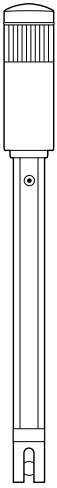
User Guide

No Cal® pH Electrodes



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This publication supersedes all previous publications on this subject.

Introduction

This user guide contains information on the preparation, operation and maintenance of the Thermo Scientific Orion No Cal pH electrodes. No Cal electrodes have a patented special reference system and a built-in temperature probe.

No Cal pH electrodes are designed to maintain their calibration to 0.1 pH units for one year when properly stored and maintained. However, a calibration can be performed at any time and will not cause any harm to the electrode.

All No Cal electrodes have a pH range of 0 to 14, pH precision of 0.01 and temperature range of 0 to 100 °C.

No Cal pH electrodes can be used in samples that contain TRIS, sulfides and proteins since they do not contain silver or mercury.

Cat. No.	Description
5107BNMD	No Cal combination pH electrode with epoxy body and waterproof BNC and 8 pin MiniDIN connectors. For use with Orion Star Series pH meters.
5107NC	No Cal combination pH electrode with epoxy body and BNC and 8 pin DIN connectors. For use with Orion A Series pH meters.
5109NC	No Cal combination pH electrode with epoxy body and waterproof E DIN and banana plug connectors. For use with Orion 260A, 261S, 265A and 266S pH meters.

- All No Cal electrodes have one meter cable lengths.
- Electrodes with a waterproof BNC connector can be used on any pH meter with a BNC connection.

Required Equipment

1. Thermo Scientific Orion pH meter, such as the 3-Star pH meter, 4-Star pH/ISE meter, 4-Star pH/DO meter, 4-Star pH/conductivity meter or 5-Star pH/ISE/DO/conductivity meter.

   No Cal electrodes with BNC and waterproof BNC connectors can be used on any pH meter with a BNC connection. The electrodes can also be used on meters with a variety of inputs when an adapter cable is used. Visit www.thermo.com/water for details.

2. Thermo Scientific Orion No Cal pH electrode.

   - The 5107BNMD No Cal electrode has a temperature connector that is compatible with the Star Series pH meters.

   - The 5107NC No Cal electrode has a temperature connector that is compatible with the A+ Series meters.

   - The 5109NC No Cal electrode has connectors that are compatible with the Orion 260A, 261S, 265A and 266S pH meters.

3. No Cal storage sleeve, Cat. No. 020017.

4. No Cal filling solution, Cat. No. 510011. Do not use any filling solution that contains silver, as silver will damage the electrode.

5. ROSS pH electrode storage solution, Cat. No. 810001, or pH 4.01 buffer, Cat. No. 910104.

6. pH buffers for electrode verification. At least two pH buffers are recommended. One buffer should be near pH 7 and buffers should be one to three pH units apart.

7. Beakers, plastic or glass.

8. Magnetic stirrer or Orion stirrer probe, Cat. No. 096019. The stirrer probe can be used with 3-Star, 4-Star and 5-Star benchtop meters.

9. Distilled or deionized water.

Sample Requirements

All sample measured with the No Cal electrode should be aqueous. The No Cal pH electrode has an epoxy outer body with a glass pH sensor. No Cal electrodes should not be used in samples that contain organic solvents or harsh samples. The calibration specification can be altered in such samples, even if the electrode is operational, and the No Cal electrode will not be covered by the warranty.

The No Cal electrode must be kept clean and in good operating condition to maintain its calibration specification. The electrode must be stored in a moist environment, so a storage sleeve is shipped with each electrode. Some samples, such as proteins, cause the additional problem of coating the sensing bulb and extra care should be taken when measuring these samples. Refer to the **Electrode Maintenance** section for electrode cleaning and maintenance information.

Measuring Hints

- Between measurements, rinse the electrode with distilled water and then with the next solution to be measured.
- Stir all buffers and samples at a uniform rate.
- Place a piece of insulating material, such as Styrofoam or cardboard, between the magnetic stirrer and beaker to prevent measurement errors from the transfer of heat to the sample.
- To reduce the chance of error due to polarization, avoid rubbing or wiping the electrode bulb. Use a lint-free tissue and gently blot the electrode bulb.
- Always use fresh pH buffers if a calibration will be performed. Choose buffers that are one to three pH units apart.
- If a two or more point calibration is performed, the slope should be 92 to 102%.
- Remove the filling hole cover during measurements to ensure a uniform flow of filling solution.

Electrode Preparation

Electrode Setup

Note: *Use extreme caution when removing the electrode from the storage sleeve, as the nonhazardous filling solution can stain clothing, workbenches and skin. A bottle of stain lifter solution, Cat. No. 510015, will remove stains from clothing if it is applied immediately. It is normal for some filling solution to be in the storage sleeve. Remove the electrode in an upright position to reduce the leakage of the filling solution into the storage sleeve.*

1. Carefully remove the electrode in its protective storage sleeve from the shipping box.

2. Hold the electrode in an upright position with the cable end on top and gently remove the electrode from the protective storage sleeve. The electrode cap is designed to seal the electrode into the storage sleeve. Use gentle pressure to separate the electrode from the sleeve.

   The protective storage sleeve is required for storage of the No Cal electrode and to ensure that the No Cal electrode retains it calibration through the warranty period. Do not throw out the protective storage sleeve.

3. Pour any excess solution out of the storage sleeve and rinse it with distilled water before setting it down on its side.

4. Clean any salt deposits or solution from the electrode exterior by rinsing it with distilled water.

5. Locate the electrode fill hole. The electrode fill hole is a small opening on the side of the electrode body and is not easily visible.

6. The electrode is shipped without filling solution, so it must be filled prior to use. Place the supplied spouted cap on the filling solution bottle, insert the tip of the spout into the center of the fill hole, and gently squeeze the bottle to fill the electrode. Stop squeezing the fill solution bottle before removing it from the fill hole to reduce the chances of spilling the filling solution.

7. Continue filling the electrode until the filling solution level is about a half inch below the fill hole. To maintain an adequate flow rate, the level of filling solution must always be above the reference junction and at least one inch above the sample level.

8. Gently tap the side of the electrode to remove any bubbles in the electrode chamber.

9. Place the electrode into an electrode holder and suspend it in air for 5 minutes to thoroughly wet the reference junction. Once the junction is wet, do not allow the electrode to dry out. Always follow the electrode storage requirements to maintain the calibration of the electrode.

10. Soak the electrode overnight in ROSS pH electrode storage solution, Cat. No. 810001, or pH 4.01 buffer, Cat. No, 910104.

11. If using the 5109NC with an Orion 260A, 261S, 265A or 266S pH meter, remove the plastic electrode holder on the meter and replace it with the No Cal storage sleeve. The rounded side of the storage sleeve should face outward.

    If using the 5107NC with an Orion A+ Series portable pH meter, remove the electrode storage sleeve from the back of the meter and replace it with the No Cal storage sleeve.

12. Connect the electrode and temperature cables to the meter as described in the meter user guide.

pH Calibration and Measurement

The No Cal pH electrode has been designed to maintain its calibration to 0.1 pH units for one year when properly stored and maintained. If the calibration must be validated, it must be validated with a Thermo Scientific Orion meter and buffers. The electrode must be clean and have been stored in its storage sleeve to keep the bulb moist when not in use. If a calibration is performed, it will not cause any harm to the electrode.

Setting the Meter Default Calibration Values

When the No Cal electrode is used, the meter must be set to the default calibration software values. Reset the meter to factory default settings or perform a one point pH calibration with the BNC shorting cap on the meter instead of an electrode. Refer to the meter user guide for details. An initial calibration of the No Cal electrode can be performed to restore the meter default calibration values.

The meter must be reset to the default calibration values if the meter is calibrated with a different electrode between uses of the No Cal electrode.

General Calibration Procedure

For detailed instructions on pH calibration, manual pH calibration and temperature compensation, consult your meter user guide.

Table 1 – pH Values of Buffers at Various Temperatures

Nominal Buffer Value at 25 °C	Temperature				
	0 °C	5 °C	10 °C	20 °C	30 °C
1.68	1.67	1.67	1.67	1.67	1.68
3.78	3.86	3.84	3.82	3.79	3.77
4.01	4.00	4.00	4.00	4.00	4.02
6.86	6.98	6.95	6.92	6.87	6.85
7.00	7.11	7.08	7.06	7.01	6.98
7.41	7.53	7.50	7.47	7.43	7.40
9.18	9.46	9.40	9.33	9.23	9.14
10.01	10.32	10.25	10.18	10.06	9.97

One Buffer Calibration

1. Choose a buffer near expected sample pH.

2. The buffer should be at same temperature as the sample. If the buffer and samples are at varying temperatures, temperature compensation is recommended.

3. Prepare the meter according to the meter user guide.

4. Rinse the electrode first with distilled water and then with the buffer being used for calibration.

5. Place the electrode into the buffer. When the reading is stable, set the meter to the pH value of the buffer at the measured temperature. Refer to the meter user guide for a detailed procedure. **Table 1** provides pH values at various temperatures.

6. Proceed to the **pH Measurement** section.

Temperature					
40 °C	**50 °C**	**60 °C**	**70 °C**	**80 °C**	**90 °C**
1.69	1.71	1.72	1.74	1.77	1.79
3.75	3.75				
4.04	4.06	4.09	4.13	4.16	4.21
6.84	6.83	6.84	6.85	6.86	6.88
6.97	6.97	6.97	6.99	7.03	7.08
7.38	7.37				
9.07	9.01	8.96	8.92	8.89	8.85
9.89	9.83				

Two Buffer Calibration

This procedure is recommended for precise measurements.

1. Select two buffers that bracket the expected sample pH. The first buffer should be near the electrode isopotential point (pH 7) and the second should be near the expected sample pH (pH 4 or pH 10).

2. The buffers should be at same temperature as the sample. If the buffers and samples are at varying temperatures, temperature compensation is recommended.

3. Rinse the electrode first with distilled water and then with the first buffer.

4. Place the electrode into the first buffer. When the reading is stable, set the meter to the pH value of the buffer at the measured temperature. Refer to the meter user guide for a detailed procedure. **Table 1** provides pH values at various temperatures.

5. Rinse the electrode first with distilled water and then with the second buffer.

6. Place the electrode into the second buffer. When the reading is stable, set the meter to the pH value of the buffer at the measured temperature. Refer to the meter user guide for a detailed procedure. **Table 1** provides pH values at various temperatures.

7. Proceed to the **pH Measurement** section.

pH Measurement

1. Use a pH meter that was reset to the default calibration software values or calibrate the meter once with the No Cal electrode, as described in the previous section.

2. Rinse the electrode with distilled water and then with the sample.

3. Place the electrode into the sample.

4. When the reading is stable, record the pH and temperature of the sample.

Electrode Storage

To ensure a quick response and free-flowing junction, and to maintain the calibration specification of the No Cal electrode, the sensing element and reference junction must not dry out. Always store the electrode in the storage sleeve with about 1 mL of deionized water in it when the electrode is not in use.

Short-term Storage (up to one week) and Long-term Storage (more than one week)

Store the electrode in the storage sleeve with about 1 mL of deionized water in it when the electrode is not in use. Ensure that the cap is tightly seated in the storage sleeve. Some filling solution will flow through the junction while the electrode is in storage, and this will keep the bulb moist.

Note: *Use extreme caution when removing the electrode from the storage sleeve, as the nonhazardous filling solution can stain clothing, workbenches and skin. A bottle of stain lifter solution, Cat. No. 510015, will remove stains from clothing if it is applied immediately. It is normal for some filling solution to be in the storage sleeve. Remove the electrode in an upright position to reduce the leakage of the filling solution into the storage sleeve. The cap is designed to seal into the storage sleeve and gentle pressure will separate the electrode from the sleeve.*

Before returning the electrode to use, prepare it as a new electrode. Refer to the Electrode Preparation section. Fill the electrode with the No Cal filling solution, Cat. No. 510011, so the level is about one half of an inch below the filling hole. Ensure the factory default calibration settings are the current calibration on the meter to be used with the No Cal electrode.

Electrode Maintenance

1. Inspect the electrode for scratches, cracks, salt crystal buildup, or membrane/junction deposits.

2. Rinse off any salt buildup with distilled water. Remove any membrane/junction deposits as directed in the **General Cleaning** section.

3. Drain the reference chamber, flush it with fresh No Cal filling solution and refill the chamber with fresh No Cal filling solution.

Draining and Refilling the No Cal Electrode

1. Tip the electrode on its side with the fill hole facing up.

2. Carefully insert a 3 mL syringe with a blunt 18 or 20 gauge needle into the fill hole.

3. Gently withdraw the filling solution. Tip the electrode to remove all of the filling solution. The space above the fill hole is not visible, so be sure to remove any solution that may be there.

4. Place the supplied spouted cap on the filling solution bottle, insert the tip of the spout into the center of the fill hole and gently squeeze the bottle to fill the electrode. Stop squeezing the filling solution bottle before removing it from the file hole to reduce the chance of spillage.

5. Continue to fill the electrode until the filling solution level is about a half inch below the fill hole. To maintain an adequate flow rate, the level of filling solution must always be above the reference junction and at least one inch above the sample level on immersion.

6. Gently tap the side of the electrode to remove any bubbles in the chamber.

7. Rinse the electrode with distilled or deionized water and immerse it in fresh pH 4 buffer for a few minutes.

Electrode Cleaning Procedures

General Cleaning

1. Soak the electrode for 30 minutes in a 1:10 dilution of cleaning solution C, Cat. No. 900023; 15 minutes in a 1:100 dilution of cleaning solution B, Cat. No. 900022; 15 minutes in cleaning solution A, Cat. No. 900021; or 15 minutes in cleaning solution D, Cat. No. 900024. Stir the solution thoroughly while soaking the electrode.

2. Rinse the electrode thoroughly with deionized water to remove all traces of cleaning solution. Drain the reference chamber and refill it with fresh No Cal filling solution.

3. Soak the electrode in ROSS pH electrode storage solution or pH 4.01 buffer in the storage sleeve for at least one hour.

Cleaning Solutions

Cat. No. 900021– pH cleaning solution A for removing protein contaminants.

Cat. No. 900022– pH cleaning solution B for removing bacterial contaminants.

Cat. No. 900023– pH cleaning solution C for general cleaning.

Cat. No. 900024– pH cleaning solution D for removing oil and grease contaminants.

Cat. No. 900020– pH cleaning solution kit, includes cleaning solutions A, B, C and D.

Electrode Characteristics

Temperature Effects

The most common cause of error in pH measurements is temperature. There are at least five ways that temperature variations can affect pH: electrode slope, buffers, samples, reference element drift and temperature sensor errors

Electrode Slope Changes

The electrode slope will change with variations in temperature. Slope changes may be compensated for automatically with the automatic temperature compensation (ATC) probe that is built into the No Cal pH electrodes. Thermo Scientific Orion pH meters calculate the slope based on the measured temperature and automatically adjust the pH value based on the temperature.

Buffer and Sample pH Changes

Buffer and sample pH values change with temperature because of their temperature dependent chemical equilibria. The pH electrode should be calibrated with buffers that have known pH values at different temperatures. Buffer values at different temperatures are given in **Table 1**. Thermo Scientific Orion pH meters automatically calibrate with the correct pH buffer values based on the measured temperature. All pH meters are unable to correct pH values back to a reference temperature because every sample has a unique pH value vs. temperature relationship. Therefore, calibration and measurements should be performed at the same temperature and pH values should be reported with temperature.

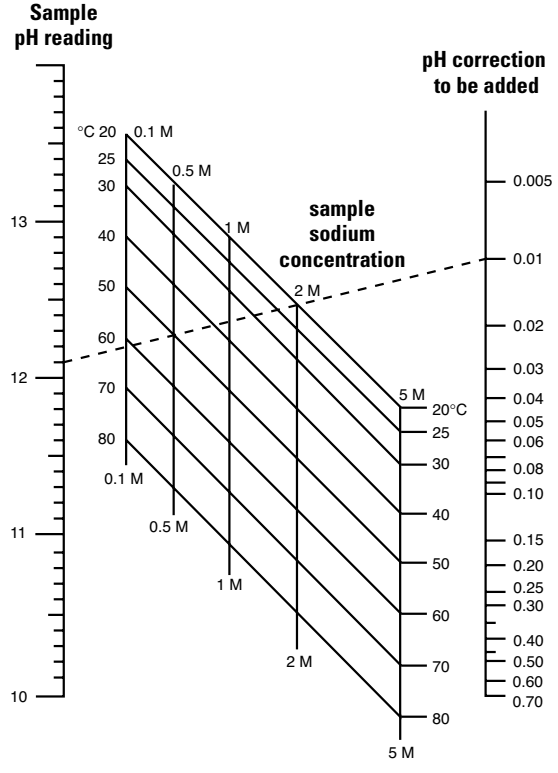
Reference Element Drift

Drift can occur when the internal reference elements inside the pH and reference portions of the electrode are reaching thermal equilibrium after a temperature change. Long-term drift or slow response can last until the sample and electrode are at the same temperature. The electrode body material must reach thermal equilibrium after it has been transferred from a solution of one temperature to another. The No Cal pH electrode has been designed to minimize this effect.

Interferences

Sodium ions are the principal interference of the pH electrode and cause increasing error at higher pH (lower hydrogen ion activities) and at higher temperatures. Because the pH membrane is composed of special low sodium error glass, error due to sodium is negligible when measuring at pH values less than 12. When measuring at pH values greater than 12, add the correction value from the nomograph below to the observed pH reading.

Typical Sodium Error



Example:

pH reading	12.10
Sodium concentration	0.5 M
Temperature	50 °C
Correction	0.01
Corrected pH reading	12.11

Troubleshooting

Follow a systematic procedure to isolate the problem. The pH measuring system can be divided into four components for ease in troubleshooting: pH meter, electrode, sample/application and technique.

pH Meter

The meter is the easiest component to eliminate as a possible cause of error. Thermo Scientific Orion pH meters include an instrument checkout procedure and shorting cap for convenience in troubleshooting. Consult the pH meter user guide for directions.

Electrode

If the electrode response is slow, the electrode readings are drifting or the electrode is reading outside of the 0.1 pH unit calibration specification, drain the electrode and refill it with fresh No Cal filling solution, Cat. No. 510011.

To test electrode operation:

1. Connect the electrode to a working meter that has a mV measuring mode.

2. Set the meter to the mV measuring mode.

3. Rinse the electrode with distilled water and then insert the electrode into fresh pH 7 buffer.

4. When the reading is stable, record the mV value of the pH 7 buffer. The mV value should be -10 to +10 mV.

5. Rinse the electrode with distilled water and then insert the electrode into fresh pH 4 buffer.

6. When the reading is stable, record the mV value of the pH 4 buffer. The mV value should be +150 to +190 mV.

7. Calculate the absolute mV difference between the two buffers. The mV difference should be 160 to 180 mV. The actual mV values will change as the electrode ages, but the mV difference between the two buffers should always be 160 to 180 mV.

If the electrode fails this procedure, clean the electrode thoroughly as directed in the **Electrode Maintenance** section.

Sample/Application

The electrode and meter may operate with buffers, but not with the sample. In this case, check the sample composition for interferences, incompatibilities or temperature effects. Refer to the **Interferences** section.

Technique

If trouble persists, review operating procedures. Review calibration and measurement sections to be sure proper technique has been followed.

Assistance

After troubleshooting all components of your measurement system, contact Technical Support. Within the United States call 1.800.225.1480 and outside the United States call 978.232.6000 or fax 978.232.6031. In Europe, the Middle East and Africa, contact your local authorized dealer. For the most current contact information, visit www.thermo.com/contactwater.

Warranty

For the most current warranty information, visit www.thermo.com/water.

Ordering Information

Electrodes

Refer to the **Introduction** section for a complete list of No Cal pH electrodes.

Accessories

Cat. No.	Description
510011	No Cal filling solution, 5 x 60 mL bottles
020017	No Cal electrode storage sleeve
810001	ROSS pH electrode storage solution, 475 mL bottle
900020	pH cleaning solution kit, includes 1 x 15 mL bottle each of cleaning solutions A, B, C and D; pipette and beaker
900021	pH cleaning solution A, includes 4 x 15 mL bottles, pipette and beaker
900022	pH cleaning solution B, includes 4 x 15 mL bottles, pipette and beaker
900023	pH cleaning solution C, includes 4 x 15 mL bottles, pipette and beaker
900024	pH cleaning solution D, includes 4 x 15 mL bottles, pipette and beaker
910199	All-in-One pH buffer kit, includes 475 mL bottle each of pH 4.01, 7..00 and 10.01 buffers and pH electrode storage solution, and pH electrode storage bottle
910168	pH 1.68 buffer, 475 mL bottle
910104	pH 4.01 buffer, 475 mL bottle
910105	pH 5.00 buffer, 475 mL bottle
910686	pH 6.86 buffer, 475 mL bottle
910107	pH 7.00 buffer, 475 mL bottle
910918	pH 9.18 buffer, 475 mL bottle
910110	pH 10.01 buffer, 475 mL bottle
910112	pH 12.46 buffer, 475 mL bottle

Visit www.thermo.com/water for additional buffers and buffer sizes.

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