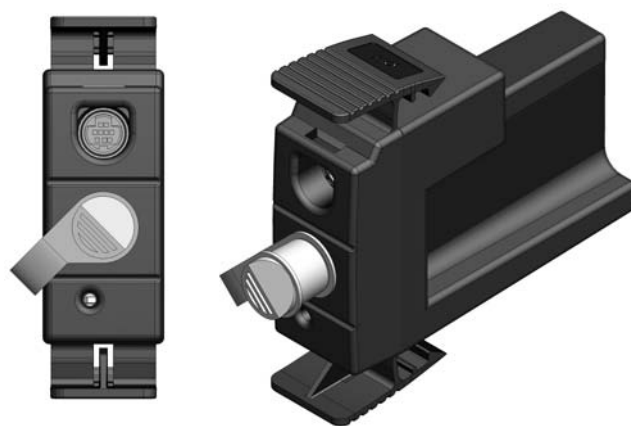


**Thermo Scientific Orion VERSA STAR™
pH/ISE/temperature Module**

Reference Guide



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This publication supersedes all previous publications on this subject.

Thermo Scientific Orion VERSA STAR™ pH/ISE/Temperature Module

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Chapter 1 Introduction

Thank you for your purchase of the Thermo Scientific Orion VERSA STAR™ pH/ISE/Temperature Module. This module is for use with the Thermo Scientific Orion VERSA STAR Advanced Electrochemistry Benchtop Meter. Some key features of this module include:

- pH range from -2 to 20 with resolution options of 0.001, 0.01 and 0.1
- ISE range from 0 to 19999 with resolution of up to four significant digits
- mV and RmV ranges from ± 2000 mV
- Automatic and manual datalogging options
- Up to 6-point pH calibration with automatic recognition for USA/NIST and DIN buffers
- Up to 6-point ISE calibration with adjustable ISO point capabilities
- The ability to fix pH/ISE calibration errors without a complete recalibration thanks to calibration editing
- Advanced ISE features such as auto-blank, timed end point, linear point-to-point, non-linear selectable auto-blank, low-concentration range stability, ISE ID and incremental techniques

Please read this reference guide thoroughly. Any use outside of these instructions may invalidate your warranty and cause permanent damage to the meter.

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Chapter 2 Module Overview

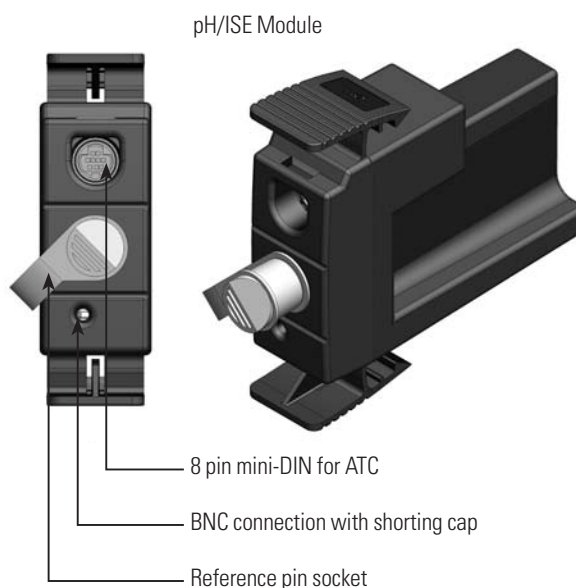
To connect the modules to the meter and for specific information regarding the meter outputs, please see the Orion VERSA STAR Reference Guide. The Reference Guide is on the CD included with the meter and also available at www.thermoscientific.com/water.

Module Connections and Inputs

The Orion VERSA STAR meter can accept Orion combination ISE electrodes as well as separate reference and sensing half-cell electrodes. This allows for a wider ISE measurement offering. Half-cell electrodes separate the ions sensing from the reference electrode. For difficult samples, the flexibility of using alternate fill solutions may be an advantage to researchers.

1. Prepare the pH or ISE electrode and ATC probe for use as instructed in the electrode user guides. The pin tip reference connector is on the lowest panel of the pH/ISE module.
2. Place the pH or ISE, ATC probe and Orion Star stirrer probe (cat. no. 096019, optional) into the electrode arm.
3. Attach the pH or ISE BNC and ATC probe to the pH/ISE meter module. Lower ISE and ATC into solution for conditioning if required. If using the stirrer probe, attach probe to the meter, place into the electrode arm and assign the probe to the channel in the setup menu for instrument settings.
4. Prepare fresh standards daily for calibration. For ISE testing, standards should be at least one decade (10 times) apart. The standards should exceed the expected minimum and maximum sample range. Serial dilution is recommended using calibrated pipettes to accurately prepare calibration standards from a stock solution.
5. Gather reagents, rinse water, and other supplies.

For ISE testing, if ISA will be added to the sample, it needs to be added to all the standards prior to calibration to ensure a consistent dilution factor.

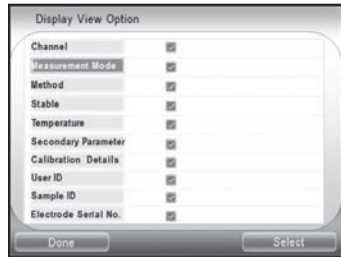
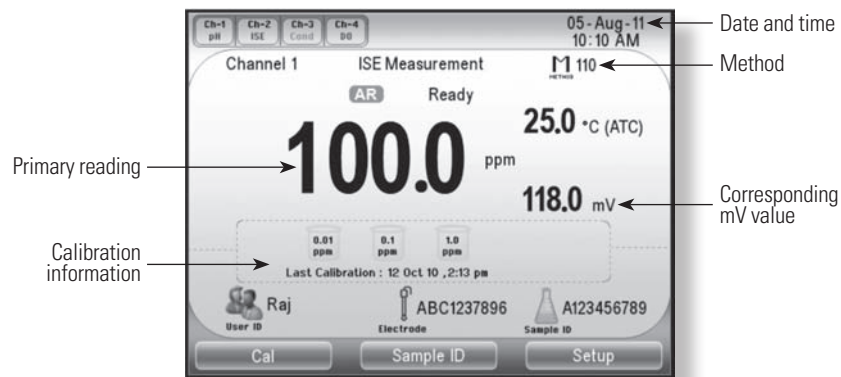


Module Maintenance

For routine maintenance, dust and wipe the module with a damp cloth. If necessary, warm water or mild water-based detergent can be used. Maintenance can be performed on a daily, weekly or monthly basis, as required by operating environment. Immediately remove any spilled substance using the proper cleaning procedure for that spill type.

Display Information from Module

Example ISE Measurement Screen – Single Channel



The information on the display can be customized. Enter the setup menu to make changes.

1. Press **Setup**.
2. Use the arrow keys to highlight Inst. Settings, press **(f3/select)** key.
3. Use the arrow key to highlight Display View. Press **(f3/select)** key.
4. Follow the onscreen prompts to choose what you would like to see on the measurement screen.

Chapter 3 Setup Menus

Setup Menus for Primary Measurements

1. Press **Setup (f3)** to access the Main Setup Screen.
2. Use the arrow key to scroll across to the modules to ISE channel you wish to use and press **Select (f3)**.
3. Scroll to across to the mode menu and press **Select (f3)**.

ISE Setup Menu (Default values are in bold in the table below)

| | |
|-------------------------|--|
| Electrode Serial Number | Input |
| Electrode Type | See table below |
| Sample ID | Off , Manual, Auto Increment |
| Significant Digits | 1, 2 , 3, 4 digits |
| Stability | Smart , Fast, Medium, Slow |
| Averaging | Off, Automatic Smart |
| Read Type | AutoRead , Timed, Continuous |
| Measure Unit | ppm , Molar, mg/L, %, ppb, None |
| Isopotential Value | Off , On |
| Linear Regression | Off , On |
| Blank Correction | Off , On |
| Low Level Stability | Off , On |
| Alarm** | Limit, CalDue, Set Point |

** Limit and set point alarm default set to 'off'.
Cal due alarm set to 12 hours.

pH Setup Menu (Default values are in bold in the table below)

| | |
|--------------------|-------------------------------------|
| Electrode ID | Input |
| Sample ID | Off , Manual, Auto Increment |
| Resolution | 0.1, 0.01, 0.001 |
| Stability | Smart , Fast, Medium, Slow |
| Averaging | Off, Automatic Smart |
| Read Type | AutoRead , Timed, Continuous |
| Buffer Group | USA , DIN, Custom |
| Isopotential Value | Off, On 7.000 |
| Linear Regression | Off , On |
| Alarm** | Limit, CalDue, Set Point |

** Limit and set point alarm default set to 'off'.
Cal due alarm set to 12 hours.

ORP, RmV and mV Setup Menus
(Default values are in bold in the table below)

| | |
|--------------|-------------------------------------|
| Electrode ID | Input |
| Sample ID | Off , Manual, Auto Increment |
| Resolution | 1.0, 0.1 |
| Stability | Smart , Fast, Medium, Slow |
| Averaging | Off, Automatic Smart |
| Read Type | AutoRead , Timed, Continuous |
| Alarm** | Limit, CalDue*, Set Point |

*Only for ORP and RmV modes.

** Limit and set point alarm default set to 'off'.

Cal due alarm set to 12 hours.

- For ISE testing, select the ISE electrode being used in setup. If your electrode is not listed, use the "X" electrode with the valence (+1, +2, -1, or -2) matching your electrode for accurate results.

ISE Types

| | | | | | | | | |
|------------------|------------------|------------------|-------------------|-----------------|------------------|------------------|------------------|-----------------|
| Ag+ | I- | X- | CO ₂ | REDOX (ORP) | Cl ₂ | S ⁻² | ClO ₄ | O ₂ |
| Cd ⁺² | NH ₃ | BF ⁻⁴ | K+ | X ⁻² | Cu ⁺² | X ⁺ | F- | SCN- |
| CN- | Pb ⁺² | Cl- | NO ₃ . | Br- | NO _x | Ca ⁺² | Na+ | X ⁺² |

Read Type Information

There are three main read types available as shown in the setup menus.

- **Auto-Read** – The meter will display the measurement as it stabilizes and lock and hold the measurement when it is stable (The AR icon will lock on the screen.) Once the measurement is locked, the meter will automatically export the measurement to the data log, if the data log is enabled in the setup menu, and to a printer or computer, if a printer or computer is connected to the meter and enabled in the setup menu. To take a new measurement, press **measure (esc)/1**.
- **Timed** – The meter will read and display a measurement at the set time interval that is programmed by the operator. There are two options:
 1. By checking/selecting the "Interval" box, at the set time interval, the meter will automatically export the measurement to the data log, if the data log is enabled in the setup menu, and to a printer or computer, if a printer or computer is connected to the meter and enabled in the setup menu. If selected, enter the time interval value in a hours:minutes:seconds format using the numeric keypad and press **f3 (select)** key.
 2. If the "Interval" box is unchecked/not selected, a single timed measurement will be taken. The meter will apply the same saving and exporting conditions as with the set time interval to record and export data, but lock after one timed interval has expired. Press **measure (esc)/1** to reset the countdown clock and take a new reading.

- **Continuous** – The meter will continuously measure and update the display. This read type is useful when performing an experiment that requires continuous measurements to be taken. Press the **log/print/0** print key to export the measurement to the data log, if the data log is enabled in the setup menu, and to a printer or computer, if a printer or computer is connected to the meter and enabled in the setup.

Isopotential Value

The slope of all electrodes changes with temperature, based on the Nerst equation. The slope curves at the different temperatures intersect at the isopotential value, which is the concentration at which the potential of the electrode does not vary with temperature. For glass pH electrodes, this value is 7.00. For other ion selective electrodes (ISEs), if the isopotential value is known or can be measured experimentally, adjusting this value makes temperature compensation for an ISE possible. Temperature compensation can be performed for one and two point calibrations.

Linear Regression Information

The default is off which uses the traditional, segmented approach. The segmented approach is the most accurate and precise. More information can be found in the appendix section of this reference guide under the Multipoint Calibration Curve Feature.

Selecting “on” for this option results in the use of a single best fit line for the calibration curve, and can be beneficial if pH measurements vary greatly.

Low Level Stability

This feature adjusts the timing for the calibration points for lower level ISE standards.

Setup Menu for Temperature

All of the temperature measurement settings are found in Temperature Setup menu for each measurement.

| | |
|-----------------------------------|--|
| Temperature Unit | °C or °F selection |
| Temperature Input and Type | Ch-1 ATC, Ch-2 ATC, Ch-3 ATC, Ch-4 ATC, MTC |
| Temperature Cal | Ch-1* ATC only or All ATC allows all ATCs to be calibrated at once |

* This number will change to match the setup menu channel.

Temperature probes can be set up in the measurement mode of the sample you are measuring. Ch-1 ATC allows the temperature probe to be used in more than one channel for temperature-compensated measurements, such as when a pH electrode and a 2-cell conductivity cell are in the same measurement sample. Temperature is a critical pH and conductivity measurement as the measurement values require a temperature correction to determine the reference value, often 25 °C in the America and 20 °C in Europe.

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Chapter 4 pH, RmV and ORP Calibration

pH Calibration

Up to six pH buffers can be used for calibration. This can be a combination of automatically-recognized USA/NIST or DIN buffer values and custom buffers. Always use fresh pH buffers and select buffers that bracket the sample pH and are at least one pH unit apart. Prepare the pH electrode according to the instructions in the electrode user guide.

1. Press **f1 (Cal)** to perform a pH calibration.
2. Follow screen prompts for calibration. Use fresh buffers, rinse electrode with DI water before each reading, blot with a lint free tissue.
3. USA and DIN buffer sets are automatically recognized based off the selection in the setup menu, and the meter allows custom buffers to be used for up to 6 calibration points. Custom buffer option prompts for the nominal values and stores data.
4. During calibration, points can be edited or retested prior to acceptance.
5. Information for the last calibration can be displayed on the main measurement screen. Refer to this reference guide, Chapter 2 Module Overview, Display Information section for more information.

RmV Calibration

One standard can be used for relative mV calibration. Always use fresh standard. Prepare the electrode according to the instructions in the electrode user guide.

1. Press **f1 (Cal)** to enter calibration mode.
2. Follow the screen prompts for calibration.
3. The calibration can be saved or printed when complete.
4. Information for the last calibration can be displayed on the main measurement screen. Refer to this reference guide, Chapter 2 Module Overview, Display Information section for more information.

ORP Calibration

The mV reading of an ORP standard is dependent on the ORP electrode reference system, reference material, filling solution and ORP standard temperature. An ORP electrode can be automatically calibrated to read 420 mV relative to the Standard Hydrogen Electrode (E_H) at 25 °C when the Orion ORP standard (cat. no. 967901 or 96791), Orion ORP electrode (cat. no. 9678BNWP, 9778BNWP, 9180BNMD or 9179BNMD) and Orion 4M KCl filling solution (cat. no. 900011) or 4M KCl gel (in electrode with cat. no. 9179BNMD) are used. The raw mV reading of an electrode with the same conditions is 220 mV at 25 °C.

One standard can be used for ORP calibration. Always use fresh standard. Prepare the electrode according to the instructions in the electrode user guide.

1. Press **f1 (Cal)** to enter calibration mode.
2. Follow the screen prompts for calibration.
3. The calibration can be saved or printed when complete.
4. Information for the last calibration can be displayed on the main measurement screen. Refer to this reference guide, Chapter 2 Module Overview, Display Information section for more information.

Chapter 5 ISE Calibration

One to six standards can be used for ISE calibration. If more than one standard is used, start with the lowest concentration first. Always use fresh standards. Select standards that bracket the sample concentration and are a decade apart. Prepare the ion selective electrode according to the electrode use guide.

1. Press **channel** key until ISE channel is displayed. Press **Cal (f1)**. Follow the screen prompts starting with the lowest concentration.
2. Press **Edit (f3)** to the correct concentration value of a standard if it is not automatically recognized.
3. After the first data point has been accepted, press **Accept (2)** to continue calibration. The meter then offers options of **Esc (f1)** to leave calibration, **Next (f2)** measure next calibration point, or **Cal Done (f3)**.
4. The options after Cal Done is pressed are **Print (f1)**, **Cal Edit (f2)** or **Slope Edit (f3)**.
5. The Calibration report table is displayed with the concentration, mV reading, and Temperature and average slope which is updated with each successive point measured.
6. From this screen the navigation options are **Print (f1)**, **Cal Edit (f2)** or **Slope Edit (f3)**. Print exports data to printer or computer, Cal edit allows concentration to be corrected prior to the completion of the calibration by **Delete (f1)** or **ReMeasure (f3)**.
7. Pressing the Slope Edit changes the screen title to Single Point Cal – Slope Edit. This allows the current slope line to be updated with the present electrode performance.
8. Press **Cal Done (f1)** when completed, press view graph, save the calibration in CalLog.

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Chapter 6 Temperature Calibration

The ATC temperature display has a relative accuracy of ± 0.1 °C. ATC probes (both separate and those built into electrodes) have varying temperature accuracies, usually ± 0.5 °C to ± 2 °C. *Use this function only if necessary.* Since the temperature offset calculated during the calibration is applied to all future temperature measurements, recalibrate if a different ATC probe is used. For temperature calibration, the probe needs to be connected to the meter and the calibration solution should have a known, stable temperature. It is recommended that two NIST-traceable thermometers be used to measure and verify solution temperature.

1. Press **f3 (setup)** key.
2. Use the arrow keys to highlight the channel that the temperature probe is connected to. Press **f3 (select)**.
3. Use the arrow keys to highlight Temperature and press **f3 (select)**.
4. Use the arrow keys to highlight the appropriate Temperature Cal option and press **f3 (select)**.
5. Follow the onscreen prompts.

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Chapter 7 Measurement

pH/mV/RmV/ORP Measurement

After a successful calibration, the samples can be tested.

1. Rinse the electrode with deionized water. Blot dry with lint-free tissue.
2. Place electrode/ATC probe in first sample and stir gently.
3. If the meter is in AutoRead mode (meter default) press **measure (esc) (1)** key. If the meter is in continuous or timed read mode, the meter will immediately start taking readings.
4. If in AutoRead mode and datalog is enabled (default), the reading will automatically be stored when the "AR" appears. If in continuous read mode and datalog is enabled, press **log/print (0)** key to store into the meter's memory.

Note: To enable or disable datalogging, press **setup** and select Inst. Settings.

ISE Measurement

1. Prepare the sample as instructed in the electrode user guide.
2. Follow directions carefully on ISA and other sample additions.
3. Rinse the probe(s) and place into the sample. If the meter is in AutoRead mode (meter default) press **measure (esc) (1)** key. If the meter is in continuous or timed read mode, the meter will immediately start taking readings.
4. If in AutoRead mode and datalog is enabled (default), the reading will automatically be stored when the "AR" appears. If in continuous read mode and datalog is enabled, press **log/print (0)** key to store into the meter's memory.

Note: To enable or disable datalogging, press **setup** and select Inst. Settings.

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Chapter 8 Methods

The meter stores up to ten methods per channel with the last calibration data stored for each method. Use the channel setup to access and modify methods.

1. Press **f3 (setup)** key.
2. Use the arrow keys to highlight the appropriate channel. Press **f3 (select)**.
3. Use the arrow keys to highlight Method and press **f3 (select)**.
4. The methods can be loaded, copied, saved and edited by following the onscreen prompts.

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Chapter 9 Incremental Techniques

Known Addition and Subtraction

The Orion VERSA STAR meter has preset methods for single known addition, single known subtraction, double known addition and double known subtraction.

- When performing incremental techniques, the sample concentration must be known within an order of magnitude so the increment may be correctly chosen and the sample and standard must be volumetrically determined.
- It is very important that any complexing agent is present in excess (at least 50 to 100 times) or not at all. The ratio of free to complexed ions must remain constant over the addition. An indication that a complexing agent is present, but not in great enough quantity to maintain a constant free ion to complexed ion ratio, is an abnormally high or low slope. If this is a suspected problem, add an excess amount of complexing or decomplexing agent to the original solution in the beaker.
- Electrode interferences should be at a minimum, since the effect of the interference might change as the concentration of the ion of interest changes. This situation may also result in high or low electrode slopes. Consult the electrode user guide for information on reducing or eliminating some electrode interferences.
- Known addition is a useful method for measuring dilute samples, occasional samples or samples that contain an excess of complexing agent. Known addition can also be used to verify the results of a direct measurement.
- Known subtraction is useful when measuring ions for which stable standards do not exist. Known subtraction can also be used as a quick version of a titration. When performing a known subtraction, it is necessary to know the stoichiometric ratio between the standard and sample.
- Double incremental techniques calculate the electrode slope and sample concentration simultaneously. The electrode slope is determined directly in the sample, which results in greater accuracy for samples with complex matrices and greater analysis speed.

Single Known Addition

A standard of known concentration is added to a sample of unknown concentration. The total concentration should approximately double upon the addition of the standard, therefore sample concentration should be known within an order of magnitude. Refer to the following table to choose the correct standard concentration and volume of addition.

| Amount of standard to be added per 100 mL of sample | Standard concentration compared to expected sample concentration |
|---|--|
| 1 mL | 100 times more concentrated |
| 5 mL | 20 times more concentrated |
| 10 mL | 10 times more concentrated |

- Refer to the appropriate electrode user guide for instructions for preparing the electrode, required solutions (ionic strength adjusters, standards, etc) and any special requirements. Determine the electrode slope as directed in the electrode user guide.
- Ensure that the electrode, ATC probe and reference electrode (if applicable) are connected to the meter inputs that correspond with the selected channel.

Double Known Addition

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

- The sample volume should be 100 mL.
- The concentration of the standard added should be 100 times the expected sample concentration.
- Calculate the volume of standard required to halve the initial sample concentration and divide by six. Five sixths of the volume will be added in the first addition and the remainder in the second. If available, consult a printout from a previous analysis of a similar sample. Note: the proposed values for constant mV will be smaller than those recommended for known addition. This is an effort to minimize the chance of over "subtracting" the sample (overshooting the endpoint).

Refer to the appropriate electrode user guide for instructions for preparing the electrode, required solutions (ionic strength adjusters, standards, etc) and any special requirements.

Ensure that the electrode, ATC probe and reference electrode (if applicable) are connected to the meter inputs that correspond with the selected channel.

Single Known Subtraction

In known subtraction, each addition of standard subtracts an increment of the species to be measured. Enter the correct reaction ratio of the species to be measured with the standard to be added. For example, a sulfide (S²⁻) sample is to be subtracted by the addition of silver (Ag⁺). Two silver ions are required to subtract each sulfide ion and the reaction ratio is 0.5.

Sample concentration should be known within an order of magnitude and the total sample concentration should be approximately halved upon addition of the standard. Refer to the following table to choose the correct standard concentration and volume of addition.

| Amount of standard to be added per 100 mL of sample | Standard concentration compared to expected sample concentration |
|--|---|
| 1 mL | 50 times more concentrated |
| 5 mL | 10 times more concentrated |
| 10 mL | 5 times more concentrated |

Refer to the appropriate electrode user guide for instructions for preparing the electrode, required solutions (ionic strength adjusters, standards, etc) and any special requirements. Determine the electrode slope as directed in the electrode user guide.

Ensure that the electrode, ATC probe and reference electrode (if applicable) are connected to the meter inputs that correspond with the selected channel.

Double Known Subtraction

Ensure that the subtraction ability of the chosen standard concentration and volume added does not exceed the concentration of sample.

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

- The sample volume should be 100 mL.
- The concentration of the standard added should be 50 times the expected sample concentration.
- Calculate the volume of standard required to halve the initial sample concentration and divide by six. Five sixths of the volume will be added in the first addition and the remainder in the second. If available, consult a printout from a previous analysis of a similar sample. Note: the proposed values for constant mV will be smaller than those recommended for known addition. This is an effort to minimize the chance of over "subtracting" the sample (overshooting the endpoint).

Refer to the appropriate electrode user guide for instructions for preparing the electrode, required solutions (ionic strength adjusters, standards, etc) and any special requirements.

Ensure that the electrode, ATC probe and reference electrode (if applicable) are connected to the meter inputs that correspond with the selected channel.

Analyte Addition and Subtraction

In Analyte Addition, the first measurement is in a known standard solution containing the same type of analyte in interest as the sample. The second measurement follows the addition of the unknown solution. The concentration of the unknown is then calculated.

In Analyte Subtraction, the first measurement uses known standard solution containing the type of ions that the ISE can measure and that will complex with the analyte in interest in the unknown sample. The second measurement follows the addition of the unknown sample that reduces the concentration of the ions in the measurement solution. The concentration of the analyte in interest in the unknown is then calculated.

- Isopotential value needs to be known and entered.
- Blank correction is not applied.
- The slope value at 25°C needs to be known and entered.

To Access Incremental Techniques

1. Set the measurement mode to ISE.
2. Press **f3 (setup)** key.
3. Use the arrow keys to highlight the ISE channel. Press **f3 (select)**.
4. Use the arrow keys to highlight Incremental Techniques and press **f3 (select)**.
5. Follow the onscreen prompts.

Chapter 10 Data Storage and Review

Data Storage Settings

Measurement Read Type

The measurement read type determines when the meter sends measurements to outputs as selected in the setup menu and when properly connected to the meter. These are set individually for each channel. Measurement Read Type is set per channel in the setup menu. Please refer chapter 3 Setup Menus in this reference guide for more information.

Datalog, Computer and Printer Export Settings

Orion VERSA STAR Meters have a 2000-datalog capability. To make your selection:

1. From measurement mode, press **setup/3**.
2. Press the arrow keys to highlight Inst. Settings. Press **setup/3**.
3. Use the arrow keys, **f2 (page)** key and **f3 (select)** key to:
 - a. set the communication protocol
 - b. turn on printing
 - c. select the print format
 - d. turn on datalogging

For more information on these settings, refer to the Orion VERSA STAR Reference Guide, Chapter 3 Instrument Settings to turn on Data Log to enable data storage.

Datalog Review

This option allows for stored data to be:

- reviewed
- printed individually, in a group or all
- deleted
- analyzed with general statistical information

The datalog will reflect a screen capture of all the information at the time of datalogging.

To review datalog information

- Press **log view (9)** key
- Press **f3 (select)** key
- Follow prompts to review information

Calibration Review

This feature allows for review and printing of each of the last 10 calibrations for each parameter of the meter. The information will match the information recorded for that calibration.

To review calibration information

1. Press **log view (9)** key.
2. Press **right arrow (6)** key to select CalLog information and **down arrow (8)** to highlight the desired parameter.
3. Press **f3 (select)** key and follow the prompts.

Chapter 11 Customer Services

Troubleshooting Guide

| Error | Recommended Actions |
|---|--|
| Measurement is flashing 9999 and over range or under range. | Measurement is outside the allowable measurement range. Check electrode connection and settings in the setup menu. Clean the electrode according to the electrode user guide and recalibrate the electrode with new buffers or standards. If the error continues, perform the meter self test in the diagnostics menu. |
| The measurement freezes and will not change. | The meter is in AutoRead mode. (AR icon appears solid on the display.) Press measure (esc)/1 key to take a new reading or go to setup to change the read type. |

Assistance

After troubleshooting all components of your measurement system, contact Technical Support. Within the United States call 1.800.225.1480 and outside the United States call 978.232.6000 or fax 978.232.6031. In Europe, the Middle East and Africa, contact your local authorized dealer. For the most current contact information, or the latest application and technical resources for Thermo Scientific Orion products, visit www.thermoscientific.com/water.

Warranty and Registration

To register your new meter and for the most current warranty information, visit www.thermoscientific.com/water.

WEEE Compliance



This product is required to comply with the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2002/96/EC. It is marked with the symbol above.

Thermo Fisher Scientific has contracted with one or more recycling/disposal companies in each EU Member State and this product should be disposed of or recycled through them. Further information on compliance with these directives, the recyclers in your country, and information on Thermo Scientific Orion products that may assist the detection of substances subject to the RoHS Directive are available at www.thermoscientific.com.

Declaration of Conformity

Manufacturer: Thermo Fisher Scientific Inc.

Address: Ayer Rajah Crescent
Blk 55 #04-16/24
Singapore 139949
Singapore

Hereby declares that the following products:

Orion VERSA STAR Advanced Electrochemistry Benchtop Meters with Modules are rated 100 to 240 VAC, 50/60 Hz, 0.5A.

Equipment Class:

Measurement, control and laboratory
Orion Star A-series meters are EMC Class A

Conforms with the following directives and standards:

EN61326-1:2006

Electromagnetic Compatibility (EMC Directive)

Electrical equipment for measurement,
control and laboratory use - EMC requirements

EN61010-1:2001

Safety Standards

UL61010-1:2004

Safety requirements for electrical equipment for measurement,

CAN/CSA C22.2 No. 61010-1-04

control and laboratory use - general requirements



Cheow Kwang Chan
QA/Regulatory Manager

Place and Date of Issue:
12 December, 2011
Singapore

pH/ISE/Temperature Module Specifications



| pH/ISE Module (VSTAR-ISE) Specifications | | |
|--|---|---|
| pH | Range | -2.000 to 20.000 |
| | Resolution | 0.1, 0.01, 0.001 |
| | Relative Accuracy | ±0.002 |
| | Calibration Points | Up to 6 |
| | Calibration Editing | Yes |
| | Adjustable ISO Point | Yes |
| mV/RmV | Range | ±2000.0 mV |
| | Resolution | 0.1 |
| | Relative Accuracy | ±0.2 mV or ±0.05 % of reading whichever is greater |
| | E _H ORP Mode | Yes |
| ISE | Range | 0 to 19999 |
| | Resolution | Up to 4 significant digits |
| | Relative Accuracy | ±0.2 mV or ±0.05 % of reading whichever is greater |
| | Units | ppm, M, mg/L, %, ppb, none |
| | Calibration Points | Up to 6 |
| | Calibration Editing | Yes |
| | Adjustable ISO Point | Yes |
| | Calibration Features | Timed end point, linear point to point, non-linear selectable auto-blank, low concentration range stability |
| | Incremental Techniques | Single known addition & subtraction, double known addition & subtraction, single analyte addition & subtraction |
| Advanced Features | Displays electrode type, temperature compensation | |
| Temperature | Range | -5 to 105 °C, 23 to 221 °F |
| | Resolution | 0.1 |
| | Relative Accuracy | ±0.1 |
| | Offset Calibration | 1 point |
| Inputs | pH/ISE: BNC, reference pin ATC: 8-pin mini-DIN | |

NOTE: We reserve the right to make improvements. Specifications subject to change without notice.

Ordering Information

| CML # | Description |
|--------------|---|
| VSTAR00 | Orion VERSA STAR Benchtop Meter - Electrode arm with redesigned holder - Universal power adapter |
| VSTAR10 | Orion VERSA STAR pH Benchtop Meter Set - Orion VERSA STAR meter with pH/temperature module - Electrode arm with redesigned holder - Universal power adapter |
| VSTAR12 | Orion VERSA STAR pH Benchtop Meter Kit - Orion VERSA STAR meter with pH/temperature module - 8302BNUMD Orion ROSS Triode pH/ATC probe - 096019 Orion Star stirrer probe - 810199 ROSS solution kit (475 mL each of pH 4, 7 and 10 buffers; storage solution; cleaning solution; and pH electrode storage bottle) - Electrode arm with redesigned holder - Universal power adapter |
| VSTAR20 | Orion VERSA STAR Conductivity Benchtop Meter Set - Orion VERSA STAR meter - Orion VERSA STAR conductivity/temperature module - Electrode arm with redesigned holder - Universal power adapter |
| VSTAR22 | Orion VERSA STAR Conductivity Benchtop Meter Kit - Orion VERSA STAR meter - Orion VERSA STAR conductivity/temperature module - 013005MD Orion DuraProbe conductivity cell, K=0.475 - 011007 conductivity standard, 1413 μ S, 5x60 mL - Electrode arm with redesigned holder - Universal power adapter |
| VSTAR30 | Orion VERSA STAR RDO/Dissolved Oxygen Benchtop Meter Set - Orion VERSA STAR meter - Orion VERSA STAR dissolved oxygen/temperature module - Electrode arm with redesigned holder - Universal power adapter |
| VSTAR32 | Orion VERSA STAR RDO/Dissolved Oxygen Benchtop Meter Kit - Orion VERSA STAR meter - Orion VERSA STAR dissolved oxygen/temperature module - 083005MD Orion polarographic DO probe - 080017 calibration sleeve for DO probe - 080513 DO probe maintenance kit - 970802 BOD funnel/stirrer - 080360 BOD adapter - Electrode arm with redesigned holder - Universal power adapter |

| CML # | Description |
|--------------|--|
| VSTAR40A | <p>Orion VERSA STAR pH/ISE Benchtop Meter Set</p> <ul style="list-style-type: none"> - Orion VERSA STAR meter - Orion VERSA STAR pH/ISE/temperature module - Electrode arm with redesigned holder - Universal power adapter |
| VSTAR40A2 | <p>Orion VERSA STAR pH/ISE Benchtop Meter Kit</p> <ul style="list-style-type: none"> - Orion VERSA STAR meter - Orion VERSA STAR pH/ISE/temperature module - 8102BNUWP Orion ROSS Ultra pH electrode - 096019 Orion Star stirrer probe - 927007MD ATC probe, stainless steel - ROSS solution kit (475 mL each of pH 4, 7 and 10 buffers; storage solution; cleaning solution; and pH electrode storage bottle) - Electrode arm with redesigned holder - Universal power adapter |
| VSTAR40B | <p>Orion VERSA STAR Benchtop Meter with Two pH/ISE Modules</p> <ul style="list-style-type: none"> - Orion VERSA STAR meter - Two Orion VERSA STAR pH/ISE/temperature modules - Electrode arm with redesigned holder - Universal power adapter |
| VSTAR40B2 | <p>Orion VERSA STAR Benchtop Meter with Two pH/ISE Modules Kit</p> <ul style="list-style-type: none"> - Orion VERSA STAR meter - Two Orion VERSA STAR pH/ISE/temperature modules - 8102BNUWP Orion ROSS Ultra pH electrode - 096019 Orion Star stirrer probe - 927007MD ATC probe, stainless steel - ROSS solution kit (475 mL each of pH 4, 7 and 10 buffers; storage solution; cleaning solution; and pH electrode storage bottle) - Two electrode arms with redesigned holders - Universal power adapter |
| VSTAR50 | <p>Orion VERSA STAR pH/Conductivity Benchtop Meter Set</p> <ul style="list-style-type: none"> - Orion VERSA STAR meter - Orion VERSA STAR pH/temperature module - Orion VERSA STAR conductivity/temperature module - Electrode arm with redesigned holder - Universal power adapter |
| VSTAR52 | <p>Orion VERSA STAR pH/Conductivity Benchtop Meter Kit</p> <ul style="list-style-type: none"> - Orion VERSA STAR meter with pH/temperature module - Orion VERSA STAR conductivity/temperature module - 8157BNUMD Orion ROSS Ultra Triode pH/ATC probe - 013005MD Orion DuraProbe conductivity cell, K=0.475 - 810199 ROSS solution kit (475 mL each of pH 4, 7 and 10 buffers; storage solution; cleaning solution; and pH electrode storage bottle) - 011007 conductivity standard, 1413 μS, 5x60 mL - Electrode arm with redesigned holder - Universal power adapter |

| CML # | Description |
|---------|--|
| VSTAR80 | <p>Orion VERSA STAR pH with LogR Benchtop Meter Set</p> <ul style="list-style-type: none"> - Orion VERSA STAR meter - Orion VERSA STAR pH/temperature with LogR technology module - Electrode arm with redesigned holder - Universal power adapter |
| VSTAR82 | <p>Orion VERSA STAR pH Benchtop Meter Kit</p> <ul style="list-style-type: none"> - Orion VERSA STAR meter - Orion VERSA STAR pH/temperature with LogR technology module - 8172BNX Orion ROSS Sure-Flow pH electrode - 927007MD ATC probe, stainless steel - ROSS solution kit (475 mL each of pH 4, 7 and 10 buffers; storage solution; cleaning solution; and pH electrode storage bottle) - 810007 ROSS fill solution, 5x60 mL - Electrode arm with redesigned holder - Universal power adapter |
| VSTAR90 | <p>Orion VERSA STAR pH/ISE/Conductivity/RDO/Dissolved Oxygen Benchtop Multiparameter Meter Set</p> <ul style="list-style-type: none"> - Orion VERSA STAR meter - Orion VERSA STAR pH/ISE/temperature module - Orion VERSA STAR conductivity/temperature module - Orion VERSA STAR dissolved oxygen/temperature module - Electrode arm with redesigned holder - Universal power adapter |
| VSTAR91 | <p>Orion VERSA STAR pH/ISE/Conductivity/RDO/Dissolved Oxygen Benchtop Multiparameter Meter Set</p> <ul style="list-style-type: none"> - Orion VERSA STAR meter - Two Orion VERSA STAR pH/ISE/temperature modules - Orion VERSA STAR conductivity/temperature module - Orion VERSA STAR dissolved oxygen/temperature module - Two 096019 Orion Star stirrer probes - Two electrode arms with redesigned holders - Universal power adapter |

| CML # | Description |
|---------|---|
| VSTAR92 | <p>Orion VERSA STAR pH/ISE/Conductivity/RDO/Dissolved Oxygen Benchtop Multiparameter Meter Set</p> <ul style="list-style-type: none"> - Orion VERSA STAR meter - Orion VERSA STAR pH/ISE/temperature module - Orion VERSA STAR conductivity/temperature module - Orion VERSA STAR dissolved oxygen/temperature module - 8157BNUMD Orion ROSS Ultra Triode pH/ATC probe - 013005MD Orion DuraProbe conductivity cell, K=0.475 - 083005MD Orion polarographic DO probe - 080017 calibration sleeve for DO probe - 080513 DO probe maintenance kit - 970802 BOD funnel/stirrer - 080360 BOD adapter - 810199 ROSS solution kit (475 mL each of pH 4, 7 and 10 buffers; storage solution; cleaning solution; and pH electrode storage bottle) - 011007 conductivity standard, 1413 μS, 5x60 mL - Electrode arm with redesigned holder - Universal power adapter |
| VSTAR93 | <p>Orion VERSA STAR pH/ISE/Conductivity/RDO/Dissolved Oxygen Ultimate Benchtop Multiparameter Meter Set</p> <ul style="list-style-type: none"> - Orion VERSA STAR meter - Orion VERSA STAR pH/ISE/temperature module - Orion VERSA STAR conductivity/temperature module - Orion VERSA STAR dissolved oxygen/temperature module - 8157BNUMD Orion ROSS Ultra Triode pH/ATC probe - 013005MD Orion DuraProbe conductivity cell, K=0.475 - 083005MD Orion polarographic DO probe - Two 096019 Orion Star stirrer probes - 080017 calibration sleeve for DO probe - 080513 DO probe maintenance kit - 970802 BOD funnel/stirrer - 080360 BOD adapter - 810199 ROSS solution kit (475 mL each of pH 4, 7 and 10 buffers; storage solution; cleaning solution; and pH electrode storage bottle) - 011007 conductivity standard, 1413 μS, 5x60 mL - Two electrode arms with redesigned holders - Universal power adapter |

| Accessories | |
|--------------------|---|
| CML # | Description |
| VSTAR-PH | Orion VERSA STAR pH/temperature module |
| VSTAR-ISE | Orion VERSA STAR pH/ISE/temperature module |
| VSTAR-CND | Orion VERSA STAR conductivity/temperature module |
| VSTAR-RD | Orion VERSA STAR RDO/DO/temperature module |
| VSTAR-LR | Orion VERSA STAR pH/temperature with LogR technology module |
| STARA-BEA | Benchtop electrode arm for Orion Star A-series meters |
| STARA-HB | Freestanding base for use with Orion Star A-series benchtop electrode arm |
| STARA-PWR | Replacement universal power adapter for Orion VERSA STAR meters |
| 096019 | Orion Star stirrer probe |
| 8102BNUWP | Orion ROSS Ultra pH electrode, refillable, glass body |
| 8172BNWP | Orion ROSS Sure-Flow pH electrode, glass body |
| 8156BNUWP | Orion ROSS Ultra refillable pH electrode, epoxy body |
| 8157BNUMD | Orion ROSS Triode pH/ATC electrode, refillable, epoxy body |
| 8302BNUMD | Orion ROSS Triode pH/ATC electrode, refillable, glass body |
| 8172BNX | Orion ROSS Sure-Flow pH electrode, glass body |
| 8611BNWP | Orion ROSS sodium combination ISE |
| 927007MD | Orion ATC probe, stainless steel body |
| 927005MD | Orion ATC probe, epoxy body |
| 013005MD | Orion DuraProbe conductivity cell, 4-cell, K=0.475 |
| 013016MD | Orion conductivity cell, flow through, K=0.1 |
| 083005MD | Orion dissolved oxygen probe, polarographic |
| 086030MD | Orion auto-stir DO/BOD probe, polarographic |
| 087010MD | Orion RDO optical DO probe, 3 m cable |
| 810199 | Orion ROSS all-in-one pH buffer kit |
| 910104 | Orion pH 4.01 buffer, 475 mL |
| 910107 | Orion pH 7.00 buffer, 475 mL |
| 910110 | Orion pH 4.01 buffer, 475 mL |
| 011008 | Orion conductivity standard, 100 μ S/cm, 5x60 mL bottles |
| 011007 | Orion conductivity standard, 1413 μ S/cm, 5x60 mL bottles |
| 011006 | Orion conductivity standard, 12.9 mS/cm, 5x60 mL bottles |
| 1010001 | Orion conductivity calibration resistor kit |
| 9512HPBNWP | Orion high-performance ammonia ISE |
| 9512BNWP | Orion standard ammonia ISE |
| 951007 | Ammonia standard, 1000 ppm, 475 mL |
| 951210 | Low-level ammonia ISA |
| 951211 | Ammonia ISA, 475 mL |
| 951209 | Fill solution for Orion high-performance ammonia ISE, 60 mL |
| 951202 | Fill solution for standard ammonia ISE, 60 mL |
| 951213 | Ammonia ISE storage solution |
| 9609BNWP | Orion fluoride combination ISE |
| 040906 | Fluoride standard, 1 ppm with TISAB II, 475 mL |
| 040907 | Fluoride standard, 2 ppm with TISAB II, 475 mL |
| 040908 | Fluoride standard, 10 ppm with TISAB II, 475 mL |
| 940909 | TISAB II, 1 gallon |
| 8611BNWP | Orion ROSS sodium combination ISE |

Appendix Advanced Features

Automatic pH Buffer Recognition Feature

The Orion VERSA STAR Meter with pH/ISE/Temperature module systems are capable of automatically recognizing pH 1.68, 4.01, 7.00, 10.01 and 12.46 buffers or pH 1.68, 4.01, 6.86, and 9.18 buffers during a pH calibration, depending on the pH buffer set that is selected in the setup menu. During a calibration, the meter uses the selected buffer set and the raw mV reading of the pH electrode in the buffer to recognize and display the buffer value at the measured temperature. The raw mV reading of the pH electrode in the buffer must be about ± 30 mV from the theoretical mV reading of the buffer in order for the meter to automatically recognize the buffer.

| USA pH Buffer Set | | DIN pH Buffer Set | |
|-------------------|-----------------|-------------------|-----------------|
| Buffer | mV Range | Buffer | mV Range |
| 1.68 | +285 to +345 mV | 1.68 | +285 to +345 mV |
| 4.01 | +207 to +147 mV | 4.01 | +207 to +147 mV |
| 7.00 | -30 to +30 mV | 6.86 | +38 to -22 mV |
| 10.01 | -207 to -147 mV | 9.18 | -99 to -159 mV |
| 12.46 | -293 to -353 mV | | |




Testing a pH Electrode for Automatic Buffer Recognition

To verify that the raw mV reading of the pH electrode in use is ± 30 mV from the theoretical mV reading of the buffer, and therefore verify that the pH electrode in use is capable of performing automatic buffer recognition, perform the following procedure.

1. Set the measurement mode to mV. Prepare the pH electrode according to the instructions in the pH electrode user guide.
2. Rinse the pH electrode with distilled water, blot it dry with a lint-free tissue and place the pH electrode into a pH 4.01 buffer at approximately 25 °C.
3. Wait for the measurement to stabilize and record the mV value of the pH 4.01 buffer when the meter indicates that the measurement is stable. The read type selected in the setup menu will determine how the mV measurements are displayed by the meter.
4. Remove the pH electrode from the pH 4.01 buffer.
5. Rinse the pH electrode with distilled water, blot it dry with a lint-free tissue and place the pH electrode into a pH 7.00 buffer at approximately 25 °C.
6. Wait for the measurement to stabilize and record the mV value of the pH 7.00 buffer when the meter indicates that the measurement is stable.
7. The mV reading of the pH electrode in pH 4.01 buffer should be in the range of +207 to +147 mV and the mV reading of the pH electrode in pH 7.00 buffer should be in the range of -30 to +30 mV. If the mV readings of the pH electrode are in the correct ranges, the pH electrode is capable of performing automatic buffer recognition. If the mV readings of the pH electrode are not in the correct ranges, the values of the pH buffers will need to be manually entered during a pH calibration.

pH Electrode Condition Icon

The electrode condition icon indicates the performance of the pH electrode, based on the last saved calibration and electrode measurement stability.

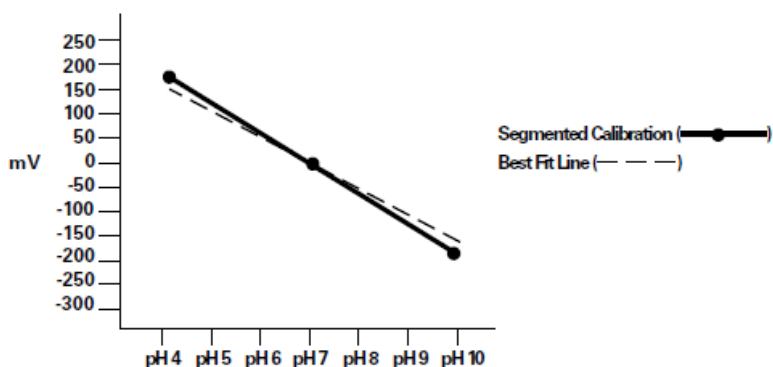
| Icon | pH Electrode Definition of Icon |
|---|---|
|  | Electrode condition is good and the electrode slope is 90 to 110 %. |
|  | Electrode condition is fair and the electrode slope is 80 to 120 %. |
|  | Electrode condition is bad and the electrode slope is less than 80 % or greater than 120 %. Consult the electrode user guide for instructions on how to clean, condition and troubleshoot the electrode. |

Multipoint Calibration Curve Feature

The Orion VERSA STAR Meter with pH/ISE/Temperature module systems utilize a point-to-point scheme for multipoint calibrations in the pH and ISE modes. In this technique, straight line segments are drawn between each successive pair of calibration points. Separate slope and E_0 values are calculated using the adjacent pair of data points. For example, in a five point calibration, four slopes and five E_0 values are calculated to correspond to the four line segments that connect the data. pH or concentration values for samples are calculated according to the segment that their potential values fall into. Those above or below the range of calibration are calculated by extrapolation from the top or bottom most segment.

The displayed slope is an average slope of the separate segments. The slope may be outside the range normally expected for an electrode. For example, if the slope of one segment is low, then the average will be lower than theoretical, even though the response may be Nernstian over most of the range.

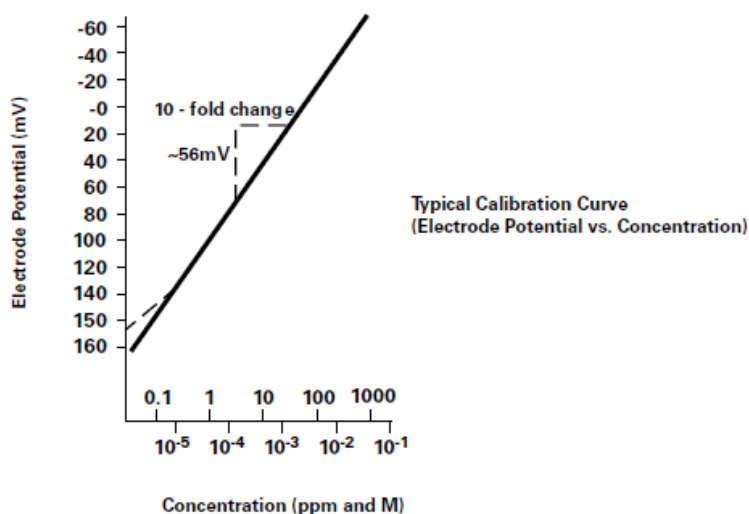
The figure below is an example of a typical calibration curve using this method.



Automatic Blank (Non-linear) Correction Feature

The Orion VERSA STAR Meter with pH/ISE/Temperature module systems have a feature known as automatic blank correction. In this technique, the meter decides whether blank correction is the best measurement strategy by analyzing the electrode response during a multipoint calibration. A separate blank does not have to be run. Graphically, automatic blank correction is equivalent to drawing a smooth curve through the lowest three points of the multipoint calibration and extrapolating to zero concentration based on the assumption of Nernstian electrode behavior.

Multipoint calibrations at the lower limit of detection are desirable when the response of an ion selective electrode is non-linear and cannot be characterized with a one or two point calibration. This is usually seen as a low electrode slope. Generally, the electrode is behaving in a Nernstian manner but the effect of a blank is being observed. See the figure below.



This blank may be a true reagent blank, traces of analyte ion in the reagents or it may be the "mud" value of the electrode. It could also be an interference in the reagents that becomes apparent at low levels of analyte ion, or it could be any combination of these effects. The expanded version of the Nernst equation traditionally used for blank correction is as follows:

$$E = E_0 + S \cdot \log(C + b) \text{ where } b \text{ is the blank}$$

In a multi-point calibration, a set of equations is generated and the relationship between them evaluated. For example the equations generated in a three point calibration would be as follows:

$$E_1 = E_0 + S \cdot \log(C_1 + b)$$

$$E_2 = E_0 + S \cdot \log(C_2 + b)$$

$$E_3 = E_0 + S \cdot \log(C_3 + b)$$

The meter evaluates the relationships between the three potentials E_1 , E_2 and E_3 and the three concentrations C_1 , C_2 and C_3 . If the relationships indicate that blank correction is desired, a blank will automatically be calculated and the non-linearity will be corrected for in a Nernstian manner. If the appropriate conditions are not met, the blank is set at zero and each segment of the multipoint calibration is treated independently.

When all three of the following conditions are met, blank correction is invoked.

1. The concentration of the first standard is zero, or the slope of the electrode between the first and second standards is less than the slope between the second and third.
2. Potential differences between points are significant. For example, $E_3 - E_1 > 10 \text{ mV}$
3. The blank correction algorithm converges at reasonable blank and slope values. Conditions in steps 1 and 2 prevent failure to converge in most situations. However, the slope will attain any value necessary for convergence to a calculated blank value of $3 \times C_3$.

When blank correction is implemented, the slope value for the electrode may be outside the range of values normally considered acceptable during an ordinary calibration. For best results, calibration standards should be close in range to the expected sample concentrations and should bracket the expected sample concentration. When conditions 1, 2 and 3 are not met, the calibration data is handled by the multipoint calibration method described earlier.

In calibrations with more than three points, a combination of methods is utilized. Automatic blank correction is used if the lowest three points satisfy the criteria and multipoint calibration is used for the other points. The slope displayed after calibration is an average of the slope calculated in the automatic blank correction algorithm and the slope(s) for each additional segment.

Determining an Isopotential Value

1. Prepare several standards with concentration ranges over the measuring range of the electrode.
2. Measure the millivolt value of the standards at room temperature, about 20 °C to 25 °C.
3. Measure the millivolt value of each standard at 75 °C.
4. Measure the millivolt value of each standard at 10 °C.
5. On semi-logarithmic graph paper, plot the concentration values on the log axis versus the millivolt values on the linear axis.
6. The lines will intersect at the isopotential value. Read the concentration from the graph for this point from the log axis. This is the isopotential value.

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