

# Na<sup>+</sup>

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Orion 84-11,  
86-11

## Orion ROSS™ Sodium 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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The specifications, descriptions, drawings, ordering information and part numbers within this document are subject to change without notice.

This publication supersedes all previous publications on this subject.

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# GENERAL INFORMATION

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## Introduction

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The Orion 84-11 ROSS™ Sodium and Orion 86-11 ROSS Sodium Combination Electrodes allow sodium in aqueous solutions to be measured quickly, accurately, and economically. With its unique redox internal system, the ROSS electrode provides faster response, greater stability and accuracy than can be obtained from conventional sodium electrodes.

For the most consistent and fastest results, Thermo Electron Corporation recommends measuring sodium by the known addition procedure. Detailed instructions for performing this procedure are outlined in this manual. General guidelines for direct calibration, apparatus and solutions required for measurement, electrode characteristics and electrode theory are also discussed.

Technical Service Chemists can be consulted for assistance and troubleshooting advice. Please refer to **TROUBLESHOOTING** for information on contacting Thermo.

## Package Contents

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Your Orion 84-11 and Orion 86-11 ROSS Sodium Electrode Kits contain the following:

Orion	Description
900010	Reference Electrode Filling Solution, 2 M NH <sub>4</sub> Cl, 50 mL
841111	Sodium Ionic Strength Adjustor (ISA), 475 mL
841109	Sodium Known Addition Standard, 1000 ppm with ISA, 475 mL
841108	1000 ppm Sodium Standard, 475 mL
841113	Sodium Reconditioning Solution, 475 mL
841101	Sodium Electrode Storage Solution, 475 mL
209569-001	Instruction Manual
208960-001	Warranty Card

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## Required Equipment

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**Meter** – The easiest to use for known addition are those which have direct known addition readout. These include the Orion 960, EA 940 and EA 920 with Orion Software Upgrade Module Incremental Techniques PROM, Orion 092011. If unavailable, any meter with millivolt readability to 0.1 mV, or direct concentration capability such as Orion SA 720, SA 270, or Orion 811 is recommended.

**Reference Electrode** – For Orion 84-11: Orion 80-03 ROSS™ Sure-Flow® Reference Electrode. For Orion 86-11: None required.

**Magnetic Stirrer, Stir Bars** – Recommended for laboratory measurements

**Graph Paper** – 4-cycle semilogarithmic paper for preparing calibration curves (for use with digital pH/mV laboratory meters like the Orion 811 and 701A).

## Required Solutions

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**Distilled or Deionized Water** – To prepare all solutions.

**Standard Solutions** – Select the appropriate Thermo standard from the list below.

<b>Standard Solutions</b>	<b>Orion No.</b>
<b>Known Addition Standard Solutions</b>	
1000 ppm Sodium Standard with ISA	841109*
1 M Sodium Standard with ISA	650700
<b>Standard Solutions</b>	
0.1 M Sodium Chloride Standard	941706
1000 ppm Sodium Standard	841108*
100 ppm Sodium Standard	941107
10 ppm Sodium Standard	941105

\* Shipped in Sodium Electrode Kit, Orion 8411BN

<b>Standard Solutions</b>	<b>Orion No.</b>
<b>Sodium Ionic Strength Adjustor (ISA)</b> To keep a constant background ionic strength and adjust pH, 4 M NH <sub>4</sub> Cl and 4 M NH <sub>4</sub> OH	841111*
<b>Electrode Rinse Solution</b> For rinsing sodium electrodes between measurements. Make 1 liter of rinse solution by adding 10 mL of the ISA to a 1 liter squeeze bottle and filling it with distilled water	Customer Prepared
<b>Sodium Reconditioning Solution</b> For restoring electrode response, 0.1 M NH <sub>4</sub> HF <sub>2</sub>	841113*
<b>Sodium Electrode Storage Solution</b> For storing Orion Sodium Electrodes, 5 M NaCl, 0.08 M NH <sub>4</sub> OH, and 0.08 M NH <sub>4</sub> Cl	841101*
<b>Reference Electrode Filling Solutions</b> Use for filling the ROSS™ Sure-Flow® Reference Electrode Orion 80-03 when used in conjunction with the Sodium Electrode, Orion 84-11	
<b>2 M NH<sub>4</sub>Cl</b> – For routine measurements (sodium concentration greater than 10 <sup>-5</sup> or .2 ppm)	900010*
<b>0.1 M NH<sub>4</sub>Cl</b> – For low-level measurements (less than 10 <sup>-5</sup> or .2 ppm sodium)	900012

\* Shipped in Sodium Electrode Kit, Orion 8411BN

# USING THE ELECTRODE

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## Set Up

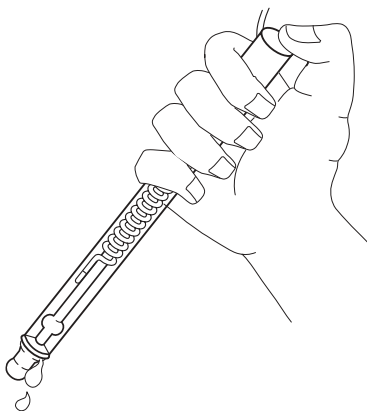
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### Electrode Preparation

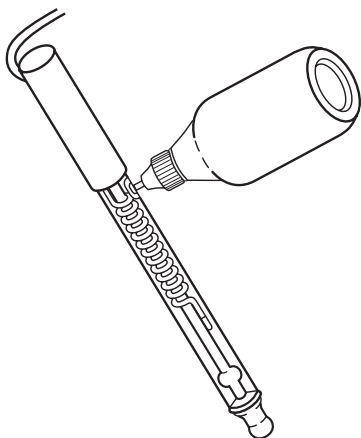
*NOTE: Perform this procedure on new electrodes or electrodes which have been stored dry.*

1. Remove protective shipping cap from the ROSS™ Sodium Electrode sensing element and save for electrode storage.
2. Clean any salt deposits from the exterior of the electrode by rinsing it with sodium electrode rinse solution. Do not use water. (See **Required Solutions** for preparation instructions.)
3. **Orion 86-11:**
  - A. Uncover the fill hole by unscrewing plug (save for storage), and empty electrode by pressing the cap. See **Figure 1**.
  - B. Fill the reference portion of the electrode with Sodium Electrode Filling Solution, Orion 900010. See **Figure 2**. For low-level measurements (less than  $10^{-5}$  M), Orion 900012 is recommended. To function properly, the level of the filling solution must cover the coil and be at least one inch above the sample level on immersion. Electrode fill hole should be open whenever the electrode is in use.
  - C. Thoroughly wet the junction by pressing down on the electrode cap and allowing a small amount of filling solution to flow out. Replenish lost filling solution.
4. **Orion 84-11/80-03**

Fill the reference electrode according to the instructions in the reference electrode instruction manual. The ROSS Sure-Flow® Reference Electrode, Orion 80-03 is shipped with 3 M KCl filling solution, Orion 810007, for use with pH electrodes. Do not use this filling solution for sodium measurements. Use Orion 900010, 2 M  $\text{NH}_4\text{Cl}$  which is provided with the Orion 84-11. For low-level measurements, use Orion 900012 Filling Solution, 0.1 M  $\text{NH}_4\text{Cl}$ .
5. Soak the electrode at least two hours in Sodium Electrode Storage Solution, Orion 841101.
6. After storage, refresh the junction by pressing on the cap and letting a small amount of solution flow out. Replenish lost filling solution.



**Figure 1**  
**ROSS™ Sure-Flow® Sodium Electrode Being Flushed**



**Figure 2**  
**Filling the ROSS Sure-Flow Sodium Electrode**

## Checking Electrode Operation (Slope)

These are general instructions, which can be used with most meters. See individual meter instruction manuals for more specific information.

This procedure measures electrode slope. Slope is defined as the change in millivolts observed with every tenfold change in concentration. Obtaining the slope value provides the best means for checking electrode operation.

1. If electrodes have been stored dry, condition the electrodes as described under **Electrode Preparation**.
2. Connect electrodes to the meter (refer to the meter instruction manual for assistance if needed).
3. Place 100 mL distilled water into a 150 mL beaker. Add 10 mL ISA, Orion 841111. Stir thoroughly. Set the function switch of the meter to read in mV.
4. Rinse electrodes with sodium electrode rinse solution (see **Required Solutions**) and place in the solution prepared in step 3 above.
5. Select any standard from **Table 1**. Pipet 1 mL of this standard solution into the beaker. Stir thoroughly. When a stable reading is displayed, record the electrode potential in millivolts.
6. Pipet 10 mL of the same standard into the same beaker. Stir thoroughly. When a stable reading is displayed, record the electrode potential in millivolts.
7. The difference between the first and second potential readings is the slope of the electrode. The difference should be in the range of 54-60 mV, assuming the solution temperature is between 20 and 25 °C. If the potential is not within this range, recondition the electrode as described in **Electrode Reconditioning**. For other troubleshooting techniques, refer to the **Troubleshooting Checklist**.

**Table 1**  
**Standards For Checking Electrode Slope**

Orion No.*	Description
941706	0.1 M Sodium Chloride Standard
841108	1000 ppm Sodium Standard

\* The other standards do not have sufficient sodium concentration to accurately perform the slope check.

## Before Analysis

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### Units of Measurement

Sodium can be measured in units of moles per liter, parts per million, % salt, mg/serving, or any other convenient units depending on the concentration units used for standard solutions. A list of some conversion factors can be found in **Table 2**.

**Table 2**  
**Concentration Unit Conversion Factors**

To Convert From:	To:	Multiply By:
Moles/Liter NaCl or Moles/Liter Na	ppm Na	23,000
	ppm NaCl	58,500
	% Na	2.3
	% NaCl	5.85
	mg Na/100 g, mg Na/100 mL	2,300
	mg NaCl/100 g, mg NaCl/100 mL	5,850
ppm Na	moles/liter Na	0.0000434
	moles/liter NaCl	0.0000171
	% Na	0.0001
	% NaCl	0.000254
	ppm NaCl	2.54
	mg NaCl/100 g, mg Na/100 mL	0.100
mg NaCl/100 g, mg NaCl/100 mL	0.254	

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## Concentration Unit Conversion Factors (cont.)

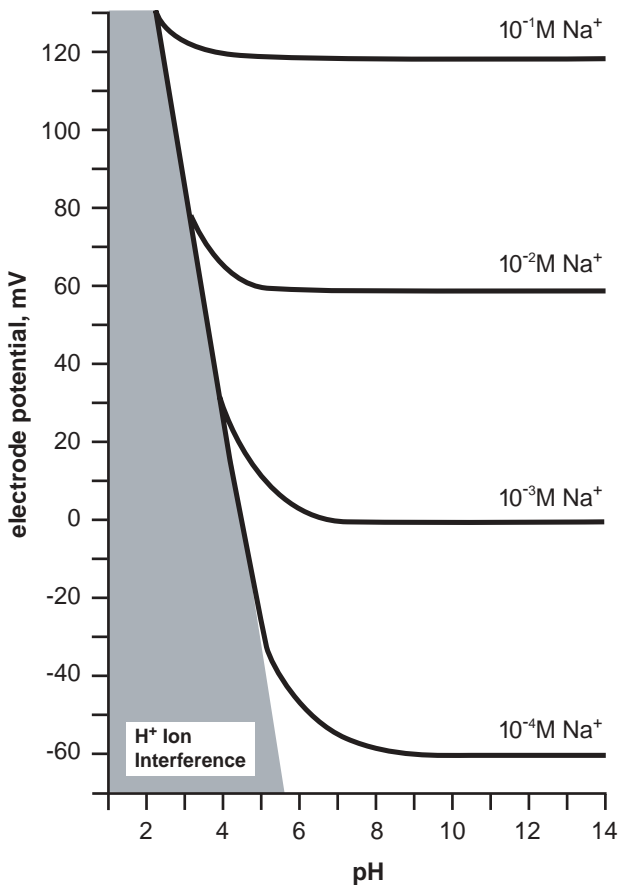
To Convert From:	To:	Multiply By:
% NaCl, % salt	moles/liter Na	0.434
	moles/liter NaCl	0.171
	ppm Na	3,932
	% Na	0.3932
	ppm NaCl	10,000
	mg Na/100 g, mg Na/100 mL	393
	mg NaCl/100 g, mg NaCl/100 mL	1,000

### Sample Requirements

Samples must fall in the pH range of 6-12 after pH adjustment depending on sample concentration. For best accuracy, use the recommended ISA to adjust the pH to between 9-10. Refer to **Figure 3**.

The glass body is resistant to attack by most organic solvents, however, the response of the sensing bulb may become sluggish and measurements may drift when used in organic solvents. Contact Thermo's Technical Service Chemists for information on using the electrode in unusual applications such as non-aqueous samples.

One of the benefits of the ROSS™ Sodium Electrode is that the electrode responds rapidly to temperature changes. If the meter has an adjustable isopotential point and an automatic temperature compensator probe, it is possible to perform temperature compensated sodium measurements. Refer to **Temperature Effects** for more information. If these features are unavailable, samples and standards should be at the same temperature.



**Figure 3**  
Electrode Potential Behavior Vs. Solution pH in Pure NaCl Solution at 25 °C

## Measuring Hints

- For fastest, most consistent results, use a known addition procedure.
- Add ISA to all standards and samples. Use ratio of 10 mL of ISA per 100 mL sample or standard.
- Stir all standards and samples at a uniform rate during measurement. Magnetic stirrers may generate sufficient heat to change solution temperature. Place a piece of insulating material such as cork, cardboard, or styrofoam between the stirrer and beaker.
- If using direct calibration, verify calibration every two hours by placing electrodes in the first standard solution used for calibration and if necessary recalibrate.
- Always use fresh standards for calibration and measurement.
- Check the electrode slope daily. See **Electrode Operation**.
- Always rinse electrodes with sodium electrode rinse solution between measurements. (See **Required Solutions** for preparation.) Shake after use of rinse solution to prevent solution carryover. **Do not wipe or rub the sensing element.**
- Adjust all samples and standards to between pH 9-10 with Orion Sodium Ionic Strength Adjustor, Orion 841111. Be sure to add same proportion of ISA to samples and standards.
- Use plastic laboratory ware for low-level measurements.
- If response becomes sluggish, treat sodium electrode with sodium reconditioning solution, Orion 841113. See **Electrode Reconditioning**.
- Store sodium electrode in Sodium Electrode Storage Solution, Orion 841101 when electrode is not in use. For low-level measurements, use a more dilute storage solution, 1 part storage solution to 100 parts of distilled water.
- Do not store in or rinse with distilled water.
- For high ionic strength samples, prepare standards with composition similar to that of the sample.

## Analytical Procedures

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### Analytical Techniques

A variety of analytical techniques are available to the analyst.

#### Incremental Techniques

Useful methods since calibration is not required. These methods include a variety of spiking procedures – adding a standard solution to the sample, or sample to a standard solution. Advantages of incremental techniques are speed and ease of measurement, and ability to analyze samples containing complexing agents, concentrated samples, those varying widely in temperature, or dry soluble samples. The incremental techniques which are useful for sodium analysis are described below.

**Known Addition** provides the fastest, most consistent results when performing sodium measurements. The electrodes are immersed in the sample solution and an aliquot of a standard solution containing sodium is added to the sample. From the change in potential before and after the addition, the original sample concentration is determined. There are three types of known addition procedures: multiple known addition, double known addition, and single known addition.

**Multiple Known Addition** is performed by the Orion 960 Autochemistry System and provides the most accurate results of any of these techniques. A series of additions of a sodium known addition standard solution are automatically dispensed into the sample and the original sodium concentration is calculated and reported by the instrument.

**Double Known Addition** is performed on the Orion EA 940. Two aliquots of sodium standard solution are added to the sample, resulting in the automatic determination of the original sodium concentration of the sample and the slope of the electrode. Both double known addition and multiple known addition measure electrode slope during analysis, thus eliminating the need for a separate slope check.

**Single Known Addition** can be most conveniently performed on the Orion EA 940 and the Orion EA 920 with Orion Software Upgrade Module Incremental Techniques PROM, Orion 092011. This technique involves the addition of an aliquot of sodium standard. Electrode slope should be measured as a preliminary step using the procedure described in the meter instruction manual or in **Checking Electrode Operation (Slope)**.

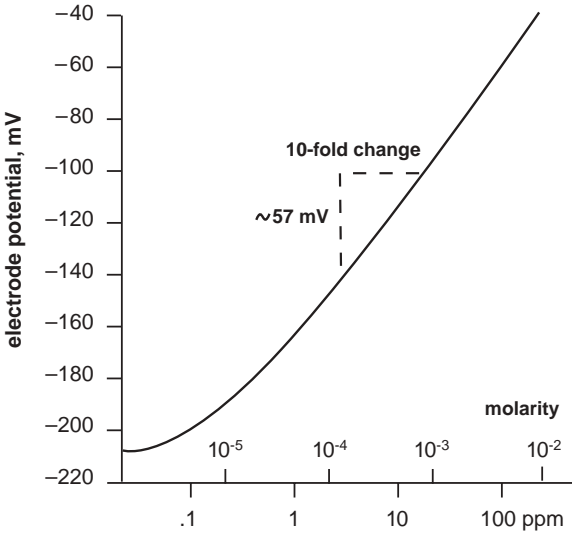
Orion 901 and 407A also offer direct readout capability for single known addition. If a direct readout known addition instrument is unavailable, known addition can be performed on any meter with a millivolt mode.

**Analate Addition** is often used to measure soluble solid samples, viscous samples, small or very concentrated samples, to diminish the effects of complex sample matrices, or to diminish the effects of varying sample temperatures. This method is not suitable for dilute or low concentration samples. The electrodes are immersed in a standard solution containing the ion to be measured and an aliquot of the sample is added to the standard. The original sample concentration is determined from the change in potential before and after the addition.

### **Direct Calibration**

A procedure used for measuring a large number of samples whose concentration varies over a wide range. Calibration is performed in a series of standards. The concentration of the samples is determined by comparison to the standards. ISA is added to all solutions to ensure that samples and standards have similar ionic strength.

Detailed instructions for double and single known addition are found in this instruction manual. For the multiple known addition procedure, refer to the Orion 960 Instruction Manual. General instructions for direct calibration are also described in this manual.



**Figure 4**  
**Typical ROSS™ Sodium Electrode Calibration Curve**

A calibration curve of a typical ROSS™ Sodium Electrode demonstrates the log/linear response of the electrode using a pH/mV meter. The calibration curve is constructed on semilogarithmic paper. Electrode potentials (mV) of standard solutions are measured and plotted on the linear axis against their concentrations on the log axis. When measuring in the non-linear region of the curve, special procedures are recommended. See **Low-Level Measurements**.

## Known Addition

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### General Preparation

Known addition has been found to be the best technique for measuring sodium, providing the fastest, most consistent results. It is especially convenient since no calibration is required. The electrodes are immersed in the sample, an aliquot of sodium standard is added, and the original sodium concentration is measured.

For optimal results, total concentration of the sample solution should double upon the addition of an aliquot of sodium standard solution. Therefore, the sample concentration must be known to within a factor of three. The most commonly used volume addition is 10 mL of standard to 100 mL of sample, using a standard which is ten times more concentrated than the sample.

For double known addition, two additions are required, thus the most convenient method is to make a 1 mL and a 10 mL addition of a standard whose concentration is 100 times the sample concentration. These size aliquot are most convenient and minimize volume change.

To minimize changes in ionic strength, ISA is added to all sodium standards in the same ratio as it is added to the samples. All samples should be stirred throughout measurements.

1. Prepare electrode according to instructions in **Electrode Preparation**.
2. Connect electrodes to meter.
3. If using single known addition technique, measure the electrode slope as in **Checking Electrode Operation (Slope)** or the meter instruction manual.

### Solution Preparation

1. Prepare 1 liter of sodium electrode rinse solution by adding 10 mL of ISA, Orion 841111, to a 1 liter squeeze bottle and filling it with distilled water.
2. Prepare sodium standard solution. Add 10 mL of ISA to every 100 mL of sodium standard. Mix thoroughly. Use for known addition technique.

If more dilute standards are required than those available, dilute standard and then add 10 mL of ISA to every 100 mL of standard.

### Standard Preparation For Single Known Addition

Prepare a sodium standard whose concentration is ten times the sample concentration (if concentration is unknown see note below). For example, if the sample is about 1 ppm sodium, prepare a sodium standard whose concentration is 10 ppm sodium, then add ISA.

### Standard Preparation For Double Known Addition

Prepare a sodium standard whose concentration is 100 times the sample concentration. For example, if sample is about 1 ppm sodium, prepare a sodium standard whose concentration is 100 ppm; then add ISA.

### Notes On Known Addition

For sodium analysis the ratio of addition of ISA to samples and standards is 10:100. This represents a 10% dilution and must be taken into consideration when calculating the results of the analysis. The procedures in this manual when followed exactly will yield the correct answer. If you modify the procedures to better suit your analysis, remember to take the dilution into account.

For known addition the basic equation is as follows:

$$C_{\text{sam}} = \frac{p}{[(1 + p)10^{\Delta E/S}] - 1} \cdot C_{\text{std}}$$

where:

$C_{\text{sam}}$  = concentration of the sample

$C_{\text{std}}$  = concentration of the standard

$\Delta E$  = change in millivolts

$S$  = slope of the electrode

$$p = \frac{\text{volume of standard}}{\text{volume of sample}}$$

By keeping the proportion of ISA added to samples and standards the same, the dilution factor cancels in the equation as shown:

$$C_{\text{sam}} \cdot \frac{100 \text{ mL}}{110 \text{ mL}} = \frac{p}{[(1 + p)10^{\Delta E/S}] - 1} \cdot C_{\text{std}} \cdot \frac{100 \text{ mL}}{110 \text{ mL}}$$

$$C_{\text{sam}} = \frac{p}{[(1 + p)10^{\Delta E/S}] - 1} \cdot C_{\text{std}} \cdot \frac{100 \text{ mL}}{110 \text{ mL}} \cdot \frac{110 \text{ mL}}{100 \text{ mL}}$$

If any of the terms are changed the dilution must be taken into consideration. For example, using the known addition standard prepared in a background of 10% ISA, such as Orion 841109, changes the equation:

$$C_{\text{sam}} \cdot \frac{100 \text{ mL}}{110 \text{ mL}} = \frac{p}{[(1 + p)10^{\Delta E/S}] - 1} \cdot C_{\text{std}}$$

$$C_{\text{sam}} = \frac{p}{[(1 + p)10^{\Delta E/S}] - 1} \cdot C_{\text{std}} \cdot \frac{100 \text{ mL}}{110 \text{ mL}}$$

$$C_{\text{sam}} = \frac{p}{[(1 + p)10^{\Delta E/S}] - 1} \cdot C_{\text{std}} \cdot 1.1$$

In conclusion, follow the procedures recommended in this manual for the easiest method. When changing anything in these procedures, make sure to take the dilution factor into account. If using a meter which calculates the answer, be certain that your procedure is in agreement with the requirements of that particular meter technique.

**NOTE:** If sample concentration is unknown, obtain a millivolt reading on the sample with ISA added. Using the typical electrode calibration curve in **Figure 4**, read the approximate concentration from the graph, and use this value as a guideline in preparing the sodium standard.

## Calibration and Measurement

### *Double Known Addition Using the EA 940*

For most double known addition analysis, it is recommended that:

- Sample volume be 100 mL
- The concentration of the standard added be 100 times the expected sample concentration
- The volume of the first addition of standard be 1 mL
- The volume of the second addition of standard be 10 mL

Before Analysis: Press **SPEED**, then **2**, to proceed through the **OPERATOR MENU** steps listed below.

Display	Action
1. OPERATOR MENU?	Press <b>yes</b> .
2. CHANGE THE ELECTRODE ID?	Select Na <sup>+</sup> .
3. Na <sup>+</sup> ISO = 1.0000	Press <b>yes</b> .
4. SET NUMBER OF SIGNIFICANT DIGITS?	Select 3.

***NOTE:** Since ISA is added to the standards and samples in the same ratio it is unnecessary to correct for the dilution which occurs when adding ISA. Make sure to follow instructions exactly. Enter the value of the standard before the addition of the ISA and enter the volume of the sample plus ISA.*

Analysis: Following is the sequence of messages displayed when performing a double known addition measurement. Press **SPEED**, then **0** to begin.

Display	Action
1. CALIBRATE 1:Na <sup>+</sup> 10:24 12-07-86	Press <b>yes</b> .
2. CALIBRATE BY DIRECT MEASUREMENT?	Press <b>no</b> .
3. USE INCREMENTAL TECHNIQUES?	Press <b>yes</b> .

Display	Action
4. 1 = KA 2 = KS 3 = AA 4 = AS	Press <b>1</b> to choose known addition.
5. 1 = SINGLE INCREMENT 2 = DOUBLE INCREMENT	Press <b>2</b> to choose double known addition.
6. 1:NA <sup>+</sup> ELECTRODE IN SAMPLE?	Add 10 mL ISA to 100 mL sample and place electrode in sample. Stir moderately throughout measurement. Then press <b>yes</b> .
7. SAMPLE VOL = 100.00 IS THIS CORRECT?	Press <b>yes</b> if sample plus ISA volume is correct. Use numeric keys to change sample volume if it is incorrect, then press <b>yes</b> . (If 10 mL were added to 100 mL, change to 110.)
8. EMF = -182.3 mV NOT READY	None required. Electrode response is unstable, wait for a stable reading. <i>NOTE: EA 940's internal stability criteria may be overridden and current stability accepted for measurement by pressing yes.</i>
9. EMF = -171.3 YES TO CONTINUE	Electrode response is stable, press yes to continue with known addition.
10. STD ADDED TO SAMPLE?	Add first addition of sodium standard to sample (usually 1 mL), then press <b>yes</b> .
11. STD CONCN = 1.0000 IS THIS CORRECT?	Press <b>yes</b> if standard concentration is correct. Enter the concentration the standard would have had before addition of ISA. Use numeric keys to change standard concentration if it is incorrect, then press <b>yes</b> .
12. STD VOL = 1.0000 IS THIS CORRECT?	Press <b>yes</b> if volume of standard added is correct. Use numeric keys to change standard volume if it is incorrect, then press <b>yes</b> .

## Display Action

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- |   |  |
|---|--|
| 13. EMF = -155.6 NOT READY                | None required. Electrode response is unstable, wait for a stable reading.<br><i>NOTE: EA 940's internal stability criteria may be overridden and current stability accepted for measurement by pressing yes.</i>                                 |
| 14. EMF = -154.3<br>YES TO CONTINUE       | Electrode response is stable, press <b>yes</b> to continue with known addition.  |
| 15. STD ADDED TO<br>SAMPLE + STD          | Add second addition of same standard to sample containing first addition (usually 10 mL), then press <b>yes</b> .  |
| 16. STD VOL = 10.000<br>IS THIS CORRECT?  | Press <b>yes</b> if volume of standard added is correct. Enter volume of second addition. Use numeric keys to change standard volume if it is incorrect, then press <b>yes</b> .   |
| 17. EMF = -139.4 NOT READY                | None required. Electrode response is unstable, wait for a stable reading.<br><i>NOTE: EA 940's internal stability criteria may be overridden and current stability accepted for measurement by pressing yes.</i>                                 |
| 18. EMF = -137.2<br>YES TO CONTINUE       | Electrode response is stable, press <b>yes</b> to continue with known addition.  |
| 19. 1:NA+ CONCN=1.00<br>REPEAT TECHNIQUE? | Sodium concentration of sample is displayed. Press <b>yes</b> to do another double known addition measurement. Press <b>no</b> to select a different technique. Electrode slope may be checked by pressing <b>2nd Function</b> , then <b>4</b> . |
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### Single Known Addition Using the EA 940

Before Analysis: Press **SPEED**, then **2**, to proceed through the **OPERATOR MENU** steps listed below.

Display	Action
1. OPERATOR MENU?	Press <b>yes</b> .
2. CHANGE THE ELECTORDE ID?	Select Na <sup>+</sup> .
3. Na <sup>+</sup> ISO = 1.0000	Press <b>yes</b> .
4. SET NUMBER OF SIGNIFICANT DIGITS?	Select 3.

Analysis: Following is the sequence of messages displayed when performing a single known addition. Press **SPEED**, then **0** to begin.

Display	Action
1. CALIBRATE 1: Na <sup>+</sup> 10:24 12-07-86	Press <b>yes</b> .
2. CALIBRATE BY DIRECT MEASUREMENT?	Press <b>no</b> .
3. USE INCREMENTAL TECHNIQUES?	Press <b>yes</b> .
4. 1 = KA      2 = KS 3 = AA      4 = AS	Press <b>1</b> to choose known addition.
5. 1 = SINGLE INCREMENT 2 = DOUBLE INCREMENT	Press <b>1</b> to choose single known addition.
6. NA <sup>+</sup> ELECTRODE IN SAMPLE?	Add 10 mL ISA and place electrode in sample. Stir moderately throughout measurement. Then press <b>yes</b> .
7. SAMPLE VOL = 100.00 IS THIS CORRECT?	Press <b>yes</b> if sample plus ISA volume is correct. (If 10 mL ISA were added to 100 mL samples, change to 110.) Use numeric keys to change sample volume if it is incorrect, then press <b>yes</b> .

Display	Action
8. SLOPE = +59.2 mV/DEC IS THIS CORRECT?	Press <b>yes</b> if slope value and polarity sign are correct. Use numeric keys to change slope value if it is incorrect, then press <b>yes</b> . If actual slope is unknown, enter +59 mV/DEC, or perform slope check in <b>Checking Electrode Operation (Slope)</b> or according to EA 940 Instruction Manual.
9. EMF = -182.3 mV NOT READY	None required. Electrode response is unstable, wait for a stable reading. <i>NOTE: EA 40's internal stability criteria may be overridden and current stability accepted for measurement by pressing yes.</i>
10. EMF = -171.3 YES TO CONTINUE	Electrode response is stable, press <b>yes</b> to continue with known addition.
11. STD ADDED TO SAMPLE?	Add sodium standard to sample, then press <b>yes</b> .
12. STD CONCN = 1.0000 IS THIS CORRECT?	Press <b>yes</b> if sodium standard concentration is correct. Enter volume of standard before addition of ISA. Use numeric keys to change standard concentration if it is incorrect, then press <b>yes</b> .
13. STD VOL = 10.000 IS THIS CORRECT?	Press <b>yes</b> if volume of sodium standard added is correct. Use numeric keys to change standard if it is incorrect, then press <b>yes</b> .
14. EMF = -155.6 NOT READY	None required. Electrode response is unstable, wait for a stable reading. <i>NOTE: EA 940's internal stability criteria may be overridden and current stability accepted for measurement by pressing yes.</i>

Display	Action
15. EMF = -154.3 YES TO CONTINUE	Electrode response is stable, press yes to continue with known addition.
16. 1:NA+ CONCN=1.00 REPEAT TECHNIQUE?	Sodium concentration of sample is displayed. Press <b>yes</b> to do another known addition measurement. Press <b>no</b> to select a different technique.

### *Single Known Addition Using The EA 920*

#### *With Thermo Software Upgrade Module Incremental Techniques PROM*

Be sure Incremental Techniques PROM, Orion 092011 is inserted before beginning analysis. Refer to Orion EA 920 Instruction Manual.

Before beginning analysis by known addition, perform the following steps:

1. Clear the blank value if a blank value has been entered. Known addition mode will not be displayed if a blank value is entered in the **CONC** mode.

To clear the blank value:

- a. Press **mode** key until **CONC** is displayed.
- b. Press function key until **BLANK** is displayed.
- c. Press clear keys, **STD 1** will be displayed under function, **BLANK** will disappear.

2. Enter a slope value in the CONC (concentration) mode. The known addition mode cannot be displayed unless a slope value has been entered in the CONC mode.

To enter a slope value:

- a. Press **mode** key until **CONC** is displayed.
- b. Press **function** key until **SLOPE** is displayed.
- c. Scroll in correct electrode slope value as measured in **Checking Electrode Operation (Slope)**. If unknown, enter the theoretical value of +59.
- d. Press **enter**.

3. Press **function** key until **SAMPLE** appears.

4. Press **mode** key until **AAAS/KAKS** appears.

5. Press **function** key again to display **KAKS** only.

## Analysis:

1. Place electrodes into 100 mL sample. Add 10 mL ISA, Orion 841111. Stir moderately throughout measurement.
2. Press enter to begin analysis. Display will read the mV potential developed in solution.
3. Wait for **READY** indication. Press **enter**.
4. **STD 1** and **%** will be lit. For known addition, **%** indicates the percent change in volume when standard is added to sample. To calculate, use the following formula:

$$\frac{\text{standard volume}}{\text{sample volume}} \times 100$$

For example: if 10 mL of ISA is added to 100 mL of sample, the total sample volume is 110 mL. Making a 10 mL addition will give the following ratio:

$$\frac{10 \text{ mL}}{110 \text{ mL}} \times 100 = 9.09$$

Scroll until 9.09 is displayed and press **enter**. **CONC** and **STD 1** will be lit.

5. Add sodium standard to sample. Scroll until the concentration of the standard is displayed. Press **enter**.

***NOTE:** Enter the concentration value of the standard before ISA was added.*

6. The EA 920 then automatically calculates the sample concentration. **KA** will appear as well as the concentration of the sample.

Wait for **READY** indication, then record sample concentration value.

### To repeat the technique:

1. Prepare a fresh sample, rinse electrodes, shake off excess, and place into sample.
2. Press **enter** to begin analysis. **KAKS** will light and mV potential will be displayed.
3. Wait for **READY** indication and press **enter**.
4. Adjust the % volume change value if necessary.
5. Press **enter**.
6. Add standard to sample.
7. Change the standard concentration if necessary.
8. Press **enter**.
9. Wait for **READY** indication and record the sample concentration.

### *Single Known Addition Using The 901*

1. Turn slope thumbwheel switches to display the slope value measured in **Checking Electrode Operation (Slope)**. Set sign to plus.  
  
If **SET BLANK** button is lit, press to turn off.
2. Turn **STD** thumbwheel switches to read the concentration of standard before ISA is added. Set mode switch to KA/10.
3. Rinse electrodes, shake off excess, and place in 100 mL sample. Add 10 mL sodium ISA, Orion 841111. Press **CLEAR/READ MV** button. Stir moderately throughout measurement.
4. Allow time for the reading to stabilize. Press **SET CONC** button. The display may be unstable.
5. Pipet 11 mL of sodium standard into the sample.
6. Allow time for reading to stabilize. Record the sample concentration from the display.

### Single Known Addition Using The 811 or 701A

Use this procedure for any meter which does not have a direct readout known addition mode.

1. Set the meter to measure in relative mV.
2. Measure 100 mL of the sample into a 150 mL beaker. Add 10 mL ISA, Orion 841111. Stir thoroughly.
3. Rinse electrodes with sodium electrode rinse solution (see **Set Up**) and place into beaker. When a stable reading is displayed, set the reading to 000.0 by turning the calibration control. If the reading cannot be set to 000.0, record the mV value.
4. Pipet 10 mL of the sodium standard solution into the beaker. Stir thoroughly.
5. When a stable reading is displayed, record the mV value. If the meter could not be zeroed in step 3, subtract the second reading from the first to find  $\Delta E$ , ( $\Delta E = E_2 - E_1$ ).
6. From **Table 3** find the value, Q, that corresponds to the change in potential,  $\Delta E$ . To determine the original sample concentration, multiply Q by the concentration of the added standard:

$$C_o = QCS$$

where:

$C_S$  = standard concentration

$C_o$  = sample concentration

Q = reading from known addition table

The table of Q values is calculated for a 10 mL addition to 110 mL of sample for electrodes with a slope of 59 mV. Make sure you have added 10 mL of ISA for every 100 mL of standard prior to using for known addition. The equation for the calculation of Q for different slopes and volume changes is given below:

$$Q = \frac{p}{[(1 + p)10^{\Delta E/S}] - 1}$$

Q = value to be used in equation above

$\Delta E$  = change in millivolts

S = Slope of the electrode

$p = \frac{\text{volume of standard}}{\text{volume of sample}}$

**Table 3**  
**Q Tables for ROSS™ Sodium**

Dilution: 10 mL to 110 mL      0.090909  
Mixture: Sample 100 mL, ISA = 10 mL, KA = 10 mL

**Na<sup>+</sup> Slope**

<b>ΔE</b>	<b>55.0</b>	<b>57.0</b>	<b>58.0</b>	<b>59.0</b>	<b>60.0</b>
5.0	0.2636	0.2713	0.2751	0.2789	0.2826
5.2	0.2552	0.2628	0.2666	0.2703	0.2739
5.4	0.2473	0.2548	0.2585	0.2621	0.2657
5.6	0.2398	0.2471	0.2508	0.2544	0.2579
5.8	0.2327	0.2399	0.2435	0.2470	0.2505
6.0	0.2259	0.2330	0.2365	0.2400	0.2435
6.2	0.2195	0.2265	0.2299	0.2334	0.2368
6.4	0.2133	0.2202	0.2236	0.2270	0.2304
6.6	0.2075	0.2143	0.2176	0.2210	0.2243
6.8	0.2019	0.2086	0.2119	0.2152	0.2184
7.0	0.1966	0.2032	0.2064	0.2097	0.2129
7.2	0.1915	0.1980	0.2012	0.2044	0.2075
7.4	0.1866	0.1930	0.1962	0.1993	0.2024
7.6	0.1820	0.1882	0.1913	0.1944	0.1975
7.8	0.1775	0.1837	0.1867	0.1898	0.1928
8.0	0.1732	0.1793	0.1823	0.1853	0.1882
8.2	0.1691	0.1751	0.1780	0.1810	0.1839
8.4	0.1651	0.1710	0.1739	0.1768	0.1797
8.6	0.1613	0.1671	0.1700	0.1728	0.1757
8.8	0.1576	0.1633	0.1662	0.1690	0.1718
9.0	0.1541	0.1597	0.1625	0.1653	0.1681
9.2	0.1506	0.1562	0.1590	0.1617	0.1644
9.4	0.1474	0.1528	0.1556	0.1583	0.1610
9.6	0.1442	0.1496	0.1523	0.1549	0.1576
9.8	0.1411	0.1464	0.1491	0.1517	0.1543
10.0	0.1381	0.1434	0.1460	0.1486	0.1512
10.2	0.1353	0.1405	0.1431	0.1456	0.1482
10.4	0.1325	0.1376	0.1402	0.1427	0.1452
10.6	0.1298	0.1349	0.1374	0.1399	0.1424
10.8	0.1272	0.1322	0.1347	0.1372	0.1396
11.0	0.1247	0.1296	0.1321	0.1345	0.1369
11.2	0.1223	0.1271	0.1295	0.1320	0.1343
11.4	0.1199	0.1247	0.1271	0.1295	0.1318
11.6	0.1176	0.1224	0.1247	0.1271	0.1294
11.8	0.1154	0.1201	0.1224	0.1247	0.1270

**Na+ Slope**

$\Delta E$	55.0	57.0	58.0	59.0	60.0
12.0	0.1132	0.1179	0.1201	0.1224	0.1247
12.2	0.1111	0.1157	0.1180	0.1202	0.1225
12.4	0.1091	0.1136	0.1158	0.1181	0.1203
12.6	0.1071	0.1116	0.1138	0.1160	0.1182
12.8	0.1052	0.1096	0.1118	0.1140	0.1161
13.0	0.1033	0.1077	0.1098	0.1120	0.1141
13.2	0.1015	0.1058	0.1079	0.1101	0.1122
13.4	0.0997	0.1040	0.1061	0.1082	0.1103
13.6	0.0980	0.1022	0.1043	0.1064	0.1084
13.8	0.0963	0.1005	0.1025	0.1046	0.1066
14.0	0.0947	0.0988	0.1008	0.1028	0.1049
14.2	0.0931	0.0971	0.0991	0.1012	0.1032
14.4	0.0915	0.0955	0.0975	0.0995	0.1015
14.6	0.0900	0.0940	0.0959	0.0979	0.0999
14.8	0.0885	0.0924	0.0944	0.0963	0.0983
15.0	0.0871	0.0909	0.0929	0.0948	0.0967
15.2	0.0857	0.0895	0.0914	0.0933	0.0952
15.4	0.0843	0.0881	0.0900	0.0918	0.0937
15.6	0.0829	0.0867	0.0886	0.0904	0.0923
15.8	0.0816	0.0853	0.0872	0.0890	0.0909
16.0	0.0803	0.0840	0.0858	0.0877	0.0895
16.2	0.0791	0.0827	0.0845	0.0863	0.0881
16.4	0.0779	0.0815	0.0833	0.0850	0.0868
16.6	0.0767	0.0802	0.0820	0.0838	0.0855
16.8	0.0755	0.0790	0.0808	0.0825	0.0843
17.0	0.0744	0.0778	0.0796	0.0813	0.0830
17.2	0.0732	0.0767	0.0784	0.0801	0.0818
17.4	0.0721	0.0756	0.0773	0.0790	0.0807
17.6	0.0711	0.0745	0.0761	0.0778	0.0795
17.8	0.0700	0.0734	0.0750	0.0767	0.0784
18.0	0.0690	0.0723	0.0740	0.0756	0.0773
18.5	0.0665	0.0698	0.0714	0.0730	0.0746
19.0	0.0642	0.0673	0.0689	0.0705	0.0720
19.5	0.0619	0.0650	0.0666	0.0681	0.0696
20.0	0.0598	0.0628	0.0643	0.0658	0.0673

**Na<sup>+</sup> Slope**

$\Delta E$	55.0	57.0	58.0	59.0	60.0
20.5	0.0578	0.0607	0.0622	0.0637	0.0651
21.0	0.0558	0.0587	0.0602	0.0616	0.0630
21.5	0.0540	0.0568	0.0582	0.0596	0.0610
22.0	0.0522	0.0550	0.0564	0.0577	0.0591
22.5	0.0506	0.0532	0.0546	0.0559	0.0573
23.0	0.0489	0.0516	0.0529	0.0542	0.0555
23.5	0.0474	0.0500	0.0513	0.0526	0.0539
24.0	0.0459	0.0485	0.0497	0.0510	0.0522
24.5	0.0445	0.0470	0.0482	0.0495	0.0507
25.0	0.0431	0.0456	0.0468	0.0480	0.0492
25.5	0.0418	0.0442	0.0454	0.0466	0.0478
26.0	0.0406	0.0429	0.0441	0.0452	0.0464
26.5	0.0394	0.0417	0.0428	0.0439	0.0451
27.0	0.0382	0.0405	0.0416	0.0427	0.0438
27.5	0.0371	0.0393	0.0404	0.0415	0.0426
28.0	0.0360	0.0382	0.0393	0.0403	0.0414
28.5	0.0350	0.0371	0.0382	0.0392	0.0403
29.0	0.0340	0.0361	0.0371	0.0381	0.0392
29.5	0.0330	0.0351	0.0361	0.0371	0.0381
30.0	0.0321	0.0341	0.0351	0.0361	0.0371
31.0	0.0304	0.0323	0.0332	0.0342	0.0352
32.0	0.0287	0.0306	0.0315	0.0324	0.0334
33.0	0.0272	0.0290	0.0299	0.0308	0.0317
34.0	0.0258	0.0275	0.0283	0.0292	0.0301
35.0	0.0244	0.0261	0.0269	0.0278	0.0286
36.0	0.0232	0.0248	0.0256	0.0264	0.0272
37.0	0.0220	0.0235	0.0243	0.0251	0.0259
38.0	0.0209	0.0224	0.0231	0.0239	0.0246
39.0	0.0198	0.0213	0.0220	0.0227	0.0235
40.0	0.0189	0.0202	0.0210	0.0217	0.0224

**Na<sup>+</sup> Slope**

$\Delta E$	55.0	57.0	58.0	59.0	60.0
41.0	0.0179	0.0193	0.0200	0.0206	0.0213
42.0	0.0171	0.0184	0.0190	0.0197	0.0203
43.0	0.0162	0.0175	0.0181	0.0188	0.0194
44.0	0.0155	0.0167	0.0173	0.0179	0.0185
45.0	0.0147	0.0159	0.0165	0.0171	0.0177
46.0	0.0140	0.0152	0.0157	0.0163	0.0169
47.0	0.0134	0.0145	0.0150	0.0156	0.0162
48.0	0.0127	0.0138	0.0144	0.0149	0.0155
49.0	0.0121	0.0132	0.0137	0.0142	0.0148
50.0	0.0116	0.0126	0.0131	0.0136	0.0141
51.0	0.0111	0.0120	0.0125	0.0130	0.0135
52.0	0.0105	0.0115	0.0120	0.0125	0.0129
53.0	0.0101	0.0110	0.0114	0.0119	0.0124
54.0	0.0096	0.0105	0.0109	0.0114	0.0119
55.0	0.0092	0.0100	0.0105	0.0109	0.0114
56.0	0.0088	0.0096	0.0100	0.0104	0.0109
57.0	0.0084	0.0092	0.0096	0.0100	0.0104
58.0	0.0080	0.0088	0.0092	0.0096	0.0100
59.0	0.0076	0.0084	0.0088	0.0092	0.0096
60.0	0.0073	0.0080	0.0084	0.0088	0.0092
61.0	0.0070	0.0077	0.0081	0.0084	0.0088
62.0	0.0067	0.0074	0.0077	0.0081	0.0084

### Single Known Addition Using the 407A

When measuring sodium by known addition on the 407A, the standard must be 100 times as concentrated as the sample and a 1 mL addition to 100 mL of sample must be used. Follow instructions for preparing the double known addition standard.

1. Turn function switch to X+. Set the slope indicator dial to the percent slope from mV/decade, use the equation below:

$$\frac{\text{measured slope in mV}}{59.2 \text{ mV}} \times 100 = \text{percent slope}$$

2. Prepare sample. Add 10 mL ISA to 100 mL of sample. Mix thoroughly. Pipet 100 mL of the sample ISA mixture into a beaker and place electrodes in solution.
3. Turn temperature compensator knob until the white arrow points to the temperature of the solution. Adjust calibration control until the needle points to center scale (marked "00").

***NOTE:** If resistance is met turning the calibration control, turn harder. The control will not be damaged by forcing it to turn.*

4. Pipet 1 mL sodium standard into the sample. Stir thoroughly. Record the reading, "Q", on the green increment scale.

Calculate the original sample concentration from:

$$C_o = (Q/100) C_s / .909$$

where:

Q = reading on green increment scale

C<sub>s</sub> = concentration of added standard

C<sub>o</sub> = sample concentration

**Example:** Suppose a measurement is to be made on a sample whose concentration is in the range of 0.5 to 5 ppm. A standard with a concentration of 100 ppm is added to the sample, and "Q" is 0.8. The sample concentration is:

$$C_o = \frac{(0.8/100)(100)}{.909} = 0.88 \text{ ppm}$$

## Direct Calibration Using Any Meter

For new electrodes, or those which have been stored dry, follow the procedure under **Electrode Preparation**.

1. Connect electrodes to the meter.
2. Prepare standards with a ten-fold difference in concentration in the range of the expected sample concentration. Standards can be prepared in any concentration unit to suit the particular analysis requirement. Use **Table 4** as a guide for diluting standards. All standards should be at the same temperature as the samples. (For details on temperature effects on electrode performance, refer to **Temperature Effects**.)
3. Prepare 1 liter of sodium electrode rinse solution by adding 10 mL of ISA, Orion 841111, to a 1 liter squeeze bottle and filling it with distilled water.

**Table 4**  
**Standards Table**

### A. Salt as Sodium Chloride (NaCl)

Units	Stock Solution	Dilution	Dilution	Dilution
percent (%)	10% NaCl Orion No. 841105	1% NaCl 1:10 diln* of 10%	0.1% NaCl 1:10 diln of 1%	
ppm (parts per million, mg/L)	1000 ppm NaCl, use 0.1% Orion No. 841106	100 ppm NaCl, 1:10 diln of 1000 ppm	10 ppm NaCl, 1:10 diln of 100 ppm	
mg/100 g or mg/100 mL	100 mg/100 g NaCl, use 0.1% Orion No. 841106	10 mg/100 g NaCl, 1:10 diln of 100 mg/100	1 mg/100 g NaCl, 1:10 diln of 10 mg/100	
molarity (M)	0.1 M Orion No. 941706	0.01 M 1:10 diln of 0.1 M	0.001 M 1:10 diln of 0.01 M	0.0001 M 1:10 diln of 0.001 M

## B. Sodium (Na<sup>+</sup>)

Units	Stock Solution	Dilution	Dilution	Dilution
percent (%)	10% sodium Orion No. 841107	1% sodium 1:10 diln of 10%	0.1% sodium 1:10 diln of 1%	
ppm (parts per million, mg/L)	1000 ppm Na Orion No. 841108	100 ppm Na Orion No. 941107	10 ppm Na, Orion No. 941105	1 ppm Na 1:10 diln of 10 ppm
mg/100 g or mg/100 mL	mg/100 g or mg/100 mL 100 mg/100 g Na, Orion No. 841108	10 mg/100 g Na, 1:10 diln of 100 mg/100 g	1 mg/100 g Na, 1:10 diln of 10 mg/100 g	
molarity (M)	0.1 M Orion No. 941706	0.01 M 1:10 diln of 0.1 M	0.001 M 1:10 diln of 0.01 M	0.0001 M 1:10 diln of 0.001 M

\*dilution

If using a meter with direct concentration readout capability: These instructions assume familiarity with meter operation.

1. Measure 100 mL of the more dilute standard into a 150 mL beaker. Add 10 mL ISA. Stir thoroughly.
2. Rinse electrodes with sodium electrode rinse solution and place into beaker. Wait for a stable reading, then calibrate the meter to display the value of the standard as described in the meter instruction manual.
3. Measure 100 mL of the more concentrated standard into a second 150 mL beaker. Add 10 mL ISA. Stir thoroughly.
4. Rinse electrodes with sodium electrode rinse solution and place in more concentrated standard. Wait for a stable reading, then adjust the meter to display the value of the second standard as described in the meter instruction manual.
5. Measure 100 mL of the sample into a 150 mL beaker. Add 10 mL ISA. Stir thoroughly. Rinse electrodes with sodium electrode rinse solution and place into sample. The concentration will be displayed on the meter.

If your meter does not have a concentration mode, use a calibration curve and read millivolts:

1. Adjust the meter to measure absolute mV.
2. Measure 100 mL of the more dilute standard into a 150 mL beaker. Add 10 mL ISA. Stir thoroughly.
3. Rinse electrodes with sodium electrode rinse solution and place into beaker. When a stable reading is displayed, record the mV value and corresponding standard concentration.
4. Measure 100 mL of the more concentrated standard into a second 150 mL beaker. Add 10 mL ISA. Stir thoroughly.
5. Rinse electrodes with sodium electrode rinse solution and place into beaker. When a stable reading is displayed, record the mV value and corresponding standard concentration.
6. Using semilogarithmic graph paper, prepare a calibration curve by plotting the millivolt values on the linear axis and the concentration value of the standards on the logarithmic axis. An example of a graph can be found in **Figure 3**.
7. Measure 100 mL sample into a 150 mL beaker. Add 10 mL ISA. Stir thoroughly.
8. Rinse electrodes with sodium electrode rinse solution and place into beaker. When a stable reading is displayed, record the mV value.
9. Using the calibration curve prepared in step 6, determine the concentration of the unknown.

## Low-Level Measurement

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The lower limit of detection for the ROSS™ Sodium Electrode is specified as 0.02 ppm ( $10^{-6}$  M). This is considered the lowest concentration which can be reasonably measured under laboratory conditions.

Below 1 ppm, the apparent slope of the electrode decreases as a result of a number of problems encountered in normal laboratory measurements. These include absorption of sodium ions onto the walls of beakers and solution containers; contamination from the air, reagents, skin, and distilled water; long time response; and interferences, which become a larger problem at lower concentrations of sodium. To minimize these problems, follow the recommendations below, using careful technique to afford greater accuracy and reproducibility.

- Use plastic or teflon labware.
- Be sure all labware is thoroughly rinsed with sodium-free distilled water.
- Reduce the concentration of ISA from 10 mL per 100 mL sample and standard to 1 mL per 100 mL sample and standard.
- Use the known addition technique to increase the measured concentration. Prepare known addition standards with the same ratio of ISA as used in the samples.
- If the meter has a blank correction, use according to instructions in meter manual.
- If measuring by direct measurement, measure dilute solutions before concentrated solutions.
- Check distilled water to be sure it is sodium free. Add 1 mL ISA to 100 mL distilled water, place electrodes in solution and record the millivolt reading after two minutes. It will be unstable. Use the calibration curve in the manual to determine the sodium concentration of the water.
- Allow up to 5-10 minutes for stable readings.
- Minimize sample contact with the atmosphere.
- Wear gloves to keep sodium from the skin from coming in contact with solutions.
- pH must be  $>7$  to prevent hydrogen ion interference.
- Store electrodes in diluted storage solution. Dilute Orion Sodium Electrode Storage Solution, Orion 841101, 1 part per 100 parts of distilled water.

## Electrode Maintenance and Storage

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### Cleaning the Sure-Flow® Junction

1. Press the electrode cap and let filling solution drain from the electrode carrying away any contamination. Refill the electrode with fresh filling solution.
2. For particularly dirty electrodes, the junction can be held open and flushed with Sodium Rinse Solution. Refill the electrode with fresh filling solution.

### Orion 84-11/80-03

#### Routine Storage (1 week or less)

Soak the sodium electrode in Orion Sodium Electrode Storage Solution, Orion 841101. Replace with fresh storage solution weekly or sooner if crystallization occurs or solution becomes contaminated.

Soak the reference electrode in reference electrode filling solution. Distilled water is also an acceptable storage solution. Do not soak the reference electrode in sodium electrode storage solution. If this should occur, change the filling solution before use.

#### Long Term Storage (over 1 week)

Rinse the sodium electrode well with sodium electrode rinse solution and cover the sensing element with its protective cap containing a few drops of storage solution.

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

### Orion 86-11

#### Routine Storage (1 week or less)

Soak the electrode in Orion Sodium Electrode Storage Solution, Orion 841101. Immerse both the tip of the electrode and the reference junction. Replace storage solution weekly or sooner if crystallization or contamination occur. Maintain sodium electrode filling solution at a level which covers the coil.

After storage, refresh the junction by pressing on the cap and letting a small amount of filling solution drain out. Replenish lost filling solution.

#### Long Term Storage (over 1 week)

Rinse exterior of the electrode well with sodium electrode rinse solution. Fill reference chamber and replace the fill hole plug. Cover the sensing element and reference junction with the protective cap containing a few drops of storage solution.

Before returning to use, prepare as for new electrode.

# TROUBLESHOOTING

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## Troubleshooting Checklist

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Symptom	Possible Causes
Off-scale or Over-range reading	Defective meter  Electrodes not plugged in properly No reference electrode or reference electrode not filled Electrodes not in solution Defective electrode
Noisy or unstable readings	Defective meter Meter or stirrer improperly grounded Defective electrode Blocked reference junction
Drift	Electrode rinsed with distilled water Membrane exposed to interferences Defective electrode Insufficient flow from reference electrode Incorrect reference electrode fill solution
Low slope or No slope	Standards contaminated or incorrectly made ISA not used pH too low Membrane needs reconditioning Blocked reference junction  Defective electrode
Wrong Answer	Contaminated standards Sample pH too low Meter calibrated incorrectly Interferences present

## Next Step

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Perform meter checkout

(see meter instruction manual)

Check meter manual for correct electrode connection

Reference electrode is required; see **Required Equipment**  
or **Required Solutions**

Put electrodes in standard solution

See electrode section in **Troubleshooting Guide**

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Perform meter checkout procedure (see meter instruction manual)

Check meter and stirrer for grounding

See electrode section in **Troubleshooting Guide**

Clean reference electrode as described in reference electrode  
instruction manual

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Use sodium electrode rinse solution

Recondition sodium electrode

See electrode section in **Troubleshooting Guide**

Suspend electrode in air and let filling solution flow  
for fifteen minutes

Check that electrode is filled with correct solution

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Prepare fresh standards

Use recommended ISA

Use recommended ISA

Recondition sodium electrode

Clean reference electrode as described in reference electrode  
instruction manual

See electrode section in **Troubleshooting Guide**

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Prepare fresh standards

Use recommended ISA

Check **Troubleshooting Guide** of meter instruction manual

See section on **Interferences**

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## Troubleshooting Guide

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The most important principle in troubleshooting is to isolate the components of the system and check each in turn. The components of the system are: 1) Meter, 2) Electrodes, 3) Standard, 4) Sample, and 5) Technique.

### Meter

The meter is the easiest component to eliminate as a possible cause of error. Thermo meters are provided with an instrument checkout procedure in the instruction manual and a shorting strap cap for convenience in troubleshooting. Consult the manual for complete instructions and verify that the instrument operates as indicated and is stable in all steps.

### Electrodes

1. Rinse electrodes thoroughly with sodium rinse solution.
2. See **Checking Electrode Operation (Slope)**.
3. If electrode fails this procedure, restore sodium electrode response as directed in **Electrode Reconditioning**. Clean reference electrode as described in reference electrode instruction manual.
4. Repeat step 2, **Checking Electrode Operation (Slope)**.
5. If the electrodes still do not perform as described, determine whether the sodium or reference electrode is at fault. To do this, substitute a known working ROSS™ electrode for the electrode in question and repeat the slope check.
6. If the stability and slope check out properly, but measurement problems persist, the sample may contain interferences or the technique may be in error. See **Standard, Sample, and Technique** sections.
7. Before replacing a "faulty" electrode, or if another electrode is not available for test purposes, review the instruction manual and be sure to:
  - Clean the electrode thoroughly
  - Condition the electrode properly
  - Use proper filling solutions, ISA, and standards
  - Measure correctly
  - Review **Troubleshooting Checklist**

## Standard

The quality of results depends greatly upon the quality of the standards. *ALWAYS* prepare fresh standards when problems arise – it could save hours of frustrating troubleshooting! Error may result from contamination of prepared standards, inaccuracy of dilution, quality of distilled water, or a mathematical error in calculating the concentrations.

The best method for preparation of standards is by serial dilution. This means that an initial standard is diluted, using volumetric glassware, to prepare a second standard solution. The second is similarly diluted to prepare a third standard, and so on, until the desired range of standards has been prepared. See **Required Solutions** for standard preparation.

## Sample

If the electrodes work properly in standards but not in sample, look for possible interferences or substances which could affect response or physically damage the sensing electrode or the reference electrode. If possible, determine the composition of the samples and check for problems. See **Sample Requirements**, **Interferences**, and **pH Requirements**.

## Technique

Check the method of analysis for compatibility with your sample. Known addition is usually the method of choice for this electrode. If the sample is viscous, alternate addition may solve the problem. Check your Thermo meter manual for information on this technique. If working at low levels, be sure to follow the low-level measurement technique.

Also, be sure that the expected concentration of the ion of interest is within the electrode's limits of detection!

If problems persist, review operational procedures and instruction manuals to be sure that proper technique has been followed. Reread **Measuring Hints** and **Analytical Procedures**.

After troubleshooting all components of your measurement system, contact The Technical Edge<sup>SM</sup> 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](http://www.thermo.com).

# ELECTRODE CHARACTERISTICS

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## Electrode Response

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The electrode potential plotted against concentration on semilogarithmic paper results in a straight line with a slope of about 57 mV per decade. See **Figure 4**.

The electrode exhibits good time response (99% response in one minute or less) for concentrations above  $10^{-5}$ M. Electrode response time is also a function of temperature. The response times will be faster at temperatures above room temperature; it may become increasingly longer at lower temperatures. For normal use, operation below 15 °C should be avoided. Below this concentration or temperature, response times are considerably longer. See **Figure 4**.

Polarization of the sodium electrode glass membrane may occur from wiping the bulb or repeatedly moving the electrode from solution to solution. This build-up of static electrical charge is common to sodium electrodes in general. This can be overcome by using Known Addition as the analytical technique, as concentration is calculated based on a change in mV, not comparison to an absolute mV value.

If your electrode becomes polarized and you prefer to use direct measurement techniques, allow the electrode to discharge by soaking in storage solution for several hours.

After prolonged use, a hydrated layer forms on the surface of the sodium-sensitive glass, which causes slower response times. This layer may be removed by briefly exposing the electrode to Sodium Reconditioning Solution, Orion 841113.

See **Electrode Reconditioning**.

## Limit of Detection

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The sodium concentration in basic solutions can be measured under normal laboratory conditions down to  $5 \times 10^{-6}$ M. Measurements below  $10^{-5}$ M sodium must be made with extreme care as significant pickup of sodium ion may occur due to desorption from container walls as well as from dust and other contamination. Ordinary glass will dissolve sufficiently to produce spurious results at low levels. Plastic laboratory ware is recommended. See **Low-Level Measurements**.

## Reproducibility

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Reproducibility is limited by factors such as drift and noise. Within the electrode's operating range, reproducibility is independent of concentration. Known addition measurements reproducible to  $\pm 2\%$  can be obtained.

## Temperature Effects

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In traditional reference and sensing electrodes, the potential of the internal cells is based on a slightly soluble, metal/metal salt reference system, most commonly calomel/mercury or silver/silver chloride. These cells have two distinct disadvantages when temperature fluctuations are encountered. First, the internal cell potential will change because the salt solubility changes with temperature. The internal cell potentials of the sensing and the reference electrode may not change in the same way, nor at the same rate. This results in a potential error which will be interpreted as an error in concentration of the ion being measured. Second, longer equilibrium times are required to compensate for varying solubilities that occur with temperature changes. Slow response and drift are often seen when such electrodes are used with temperature variation.

The internal cell design of the ROSS™ Sodium Electrode and the ROSS Reference Electrode eliminates these shortcomings. Since there is little change due to temperature, the internal equilibration time is no longer a factor.

The slope term  $S$ , in the Nernst equation is actually  $2.3 RT/nF$ , where  $R$  and  $F$  are constants,  $n$  is the charge on the measured species, and  $T$  is the temperature in degrees Kelvin. This means that the slope of the electrode, like all electrodes, will change with changes in temperature. Calibration curves generated at varying temperatures are shown in **Figure 5**.

These curves intersect at the isopotential point, which is the concentration at which the potential of the electrode does not vary with temperature. If the isopotential point is known or can be measured experimentally, and if the meter has a means of adjusting the isopotential point, temperature compensation for the ROSS Sodium Electrode is possible. If this correction is not possible for the meter in use, all standards and samples should be kept at the same temperature for utmost accuracy. Whichever the case, the performance of the ROSS Sodium Electrode will be far superior to that of conventional sodium probes because of its unique ability to resist many complications of temperature variation.

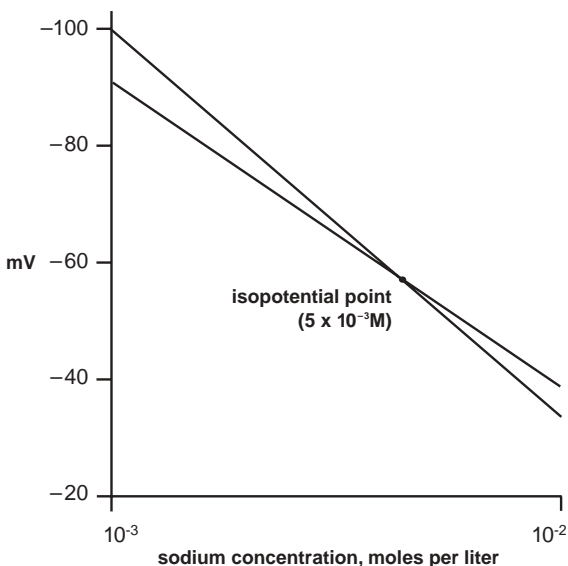
The following Thermo Meters have adjustable isopotential points: EA 940, EA 920, SA 720, and the SA 270.

The typical isopotential point for the ROSS™ Sodium Electrode is  $5 \times 10^{-3}\text{M}$  (114 ppm as  $\text{Na}^+$ ). This value may vary and will change as the electrode ages, the typical range is  $5 \times 10^{-3}\text{M}$  to  $5 \times 10^{-1}\text{M}$ . For greatest temperature accuracy, the isopotential of each electrode can be determined as outlined.

## Determining An Isopotential Point

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1. Prepare two standards whose concentration range brackets the isopotential point. For the ROSS Sodium Electrode, prepare  $10^{-2}$  and  $10^{-3}\text{M}$  or 100 and 1000 ppm standards.
2. Measure the millivolt value of the standards at room temperature, 20-25 °C.
3. Measure the millivolt value of the standards at a different room temperature; 75 °C is recommended.
4. On semilogarithmic graph paper, plot the concentration values on the log axis versus the millivolt values on the linear axis, as any calibration curve would be drawn (see **Figure 5**).
5. The lines will intersect at the isopotential point. Read the concentration off the graph for this point from the log axis.



**Figure 5**  
**Isopotential Point**

*To determine the isopotential point of a sodium electrode, two standard solutions are measured at two different temperatures. The observed millivolt values are plotted on the linear axis and concentration is plotted on the log axis. The point of intersection is the isopotential point.*

## Interferences

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Other cations, if present at high enough levels are measurement interferences and will cause errors. **Table 5** indicates levels of common cations that will cause 10% error at various concentrations of sodium.

In practically all samples, most cations listed in **Table 5** are absent or insignificantly low. Using ammonium ion in the recommended ISA does not result in an error, provided that there is not a large amount of ammonium ion in the sample, and that all standards and samples have the same level of ISA added.

**Table 5**  
**Levels of Possible Interferences**  
**Causing a 10% Error at Various Levels of Sodium**

Interferences (Moles/Liter)	10 <sup>-4</sup> M Na <sup>+</sup>	10 <sup>-3</sup> M Na <sup>+</sup>	10 <sup>-2</sup> M Na <sup>+</sup>
Li <sup>+</sup>	4 x 10 <sup>-3</sup>	4 x 10 <sup>-2</sup>	0.4
K <sup>+</sup>	1 x 10 <sup>-2</sup>	0.1	1
Rb <sup>+</sup>	0.3	3	–
NH <sub>4</sub> <sup>+</sup>	0.3	3	–
Ag <sup>+</sup>	1 x 10 <sup>-7</sup>	1 x 10 <sup>-6</sup>	1 x 10 <sup>-5</sup>
Tl <sup>+</sup>	5 x 10 <sup>-2</sup>	0.5	–

Interferences (ppm)	1 ppm Na <sup>+</sup>	10 ppm Na <sup>+</sup>	100 ppm Na <sup>+</sup>
Li <sup>+</sup>	12	121	1,206
K <sup>+</sup>	170	1,700	17,000
Rb <sup>+</sup>	11,000	110,000	–
NH <sub>4</sub> <sup>+</sup> as N	1,800	18,000	–
Ag <sup>+</sup>	0.004	0.04	0.4
Tl <sup>+</sup>	4,500	45,000	–

## pH Effects

The electrode response to sodium ion in solutions at various pH is shown in **Figure 1**. Although the electrode can be used over a wide pH range, hydrogen ion interferes with measurements of low levels of sodium ion. The edge of the shaded area to the left of **Figure 1** indicates a minimum pH at which dilute sodium measurements can be made without hydrogen ion interference.

## Electrode Life

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The ROSS™ Sodium Electrode should last at least one year under normal laboratory use. In time, electrode slope will decrease and readings will drift, indicating that the electrode should be reconditioned. Refer to **Troubleshooting Guide** for more information.

## Electrode Reconditioning

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Use this procedure when electrode slope is low, or electrode experiences drift, and performance cannot be restored by soaking in sodium electrode storage solution.

Immerse ROSS Sodium Electrode in Sodium Reconditioning Solution, Orion 841113 for 30 seconds. Rinse with sodium electrode rinse solution and store in Sodium Electrode Storage Solution, Orion 841101 for 15 minutes before returning to use.

## Theory Of Operation

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In sodium measurement, the potential developed at a sodium selective membrane is measured through the use of two internal electrochemical cells. The membrane potential is added in series, to the potential of the sensing reference cell, and their sum is measured against the potential of the second (reference) cell. Since the potentials of the two internal reference cells remain constant, changes in potential are due to changes in sodium concentration.

The measured potential corresponding to the level of sodium ion in solution is described by the Nernst equation:

$$E = E_0 + S \log (A)$$

where:

E = measured electrode potential

$E_0$  = constant potential largely dependent on the reference electrode

A = sodium ion activity or "effective concentration of sodium"

S = electrode slope

Most analytical measurements are made to determine not the sodium activity, but the total concentration of sodium ion in solution.

The sodium ion activity is related to sodium concentration by the activity coefficient,  $x$ :

$$A = xC$$

Ionic activity coefficients are variable and largely depend on total ionic strength.

Ionic strength is defined as:

$$\text{Ionic strength} = 1/2 \sum C_j Z_j^2$$

where:

$C_j$  = concentration of ion  $j$

$Z_j$  = charge of ion  $j$

If background ionic strength is high and constant relative to the sensed ion concentration, then the activity coefficient is constant and activity is proportional to concentration. The electrode can then be used to measure concentration.

Ionic strength adjustor (ISA) is added to all sodium standards and samples so that the background ionic strength is high and constant relative to the variable concentrations of the sodium ion, and activity effects can be ignored in concentration measurements. A mixture of ammonium chloride and ammonium hydroxide is used with the sodium electrode as the ionic strength adjustor.

The reference electrode must also be considered. Liquid junction potentials arise any time two solutions of different composition are brought into contact. The potential results from the interdiffusion of ions in the two solutions. Since ions diffuse at different rates, ionic charge will be carried unequally across the solution boundary resulting in a potential difference between the two solutions. In making electrode measurements it is important that this potential be the same when the reference is in the standardizing solution as well as in the sample solution; otherwise, the change in liquid junction potential will appear as an error in the measured electrode potential.

To control this, the composition of the reference electrode filling solution is carefully chosen to be equitransferent. That is, the speed with which the positive and negative ions in the filling solution diffuse into the sample should be as nearly equal as possible. If the rate at which positive and negative charge is carried into the sample solution is equal, then no junction potential can result. The recommended filling solution, 2M  $\text{NH}_4\text{Cl}$ , very nearly meets these requirements.

# WARRANTY

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For the most current warranty information, visit [www.thermo.com](http://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 EDGE<sup>SM</sup> 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 AutoEZ<sup>TM</sup>, EZ Flash<sup>®</sup> GC Accessory and TEA Analyzer<sup>®</sup>. Contact our Field Service department for details on quotations, service and 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 and 136S), Conductivity Meters (Orion 105Aplus, 115Aplus, 125Aplus, 145Aplus, 150Aplus and 162A), PerpHect<sup>®</sup> 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, Orion AQUAfast® IV Colorimeters, Orion 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), 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](http://www.thermo.com)

THE WARRANTIES DESCRIBED ABOVE ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER STATUTORY, EXPRESS OR IMPLIED INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE AND ALL WARRANTIES ARISING FROM THE COURSE OF DEALING OR USAGE OF TRADE. THE BUYER'S SOLE AND EXCLUSIVE REMEDY IS FOR REPAIR OR REPLACEMENT OF THE NON-CONFORMING PRODUCT OR PART THEREOF, OR REFUND OF THE PURCHASE PRICE, BUT IN NO EVENT SHALL THERMO (ITS CONTRACTORS AND SUPPLIERS OF ANY TIER) BE LIABLE TO THE BUYER OR ANY PERSON FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES WHETHER THE CLAIMS ARE BASED IN CONTRACT, IN TORT (INCLUDING NEGLIGENCE), OR OTHERWISE WITH RESPECT TO OR ARISING OUT OF THE PRODUCT FURNISHED HEREUNDER.

REPRESENTATION AND WARRANTIES MADE BY ANY PERSON, INCLUDING ITS AUTHORIZED DEALERS, REPRESENTATIVES AND

EMPLOYEES OF THERMO WHICH ALTER OR ARE IN ADDITION TO THE TERMS OF THIS WARRANTY SHALL NOT BE BINDING UPON THERMO UNLESS IN WRITING AND SIGNED BY ONE OF ITS OFFICERS.

## ORDERING INFORMATION

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Orion No.	Description
800300	ROSS™ Reference Electrode
900010	Reference Electrode Internal Filling Solution, 2 M $\text{NH}_4\text{Cl}$ , five 50 mL bottles
841111	Sodium ISA, 4 M $\text{NH}_4\text{Cl}$ /4 M $\text{NH}_4\text{OH}$ , 475 mL
841113	Sodium Electrode Reconditioning Solution, 0.1 M $\text{NH}_4\text{HF}_2$ , 475 mL
841101	Sodium Electrode Storage Solution 5 M NaCl, 475 mL
941706	Sodium Chloride Standard Solution, 0.1 M NaCl, 475 mL
941107	Sodium Standard Solution, 100 ppm, 475 mL
900012	Reference Electrode Filling Solution for low-level sodium measurement, 0.1 M $\text{NH}_4\text{Cl}$
841109	Sodium Known Addition Standard, 1000 ppm with ISA, 475 mL
650700	Sodium Known Addition Standard, 1 M with ISA, 475 mL
841108	Sodium Standard, 1000 ppm, 475 mL
941105	Sodium Standard, 10 ppm, 475 mL

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See Thermo product literature for recommended instruments to use with your ion-selective electrode work.

# SPECIFICATIONS

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## Concentration Range

Saturated to  $10^{-6}$  M (0.02 ppm)

## pH Range

6 to 12 pH\*

## Temperature Range

0 to 80 °C continuous use; 80 to 100 °C intermittent use  
(see **Electrode Response**)

## Electrode Resistance

Less than 300 megohms

## Reproducibility

±2%

## Isopotential Point

Approximately 114 ppm Na (0.005 M)

## Minimum Sample Size

3 mL in a 50 mL beaker

## Size

Electrode Length: 12.5 cm

Diameter: 1.2 cm

Cap Diameter: 1.6 cm

Cable Length: 100 cm

\* Use at recommended pH

Specifications subject to change without notice

## NOTES

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## **Environmental Instruments**

Water Analysis

### **North America**

166 Cummings Center  
Beverly, MA 01915 USA  
Tel: 978-232-6000  
Dom. Fax: 978-232-6015  
Int'l. Fax: 978-232-6031

### **Europe**

12-16 Sedgeway Business Park  
Witchford, Cambridgeshire  
England, CB6 2HY  
Tel: 44-1353-666111  
Fax: 44-1353-666001

### **Far East**

Room 904, Federal Building  
369 Lockhart Road  
Wanchai, Hong Kong  
Tel: 852-2836-0981  
Fax: 852-2834-5160

### **Customer Support**

Toll Free: 800-225-1480  
[www.thermo.com](http://www.thermo.com)  
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Int'l. e-mail: [intcs1@thermoorion.com](mailto:intcs1@thermoorion.com)

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