How Often Do Sensors Require Maintenance?

The short answer: Every application is different – there are a variety of factors that influence maintenance frequency so the best schedule must be determined empirically. This guide explains those factors, along with how to perform calibration checks and determine a calibration schedule.

Factors That Increase Maintenance Frequency

Environmental Factors

1. **Excess Debris**
   Debris may block sensing elements.
2. **Fast Biological Growth**
   Algae and biofilm may clog sensing elements. These often grow faster when sensors are installed in sunny or nutrient-rich areas.
3. **Highly Reactive Compounds**
   Certain reactive compounds may alter sensing elements, causing electrode “poisoning”.
4. **High Flow Rate**
   Higher flow rates may deplete sensing elements sooner
5. **Extreme Temperatures**
   Extreme cold or heat, or extreme temperature fluctuations may impact sensing elements.

Figure 1. Dirty Electrodes

Additional Factors:

- **Electrode Age**
  - Older electrodes lose their calibration sooner than newer electrodes.
- **Accuracy Requirements**
  - Applications that require extreme accuracy also require more frequent calibration.

Background

"Maintenance" refers to **calibration** and/or **cleaning**.

Calibration is the process of adjusting a sensor's output to accurately reflect its input. For example, the pHionics STs Series pH Sensor has a 4-20 mA output that has a linear relationship to pH. The relationship between the 4-20 mA signal and the corresponding pH changes over time due to a variety of environmental factors, so calibration must be checked and adjusted periodically. The same is true for most other water quality sensors that measure parameters like oxidation-reduction potential (redox or ORP), dissolved oxygen, conductivity, total dissolved solids, etc.

Cleaning is the process of washing the electrode (sensing element) by mechanical or chemical means, as outlined on our website for pH, DO, ORP, or conductivity sensors. Debris and biological buildup can reduce a sensor's accuracy and impact calibration, so cleaning is an important part of maintenance.

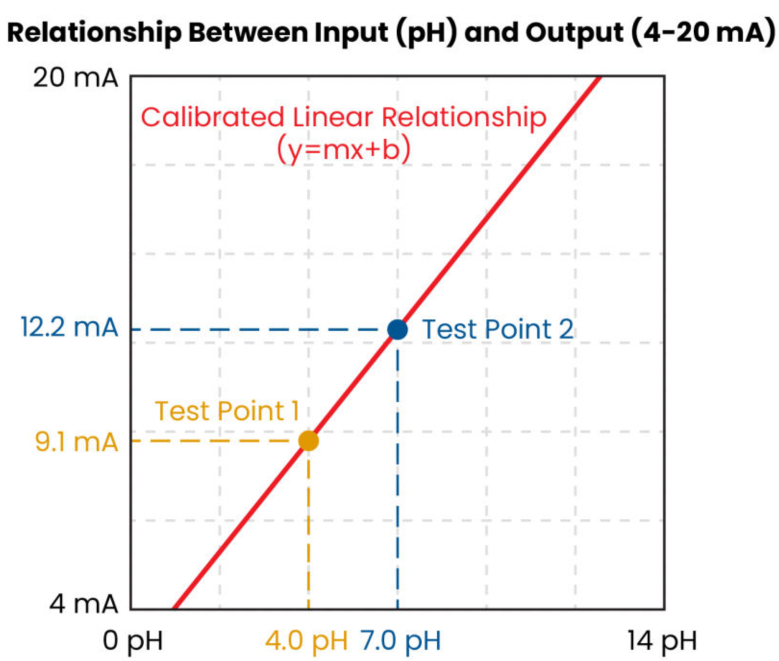
How Is Calibration Performed?

The exact calibration process varies depending on the sensor (see pHionics Product Resources) but **a basic calibration procedure uses two known inputs to determine the relationship with the output**. The output of pHionics sensors is always **linearly related** to the parameter being measured. Here is an example of a calibration procedure:

A pHionics STs Series pH Sensor is placed in a 4 pH calibration solution (the input) and the 4-20 mA output is recorded. Next, the sensor is cleaned and placed in a 7 pH calibration solution and the 4-20 mA output is recorded. With these two points, we can determine the slope formula (y=mx+b – typically automatically calculated by software in datalogger/PLC/SCADA).

Data:

Output	Input
9.1 mA	4.0 pH
12.2 mA	7.0 pH

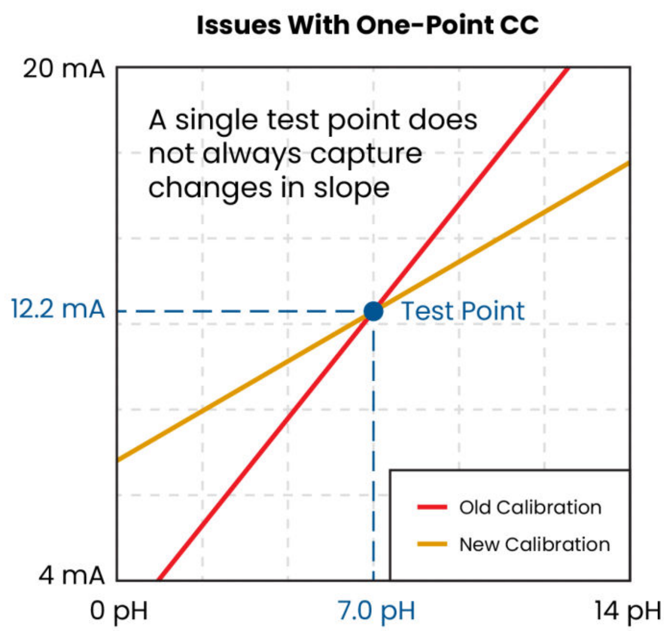


How Are Calibration Checks (CC) performed?

The goal is to test how much a sensor's calibration accuracy has changed since it's last calibration. After cleaning the sensor, there are two options:

Option #1

The first option is to do the standard calibration procedure using known solutions or techniques (depending on sensor type). For sensors that regularly require 2-point calibration (pH, conductivity), this is the most thorough testing method because the two calibration solutions capture any changes to the slope or offset, whereas a single calibration point may indicate there has not been a change even though the slope has changed (see image to right). Regardless, the method does take longer than Option #2 so may not be optimal when performing CCs on a large quantity of sensors.



Option #2

A quick CC may be performed by using an additional sensor to spot check the measurements of an installed sensor. For example, a calibrated handheld pH sensor may be used to test how accurate the output is. If the output is outside of what is acceptable for the application, then maintenance is needed. This method does have the weakness of potentially not capturing changes in slope, as mentioned in Option #1. That being said, it may be best for applications with many sensors that require CCs. Slope changes are not as serious of a concern for applications where a parameter only varies within a small range.

Determining Maintenance Frequency

There is no single maintenance schedule that works for every application. Each application has different environmental factors that affect the frequency. Some sensors in industrial processes may require maintenance every day due to sludge buildup and frequent temperature fluctuations. Other sensors may only require maintenance every 6 months in slow-flowing and shaded streams. The schedule also may change as electrodes get older. **These varying factors explain why the calibration schedule must be determined empirically for each application and sensor**. The wrong calibration schedule creates unreliable data that wastes time and money. Here is our recommended procedure to understand its performance and develop a calibration schedule:

Determining Calibration Schedule

Application Type	Calibration Period
Harsh Industrial Application (3-4+ Factors)	7 Days
Seawater Monitoring (1-2 Factors)	14 Days
Innocuous Freshwater Stream (0-1 Factors)	28 Days

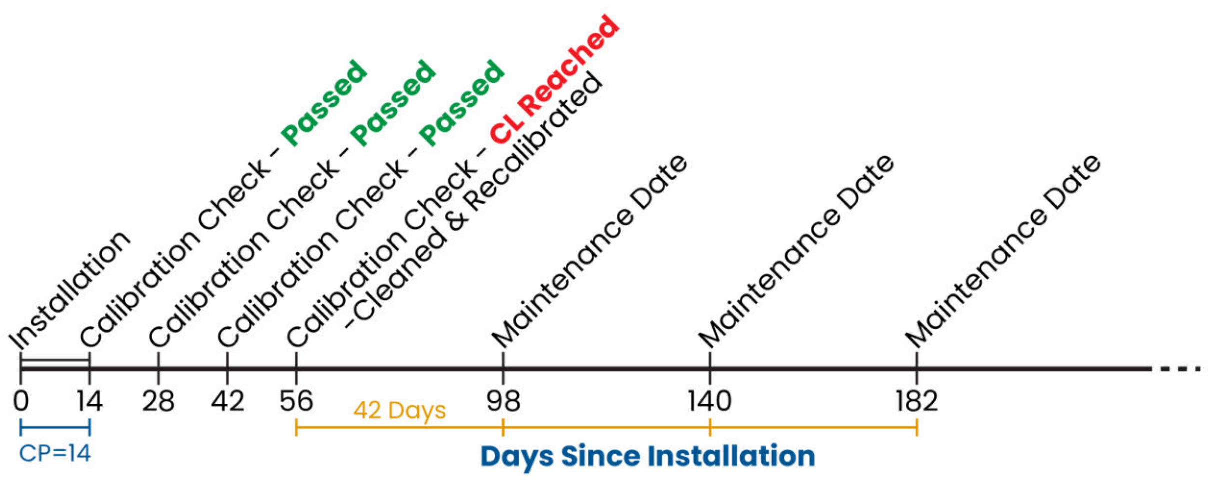
The initial Calibration Period (CP) depends on how many environmental factors may affect the sensor. A good initial time for the average application with only 1-2 of the Factors discussed above is 7 days. If the application has several extreme environmental factors (i.e. large debris load and high flow rate), then the initial time should be shortened to 2-3 days, while innocuous applications with no environmental factors may start at 10+ days.

To find the optimal calibration period for your application, start by performing a Calibration Check (CC) after the applicable CP. If the sensor remains within acceptable accuracy, then *do not recalibrate*. Repeatedly perform a CC after the CP passes until the sensor fails the CC. Once it fails, record the number of days since installation and subtract one CP from the total. This gives a good estimate for the number of days to wait before performing a calibration test.

Example:

Days Since Installation	CC Results
14	Pass
28	Pass
42	Pass
56	Fail - Recalibrate

In this example, the client places a pHionics STs Series Dissolved Oxygen Sensor at a shaded spot in a slow-flowing stream with occasional debris (1 Factor), leading them to choose an initial CP of 14 days. The accuracy requirement is ±0.3 mg/L. The sensor passes each CC through 42 days but fails at 56 days, indicating the optimal maintenance frequency is 42-55 days. Depending on the goal, the client may wish to use 42 days as the new calibration frequency or try to optimize further to reduce the frequency of site visits. In this example, the client chose to use 42 days as the new maintenance interval and recalibrated the sensor. Again, this schedule changes as a sensor ages. The interval may become much shorter until the electrode eventually requires replacement. In addition, if data integrity is critical, then more frequent calibration may be recommended.



Note: It is important to consider what causes a sensor to fail the CC early. If an abnormal event like extreme flooding caused more debris than normal, then it may be worth considering testing a longer maintenance period even though the sensor failed. Use your best judgement to determine whether any irregularities may affect the experiment.

Please reach out to pHionics customer support for questions and advice about creating a calibration schedule for your application.

Contact information:

support@phionics.com; +1 (775) 339-0565

Monday to Friday 9 AM - 5 PM PST