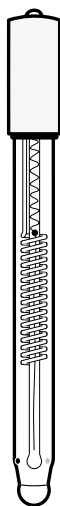


User Guide

AquaPro and
Double Junction
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 AquaPro and double junction pH electrodes.

AquaPro Professional pH Electrodes

All AquaPro pH electrodes feature a patented double junction reference design and are mercury-free. These electrodes use an isolated Ag/AgCl internal reference and a polymer external reference with an open junction for fast, accurate readings in complex sample matrices without the sample coming in contact with silver ions. The AquaPro electrodes are easy to use and require minimal electrode preparation due to the low maintenance polymer gel reference.

Double Junction pH Electrodes

Double junction pH electrodes are for general purpose samples and feature an isolated Ag/AgCl internal reference and an external reference that is either refillable or gel-filled. These electrodes offer a mercury-free alternative to hazardous calomel pH electrodes.

KNIpHE® Double Junction pH Electrodes

The KNIpHE double junction pH electrode is designed for meat, cheese and other solid or semi-solid food samples. The pH electrode is surrounded by a stainless steel blade that protects the electrode and cuts through solid or tough materials. This electrode is mercury-free and environmentally safe.

Cat. No.	Description
9102AP	AquaPro combination pH electrode with glass body and BNC connector
9103APWP	AquaPro combination pH electrode with glass body, semi-micro tip, and waterproof BNC connector
9104APWP	AquaPro combination pH electrode with glass body, rugged bulb, and waterproof BNC connector
9107APMD	AquaPro pH/ATC Triode with epoxy body and waterproof BNC and 8 pin MiniDIN connectors
9115APWP	AquaPro combination pH electrode with epoxy body, semi-micro tip, and waterproof BNC connector
9135APWP	AquaPro combination pH electrode with epoxy body, flat surface tip, and waterproof BNC connector
9156APWP	AquaPro combination pH electrode with epoxy body and waterproof BNC connector
9102DJWP	Double junction refillable combination pH electrode with glass body and waterproof BNC connector
9110DJWP	Double junction refillable combination pH electrode with glass body, semi-micro tip, and waterproof BNC connector
9156DJWP	Double junction gel-filled combination pH electrode with epoxy body and waterproof BNC connector
9120APWP	KN1pHE double junction refillable combination pH electrode with stainless steel cutting blade and waterproof BNC connector

- All electrodes with a waterproof BNC and BNC connector 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.

AquaPro and double junction pH electrodes 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.

The AquaPro Triode has a temperature connector that is compatible with specific meters, refer to the list below.

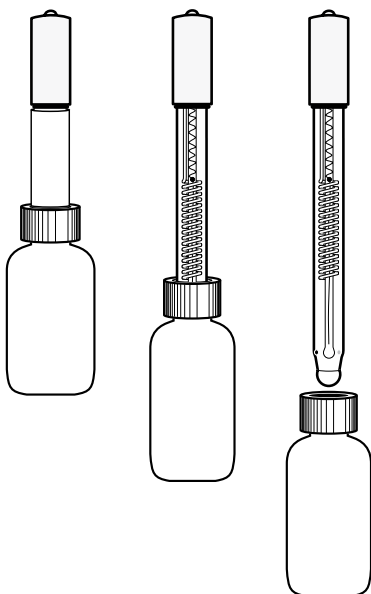
2. Thermo Scientific Orion AquaPro or double junction pH electrode.
 - The 9107APMD pH/ATC Triode has a temperature connector that is compatible with the Star Series pH meters.
3. Electrode filling solution (for 9102DJWP, 9110DJWP and 9120APWP electrodes only), Cat. No. 910008.
4. pH electrode storage solution, Cat. No. 910001.
5. 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.
6. Beakers, plastic or glass.
7. 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.
8. Distilled or deionized water.

Electrode Preparation

1. AquaPro electrodes ship in a storage bottle that contains storage solution. Remove the electrode from the storage bottle and save the storage bottle for later storage. Refer to the figure below.

For double junction electrodes, carefully 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. If using a refillable electrode, uncover the filling hole by removing the tape and then add electrode filling solution, Cat. No. 910008, to the electrode. 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. The filling hole should be open whenever the electrode is in use.
4. Soak electrode in pH electrode storage solution, Cat. No. 910001, for 30 to 60 minutes.
5. Connect the electrode to the meter.



KNIpHE Electrode Preparation

1. Remove the protective shipping cap from the sensing element and save the cap for storage.
2. Unscrew the electrode cap and remove the electrode from the handle. Make sure that the O-ring on the electrode does not fall off.
3. Clean any salt deposits from the exterior of the electrode by rinsing with distilled water.
4. Uncover the filling hole and add electrode filling solution, Cat. No. 910008, to the electrode. The level of filling solution must be no less than 1 cm below the fill hole.
5. Reinsert the electrode into handle and screw the electrode cap on.
6. Place the O-ring packaged with the blade over the electrode bulb until it is seated under the threaded end of the handle shaft.
7. Gently screw the blade onto the threads, covering the O-ring.
8. Do not invert the electrode while in use or filling solution will leak into the handle.

Cat. No.	Compatible Electrodes
9121APWP	Replacement electrode for 9120APWP KNIpHE electrode
712001	Replacement blade for 9120APWP KNIpHE electrode
712002	Replacement sheath for 9120APWP KNIpHE electrode

Sample Requirements

Electrodes with an epoxy body should only be used in aqueous solutions.

AquaPro pH electrodes contain a silver/silver chloride (Ag/AgCl) internal reference and polymer external reference. Due to the unique reference system, the sample does not come in contact with silver ions. These electrodes can be used with samples containing silver complexing or binding agents such as TRIS, proteins and sulfides.

Double junction pH electrodes contain a silver/silver chloride (Ag/AgCl) internal reference and refillable or gel external reference. Due to the double junction design, the sample does not come in contact with silver ions. These electrodes can be used with samples containing silver complexing or binding agents such as TRIS, proteins and sulfides.

All sample temperatures must be between 0 and 60 °C.

Measuring Hints

- Always use fresh buffers for calibration. Choose buffers that are one to three pH units apart.
- Check the electrode slope daily by performing a two buffer calibration. The slope should be 92 to 102%.
- If using a refillable electrode, remove the filling hole cover during measurements to ensure a uniform flow of filling solution.
- 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.
- 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.
- Flat surface electrodes may be used on any moist surface or in liquids.
- Buffers and samples should be at the same temperature. If samples are at different temperatures, perform temperature compensation as described in the meter user guide.

Electrode Calibration

General Calibration Procedure

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

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 °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

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 °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				

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

To ensure a quick response and free-flowing junction, the sensing element and reference junction must not dry out.

Short-term Storage (up to one week)

Soak the electrode in pH electrode storage solution, Cat. No. 910001. AquaPro electrodes should be stored in the storage bottle shipped with the electrode. Securely store the electrode so it will not tip over and the bulb stays in the storage solution.

Long-term Storage (more than one week)

AquaPro electrodes should be stored in the storage bottle shipped with the electrode. Cover the sensing element and reference junction of double junction electrodes with the protective cap with a few drops of storage solution or a storage bottle with enough storage solution to cover the electrode reference junction. If using a refillable electrode, fill the reference chamber and securely cover the filling hole. Securely store the electrode so it will not tip over and the bulb stays in the storage solution.

Storage Bottle	Compatible Electrodes
910003	9102AP, 9104APWP, 9107APMD, 9135APWP, 9156APWP, 9102DJWP, 9156DJWP
910004	9115APWP
910006	9103APWP, 9110DJWP

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. If using a refillable electrode, drain the reference chamber, flush it with fresh filling solution and refill the chamber with fresh filling solution.

Electrode Cleaning Procedures

General Cleaning

1. Soak the electrode in 0.1 M HCl or HNO₃ for half an hour.

The electrode can also be soaked for 15 minutes in a 1:10 dilution of household laundry bleach or a 0.1 to 0.5% liquid detergent solution mixed with hot water. The solution should be stirred at a moderate to fast rate.

2. If using a refillable electrode, drain the reference chamber and refill it with fresh filling solution.
3. 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 or automatically with an automatic temperature compensation (ATC) probe. 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.

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. If the electrode response is slow or drifting and the electrode is refillable, drain and refill the electrode with fresh filling solution, Cat. No. 910008. 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 AquaPro and double junction pH electrodes.

Accessories

Cat. No.	Description
910008	Double junction filling solution, 5 x 60 mL bottles
910001	pH electrode storage solution, 475 mL bottle
910003	Storage bottle for 12 mm electrodes, 3 pack
910004	Storage bottle for 8 mm electrodes, 3 pack
910006	Storage bottle for 6 mm electrodes, 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 storage solution, and storage bottle (12 mm)
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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