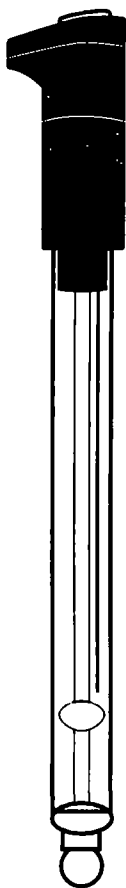


AgCl

Orion 91-72BN, 91-65BN

Orion Ag/AgCl Sure-Flow[®] Electrode

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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Despite appearances, the KCl Creep on your Orion electrode is really quite harmless.

The white crystals you may find on your Orion electrode are formed by potassium chloride (KCl) from the electrode filling solution.

Rinse the KCl from the electrode with distilled water and proceed as usual.

If you have any questions, please call our Technical Service Group at 800-225-1480 or visit www.thermo.com.



Environmental Instruments

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GENERAL INFORMATION

Introduction

This manual contains instructions for use of the Orion Glass pH Sure-Flow® Electrode with Ag/AgCl internal reference system and Orion Epoxy pH Sure-Flow® with Ag/AgCl internal reference system. Operation and maintenance instructions for the electrode are included.

Required Equipment

pH Meter - Any Orion pH or ion selective meter, or other pH/ISE meter with appropriate connectors. For use on meters requiring U.S. Standard Connectors, use BNC to U.S. Standard adapter Orion 090032.

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).

Internal Filling Solution

Filling Solution	Orion
4M KCl saturated with AgCl	900011

USING THE ELECTRODE

Set Up

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. Slide the fill hole cover down to uncover the fill hole. Add *Internal Filling Solution, Orion 900011*.

To maintain an adequate flow rate, the level of filling solution must be at least one inch above the sample level on immersion. *The fill 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 Internal Filling Solution to flow out of the electrode through the junction. Replenish lost filling solution.
5. Shake down the electrode (as a clinical thermometer) to remove air bubbles.
6. Soak combination electrode in pH Electrode Storage Solution, Orion 910001, for one hour. If Orion 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.

Before Analysis

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

Sample Requirements

Aqueous samples are recommended. Ag/AgCl electrodes are incompatible with samples containing silver complexing or binding agents such as proteins, Tris buffers and sulfides. To measure pH in such samples use an Orion Ross electrode. Proteins cause the additional problem of coating the sensing bulb. See **Electrode Maintenance** section of this manual for removal of membrane deposits.

Measuring Hints

- Always use fresh buffers for calibration. Choose buffers that are no more than 3 pH units apart.
- Check electrode slope daily by performing a two-buffer calibration. Slope should be 92 to 102%.
- Remove fill hole cover during calibration and 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.
- Avoid rubbing or wiping electrode bulb, to reduce chance of error due to polarization.

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 electrodes first with distilled water and then with pH 7 buffer. Place the electrode in pH 7 buffer.
4. Wait for a stable display. Set the meter to the pH value of the buffer at its measured temperature as described in the meter instruction manual. (A table of pH values at various temperatures is supplied on the buffer bottle.)
5. Rinse electrode first with distilled water and then with the second buffer. Place the electrode in the second buffer.
6. When display is stable, set meter to the actual pH value of the buffer as described in the meter instruction manual.
7. If all steps are performed correctly, and slope is between 92 and 102%, proceed to **pH Measurement**. If any of the above procedures do not work, refer to **Troubleshooting section**.

Single-Buffer Calibration

1. Ensure that all buffers and samples are at the same 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 with 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. (A table of pH values at various temperatures is supplied on the buffer bottle.) See **Table 1**.
5. If required enter slope determined during the 2 point calibration procedure. Proceed to pH measurement.

Table 1 pH VALUES OF NIST BUFFERS AT VARIOUS TEMPERATURES*

Nominal Value at 25°C	Temperature				
pH	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	
1.69	1.71	1.72	1.74	1.77	
3.75	3.75				
4.03	4.06	4.08	4.13	4.16	
6.84	6.83	6.84	6.85	6.86	
6.97	6.97				
7.38	7.37				
9.07	9.01	8.96	8.92	8.89	
9.89	9.83				

*NIST (National Institute of Standards and Technology) was formerly known as NBS.

pH Measurement

1. Calibrate the electrode as described in previous section.
2. Rinse the electrode with distilled water and then with some of the sample.
3. Place the electrode in the sample.
4. *When the display is stable, record sample pH.*

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 (between measurements/up to one week):

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

Long-term Storage (more than one week):

The reference chamber should be filled and the fill hole securely covered. Cover the sensing element and reference junction with its protective cap containing a few drops of storage solution.

Electrode Maintenance

Weekly

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 cleaning procedures below.
3. Drain the reference chamber, flush it with fresh filling solution and refill the chamber.

Cleaning Electrode

Open junction by depressing cap and holding. Place opened junction under warm, running tap water for 15 seconds.

General- Soak in 0.1 M HCl or 0.1 M HNO₃ for half an hour.*
A second general cleaning procedure involves soaking the electrode in a 1:10 dilution of household laundry bleach in 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.*

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 storage solution for at least one hour.**

Special Note on Electrode Cleaning

Your Sure-Flow electrode has been specially designed with a "removable cap". Difficulty depressing the electrode cap may be the result of salt crystal formation. The electrode may require cleaning as follows:

With your fingers, apply a small amount of soapy water to the portion of the electrode cable directly extending from the cap. While holding the cable and carefully "feeding" the cable through the cap opening, gently slide the cap upward. Then while carefully pulling the cable back through the cable opening, gently replace the cap.

TROUBLESHOOTING

Troubleshooting Guide

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 operator error.

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 strap or cap for convenience in troubleshooting. Consult your pH meter instruction manual for direction.

Electrodes

To test electrode operation:

1. Fill electrode with Orion No. 900011 Electrode Filling Solution.
2. Connect electrode to a working meter.
3. Set function switch to absolute mV mode.
4. Immerse electrode in fresh pH 7 buffer.
5. Displayed value should be 0 ± 30 mV.
6. Rinse electrode and immerse in fresh pH 4 buffer.
7. Displayed value should be approximately 160 to 180 mV greater than in step 5 (actual mV values may change as electrode ages, but mV difference should 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 filling solution. See **Measuring Hints**.

If cleaning and maintenance fail to rejuvenate the electrode: replace the 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.

Operator Error

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 change. The effects of temperature on pH measurements can be divided into two types, mechanical and chemical.

Mechanical

1. Electrode slope will change with variation in temperature.
This slope change may be compensated for either manually, or automatically with an automatic temperature compensator (ATC) probe, and a properly designed pH meter. Consult your pH meter instruction manual for details.
2. Thermal response of the electrode will change with temperature.
The electrode body material is slow to reach thermal equilibrium after it has been transferred from a solution of one temperature to another. This results in drift until equilibrium has been reached.

Chemical

The chemical effects are really equilibrium effects; a change in temperature causes a change in chemical equilibrium.

1. Buffer and sample pH values vary with temperature because of their temperature dependent chemical equilibria. The problem of differing pH buffer 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. Extended use in extreme temperatures may shorten electrode life.
2. The Ag/AgCl internal reference system is temperature dependent. *The metal/salt equilibrium must be re-established with each change in temperature; this takes place slowly and is evidenced by drift.*

If you are measuring over a range of temperatures or have observed any of the described slow responses to temperature change, the Orion ROSS pH Electrode is recommended. This electrode has been designed with a unique internal reference system to minimize the equilibration time and error involved in pH measurement where temperature variations are a factor.

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 1** to observed pH reading.

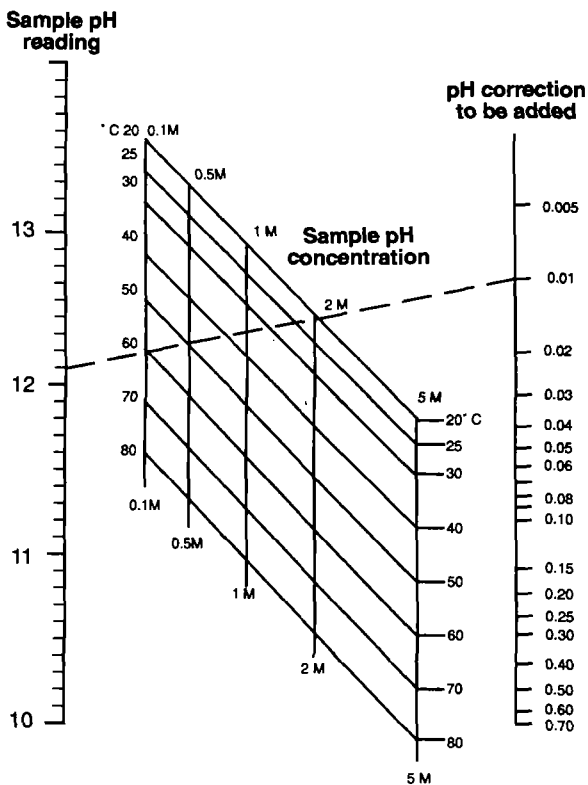


Figure 1
Typical Sodium Error Observed at pH > 12

Example:	
pH Reading	12.10
Sodium Concentration	0.5 M
Temperature	50 °C
Correction	0.01
Corrected pH Reading	12.11

ORDERING INFORMATION

Accessories

Orion	Description
9172BN	Sure-Flow Combination pH electrode, Glass body with BNC connector
9165BN	Sure-Flow® Combination pH Electrode Epoxy Body with BNC connector
900011	Internal Filling Solution, 4M KCl saturated with AgCl, five 60 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
090032	Adapter, BNC to US Std. connector
917001	Epoxy ATC probe with banana plug connector
917002	Glass ATC probe with banana plug connector
917005	Epoxy ATC for Orion A series meter
917006	Glass ATC for Orion A series meter
910410	perpHect Buffer 4, 10 pack
910425	perpHect Buffer 4, 25 pack
910710	perpHect Buffer 7, 10 pack
910725	perpHect Buffer 7, 25 pack
910750	perpHect Buffer 7, 50 pack
911010	perpHect Buffer 10, 10 pack
911025	perpHect Buffer 10, 25 pack
911110	perpHect Rinse, 10 pack
911125	perpHect Rinse, 25 pack

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.

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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.

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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 210AplusTM, 230AplusTM, 250AplusTM, 290AplusTM, 410AplusTM,

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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SPECIFICATIONS

Isopotential Point

pH 7

Temperature Range

0 - 90 °C

pH Range

0 - 14

Diameter

12 mm

Cable Length

100 cm

Cap Diameter

16 mm

Specifications subject to change without notice.

NOTE

TWO-BUFFER STANDARDIZATION

4. Place electrodes in the buffer whose pH is the isopotential point. When display is stable, turn the calibration control until the correct pH value is displayed.
5. Remove the electrodes from the isopotential buffer and rinse.
6. Place the electrodes in the second buffer solution.
7. When display is stable, turn the temperature compensator until the pH value of the second buffer is displayed. Turn the slope indicator dial until the temperature compensator arrow points to the buffer temperature. Read the percent of the theoretical Nernst slope at the "% slope" index line. *If the % Nernstian slope is less than 90%, repeat the standardization with fresh buffers. If the % slope is again less than 90%, see troubleshooting, page 15.*
8. Remove electrodes, rinse, and place in the unknown sample.
9. Allow the reading to stabilize, and record the pH measurement directly from the display.

Environmental Instruments

Water Analysis

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