

pH

Orion 8003, 8165,
8172, 8175

Orion ROSS™ Sure-Flow® Electrodes

INSTRUCTION MANUAL



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ORION Series A meters and 900A printer are protected by U.S. patents 5,108,578, 5,198,093 and German patents D334,208 and D346,753.

Sure-Flow electrodes are protected by European Patent 278,979 and Canadian Patent 1,286,720.

ionplus electrodes and Optimum Results solutions are protected by US Patent 5,830,338.

ROSS Ultra electrodes have patents pending.

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

ORION Series A conductivity meters are protected by US Patent 5,872,454.

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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 ROSS™ Sure-Flow® Series of pH electrodes. Operation and maintenance instructions for the following electrodes are included:

Orion	Description
8003	ROSS Sure-Flow Reference Half-Cell, glass body
8165	ROSS Sure-Flow Combination, epoxy body
8172	ROSS Sure-Flow Combination, glass body
8175	ROSS Sure-Flow Semi-Micro Combination, epoxy body

ROSS Sure-Flow Electrodes provide a free-flowing sleeve junction especially designed for measurement in general pH samples as well as viscous or colloidal samples whenever best performance is desired. The junction can be cleaned easily between measurements; pressing down on the cap allows filling solution to flow through the junction, carrying away any contamination that may interfere with measurement.

The Models 8165 and 8175 combine the Sure-Flow junction with a rugged epoxy body. A sleeve protects the pH sensing bulb and is removable for easy cleaning. The rugged epoxy body is resistant to strong acids and strong bases. It may be used intermittently in some organics. Polar organic compounds should be strictly avoided (Orion 8172BN is recommended for use in organics).

The Ross series of electrodes provide readings stable to 0.01 pH in a buffer solution in less than 30 seconds, even in the extreme case of buffers varying from one another by 50 °C or more. Results are three to five times more precise than those obtained with conventional electrodes.

ROSS Sure-Flow Electrodes are supplied with BNC connectors. Adaptors are available for conversion to U.S. Standard connectors. See **Ordering Information**, or consult the Thermo Electron Corporation Laboratory Products Catalog and price list. For more information contact your local Thermo Distributor, or call Thermo Customer Service.

Required Equipment

Meter — Any Orion pH or ion-selective meter, or other pH/ISE meter with appropriate connectors.

Electrode — Combination pH Electrode, or pH and Reference Electrode Half Cells. Use the Orion 8003 ROSS™ Sure-Flow® Reference Half Cell Electrode with a ROSS Half Cell.

Thermometer — Readable to ± 0.5 °C.

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.)

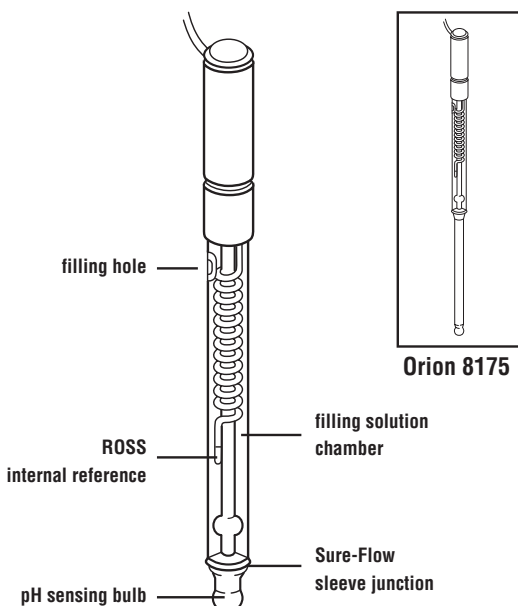


Figure 1: Orion 8172 ROSS Sure-Flow Combination

USING THE ELECTRODE

Electrode Preparation

1. Remove the protective shipping cap from sensing element and save for storage.
2. Clean any salt deposits from exterior by rinsing with distilled water.
3. Uncover filling hole by removing plastic sleeve and add ROSS™ Internal Filling Solution, Orion 810007, to electrode. See **Figure 2**.

To maintain an adequate flow rate, the level of filling solution must cover the end of coil and be at least one inch above the sample level when immersed. The filling hole should be open whenever the electrode is in use.

4. Thoroughly wet the junction by pressing down on the electrode cap and allowing some of the ROSS Internal Filling Solution to flow out of the electrode through the junction. Replenish lost filling solution. See **Figure 3**.
5. Shake down the electrode (as a clinical thermometer) to remove air bubbles.
6. Soak combination electrode and/or pH half cell in pH Electrode Storage Solution, Orion 910001, for one hour. Reference electrodes do not need to be soaked. If Orion pH Storage Solution is not available, use 200 mL pH 7 buffer to which about 1 g KCl has been added, as a temporary substitute.
7. Connect electrodes to meter.

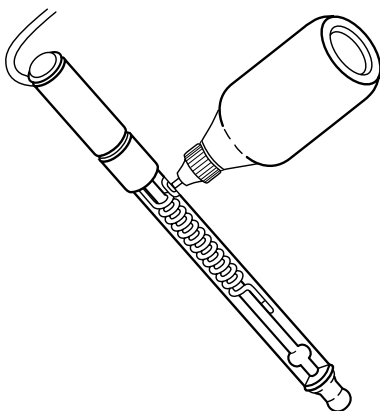


Figure 2: Filling the ROSS Sure-Flow Electrode

Sample Requirements

One of the benefits of the ROSS™ pH Electrodes is that the filling solution composition may be changed depending on sample requirements because of the double junction construction. Do not use solutions containing silver.

The ROSS pH Electrode Filling Solution, Orion 810007, is 3 M KCl. For solutions which precipitate in the presence of chloride ion, the ROSS pH Electrode could be filled with 10% KNO₃, Orion 900003.

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

The major advantage of the ROSS Sure-Flow® Electrode is that the junction can be cleaned at any time by briefly depressing the cap. See **Figure 3**. This can be done whenever necessary. To be sure to maintain a proper level of filling solution, refill as in step 3 of **Electrode Preparation**.

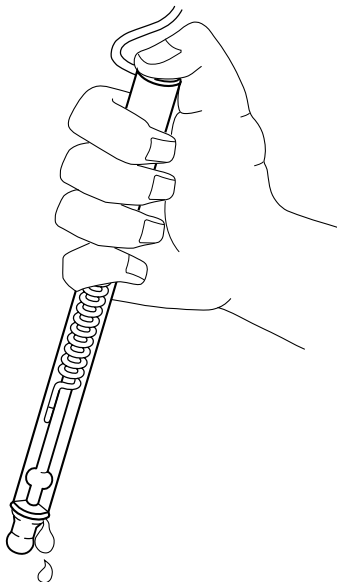


Figure 3: ROSS Sure-Flow Electrode Being Flushed

Placement of Removable Sleeve Bulb Guard

The bulb guard can be removed for cleaning or general measurement. Grasp bulb guard and gently pull. The bulb guard will slide off the electrode exposing the pH sensing bulb and junction area. See **Figure 4A**.

Press on the cap to open junction for easy cleaning.

To replace bulb guard, gently push into place. The bulb guard is secure without additional turning or fittings. See **Figure 4B**.

For general measurements the bulb guard can be left in place on the electrode. However, the bulb guard can contribute to carryover from solution to solution. When using it, be sure to rinse thoroughly between standards and samples to prevent carryover. For measurement in viscous solutions or other solution which may be retained in the protective guard area, remove the bulb guard for measurement and calibration. Exposing the pH bulb completely gives faster response and reduces carryover.

Sure-Flow® Junction

The Sure-Flow junction is operable with or without the bulb guard in place. Simply press down on the cap to open junction and let fill solution flow through, removing contamination. Removing the bulb guard and flushing with distilled water aids in the removal of more difficult deposits.

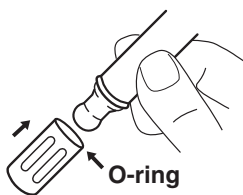


Figure 4A: Bulb Guard for 8165

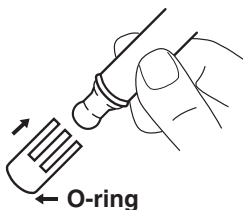


Figure 4B: Bulb Guard for 8175

Measuring Hints

See **Figure 5**.

- 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 - 102%.
- Except as noted in Sample Requirements, only use ROSS™ Internal Filling Solution, Orion 810007, for ROSS Combination pH and Reference 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 the electrodes with distilled water and then with the next solution to be measure.
- 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 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.
- After use in especially dirty or viscous samples or when electrode response becomes sluggish, empty the electrode completely and hold the junction open under running water. Empty any water from the electrode and refill with fresh ROSS Filling Solution. Briefly flush the junction to ensure that the junction contains fresh filling solution. Maintain a proper level of filling solution.

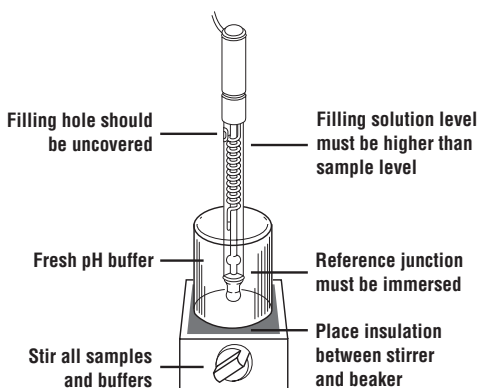


Figure 5: measuring Hints

pH CALIBRATION & MEASUREMENT

General Calibration Procedure

For detailed calibration and temperature compensation procedures, consult your meter instruction manual.

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. (See 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 10)
3. Rinse electrode first with distilled water and then with the first (pH 7) buffer. Place the electrode in the first (pH 7) buffer.
4. 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 the buffer bottle.) See **Table 1**.
5. Rinse electrode first with distilled water and then with the second buffer. Place the electrode in the second buffer.
6. When the 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, see **Troubleshooting**.

Single Buffer Calibration

1. Ensure that all buffers are at room temperature.
If samples are at varying temperatures, temperature compensation is recommended. (See meter instruction manual.)
2. Set up meter according to meter instruction manual.
3. Rinse electrode first in distilled water and then with the buffer being used for calibration (the buffer should be near the expected sample pH). Place the electrode in the buffer.
4. 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 the buffer bottle.) Proceed to **pH Measurement** section.

pH Measurement

1. Calibrate the electrode as described in above procedure.
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.

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 by holding junction open under running distilled water.
3. Drain the reference chamber, flush it with fresh ROSS® Internal Filling Solution, Orion 810007, and refill chamber.

Cleaning Electrode

General — Soak in 0.1 M HCl or HNO₃ for half an hour, followed by soaking in pH Storage Solution for at least one hour.

Removal of Membrane/Junction Deposits

When using the following procedures, do not immerse electrode more than 1/4" above junction.

Protein — Soak in 10% pepsin in 0.1 M HCl for 15 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, hold junction open under running distilled water, drain and refill the reference chamber and soak the electrode in pH Storage Solution for 15 minutes.

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 pH Electrode Storage Solution, Orion 910001. If Orion Storage Solution is not available, use about 200 mL pH 7 buffer to which about 1 g KCl has been added, as a temporary substitute.

Long-Term Storage

The reference chamber should be filled and the filling hole covered. Cover the sensing element and reference junction with its protective cap containing a few drops of pH Storage Solution. Before returning the electrode to use, prepare it as a new electrode.

Table 1
pH Values of Buffers at Various Temperatures
Nominal value
at 25 °Temperature

Buffer	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

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				

TROUBLESHOOTING

Troubleshooting Guide

Following is a systematic procedure to isolate the problem.

The pH measuring systems 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 - 180mV greater than in step 4. (Actual mV values may change as electrode ages but mV differences will remain 160 to 180 mV).

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

If electrode response is slow or drifting, drain and refill with fresh ROSS™ Internal Filling Solution, Orion 810007. See **Measuring Hints**.

If cleaning and maintenance fail to rejuvenate the electrode:

1. For separate pH and reference half cells, substitute each electrode (one at a time) with a known working electrode and repeat test procedure. By process of elimination, determine which electrode should be replaced.
2. For combination pH electrodes, replace the entire electrode.

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 EdgeSM 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.

ELECTRODE CHARACTERISTICS

Temperature Effects

The most common cause of error in pH measurement is temperature. Ordinary electrodes drift with temperature changes. The Ross pH Electrode eliminates the stability problems associated with the use of conventional electrodes in samples of varying temperatures.

There are, however, two effects of temperature change that should be kept in mind.

1. Electrode slope will change with varying temperature. This slope change may be compensated for either manually, or, automatically with an automatic temperature compensator (ATC) probe and properly designed pH meter. Consult your pH meter instruction manual for details.
2. Buffer and sample pH values vary with temperature because of their temperature dependent chemical equilibrium. The problem of differing pH values is easily solved by calibrating the electrode with characterized standard buffers whose true pH values at different temperatures are known. Buffer values at different temperatures are given in **Table 1**. The problem of the sample equilibrium varying with temperature in an uncharacterizable manner will always remain. Therefore, pH values should be reported along with the temperature at which the measurement was made.

Electrode Leak Rate

The ground glass junction of the ROSS™ Sure-Flow® Electrode has been optimized to leak at a rate of approximately 1 mL per 24 hour period. In order to keep the junction free, the leak rate is slightly higher than conventional electrodes. The loss of filling solution is minimal during the average time for a pH measurement and does not contaminate samples.

Interferences

Sodium ion is the principal interference for the pH electrode, causing increasing error at higher pH (lower hydrogen ion activities) and at higher temperatures. Because the ROSS™ 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 6** to the observed pH reading.

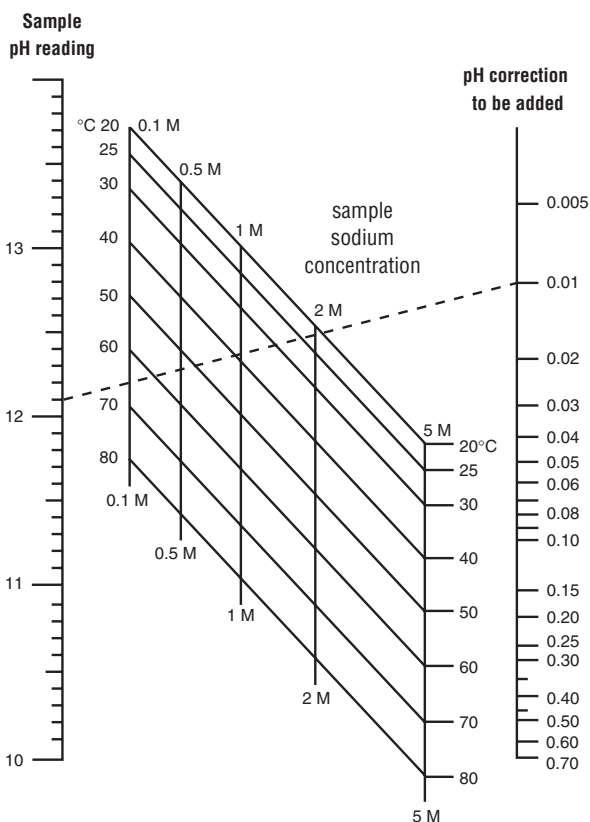


Figure 3: Typical Sodium Error Observed at pH >12

Example:

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

WARRANTY

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

The Thermo Electron Corporation, Orion products warranty covers failures due to manufacturer's workmanship or material defects from the date of purchase by the user. User should return the warranty card and retain proof of purchase. Warranty is void if product has been abused, misused, or repairs attempted by unauthorized persons.

Warranties herein are for product sold/installed by Thermo or its authorized dealers.

Any product sold by a U.S. or Canadian distributor must be returned to Thermo for any warranty work. Please contact our Technical Service department for further information. A Return Authorization Number must be obtained from The Technical EDGESM For Orion Products before returning any product for in-warranty repair or replacement.

In the event of failure within the warranty period, Thermo will at the company's option, repair or replace product not conforming to this warranty. There may be additional charges, including freight, for warranty service performed in some countries. For service, call Thermo or its authorized dealer outside the United States and Canada. Thermo reserves the right to ask for proof of purchase, such as the original invoice or packing slip.

Field Service is available on Orion BOD AutoEZTM, EZ Flash[®] GC Accessory and TEA Analyzer[®]. Contact our Field Service department for details on quotations, service, other field service-related activities.

The following products are warranted to be free from defects in material and workmanship in the period listed below from the date of purchase from the user or from the date of shipment from Thermo, whichever is earlier, provided use is in accordance with the operating limitations and maintenance procedures in the instruction manual and when not having been subjected to accident, alteration, misuse, abuse or breakage of electrodes:

Thirty-six months from date of purchase by the user (or forty-two months from date of shipment from Thermo)

- Waterproof Meters (Orion 630, 635, 830A, 835A, 260A, 261S, 265A, 266S, 130A, 131S, 135A, 136S, 1230, 142 and 842), Conductivity Meters (Orion 105AplusTM, 115AplusTM, 125AplusTM, 145AplusTM, 150AplusTM and 162A), PerpHect[®] pH/ISE Meters (Orion 310, 320, 330, 350, 370) pH/ISE Meters (Orion

210Aplus™, 230Aplus™, 250Aplus™, 290Aplus™, 410Aplus™, 420Aplus™, 520Aplus™, 525Aplus™, 710Aplus™, 720Aplus™ and 920Aplus™), pHuture MMS™ Meters (Orion 535A and 555A), pH/Conductivity Meter (Orion 550A), Dissolved Oxygen Meters (Orion 805Aplus™, 810Aplus™, 850Aplus™ and 862A).

Twenty-four months from date of purchase by the user (or thirty-six months from date of shipment from Thermo)

- Orion ROSS Ultra® Electrodes, AQUAfast® IV Colorimeters, AQUAfast® IV Turbidimeter, Orion 925 Flash Titrator™, Series 100 DuraProbe™ Conductivity Cells and Series 800 Dissolved Oxygen Probes.

Twelve months from date of purchase by the user (or eighteen months from date of shipment from Thermo)

- Laboratory pH Meters, (Orion 301, 611 and 940), SensorLink®, pHuture™ pH Meters (Orion 610 and 620), Smart Chek™ meters, Sage® Pumps, Cahn® Balances, 930 Ionalyzer®, 950 ROSS™ FAST QC™ Titrator, 960 Titrator PLUS®, Karl Fischer Titrators, Autosamplers, Liquid Handling Devices, Liquid Handling Automation Workstations (Orion AS2000, AS2500 and AS4000), Pumps (Orion SP201, SP201-HR, SP201-S, Peristaltic and Rinse), pHuture® Conversion Box, Wine Master®, 607 Switchbox, rf link™, AQUAfast® II Colorimeters, Vacuum Degasser and Flowmeter.
- Orion EZ Flash® GC Accessory, Orion TEA Analyzer® 610 and 510 excluding consumable items carry twelve months warranty only.
- Orion Ion Selective Electrodes, ionplus® Electrodes, ROSS™ Electrodes, Sure-Flow® Electrodes, PerpHecT® Electrodes, AquaPro Professional Electrodes, No Cal™ pH electrodes, Standard Line pH Electrodes, Tris pH Electrodes, KNiPHE® electrode, ORP Triode™ (Orion 9180BN), pHuture™ pH Probes (Orion 616500) and pHuture MMS™ Quatrode™ and Triode™ (Orion 616600 and 617900), Orion 97-08 DO Probe, Series 100 Conventional Conductivity Cells, temperature probes and compensators (except those products noted).
- Orion 93 and 97 ionplus Series sensing modules are warranted to give six months of operation if placed in service before the date indicated on the package, except 93-07 and 97-07 Nitrate modules are warranted to give ninety days of operation if placed in service before the date indicated on the package.

Six months from date of purchase by the user (or twelve months from date of shipment from Thermo)

- Orion Flash Titration™ Probe (Orion 092518), pHuture™ Electrode (Orion 615700), pHuture MMS™ Pentrode™ (Orion 617500), Quatrode™ (Orion 617800) and Triode™ (Orion 615800), Low Maintenance Triode™ (Orion 9107BN), ORP Low Maintenance Triode™ (Orion 9179BN), and PerpHect® Low Maintenance Triode™ (Orion 9207BN), Waterproof Triode™ (Orion 9107WP, 9107WL, 9109WL and 9109WP), QuiKcheK® Meters and Micro Electrodes.

Three months from date of purchase by the user (or six months from date of shipment from Thermo)

- Economy Line Electrodes, Orion 91-05, 91-06, 91-15, 91-16, 91-25, 91-26, 91-35, 91-36, 92-06. Warranty also includes failure for any reason (excluding breakage), except abuse, provided the electrode is not used in solutions containing silver, sulfide, perchlorate, or hydrofluoric acid; or in solutions more than one (1) Molar in strong acid or base at temperatures above 50 °C.

“Out-of-Box” Warranty - Should any of the following products fail to work when first used, contact Thermo immediately for replacement.

- Orion Solutions, Standards, Reagents, Cables, Ferrules, Tubing, Line adapters, Printers, Software, Cases, Stands, Probe Membranes, AQUAfast® Test Strips, EZ Flash® columns, Liquid Handling Probes, Adapter Plates and Racks and general accessories.

For products in the catalog not listed in this warranty statement, please visit our website at: www.thermo.com

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ORDERING INFORMATION

Electrodes

Orion	Description
800300	ROSS™ Sure-Flow® Reference Half Cell Electrode, Glass Body, with pin-tip connector
8165BN	ROSS Sure-Flow Combination pH Electrode, Epoxy Body with BNC Connector
8172BN	ROSS Sure-Flow combination pH Electrode, Glass Body with BNC Connector
8175BN	ROSS Sure-Flow Semi-micro combination pH Electrode, Epoxy Body with BNC connector

Accessories

Orion	Description
090032	Adaptor: BNC electrode to U.S. Standard meter
810007	ROSS Internal Filling Solution, 3M KCl, five 50 mL bottles
910001	pH Electrode Storage Solution, 475 mL
910104	pH 4.01 Buffer, 475 mL
910107	pH 7.00 Buffer, 475 mL
910110	pH 10.01 Buffer, 475 mL
910410	perpHect® Buffer pH 4, 10 pk
910425	perpHect Buffer pH 4, 25 pk
910710	perpHect Buffer pH 7, 10 pk
910725	perpHect Buffer pH 7, 25 pk
910110	perpHect Buffer pH 10, 10 pk
910125	perpHect Buffer pH 10, 25 pk
911110	perpHect Electrode Rinse, 10 pk
911125	perpHect Electrode Rinse, 25 pk

SPECIFICATIONS

pH Range

0 - 14

Drift

Less than 0.005 pH per day

Temperature Range

0 to 100 °C

Internal Reference

ROSS™

Junction

Sure-Flow® liquid-to-liquid

Slope

92 to 102% of theoretical Nernst slope

Isopotential Point

pH 7.0 ± .1

Accuracy of Measuring a pH 6.86 Buffer After Standardization at 25 °C

Accurate within 0.03 pH for buffer at any other temperature between 0-100 °C, using automatic temperature compensation

Speed of Response

of pH 6.86 Buffer between 25 °C and 75 °C

Response stable to 0.01 pH within 30 seconds

Speed of Response

Between pH 6.86 and 4.01 Buffers at 25 °C

Response stable to 0.005 pH within 15 seconds

Reference Half Cell Filling Solution

3 M KCl (supplied with electrode)

Size	8003	8165	8172	8175
Electrode Length (excluding cap)	120 mm	120 mm	120 mm	180 mm
Diameter	12 mm	12 mm	12 mm	7.5x100 mm 12x80 mm
Cap Diameter	16 mm	16 mm	16 mm	16 mm
Cap Length	50 mm	50 mm	50 mm	50 mm
Cable Length	100 cm	100 cm	100 cm	100 cm

NOTES

Environmental Instruments

Water Analysis

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