Introduction

The In-Situ® Inc. TROLL® 9500 Water Quality Instrument can be configured with a custom set of water quality sensors. Each sensor type has different capabilities and limitations that must be considered in order to achieve optimal performance.

TROLL 9500 sensors require calibration and routine maintenance to maintain accuracy. They must be stored properly when not in use to maximize sensor life. Proper storage techniques vary depending on the sensors and the length of time they will be stored.

This guide provides individual sensor information including recommendations for calibration, routine maintenance, and storage.

Additional sensor information can be found at www.in-situ.com/Tech Resources.

Conductivity Sensor

Keys to Calibration

- Perform calibration every 2 to 3 months.
- Ensure that the temperature sensor is fully submerged during calibration. When calibrating the high-range conductivity sensor, ensure the upper vent ports are submerged and no bubbles are present.
- The Calibration Report in Win-Situ® 4 Software displays the K-cell value.
- Low-range sensor K-cell: 0.30 to 0.39 cm⁻¹
- High-range sensor K-cell: 4.4 to 5.8 cm⁻¹

Routine Maintenance

- Remove minerals or precipitates by soaking the sensor in vinegar. Use a swab or tissue to remove the debris.
- Do not scrub, brush, or scratch the sensing surface.

Storage

- Rinse with water and store dry.

Suggested Further Reading

- Tech Note: Specific Conductance as an Output Unit for Conductivity Readings
- Tech Note: Total Dissolved Solids from Conductivity
**pH Sensor**

**Keys to Calibration**
- Condition the sensor by soaking in pH 4 buffer for at least 1 hour—preferably over night.
- Calibrate every 2 to 6 weeks, depending on site conditions.
- Always perform calibration after you replace the reference junction or the filling solution.
- The pH sensor can be reset to factory defaults at any time. This option is most effective when the sensor is new.
- The Calibration Report in Win-Situ® 4 Software allows you to view the mV response at pH 4, 7, and 10 as well as the slope and offset for the pH 7 calibration.
- Millivolt response: 0 mV ±20 mV at pH 7
- Ideal slope: -54 to -62 mV/pH (-50 to -66 is also acceptable)
- Offset: 350 to 450 mV

**Routine Maintenance**
After the pH sensor is moistened, it must be kept moist for the life of the sensor.

The pH sensor fill solution has a shelf life of 2 years. Replace the fill solution every 5 to 6 months or when:
- The sensor fails to calibrate within the acceptable slope and offset range.
- Sensor readings vary.
- Readings during calibration at pH 7 are greater than +20 mV or less than -20 mV.
- Sensor is slow to respond.

*Note: If the sensor fails to calibrate after you replace the fill solution, replace the reference junction.*

**Cleaning**
Begin with the most gentle cleaning method and continue to the other methods only if necessary. Do not directly wipe the glass bulb.

To clean the pH sensor, gently rinse with cold water. If further cleaning is required, consider the nature of the fouling.

To remove crystalline deposits:
- Clean the sensor with warm water and mild soap.
- Soak the sensor in 5% HCl solution for 10 to 30 minutes.

To remove oily or greasy residue:
- Clean the sensor with warm water and mild soap.
- Methanol or isopropyl alcohol may be used for short soaking periods, up to 1 hour.
- Do not soak the sensor in strong solvents, such as chlorinated solvents, ethers, or ketones, including acetone.

To remove protein-like material, or slimy film:
- Clean the sensor with warm water and mild soap.
- Soak the sensor in 0.1M HCl solution for 10 minutes and then rinse with deionized DI water.

After performing any of these cleaning methods, rinse the sensor with water, then soak overnight in pH 4 buffer.

**Short-term Storage**
Up to 1 week: Fill the electrode storage bottle with pH 4 buffer and immerse the sensor tip in the buffer. Tighten the cap to prevent drying. Alternatively, pH 7 buffer can be used for a few days.

**Long-term Storage**
Greater than 1 week: Prepare a storage solution by mixing pH 4 buffer with a high-concentration potassium chloride solution (e.g. 58,670 µS/cm conductivity calibration solution) in a volume ratio of 1:10. Immerse the sensor in this solution using the electrode storage bottle. Tighten the cap to prevent drying. Prior to use, condition the sensor by rinsing it with DI water and soaking it for no longer than 15 minutes.

**Storage Recommendations**
Prior to using the pH sensor after long-term storage, rinse the sensor with DI water and then soak it in pH 4 buffer for 1 or 2 hours. This will saturate the glass bulb with hydrogen ions and prepare it for use.

Do not store the pH sensor in DI water because it will deplete the reference solution and drastically reduce the life of the sensor.

**Suggested Further Reading**
- Tech Note: *Care of pH and pH/ORP Combination Sensors*
Oxidation Reduction Potential (ORP) Sensor

Keys to Calibration
• Perform calibration every 1 to 2 months.
• The Calibration Report in Win-Situ® 4 Software allows you to view the offset value. The ideal offset value is 0 mV ±20 mV.

Routine Maintenance
Follow the same cleaning procedures that are listed for the pH sensor. If the platinum electrode appears dull or dirty, it can be cleaned with a swab and methanol or isopropyl alcohol. Rub the electrode gently until the electrode is shiny.

Short-term Storage
Follow the recommendations for the pH sensor.

Long-term Storage
Follow the recommendations for the pH sensor.

Storage Recommendations
Follow the recommendations for the pH sensor.

Suggested Further Reading
• Tech Note: Care of pH and pH/ORP Combination Sensors
• Instruction Sheet: pH Sensors—Reference Junction Replacement Kit
• Instruction Sheet: pH/ORP Sensor
• Instruction Sheet: pH Sensor

Rugged Dissolved Oxygen (RDO®) Sensor

Keys to Calibration
For best results, perform a 2-point calibration at 100% and 0% dissolved oxygen (DO) saturation before using the sensor.

In-Situ® recommends performing calibration on the RDO Sensor when a new cap is installed. A new cap that has not been calibrated by the user, but instead uses the factory-calibrated values, will produce readings within 3% of the expected results. In order to achieve the published, specified accuracy of the sensor, user calibration should be performed.

Three calibration options are available in Win-Situ 4 and Pocket-Situ® 4. To perform a calibration, select the first or second option:

1. Calibrate: Starts calibration with the values stored in the sensor for the 0% and 100% calibration points, whether the values are factory defaults or set by the user. The user can then recalibrate one or both calibration points.
2. Restore defaults, then calibrate: Restores factory defaults for both 0% and 100% calibration points. The user can then recalibrate one or both calibration points.
3. Restore defaults, don’t calibrate: Restores factory defaults for both 0% and 100% calibration points and closes the Calibration Wizard.

Prepare for the 100% DO Saturation Calibration
• 100% DO calibration is performed in water saturated with air. In-Situ recommends using a container of clean water aerated with the In-Situ RDO Bubbler Calibration Kit or an aquarium pump.
• Fill the bubbler container with clean water.
• Turn on the pump and regulate air flow with the pinch valve.
• Insert the TROLL 9500 Instrument into the bubbler, resting the RDO adapter plate on the rim of the cup. Ensure that at least half of the temperature sensor is submerged and the RDO sensing foil is not in the direct path of the bubbles.
• After allowing 5–10 minutes for temperature stabilization, click the Run button in the software. Follow the on-screen instructions to complete the 100% calibration point.

Prepare for the 0% DO Saturation Calibration
• 0% DO calibration is performed in an oxygen-depleted solution. Sodium sulfite (Na₂SO₃) is available from In-Situ Inc. Bubbled nitrogen can also be used; in this case allow plenty of time for the oxygen to be completely purged from the water.

The Calibration Report in Win-Situ 4 displays the calibration slope and offset information.
• A slope between 0.9 and 1.1 is ideal. A slope between 0.8 and 1.2 is acceptable.
• For example, 100% saturation should read between 80% and 120%. A 0% saturation point should read between -0.2 ppm and 0.2 ppm.)
Values outside these ranges can indicate problems with a sensor or foil and will cause a calibration error warning.

**Routine Maintenance**
- In most cases, the sensor cap should remain on the sensor, and therefore lens cleaning is not necessary on a regular basis.
- When replacing the sensor cap, clean the lens only with the lens cloth that is included in the Sensor Cap Replacement Kit. Additional lens cloths are available from In-Situ® Inc.

**Short-term Storage**
Prior to installation, store the cap in its factory packaging until ready to install. Sensor conditioning is not required prior to use.

After installation, there are no specific storage requirements. The RDO Sensor can be stored according to the needs of the other sensors on the instrument. Storage options are available if required as determined by the other sensors on the instrument:
- Disposable, recyclable calibration and storage bags
- Sensor storage and calibration chamber for instruments with turbidity sensors
- Sensor storage and calibration chamber for instruments without turbidity sensors

**Suggested Further Reading**
- Frequently Asked Questions About the RDO Sensor Instruction Sheets:
  - Dissolved Oxygen Sensor (RDO)—Calibration Kit for Cable-Connect Sensors (purchased after 09/2008)
  - Dissolved Oxygen Sensor (RDO)—Calibration Kit for Direct-Connect Sensors (purchased after 09/2008)
  - Dissolved Oxygen Sensor Cap (RDO) Replacement Kit
  - Dissolved Oxygen Sensor (RDO)—Using the Sensor (purchased after 09/2008)

White Papers:
- In-Situ RDO Methods for Analysis of BOD, CBOD, and DO by Edward Askew, Ph.D.
- Optical Dissolved Oxygen Technology Outperforms Traditional Methods and EPA Recommends Approval of In-Situ Methods

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**Polarographic Dissolved Oxygen (Clark Cell DO) Sensor**

**Keys to Calibration**
Calibrate every 2 to 4 weeks. Calibrate every few days if the sensor is used in an environment with heavy fouling.
- Ensure the temperature sensor is fully submerged during calibration.
- Perform calibration in a temperature-stable environment.
- To minimize calibration time, ensure the software version of Win-Situ® 4 or Pocket-Situ® 4 is the most current version available. Software updates are available on the In-Situ Inc. website.
- If using a bubbler system, keep the sensor far from the source of aeration to prevent bubbles from forming on the membrane.

The Calibration Report in Win-Situ 4 displays the slope and offset.
**Slope:**
- The ideal calibration range for the 1-mil membrane is 30 to 67 [nA/(mg/L)].
- The idea calibration range for the 2-mil membrane is 15 to 34 [nA/(mg/L)].
- If the slope is too high, the sensor probably requires more conditioning time.
- If the slope is too low, refill the solution chamber.

**Offset:**
- 1-point calibration (Quick Calibration) default is 2 nA.
- 2-point calibration ideally is 3 or 4 nA, and no greater than 10 nA.

**Routine Maintenance**
Condition and calibrate the sensor:
- After cleaning the sensor
- After replacing the membrane
- When you intend to deploy the sensor at an elevation that differs from the elevation at which the sensor was last calibrated

Replace the membrane every 3 to 6 months depending on use and fouling.

Clean and polish the anode and cathode to remove silver chloride deposits.
Allow for conditioning time after the membrane is replaced.

- Following membrane replacement, connect the TROLL 9500 to a computer via Win-Situ® 4 or Pocket-Situ® 4.
- When “Dissolved Oxygen” is listed under “Parameters” in the navigation tree, the sensor conditioning begins.
- Allow the sensor to condition for at least 4 hours, preferably overnight, before calibrating.

**Short-term Storage**

Up to 2 weeks: Store assembled with the membrane immersed in clean water. If a pH/ORP sensor is also present, a pH buffer of KCl solution can also be used.

**Long-term Storage**

Greater than 2 weeks: Remove the sensor from the TROLL 9500, remove the membrane module from the sensor, rinse with DI water, put the cap on, and store the sensor dry.

**Suggested Further Reading**

- Instruction Sheet: *Dissolved Oxygen Electrode Maintenance Kit*

**Turbidity Sensor**

**Keys to Calibration**

Factory calibration is permanently stored on the TROLL 9500.

- Sensor arrives ready to use.
- Calibration is referenced to AMCO-AEPA-1 styrene divinylbenzene copolymer primary standards.
- Factory calibration can be restored at any time.
- Calibration is strongly linear across the full operating range: ±5% or ±2 NTU, whichever is greater, from 0 to 2000 NTU.

Perform Calibration:

- After cleaning the sensor
- To achieve a higher level of accuracy over a limited range
- To record measurements that are referenced to a specific calibration standard
- If readings drift

User Calibration

- The user can perform a 1-point to 4-point calibration.
- Perform calibration in the low-flow cell or with the stainless steel restrictor cage over the sensors.

**Routine Maintenance**

- Commonly used calibration standards are Diluted Stock Formazin, Stabilized Formazin, and Polymer Bead Suspensions.
- Begin with DI water, or a 0 NTU standard and progressively change to more turbid solutions.
- The limiting factor of accuracy is the precision of the selected turbidity standard.
- If problems arise with user calibration, restore the factory-calibrated defaults.

**Suggested Further Reading**

- Instruction Sheet: *Turbidity Wiper*

**Temperature Sensor**

**Keys to Calibration**

The temperature sensor is factory calibrated, and there is no option for user calibration.

**Routine Maintenance**

- Clean as needed with water, ammonia, or vinegar.

**Storage**

- The temperature sensor cannot be removed from the TROLL 9500.
- The temperature sensor can be stored according to the needs of the other sensors on the instrument.
**Pressure Sensor**

**Keys to Calibration**
- The pressure sensor is factory calibrated, and there is no option for user calibration.
- Return to the factory for calibration every 12 to 18 months depending on performance. Accuracy is compromised over time due to normal drift in electronics, exceeding operating temperature or pressure limits, and improper care.

**Routine Maintenance**
- Gently agitate the pressure sensor in mild soap and water.
- Do not poke or scrape the pressure sensor.

**Storage**
- The pressure sensor cannot be removed from the TROLL 9500.
- The pressure sensor can be stored according to the needs of the other sensors on the instrument.

**Suggested Further Reading**

Tech Notes:
- *Water Level Accuracy—Correcting for Errors Due to Gravitational Acceleration and Liquid Density*
- *Absolute vs. Gauged: Comparing Absolute and Gauged Pressure Sensors*
- *Manual Barometric Correction*
- *Manual Level Mode Correction*

**Ion Selective Electrodes (ISE): Ammonium, Chloride, and Nitrate Sensors**

**Keys to Calibration**
- Prior to calibration, soak the sensor for at least 15 minutes, up to several days, in the calibration fluid selected for the first calibration point. This will be the lowest concentration calibration standard.
- Prepare to use the sensors immediately after calibration, because calibration will last 4 to 6 hours.
- When the expected environmental water temperature range is known and variation is moderate, use a 2-point calibration at the mid-point temperature.
- A 2-point isothermal calibration will suffice if the sensor is deployed in an environment with a relatively stable temperature. Calibrate with the lowest possible and the highest possible analyte concentrations to achieve the most accurate results across the full range.
- Perform calibration at a temperature that is as close as possible to the expected deployment temperature.

If the environmental water is expected to vary by more than 20° C, a 3-point bi-thermal calibration should be used.
- The first two calibration points must be at the same temperature and in different concentrations.
- The third calibration point should be at least 10° C higher or lower than the first two points (a greater difference is preferable), depending on the sampling conditions. Allow 15 minutes for the sensor to stabilize at this temperature.
- All ISE sensors are highly susceptible to drift due to temperature changes. A 3-point bi-thermal calibration allows the sensor to compensate for temperature changes by determining the isopotential point—the concentration at which changes in temperature do not cause a change in sensor response.
- The sensor retains the slope and the temperature correction factor. All ensuing single-point calibrations adjust only the offset, not the slope.
- Use a glass beaker for the ice bath, the thick plastic calibration cup will not equilibrate as quickly as glass.

A 1-point calibration is recommended only to adjust the sensor offset following a 3-point bi-thermal calibration.
- Perform a 1-point calibration daily, or after using the sensor for 4 to 6 hours.

The Calibration Report in Win-Situ® 4 displays the slope.
- The ideal slope for a new Ammonium Sensor is approximately 54 to 58 mV per decade of concentration.
- The ideal slope for a new Chloride or Nitrate Sensor is approximately 55 to 59 mV per decade of concentration.
Ammonium Sensor Storage

- When not in use, store the sensor in 14 or 140 ppm as N calibration solution depending on whether future use will be in low or high ammonium range.
- Do not store the sensor dry.
- Do not store the sensor in DI water.

Chloride Sensor Storage

- Immerse in 35 or 355 ppm chloride solution depending on whether future use will be in low or high chloride range.
- For long-term storage, rinse with water and store dry.

Nitrate Sensor Storage

- When not in use, store the sensor in 14 or 140 ppm as N calibration solution, depending on whether future use will be in low or high nitrate range.
- Do not store the sensor dry.
- Do not store the sensor in DI water.

Suggested Further Reading

- TROLL 9500 Operator’s Manual—Contains information related to depth, pH, conductivity, temperature, and potential interfering ions.
- Tech Note: Performing a 3-point Bi-Thermal Calibration for Ion Selective Electrode Sensors

Summary

Logging accurate water quality measurements with a TROLL 9500 is dependent on the proper calibration and maintenance of the sensors. Achieve the highest possible accuracy and maximize the life of all water quality sensors by following the recommended guidelines for calibration, routine maintenance, and storage.