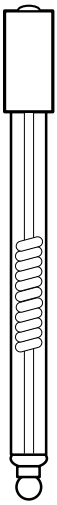
Users Guide

Orion PerpHecT® ROSS® Electrodes

8202BN, 8203BN, 8235BN, 8256BN, 8263BN, 8220BNWP



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Orion ORP Standard is protected by US Patent 6,350,367.

Orion NoCal electrodes with stabilized potential patent pending.

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This publication supersedes all previous publications on this subject.

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GENERAL INFORMATION

Introduction

This manual contains instructions for the PerpHecT ROSS series of pH electrodes. Operation and maintenance instructions for the following electrodes are included

Orion No.	Description
8202BN	PerpHecT ROSS Combination pH Electrode, 0 - 14 pH, glass body
8203BN	Semi-micro PerpHecT ROSS Combination pH Electrode, 0 - 14 pH, glass body
8235BN	Flat surface PerpHecT ROSS Combination pH Electrode, 0 - 14 pH, epoxy body
8256BN	PerpHecT ROSS Combination pH Electrode, 0 - 14 pH, epoxy body with bulb guard
8263BN	Spear tip PerpHecT ROSS Combination pH Electrode, 0 - 14 pH, glass body
8220BNWP	Micro PerpHecT ROSS Combination pH electrode, 0-14 pH, glass body

PerpHecT electrodes are the highest quality and most accurate pH electrodes available. PerpHecT electrodes are manufactured to tighter tolerances and offer even greater accuracy and precision than our standard electrodes. When combined with our PerpHecT meters, the most precise pH measurements are possible. The PerpHecT meters have patented LogR™ technology, allowing the user to make temperature compensated pH measurements without the need of a separate ATC probe.

The PerpHecT ROSS series of electrodes provide readings stable to 0.01 pH in less than 30 seconds. Results are three to five times more precise than those obtained with conventional electrodes. Because drift is less than 0.002 pH per day, restandardization is minimized.

PerpHecT LogR temperature measurement and compensation specification are based on the use of PerpHecT and PerpHecT ROSS brand electrode.

Use of other brand electrodes may impact performance.

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Required Equipment

pH Meter - Any Orion PerpHecT pH meter, or other pH and pH/ISE meters with BNC input. For use on meters requiring U.S. Standard connectors, use BNC to U.S. Standard adapter, Orion 090032.

Electrode - Combination PerpHecT pH Electrode (See **Figure 1**).

Beakers - Plastic or glass.

Magnetic Stirrer - Suggested for precision measurements.

Required Solutions

pH Buffers - Two are recommended for precise measurement. The first, near the electrode isopotential point (pH 7), and the second near the expected sample pH (e.g., pH 4 or 10).

ROSS Internal Filling Solution - 3 M KCl, Orion 810007. Do not use any filling solution which contains silver, electrode damage may result.

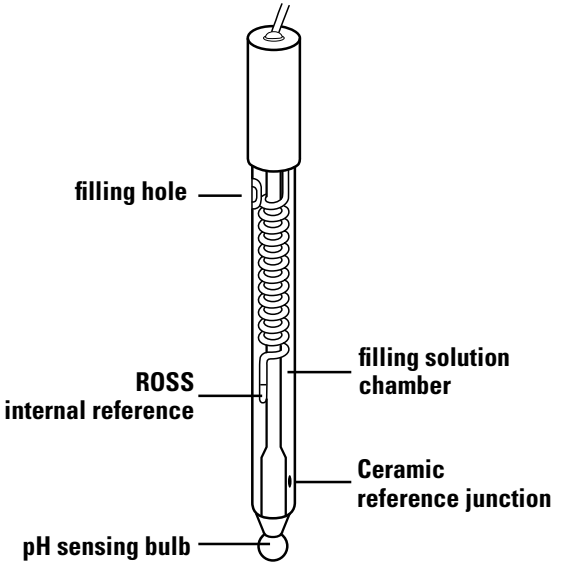


Figure 1: Orion 8202BN- PerHect ROSS Combination Electrode

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USING THE ELECTRODE

Electrode Preparation

1. Remove the protective shipping cap or shipping sleeve (Orion 8220BNWP) from sensing element and save for storage.

2. Clean any salt deposits from exterior by rinsing with distilled water. For 8220BNWP, micro pH, handle with care.

3. Uncover filling hole by removing tape and add ROSS Filling Solution, Orion 810007, to electrode (See **Figure 2**). 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 when immersed. The filling hole should be open whenever the electrode is in use.

4. Place the electrode in the electrode holder and suspend in air for 15 minutes to thoroughly wet the reference junction. For Orion 8220BNWP, micro pH, suspending in air is not necessary since the junction arrives wetted for use. Once the junction is wet, do not allow the electrode to dry out.

5. Shake down the electrode (as with a clinical thermometer) to remove air bubbles (Do not shake the Orion 8220BNWP like a clinical thermometer, only do so gently and with great care if a bubble is noticed in the internal filing solution).

6. Soak electrode in pH Electrode Storage Solution, Orion 910001, for one hour. For enhanced performance, use ROSS pH Electrode Storage Solution, 810001.

7. Connect electrode to meter.

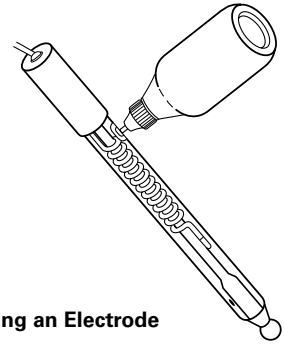


Figure 2: Filling an Electrode

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Sample Requirements

One of the benefits of the PerpHecT ROSS pH Electrode is that the filling solution composition may be changed depending on sample requirements.

The ROSS pH Electrode Filling Solution, Orion 810007 is 3 M KCl. For solutions which precipitate in the presence of chloride ion, the electrode could be filled with 10% KNO_3, Orion 900003.

Samples should be aqueous if using epoxy body electrodes (e.g., Orion 8256BN or Orion 8235BN).

In organic solutions, use an all glass PerpHecT ROSS Electrode. For good results a minimum of 20% water must be present in the sample. If there is a great deal of drift when using the PerpHecT ROSS Electrode filled with ROSS Filling Solution (Orion 810007), try filling the electrode with a mixture of methanol and water saturated with KCl.

If using the Orion 8220BNWP, micro pH electrode, great care must be taken to thoroughly rinse out the reference chamber and junction before changing the reference solutions.

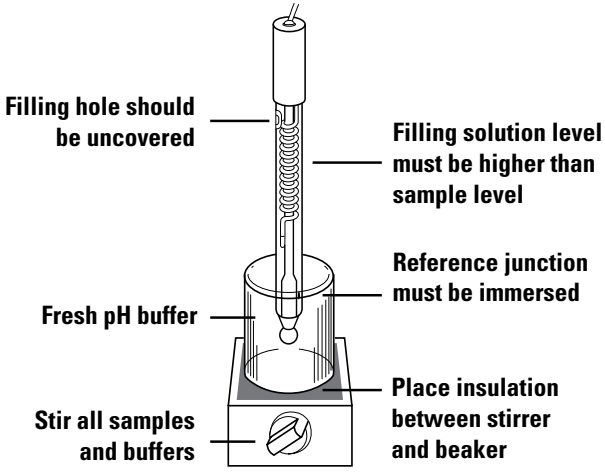


Figure 3: Measuring Hints

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Measuring Hints

See Figure 3

- Always use fresh buffers for calibration. Choose buffers that are no more than 3 pH units apart.
- Check electrode slope daily by performing two buffer calibration. Slope should be 92 to 102%.
- Except as noted in Sample Requirements, only use ROSS Filling Solution, Orion 810007, for PerpHecT ROSS Combination pH Electrodes. Do not use any filling solution which may contain silver.
- Remove filling hole cover during measurement to ensure 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.
- Place a piece of insulating material (e.g., Styrofoam or cardboard) between magnetic stirrer and beaker to prevent error from transfer of heat to sample. Since PerpHecT ROSS Electrodes respond faster than conventional electrodes, changes in pH which result from temperature changes will be noticed.
- Avoid rubbing or wiping electrode bulb, to reduce chance of error due to polarization.
- Orion 8235BN may be used on any moist surface or in liquids. See **Figure 4.**
- Handle Orion 8220BNWP with care. Do not touch the pH bulb and stem against the bottom and walls of the sample containers.

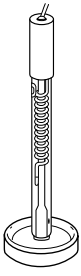


Figure 4: Use of Orion 8235BN

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pH Calibration & Measurement

General Calibration Procedure

For detailed calibration and temperature compensation procedures, consult your meter instruction manual. When using these electrodes with a PerpHecT pH meter, consult the meter's instruction manual for procedures on three buffer calibration, manual calibration, temperature calibration, or LogR™ compensated pH measurements.

Single Buffer Calibration

1. Choose a buffer near expected sample pH.

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

3. Set up meter according to meter instruction manual.

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

5. Place the electrode in the buffer. Wait for a stable display. Set the meter to the pH value of the buffer at its measured temperature. See **Table 1**. (A table of pH values at various temperatures is supplied on Orion buffer bottles.) Proceed to pH Measurement section.

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Two-Buffer Calibration

This procedure is recommended for precise measurement.

1. Ensure that all buffers are at the same temperature. If samples are at varying temperatures, temperature compensation is recommended. Refer to your pH meter instruction manual.

2. Select two buffers which bracket the expected sample pH. The first should be near the electrode isopotential point (pH 7) and the second near the expected sample pH (e.g., pH 4 or pH 10).

3. Rinse electrode first with distilled water and then with first (pH 7) buffer.

4. Place the electrode in first (pH 7) buffer. Wait for a stable display. Set the meter to the pH value of the buffer at its measured temperature. (A table of pH values at various temperatures is supplied on Orion buffer bottles). See **Table 1**.

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

6. Place the electrode in the second buffer. When display is stable, set meter to the pH value of the buffer at its measured temperature as described in the meter instruction manual.

7. If all steps are performed correctly, proceed to the pH Measurement section. If any of the above procedures do not work, refer to Troubleshooting.

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Table1
pH Values of Buffers at Various Temperatures

Nominal value at 25 °C Buffer	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

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 previous section.

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

3. Place the electrode in the sample.

4. When the display is stable, record sample pH.

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Electrode Storage

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

Short-term Storage (up to one week)

Soak electrode in ROSS pH Electrode Storage Solution, Orion 810001 or use pH Electrode Storage Solution, Orion 910001. To minimize the chance of breakage the 8220BNWP should be attached to an electrode stand and suspended in a beaker that contains pH electrode storage solution. The electrode should not touch the sides or bottom of the beaker.

Long-term Storage (more than one week)

The reference chamber should be filled and the filling hole securely covered. Cover the sensing element and reference junction with the protective cap/sleeve containing a few drops of storage solution. Before returning the electrode to use, prepare it as a new electrode.

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Electrode Maintenance

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

2. Rinse off any salt build-up with distilled water, and remove any membrane/junction deposits as directed in the cleaning procedures below.

3. Drain the reference chamber, flush it with fresh ROSS Filling Solution, Orion 810007, and refill the chamber.

Cleaning Procedures

General - Soak in 0.1 M HCl or HNO_3 for half an hour, followed by soaking in storage solution for at least one hour.*

A second general cleaning procedure involves soaking the electrode in a 1:10 dilution of house-hold laundry bleach or a 0.1-0.5% liquid detergent solution in hot water with vigorous stirring for 15 minutes.*

Removal of Membrane/Junction Deposits

Protein - Soak in 1% pepsin in 0.1 M HCl for 15 minutes or 10% Sodium hypochlorite solution for 5 minutes.*

Inorganic - Soak in 0.1 M tetrasodium EDTA solution for 15 minutes.*

Grease and Oil - Rinse with mild detergent or methanol solution.*

***** *After any of these cleaning procedures, drain and refill the reference chamber and soak the electrode in pH Storage Solution for at least one hour.*

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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, electrodes, sample/application and technique.

pH Meter

The meter is the component which is easiest to eliminate as a possible cause of error. Orion pH meters are provided with an instrument checkout procedure and shorting cap for convenience in troubleshooting. Consult your pH meter instruction manual for directions.

Electrodes

To test electrode operation:

1. Connect electrode to a working meter.
2. Set function switch to absolute mV mode.
3. Immerse electrode in fresh pH 7 buffer.
4. Displayed value should be 0 ± 30 mV.
5. Rinse electrode and immerse in fresh pH 4 buffer.
6. Displayed value should be approximately 160 mV to 180 mV greater than in step 4. (Actual mV values may change as electrode ages, but mV differences will remain 160 to 180 mV).

If electrode fails this procedure, clean thoroughly as directed in Electrode Maintenance. If electrode response is slow or drifting, drain and refill with fresh ROSS Filling Solution, Orion 810007. See Measuring Hints. If cleaning and maintenance fail to rejuvenate the electrode, replace the entire electrode

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Sample/Application

The electrode and meter may operate with buffers but not with your sample. In this case, check sample composition for interferences, incompatibilities or temperature effects.

Technique

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

Assistance

After troubleshooting all components of your measurement system, contact The Technical Edge℠ for Orion products. Within the United States call 1.800.225.1480, 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.

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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
- pH Buffers
- Samples
- Reference Element Drift
- 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 probe (ATC) or with LogR™ technology on PerpHecT pH meters. PerpHecT meters calculate the slope value based on the temperature input and automatically correct the measured pH values.

Buffer and Sample pH Changes

Buffer and sample pH values vary 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. pH buffer values at different temperatures are given in **Table 1**. PerpHecT pH meters auto calibrate with the correct pH buffer values based on the manual, ATC or LogR temperature value. 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 measurement at the same temperature is recommended and pH values should be reported along with temperature.

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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. PerpHecT ROSS pH electrodes use a patented internal reference to minimize equilibration time.

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 ROSS pH electrode. The pH and temperature response is identical and both measurements occur at the sensing bulb. Therefore drift is minimized and errors due to environmental differences are eliminated.

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Use with PerpHecT pH Meters

When these PerpHecT electrodes are used with an Orion 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 constructed to match the PerpHecT meter specifications, giving you optimum performance and accuracy in LogR mode.

It is necessary to calibrate each electrode for temperature, before proceeding with a pH measurement utilizing LogR technology. Refer to the PerpHecT meter instruction manual for more details. For maximum precision, a three point temperature calibration is recommended. A one point temperature calibration should not be used if measuring below 20 °C. To help choose the appropriate technique, the following tables below illustrate the expected pH compensation error, comparing a 1, 2 and 3 point temperature calibration. The accuracy values are valid only when 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, use of a separate ATC probe is recommended. Refer to your PerpHecT pH meter instruction manual to select the appropriate ATC probe for the system.

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One Point Temperature Calibration

Electrode °C	avg. temp. error 20-30	avg. temp. error 30-50	avg. pH comp. error 20-30	avg. pH comp. error 30-50
8202BN	0.13	0.07	0.002	0.001
8203BN	0.24	0.17	0.003	0.002
8235BN	0.91	0.95	0.011	0.011
8256BN	0.09	0.10	0.001	0.001

Two Point Temperature Calibration

Electrode °C	avg. temp. error 0-25	avg. temp. error 20-40	avg. pH comp. error 0-25	avg. pH comp. error 20-40
8202BN	0.36	0.10	0.004	0.001
8203BN	0.13	0.02	0.002	0.000
8235BN	0.04	0.14	0.000	0.002
8256BN	0.22	0.06	0.003	0.001

Three Point Temperature Calibration

Electrode °C	avg. temp. error 0-25	avg. temp. error 20-40	avg. pH comp. error 0-25	avg. pH comp. error 20-40
8202BN	0.04	0.03	0.000	0.000
8203BN	0.04	0.01	0.000	0.000
8235BN	0.07	0.06	0.001	0.001
8256BN	0.04	0.06	0.000	0.001

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Interferences

Sodium ion is the principal interference of the pH electrode, causing 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 in **Figure 5** to observed pH reading.

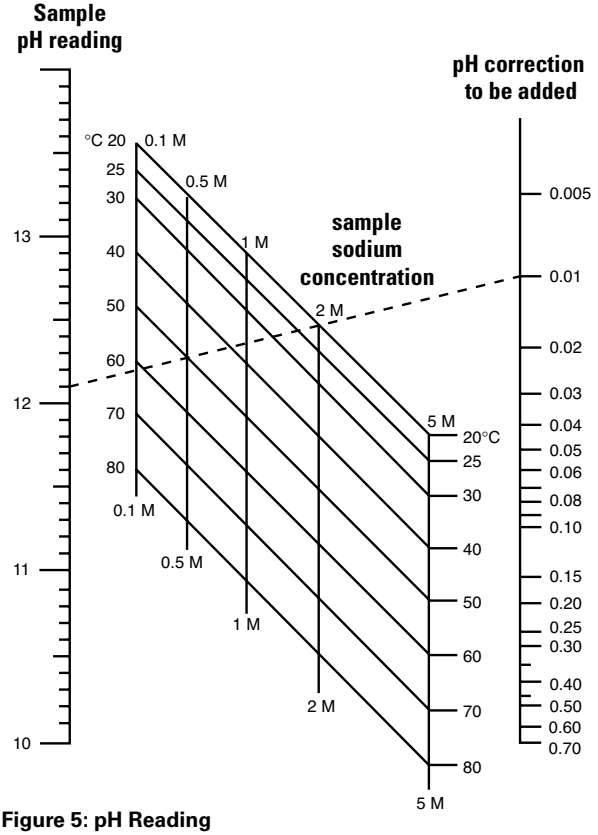


Figure 5: pH Reading

Example:

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

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WARRANTY

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

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Ordering Information

Electrodes	
Orion	**Description**
8202BN	PerpHecT ROSS Combination pH Electrode, 0 - 14 pH, glass body
8203BN	PerpHecT ROSS semi-micro Combination pH Electrode, 0 - 14, glass body
8235BN	PerpHecT ROSS flat surface Combination pH Electrode, 0 - 14, epoxy body
8256BN	PerpHecT ROSS Combination pH Electrode, 0 - 14 pH, epoxy body
8263BN	PerpHecT ROSS Spear tip Combination pH Electrode, 0 - 14 pH, glass body
8220BNWP	PerpHecT ROSS Micro Combination pH Electrode, 0-14 pH, glass body

Accessories	
Orion	**Description**
927005	PerpHecT Epoxy Body ATC Probe
927006	PerpHecT Glass Body ATC Probe
927007	PerpHecT Stainless Steel ATC Probe
928007MD	Micro Epoxy Stainless Steel ATC Probe
810007	ROSS Reference Filling Solution, 3 M KCl, five 60 mL bottles
810001	ROSS pH Electrode Storage Solution, 475 mL bottle
910001	pH Electrode Storage Solution, 475 mL bottle

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Accessories (Cont.)	
Orion	**Description**
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, 175 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
910410	PerpHecT® Buffer pH 4, 10 pk.
910425	PerpHecT Buffer pH 4, 25 pk.

See www.thermo.com/water for additional available buffers and container sizes.

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SPECIFICATIONS

pH Range
0 - 14

Isopotential Point
pH 7

Temperature Range
0 - 100 °C

Standard Cap Diameter
16 mm

Cap Length
30 mm

Electrodes	Length (excluding cap)	Diameter
8202BN	120 mm	12 mm
8203BN	165 mm	12 mm (12 mm section is 65 mm long) 6 mm (6 mm section is 100 mm long)
8235BN	120 mm	12 mm
8256BN	120 mm	12 mm
8263BN	110 mm	12 mm (12 mm section is 87 mm long) 4.5 mm (4.5 mm section is 23 mm long)
8220BNWP	155 mm	67 mm long x 12 mm diameter 48 mm long x 6 mm diameter 40 mm long x 3 mm diameter

Orion 8220BNWP ROSS Micro pH Electrode
Minimum Depth of Immersion 4.5 mm
Minimum sample size, 15 µL in 384 well plates.

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Notes

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