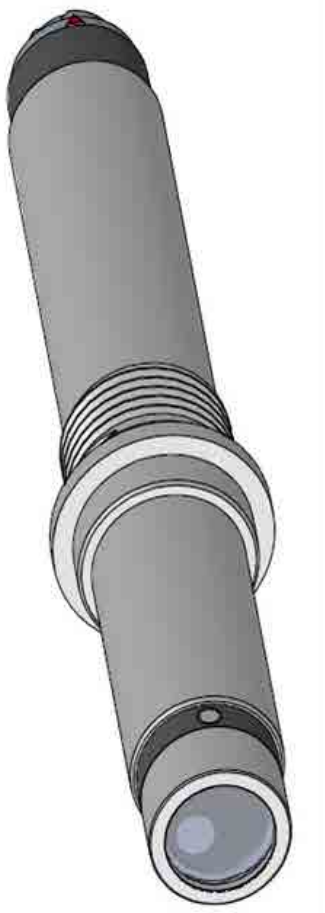
Advantage Controls — Manual

AXC-PT201



- Fluorescence Principle
- Unique Optical Configuration
- Bluetooth-enabled
- 4-20mA and Digital Output
- Automatic Temperature Compensation
- Manual Turbidity Compensation

Advantage Controls
4700 Harold-Abitz Dr.
Muskogee, OK 74403
Phone: 918-686-6211
Fax: 918-686-6212
www.advantagecontrols.com
E-mail: support@advantagecontrols.com

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AXC-PT201
Instruction & Maintenance Manual
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I. Introduction

AXC-PT201 is specially designed for monitoring **PTSA** (1,3,6,8-Pyrenetetrasulfonic acid) based on the principles of **fluorescence** spectroscopy. This is a less expensive, portable and flexible fluorometer with **Bluetooth functionality**. The unique optical and signal acquisition system makes this product not only have the characteristics of high precision (up to 0.1 ppb) and high stability but also maintain good linearity in a wider range (0-900 ppb). The probe has a temperature sensor used for automatic temperature compensation (0-50 °C), while turbidity compensation is also available with user-input (0 to 500 NTU).

This product accepts a 6-36 V.D.C. input, while the output is **4-20 mA** analog signal for the default measurement range of **0-300 ppb**. The probe outer layer is made by PVC, special glass and polymer materials with high resistance to most chemicals. As a result, it can be applied to most organic, inorganic or other corrosive water environments. The probe appearance is simple and durable, while the probe size is moderate and easy to carry or install for the applications of the field, laboratory, or online monitoring. And the output signal of 4-20 mA is compatible with most data collection platforms. The probe overview, dimensions and wiring instructions are shown Figure 1.

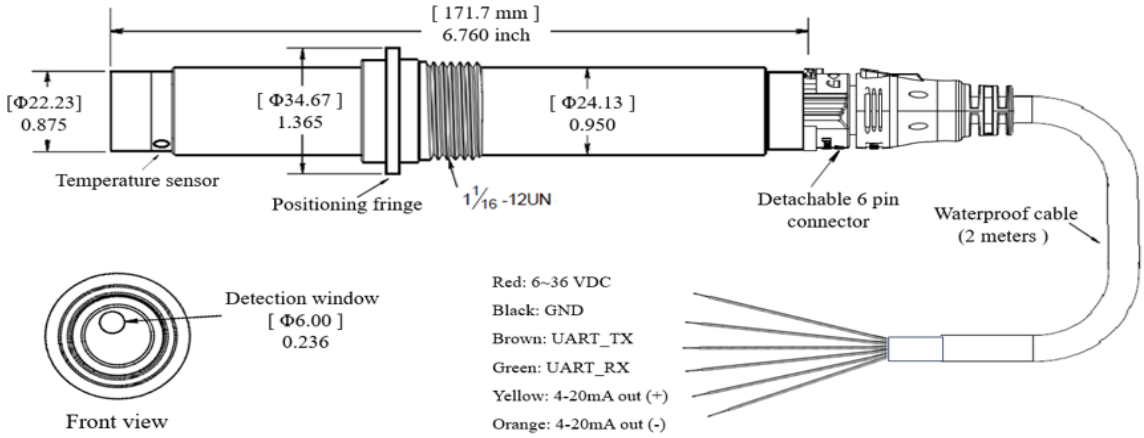


Figure 1: Probe Overview

Note:

- The color of the wires may change, and please refer to the labels on each wire when wiring.
- Two data wires TX (green) and RX (white) are used for digital access, which can be retained or cut depending on the users applications and needs.

The fixed optical configuration of AXC-PT201 is 0-degree angle measurement, and both excitation and emission pass through the detection window to obtain better linearity and stability (see the Front view in the lower left part of Figure 1). The distance between the probe head and container bottom or wall should be at least 10 cm or 4 inches during the measurements, otherwise the test results will depend on the test distance. A special Tee Fitting was designed for some applications, in which the requirement of the test distance cannot be met. As shown in Figure 2A, the probe can be installed in a Tee fitting for online testing. For convenience, users can use two Tee Fittings, one is permanently installed at the monitoring spot, and the other is used for calibration. Because the measurement results are not affected by flow rate, the probe equipped with the Tee Fitting can be calibrated directly in the beaker and then be installed back to the monitoring spot.

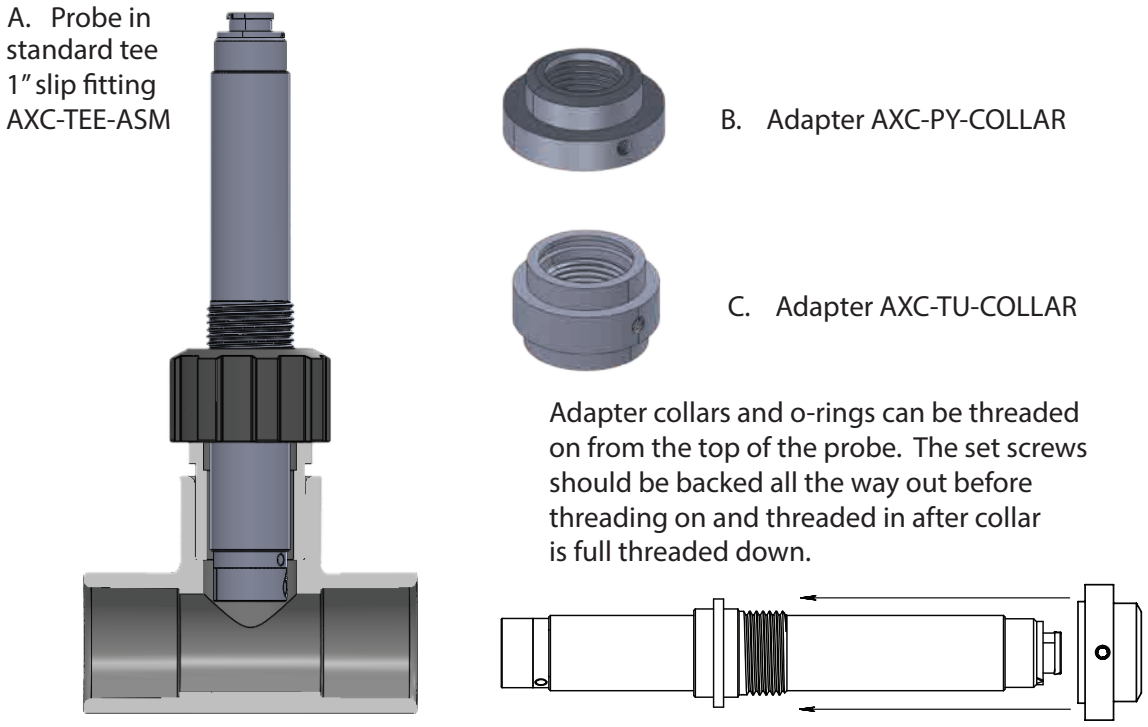


Figure 2: A Probe with our standard Tee fitting; B and C Adapters for other Tee fittings.

FLOU-TEE in Figure 2A is our standard Tee Fittings, and AXC-PT201 can be directly installed onto it. If the user chooses other Tee Fittings based on the pipe size of the test site, then the corresponding adapter may be needed. There is a special thread design (1$\frac{1}{16}$ -12UN) in the middle of AXC-PT201 body for installing the adapters. We also provide such adapters, and the available models are given in Figure 2B and 2C.

AXC-PT201 is Bluetooth-enabled so users can set up, calibrate and transfer data via the related APP of mobile phone. In addition, AXC-PT201 also has another digital access method (UART-Modbus), and the two digital access wires are labeled TX and RX as shown in Figure 1. If the user does not have such needs, these two wires can be cut off. If the user needs functions, please see the appendix 1 and 2.

II. Wiring and Installation

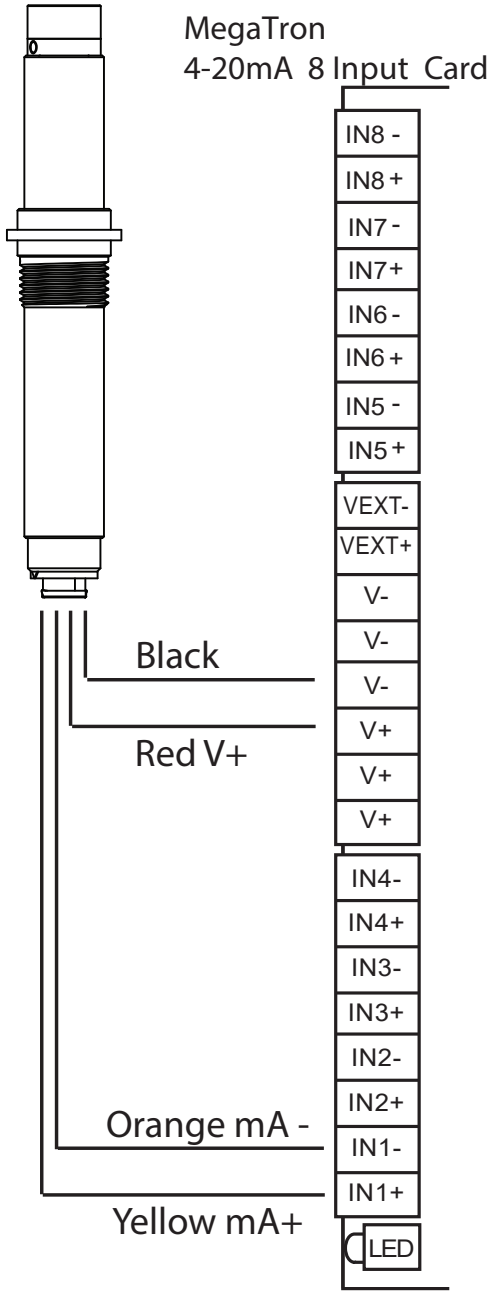
1. This product is a sophisticated electronic product, the user should read the manual carefully, follow the instructions, and integrate them into the final measurement and safety procedures to ensure the probe is installed and used within its normal specifications. Failure to follow the instructions may result in damage to the probe and warranty invalidation.

2. Before power on, please check the connection of the detachable connector and then connect wire ends strictly according to the label on it.

3. After the probe is powered, the detection window will emit an ultraviolet light spot, please do not let it directly hit the eyes or skin. If there is no light spot, the probe cannot work. Please check connections and power supply.

4. If Tee fitting is used, the whole combination can be placed directly in the test solution. If not, please make sure the test distance is more than 10 cm or 4 inches.

5. Before the formal test, power on and warm up for 10 to 15 minutes for the temperature equilibrium of the system



III. Preliminary Specifications

Range: **PTSA:** 0 to 300 ppb (µg/L). **Operating Temperature:** 0 to 50°C. **Storage Temperature:** 0 to 50°C. **Maximum Bearing Pressure:** 2 bar.	**Linearity/Resolution/Accuracy:** **PTSA Linearity:** R^2 > 0.999. **PTSA Accuracy:** 0.1 ppb. **Current Resolution:** 0.050 mA/ppb. **Temp. Accuracy:** ± 0.4°C with Tee fitting.
Response Time: **PTSA:** theoretical value < 200 ms; measured value for T_{100} is 2~5s (depending on controller or software). **Temperature:** T_{90} ~5 minutes with Tee fitting.	**PTSA Compensation Factors:** **Temperature:** automatic, full range. **Turbidity:** automatic with user-input (0 to 500 NTU).
Optic/Input/Output/Protocol: **Excitation:** ~365 nm. **Emission:** ~400 nm. **Input:** 6 - 36 VDC.	**Others:** **Size:** Φ22.2mm X 172mm; **Weight:** ~ 100g **Waterproof:** IP68 **Materials:** Grey PVC, Delrin and Epoxy.

Consumption: 760 mW **Output:** 4-20 mA/UART-Modbus/Bluetooth	**Cable:** 2m (options exist) waterproof cables and detachable connector.
Calibration and Influencing factors: **Calibration point:** 2-point (Zero and another PTSA standard solution). **Calibration frequency:** every 6 months. **Position dependent:** This effect can be ignored by using Tee fitting, otherwise, keep the probe head at least 4 inches away from the bottom of the container. **Color dependent:** If the color of the water sample is obvious, the color effect cannot be ignored. Please consider using the similar color water (zero-PTSA) to prepare PTSA standard solution and deduct the color effect with calibration.	

IV. Bluetooth Connection

App Installation

The App used for Bluetooth connection with this product is **XCITE Measure**, which will be released to Google Play or Apple Store. Before that, users can download it from the link below (Android only).

https://drive.google.com/file/d/1QWEpUFkJYMZCa62Fa4ag0gZU-FU_bLHU/view?usp=sharing

After XCITE is successfully installed, the following operations are required to proceed and are stored for future App sessions.

- Grant Bluetooth permissions.
- Accept the End User License Agreement (EULA, scroll to the bottom of the EULA page and click Accept)

Dashboard Overview

As shown in the leftmost part of Figure 3, the Home or Dashboard offers access to:

- **Connect to Bluetooth Device**: Establish a connection with your XCITE-compatible device.
- **Real-Time Measurement**: Begin live data collection.
- **Access your saved Files**: View and manage your files.
- **Adjust your Settings**: Customize themes, languages, and other app preferences.

Probe Connection

The connection operations are shown in the Figure below.

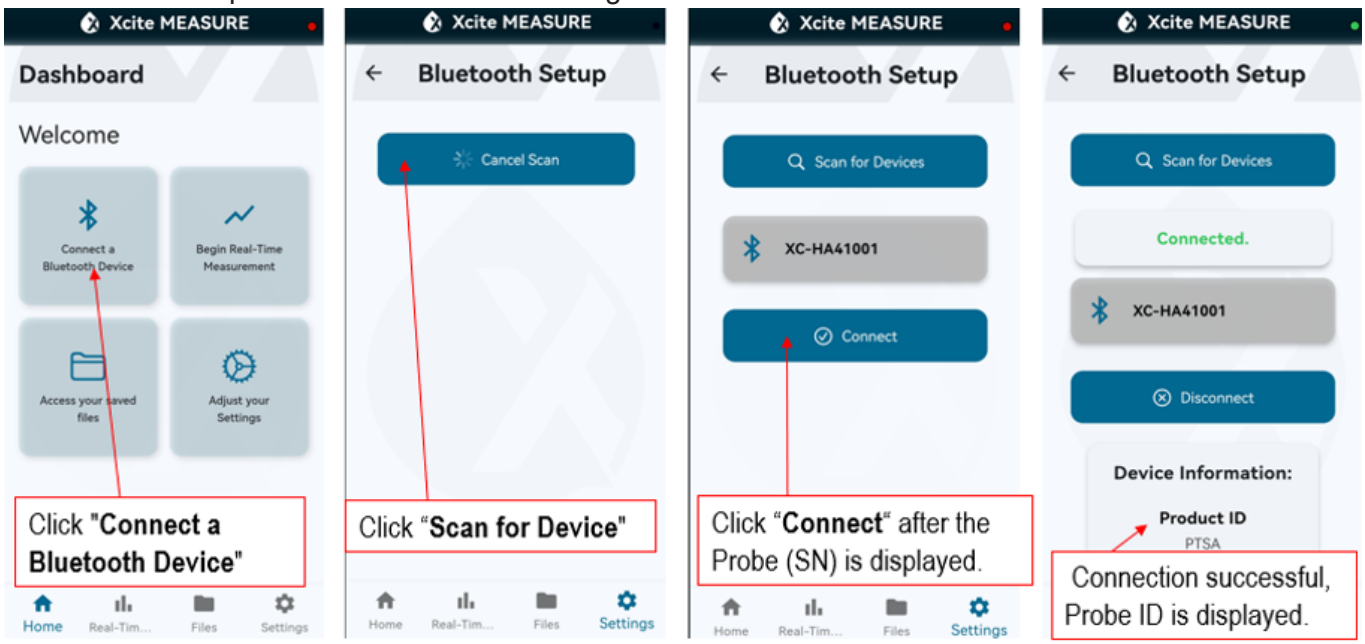


Figure 3: Connections Operations

Note:

- The connection distance should be within 5m (16.5 feet).
- If multiple probes are found, please select one of them. The connection is one-to-one, and it is not possible for one probe to be connected to two mobile phones at the same time, vice versa.
- A timeout occurs if the connection is unsuccessful (~ 30 seconds) and cancel the scan by clicking the Scan button again.
- If the connection always fails, please restart the app and try again.
- The indicator in the upper left corner contains the following status:

Red: Not ready for streaming.
Flashing Blue: Scanning for
Flashing Yellow: Connecting.
Green: Successfully connected.

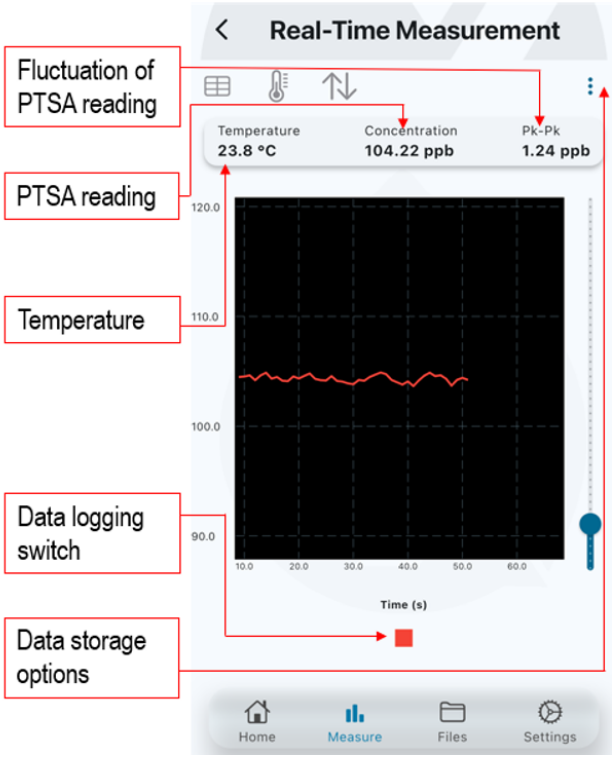
V. Measurement and Calibration

Real-Time Measurement on Mobile App

After the connection is successful, click the Icon of Column Chart (Real-Time Measurement) on the bottom navigation bar to access the Measurement Page as shown in the picture below, in which the main reading areas and function keys are given.

Note:

- Ensure the connection is OK; otherwise, a connect message will be prompted.
- Fluctuation of PTSA is the difference between maximum and minimum readings within a given time. The smaller the PK-PK, the more stable the PTSA reading.
- The Chart will appear if the Data logging switch is clicked, otherwise only the data in the upper reading area will be displayed and updated.
- Use the slider on the right to adjust Y-Axis of Chart.
- Drag left or right to view data in the Chart
- To zoom in and out, use a two-finger motion when data logging is stopped.



Data Storage

Data can be saved or shared when data logging is stopped. As shown in the Figure above, tap the three-dot menu to have the following two options:

- **Take Snapshot**: Share data via email, text, or AirDrop.
- **Save Data**: Export recordings as CSV files.

After the data are saved, additional options become available:

- **Table View**: View data in tabular format.
- **Toggle Temperature**: Show or hide real-time temperature.
- **Peak-to-Peak View**: Show or hide peak-to-peak values.

The stored data can also be viewed and processed in File Section, which is on the bottom navigation bar. To delete invalid or outdated files, please tap the three-dot menu under a file, then confirm deletion.

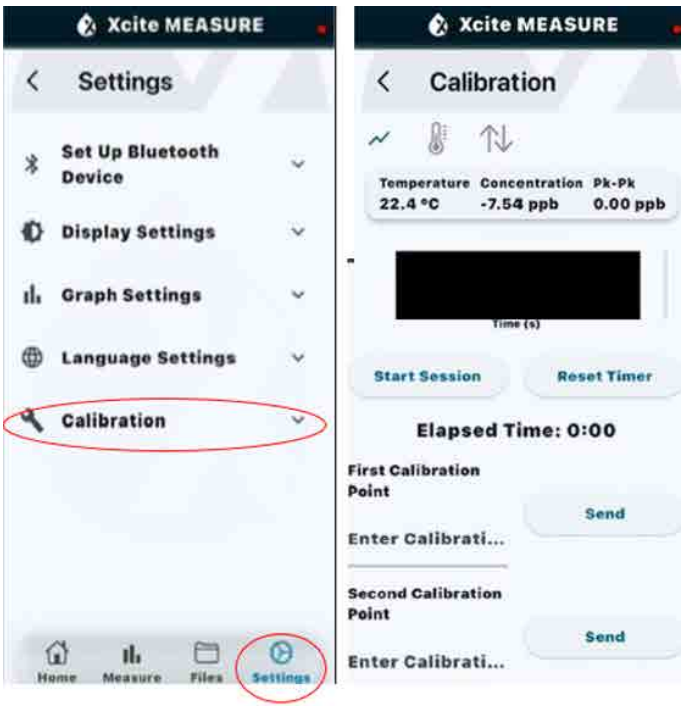
Calibration via Mobile App

Although the probes have been calibrated at the factory, timely calibration on the users' side is also necessary. Because the zero point and slope of the probe may change due to the following reasons.

i. The test distance or Tee fitting is different.
ii. Changes in water quality, like color and turbidity.
iii. Difference or error of the standard solutions.
iv. Performance degradation of emitting light sources (LED)
v. Natural drift due to the decline in the mechanical or other optical components of the probe.

It is recommended that the probe needs to be calibrated when first used and then calibrate weekly for up to a month to ensure the probe reaches a stable. After that, calibration can be performed every 6 months, and users can extend or shorten the calibration cycle based on actual measurement results and desired accuracy requirements.

Linearity of AXC-PT201 is very good in the given range, and thus, the conversion equation can be easily determined by a 2-point calibration. Usually, a zero point and a non-zero point are adopted, and the latter should be in the range of interest to the user. The calibration can first be performed in XCITE. Users can access the calibration process in the Settings Page as shown on the left in the Figure below.



After entering the calibration window, users can operate as follows

1. Place the probe in DI water (for zero calibration).
   Note: If a Tee fitting is used during measurement, then the Tee fitting is also required during calibration.
2. After 30 seconds, tap **Start Session** button, and then the "Elapsed Time" starts
3. Observe Pk-Pk value (stability).
4. If Pk-Pk is < 0.3 ppb within 60 seconds, input the zero in the dialog box of "First Calibration Point" and then tap "Send".

   Note:
   - If it is > 0.3 ppb, tap "Reset Timer" to restart the timer and pk-pk display until the stability requirement of PTSA reading are met.
   - The value entered for the zero calibration must be in the dialog box of "First Calibration Point".
   - Zero calibration is done. The sign of success is that the PTSA reading is equal or close to 0.
   - If the user's application does not involve low PTSA measurements (< 10 ppb), the zero calibration (Steps 1-4 above) can be omitted, and the user can proceed directly to a non-zero calibration (Steps 5-8).

5. Place the probe in PTSA Standard Solution.
6. After 30 seconds, tap **Start Session** button, and let the “Elapsed Time” start.
7. Observe Pk-Pk value.
8. If Pk-Pk is < 0.3 ppb within 60 seconds, input the standard concentration in the dialog box of “Second Calibration Point” and then tap “Send”.
   Note:
   - If it is > 0.3 ppb, tap “Reset Timer” to re-observe Pk-PK until the stability meets the requirements.
   - If the zero calibration is omitted, the user actually performs a 1-point calibration at a non-zero point. At this time, the standard value still needs to be entered in the dialog box of “Second Calibration Point”.
   - A successful calibration is indicated by a PTSA reading that is equal or very close to the input value

Since probe accuracy depends on the calibration and the related standard solution, the following precautions need to be carefully considered.

1. The accuracy of the standard solution must be guaranteed.
2. Before calibration, the probe should be powered on for at least ten minutes to warm up.
3. Do not calibrate the probe until the probe reading is stable.
4. Do not calibrate the probe if the environment conditions (temperature, turbidity or color and more) are unstable.
5. Keep the probe head at least 4 inches from the bottom of the container if the Tee fitting is not used.
6. If possible or necessary, use zero-PTSA water from the measurement application for zero calibration, and then use it to dilute or prepare the standard solution for non-zero calibration. This will eliminate most interference factors.
7. Users need to calibrate the probe when the following happens.

   i. The water sample has obvious color (visible to the naked eye).

      Note: PTSA emission is blue violet light, which will be absorbed more or less by the soluble colored substances, leading to a lower result. If this is case, please consider using the similar color water (zero-PTSA) to prepare PTSA standard solution and deduct the color effect with calibration

   ii. If Tee fitting is not used while the distance between the probe head and container bottom (or wall) gets changed and it is less than 10 cm (or 4 inches).
   iii. Calibrate probe whenever its reading looks different from expectation.

Calibration on User's Controller

The **zero-point** output of AXC-PT201 is **4mA**, while the **20mA** output represents **320ppb**. (Leave a margin of 20 ppb to ensure that the probe's range can be maintained at 0-300 ppb). Users can use the above values to let the related analyzer/meter/controller calculate the slope and offset of the conversion equation. Since there is a certain error between the actual output current of the probe and the current measured by the user's instrument, if the user needs a more accurate result, a 2-point calibration is needed to correct the slope and zero point. As shown in Eq.1, the user needs to record the probe's output in DI water and a standard solution, respectively for correcting the zero point and the slope. If the variation of the zero-point can be ignored, the user actually only needs one point calibration at a non-zero point. And then, the conversion equation can be obtained as shown in Eq.2.

$$\textbf{Slope} = \frac{\textbf{Output of non-zero point (mA) - Output of zero point (mA)}}{\textbf{The concentration of the standard solution (ppb)}} \qquad \text{Eq. 1}$$

$$\textbf{PTSA (ppb)} = \frac{\textbf{Output at any point (mA) - Output of zero point (mA)}}{\textbf{Slope}} \qquad \text{Eq. 2}$$

If the conversion equation cannot be directly entered in the analyzer/meter/controller software, please first set the zero-point value at 4mA as calculated by Eq. 3 below. But sometimes this may not be necessary in some controllers, since its OFFSET function may be able to complete the zero point calibration. The user just needs to ensure that the probe is placed in DI water when performing zero point adjustment. After that, the user can set the full-scale point value at 20 mA as calculated based on Eq.4 below. If the zero point does not change much, the calibration is resetting the full-scale point of the meter. This point is initially 320 ppb in probe side, but at the user's meter side, it may be close to this value or may be significantly different. It doesn't matter, since it should be subject to the latest calibration.

$$\textbf{Zero point} = \frac{\textbf{4 mA - Output of zero point (mA)}}{\textbf{Slope}} \qquad \text{Eq. 3}$$

$$\textbf{Full scale point (ppb)} = \frac{\textbf{20 mA - Output of zero point (mA)}}{\textbf{Slope}} \qquad \text{Eq. 4}$$

VI. Additional Notes of Mobile App

The following are some additional notes and features of the XCITE Measure APP, mainly involving the "File" and "Setting" sections.

Files

1. Viewing Sessions
    - The default view displays a list of all sessions.
    - Clicking a session shows metadata such as:
        - Start and end time.
        - Duration.
        - Time zone.
        - Firmware and hardware version.
        - Product ID and serial number.
2. Navigation Buttons
    - Sessions: Lists all sessions.
    - Files: Displays saved files.
    - Sort: Organize files by date or type (images/recordings).
    - Filter: Narrow files by:
        - All files.
        - Images or recordings.
        - Recent files (today, last 7 days, last 30 days).

Settings

1. Bluetooth Setup: Access the Setup Bluetooth Device section to manage connections.
2. Display Settings:
    - Switch between Light and Dark mode.
    - Choose a theme (if available).
3. Accessibility Options:
    - Adjust text size (Large, Normal, Small).
    - Revert graph colors to default settings.
4. Language Selection: Select your preferred language (varies by distribution).

VII. Interference Factors and Compensation

Temperature, turbidity and color all have a large impact on fluorescence measurements. As far as AXC-PT201 is concerned, the effect of temperature is relatively small (~1.5%°C). The reading increases as the temperature increases and decreases as the temperature decreases. The turbidity and the color have a greater impact on test results. Even a light turbidity or color in the water sample, if it is visible to the naked eye, the test result would be 20~50% lower than the actual value.

AXC-PT201 has built-in temperature sensor, and the temperature effect can be automatically compensated by the sophisticated algorithms in the firmware. However, for the effect of the turbidity and the color, AXC-PT201 cannot automatically compensate for the time being. In actual operations, the best compensation for these two interference factors is to use the same or similar water sample to prepare the PTSA standard solutions and then calibrate the probe. In addition, we studied the relationship between AXC-PT201 readings and turbidity changes, so that users can perform manual turbidity compensation or realize automatic compensation when AXC-PT201 is combined with a turbidity sensor in the case of a multi-parameter sensor. The compensation method is as follows

$$\text{PTSA Reading}_{\text{Final}} = \frac{\text{PTSA Reading}_{\text{Initial}}}{K}$$

$$K = 0.0093x^3 - 0.1404x^2 + 0.4656x + 0.5151$$

$$x = 1\text{n (turbidity reading)}$$

Here, PTSA Reading $_{\text{Initial}}$ and PTSA Reading $_{\text{Final}}$ represent the readings before and after turbidity compensation, respectively. K is the compensation factor, and x is the natural logarithm of the turbidity value in the current testing environment. The user can perform compensation manually or input the algorithm into the controller for automatic compensation, when a turbidity sensor is connected.

VIII. Maintenance

This optical sensor is easy to maintain without complex operations, and most precautions are common sense for protecting an electronic product and optical sensor as below.

1. The probe damages caused by human error should be avoided, such as avoiding wrong wiring or the operations (fall or hit) to hurt the probe body, window and cable.
2. If any contaminants or residue are present on the window, please use water or alcohol with a wipe to clean. Some residues like calcium scale can only be see with the naked eye after the window is fully dry.
3. Avoid window contact with hydrofluoric and concentrated phosphoric acid.
4. When the probe is not in use, please store dry.

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