pH Drift Troubleshooting Flowchart

Step 1. Visual Inspection to Check:

Reference # on page 2 & 3

Are there air bubbles? → Yes → Cause #1
Are there any cracks of scratches? → Yes → Cause #2
Is the reference electrolyte low? (<1/2 in or 1.27 cm) → Yes → Cause #3
Is there black precipitate in the reference electrolyte? → Yes → Cause #4
Is there visible debris? → Step 4

No

Step 2. Calibrate

Does the electrode drift in calibration buffer? → Yes → Step 4

No

Step 3. Calculate Slope and Offset

Are the slope and offset out of range? → Yes → Step 4

No → See Cause #5

	4-20 mA Output	mV Output
Acceptable Slope	1.143 ± 0.171 mA/pH	59.16 ± 8.87 mV/pH
Acceptable 7 pH Offset	12.00 ± 0.60 mA	0 ± 30 mV

Step 4. Clean the Electrode

Step 5. Calibrate and Calculate Slope and Offset

Are the slope and offset still out of range? → Yes → Cause #2, 3, or 6

No

Drift was a result of a blocked junction or debris on bulb. More thorough, frequent cleanings may be required.

Tips for Steps 2,3, and 4 can be found in Additional Information on page 4.

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Causes

1. Air Bubbles
    a. **Identification:** Visual inspection of the bulb should show an air bubble if one is present. The air causes poor circuit formation, resulting in inconsistent measurements that may appear to be drifting.
    b. Solution: Hold the sensor tightly by the end opposite the electrode and flick it down. This forces solution back into the bulb.
2. Damaged Electrode
    a. Identification: Visual inspection of the bulb may show scratches or cracks on the surface of the bulb. If the electrode is used to measure solution with larger particulates like sand, then those could hit the bulb and cause small scratches that build up over time. This wears down the gel layer, causing drift and slow response time.
    b. Solution: Unfortunately, the electrode must be replaced.
3. Reference Electrolyte
    a. Identification: The electrolyte eventually gets diluted or contaminated by any solution during use or if stored in normal water. It can also be depleted and show a low level. When this happens, the slope and offset become out of range. The electrode starts to drift and responds slower to changes in pH. It may still be usable for certain applications but should be replaced if high accuracy and response time are concerns.
    b. Solution: If the electrolyte solution is replaceable then fill with new solution, otherwise the electrode must be replaced. Always store electrodes in a high ionic storage solution such as 3.0M KCl and use a double-junction electrode for better longevity. Storage solution may vary by manufacturer.
4. Silver Precipitate
    a. Identification: Black precipitate will appear in the reference solution or on the junctions. Possible if high levels of heavy metals, organics, proteins, or other compounds that react with silver are present.
    b. Solution: If the electrode is refillable then add new reference electrolyte, then check the slope and offset again. Otherwise, the electrode requires replacement. Always use a double junction electrode for solutions containing elements that react with silver. A Calomel or ROSS electrode is best to use for those applications.
5. Other Causes of Drift
    a. pH of Solution Is Drifting
        i. **Identification:** If the slope and offset of the electrode are within range and the electrode is steady in calibration buffers, then the cause is not the electrode. Check if there are changing temperatures or if the solution is low conductivity (<100 µS/cm).
        ii. **Solutions:** Allow temperatures to stabilize and research potential chemical reactions. If frequent, rapid temperature changes or low conductivity ranges are common then a special pH electrode may be required
    b. Electromagnetic Interference

i. **Identification:** Drift caused by EMI can appear and disappear in minutes or last for days depending on the source. Sudden changes may be caused by a pump or signal turning on. Look for patterns and try calibrating the sensor away from sources of EMI to see if drift changes.

ii. **Solutions:**

1. If cable is replaceable, exchange for one with better shielding and twisted-pair wiring.
2. Use sensor with a current signal instead of a voltage signal for better noise resistance.
3. To learn more about the causes and solutions to EMI, please read our article on the topic.

6. Blocked Junction

a. **Identification:** A clear junction is necessary for accurate measurements. When high concentrations of debris like fats and oils are present, they clog the junction, resulting in drift to complete loss of signal. Some debris may or may not be visible on the junction.

b. **Solution:**

i. Cleaning should be done regularly to ensure proper flow. **If not done regularly, the debris may lodge in the junction permanently and require electrode replacement.** The best cleaning solutions depend on types of debris and a list of different cleaning solutions are available below in Additional Information for Step 4.

ii. If blocked junctions are a consistent problem, choose an electrode with a high flow-through junction to prevent clogging. These electrodes generally are refillable and electrolyte solution can be purchased or made.

Additional Information:

Step 2 – Proper Calibration Best Practices

- Use two freshly prepared, well-mixed, non-expired buffers that are at room temperature.
- If possible, move pH sensor/transmitter away from heavy machinery and other cables to prevent electromagnetic interference.
- Rinse the sensor with RO/DI water before calibration and between each buffer.
- Immerse the sensor in each buffer and let the sensor stabilize
    - Stabilization is less than 0.01 mA or pH change per minute (Approx. 2-10 mins)
    - If drift was noticed over longer periods of time (days to weeks), keep the sensor in solution for a day or more to observe drift rate.
    - For the pHionics STs Series pH, ensure the metal housing is contacting the buffer.

Step 3 – Slope and Offset

	Theoretical Slope at 25°C	Acceptable Slope Error at 25°C	Theoretical 7 pH Output at 25°C	Acceptable Offset at 25°C
4-20 mA Outputs	1.143 mA per pH	± 0.171 mA	12.00 mA	± 0.60 mA
mV outputs	59.16 mV per pH	± 8.87 mV	0 mV	± 30 mV

Slope Equation

$$\frac{1st\ calibration\ output - 2nd\ calibration\ output\ (mA\ or\ mV)}{1st\ calibration\ solution\ (7\ pH) - 2nd\ calibration\ solution\ (4\ or\ 10\ pH)} = slope$$

Offset Equation

$$Actual\ 7\ pH\ Output - Theoretical\ 7\ pH\ Output = Offset$$

Step 4 – Cleaning

General Cleaning/Mineral Deposits	Fats, oils, grease removal	Protein removal
0.1M HCl or 1:10 bleach with 0.5% detergent solution	Soak in mild detergent at 50-60°C for 1-8hr	Soak in 1% pepsin with 0.1M HCl or 0.4M HCl for 5 mins

More maintenance guidelines can be found on our pH Electrode Care and Troubleshooting page.