notes

- Avoid direct exposure to UV LEDs
- Ensure sensor is clean before calibration
- Transmissions are auto-adjusted to 10 mm reference length