User Guide

Low Maintenance
Gel-Filled pH
Electrodes

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Introduction

This user guide contains information on the preparation, operation and maintenance of the Thermo Scientific Orion low maintenance gel-filled pH electrodes.

Cat. No.	Description
9107BNMD	Gel-filled pH/ATC Triode with epoxy body, waterproof BNC and 8 pin MiniDIN connectors, and 1.5 meter cable
9107WMMD	Gel-filled pH/ATC Triode with epoxy body, waterproof BNC and 8 pin MiniDIN connectors, and 3 meter cable
9107WLMD	Gel-filled pH/ATC Triode with epoxy body, waterproof BNC and 8 pin MiniDIN connectors, and 6 meter cable
9107BN	Gel-filled pH/ATC Triode with epoxy body, BNC and 8 pin DIN connectors, and 1 meter cable
9107WP	Gel-filled pH/ATC Triode with epoxy body, E DIN and banana plug connectors, and 1 meter cable
9109WP	Gel-filled pH/ATC Triode with epoxy body, E DIN waterproof and banana plug connectors, and 1 meter cable
9109WL	Gel-filled pH/ATC Triode with epoxy body, E DIN waterproof and banana plug connectors, and 6 meter cable
9206BN	PerpHecT gel-filled pH electrode with epoxy body, BNC connector and 1 meter cable
9207BN	PerpHecT gel-filled pH/ATC Triode with epoxy body, BNC and phono tip connectors, and 1 meter cable
9106BNWP / 910500	Economy gel-filled pH electrode with epoxy body, waterproof BNC connector / U.S. standard connector, and 1 meter cable
911600	Economy gel-filled pH electrode with epoxy body, semi-micro tip, BNC connector and 1 meter cable
912600	Economy gel-filled pH electrode with epoxy body, flask length, BNC connector and 1 meter cable
913600	Economy gel-filled pH electrode with epoxy body, flat surface tip, BNC connector and 1 meter cable

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.

   Gel-filled pH electrodes can be used on any pH meter with a BNC or U.S. standard 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.

   Gel-filled Triodes have temperature connectors that are compatible with specific meters, refer to the list below.

2. Thermo Scientific Orion low maintenance gel-filled pH electrode.

   - The 9107BNMD, 9107WMMD and 9107WLMD pH/ATC Triodes have a temperature connector that is compatible with the Star Series meters.
   - The 9107BN pH/ATC Triode has a temperature connector that is compatible with the A+ Series meters.
   - The 9107WP pH/ATC Triode has a temperature connector that is compatible with the 260, 265 and 1230 meters.
   - The 9109WP and 9109WL pH/ATC Triodes have a temperature connector that is compatible with the 260A, 261S, 265A and 266S meters.
   - The 9207BN pH/ATC Triode has a temperature connector that is compatible with the PerpHecT meters.

3. pH electrode storage solution, Cat. No. 910001.

4. pH buffers, at least two pH buffers are recommended for precise measurements. One buffer should be near pH 7 and buffers should be one to three pH units apart.

5. Beakers, plastic or glass.

6. 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.

7. Distilled or deionized water.

Electrode Preparation

1. Remove the protective shipping cap from the sensing element and save the cap for storage.

2. Clean any salt deposits from the exterior of the electrode by rinsing with distilled water.

3. Soak the electrode in pH electrode storage solution, Cat. No. 910001, for at least one hour.

   If pH electrode storage solution is not available, a temporary storage solution can be prepared by adding 1 gram of potassium chloride (KCl) to 200 mL of pH 7 buffer.

4. Connect the electrode to the meter.

Note: When connecting a MiniDIN Triode, first attach the MiniDIN connector to the meter and then connect the waterproof BNC connector. To remove the electrode from the meter, detach the waterproof BNC connector first and then remove the MiniDIN connector. ▲

Sample Requirements

The low maintenance gel-filled electrodes have an epoxy body and should not be used in samples that contain non-aqueous solutions or organic solvents.

The gel-filled electrodes contain a silver/silver chloride (Ag/AgCl) reference that is incompatible with solutions that contain silver complexing or binding agents such as TRIS, proteins and sulfides. To measure pH in these solutions, use a ROSS* pH electrode. Proteins cause the additional problem of coating the sensing bulb, so extra care should be taken to keep the electrode clean while measuring samples.

** ROSS and the COIL trade dress are trademarks of Thermo Fisher Scientific Inc.*

Measuring Hints

- Always use fresh buffers for calibration. Choose buffers that are one to three pH units apart.
- Check electrode slope daily by performing a two buffer calibration. The slope should be 92 to 102%.
- Between measurements, rinse electrodes with distilled water and then with the next solution to be measured.
- Stir all buffers and samples at a uniform rate.
- Keep buffers and samples at equal temperatures. If samples are at different temperatures, use temperature compensation, as described in the meter user guide.
- 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 bulb.

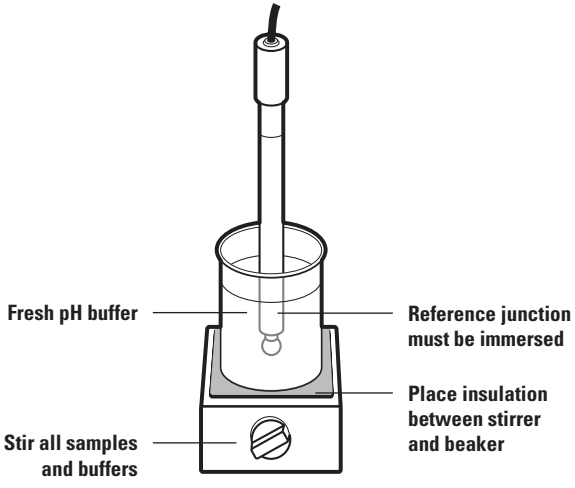


Figure 1
Measuring Hints

Electrode Calibration

General Calibration Procedure

For detailed instructions on pH calibration, manual pH calibration and temperature compensation, consult your meter user guide. When using PerpHecT electrodes with a PerpHecT pH meter, refer to the PerpHecT meter user guide for instructions on temperature calibration and LogR temperature compensated pH measurements.

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.

Table 1
pH Values of Buffers at Various Temperatures

Nominal Buffer Value at 25°C	Temperature				
	0 °	**5 °**	**10 °**	**20 °**	**30 °**
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

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.

Temperature					
40 °	**50 °**	**60 °**	**70 °**	**80 °**	**90 °**
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				

pH Measurement

1. Calibrate the electrode as described in the **Electrode Calibration** 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

Short-term Storage: (up to one week) – Soak the electrode in pH electrode storage solution, Cat. No. 910001. If pH electrode storage solution is not available, a temporary storage solution can be prepared by adding 1 gram of potassium chloride (KCl) to 200 mL of pH 7 buffer. Do not store the electrode in distilled or deionized water, as it will shorten the electrode life.

Long-term Storage: (more than one week) – Rinse off any salt buildup with distilled water and remove any membrane/junction deposits. Cover the sensing surface with the protective cap containing a few drops of storage solution.

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.

General Cleaning

1. Soak the electrode in 0.1 M HCl or HNO_3 for 15 to 30 minutes.

2. Soak the electrode in pH electrode storage solution 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 manually, automatically with an automatic temperature compensation (ATC) probe or with LogR technology when using a PerpHecT meter and electrode. 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.

Temperature Sensor Errors

When a pH and temperature probe are placed into a sample that varies significantly in temperature, the readings can drift for two reasons. First, the temperature response of the electrode and temperature probe may not be similar, which prolongs equilibration and drift. Second, a sample may not have a uniform temperature. Therefore, the pH electrode and temperature probe are responding to different environments.

Using LogR technology, PerpHecT meters sense the temperature directly from the PerpHecT pH electrodes. The pH and temperature response is identical and both measurements occur at the sensing bulb. Drift is minimized and errors due to environmental differences are eliminated.

PerpHecT® Electrode Operation with PerpHecT® pH Meters

When PerpHecT electrodes are used with a PerpHecT pH meter, enhanced temperature compensation is achieved without the need of a separate ATC probe. Using LogR technology, the temperature of the solution is measured through the resistance of the pH electrode. PerpHecT pH electrodes are manufactured to meet the PerpHecT meter specifications, so optimum performance and accuracy are achieved in LogR mode.

Each PerpHecT pH electrode must be calibrated for temperature before a pH measurement is performed using LogR technology. Refer to the PerpHecT meter user guide for details. For maximum precision, a three point temperature calibration is recommended. Do not perform a one point temperature calibration if measured solutions will be below 20 °C. The following tables illustrate the expected pH compensation error for one, two and three point temperature calibrations. The accuracy values are valid only when the temperature calibration is performed within the stated temperature range. The higher temperature range data will apply to measurements made above that temperature range, provided that calibration points are within 20 °C of each other. When highly accurate pH results are desired, a separate ATC probe is recommended.

One Point Temperature Calibration

Electrode	Average temp. error 20-30 °C	Average temp. error 30-50 °C	Average pH error 20-30 °C	Average pH error 30-50 °C
9206BN	0.14	0.13	0.002	0.002
9207BN	0.38	0.27	0.005	0.003

Two Point Temperature Calibration

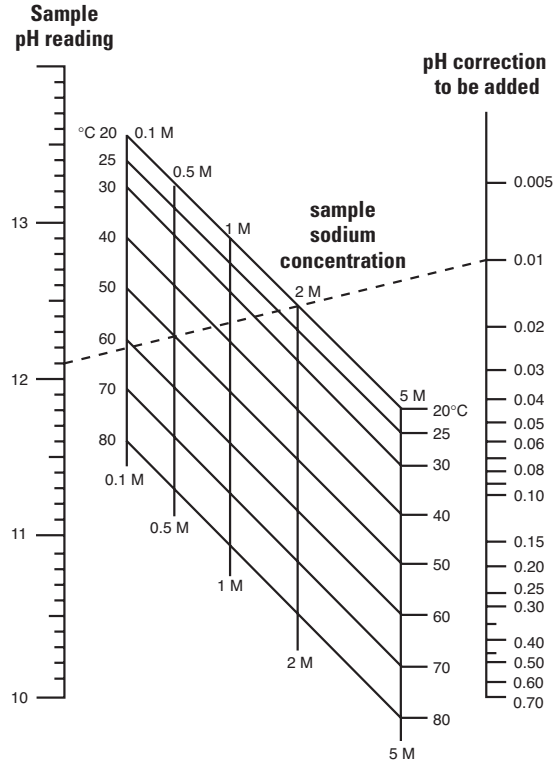
Electrode	Average temp. error 20-30 °C	Average temp. error 30-50 °C	Average pH error 20-30 °C	Average pH error 30-50 °C
9206BN	0.29	0.06	0.003	0.001
9207BN	0.16	0.07	0.002	0.001

Three Point Temperature Calibration

Electrode	Average temp. error 20-30 °C	Average temp. error 30-50 °C	Average pH error 20-30 °C	Average pH error 30-50 °C
9206BN	0.06	0.05	0.001	0.001
9207BN	0.02	0.02	0.000	0.000

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

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 -30 to +30 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 +210 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. Replace the electrode if cleaning and maintenance fail to rejuvenate it.

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.

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/water.

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 low maintenance gel-filled pH electrodes.

Accessories

Cat. No.	Description
910001	pH electrode storage solution, 475 mL bottle
910003	12 mm diameter electrode storage bottles, 3 pack
910004	8 mm diameter electrode storage bottles, 3 pack
910006	6 mm diameter electrode storage bottles, 3 pack
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 12 mm 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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