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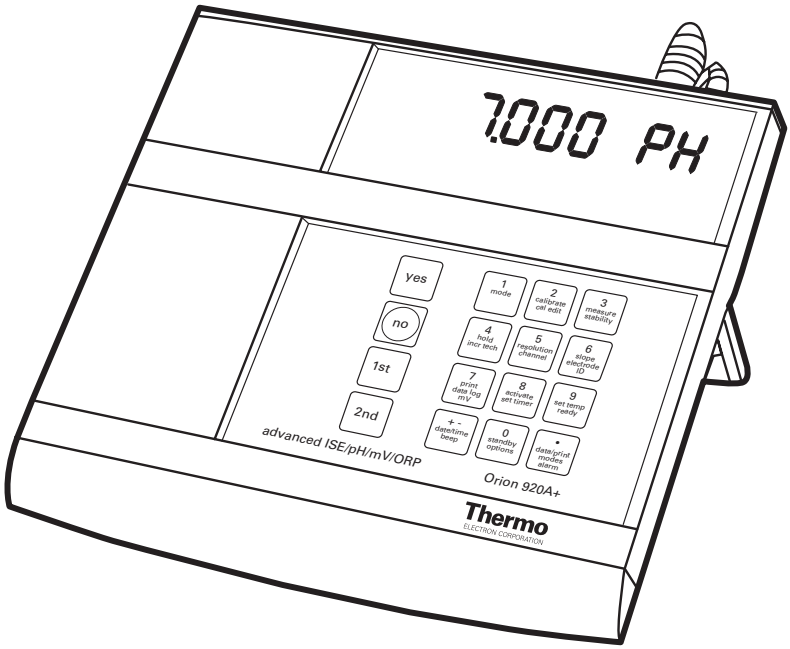
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Orion 410A+, 420A+,
520A+, 525A+,
710A+, 720A+,
920A+

Orion Aplus™

Benchtop pH and pH/ISE Meters

INSTRUCTION MANUAL



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ROSS Ultra electrodes have patents pending.

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

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This publication supersedes all previous publications on this subject.

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Chapter I

Introduction

Thermo Electron Corporation provides pH and ISE meters for every application from pH measurements to advanced Ion Selective Electrode work. This manual describes the operation and use of the Orion 410Aplus pH/Temperature Meter, Orion 420Aplus pH/mV/Temperature Meter, the Orion 520Aplus Advanced pH/mV/Temperature Meter, the Orion 525Aplus Dual Channel pH/mV/Temperature Meter, the Orion 710Aplus pH/ISE Meter, the Orion 720Aplus Dual Channel pH/ISE Meter, and the Orion 920Aplus Advanced pH/ISE Meter.

All meters are microprocessor-controlled and feature pH autocalibration, sealed keypads, simultaneous temperature display and many other features.

The Orion 410Aplus, 420Aplus and 710Aplus feature a custom LCD display. The Orion 520Aplus, 525Aplus, 720Aplus, and 920Aplus feature a two color vacuum fluorescent display with a separate prompt line that explains each step during calibration and measurement.

How to Use This Manual

For more detail on the operation of any of the models, please refer to the Table of Contents for the page location of an operation of a particular meter model. Troubleshooting instructions are common to all meters and this information is located toward the end of this manual.

Explanation of key functions and additional reference information are not required for calibration and measurement can be found in the appendices.

Chapter II

General Information

Orion 410Aplus, 420Aplus, 710Aplus General Information

The Orion 410Aplus is a pH/Temperature Meter, the Orion 420Aplus is a pH/mV/Temperature Meter and the Orion 710Aplus is a pH/ISE mV/Temperature Meter for general laboratory use. These meters feature: (1) a custom LCD display, which simultaneously displays mode, results and temperature; (2) a sealed keypad with tactile and audible feedback; and (3) an RS232 port for use with the Orion 900A printer or other serial peripheral devices.

Orion 520Aplus, 525Aplus, 720Aplus, 920Aplus General Information

The Orion 520Aplus is a pH/mV/Temperature Meter, Orion 525Aplus is an Advanced pH/mV/Temperature Meter, 720Aplus is a pH/ISE/mV/Temperature Meter and 920Aplus is an Advanced pH/ISE/mV/Temperature meter for general or advanced laboratory use. These meters feature: (1) a two color vacuum fluorescent display; (2) a sealed keypad with tactile and audible feedback; and (3) an RS232 port for use with Orion 900A printer or other serial peripheral devices. The Orion 525Aplus, 720Aplus and 920Aplus feature dual electrode inputs.

Chapter III

Set Up, Self-Test and Check-Out Procedures

A. Orion 410Aplus Set Up and Self-Test

***NOTE**: Use this procedure when the instrument is first received and whenever troubleshooting becomes necessary.*

1. Connect BNC shorting cap (Orion 090045) supplied with meter to sensing electrode input.
2. Disconnect the ATC probe.
3. Plug line (Orion 020125 for 110V, Orion 020130 for 220V) into an appropriate wall outlet then securely into meter power receptacle.

   ***NOTE:** Firmly push the power adapter into the jack on the back of the meter.*

4. Press and hold **yes** while pressing **power**. The instrument automatically performs electronic and hardware diagnostic tests. See the explanation in the Self-Test Section of the troubleshooting guide for a more detailed explanation.

   a. When "O" appears in the lower field, press each key including **power**. A numeric digit will be displayed for each keypress.

   b. During test 8, the meter will turn off. To restart meter press **power**.

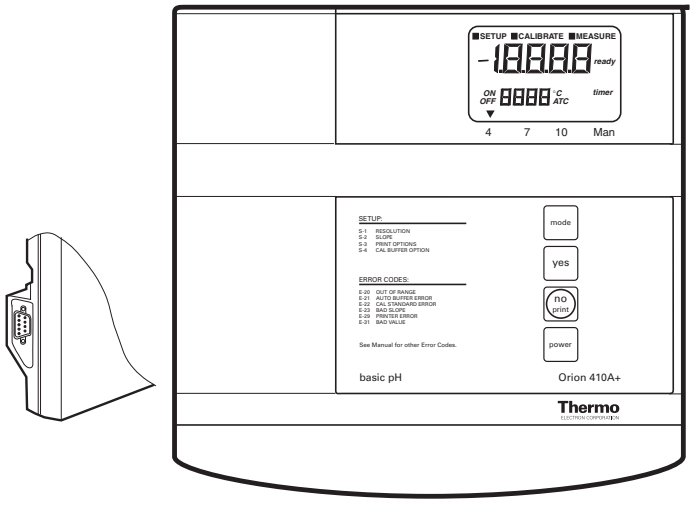


Figure #1 Front Panel Orion 410Aplus

B. Orion 420Aplus and 710Aplus Set Up and Self-Test

NOTE: *Use this procedure when the instrument is first received and whenever troubleshooting becomes necessary.*

1. Connect BNC shorting cap (Orion 090045) supplied with meter to sensing electrode input.
2. Disconnect the ATC probe.
3. Plug line adapter (Orion 020125 for 110V, Orion 020130 for 220V) into an appropriate wall outlet then securely into meter power receptacle.

   NOTE: *Firmly push the power adapter into the jack on the back of the meter.*

4. Press and hold **yes** while pressing **power**. The instrument automatically performs electronic and hardware diagnostic tests. See the explanation in the Self-Test Section of the troubleshooting guide for a more detailed explanation.
   a. When "O" appears in the lower field, press each key one at a time including **power**. A numeric digit will be displayed for each keypress.
   b. During TEST 8, the meter will turn off, then back on.
   c. After completion of the self-test, proceed to the Check-Out Procedure.

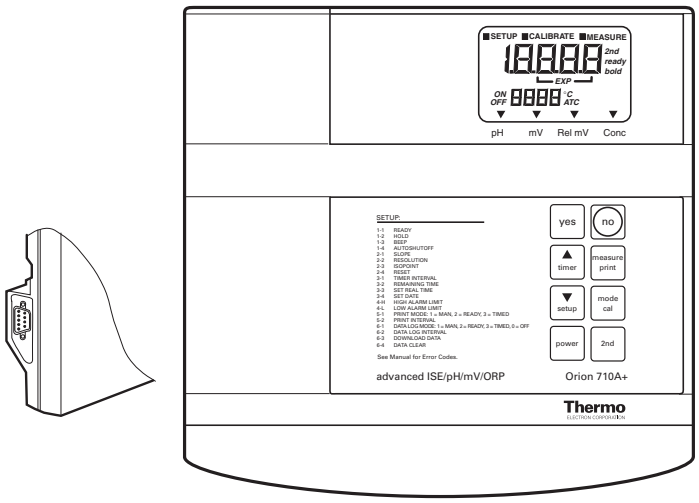


Figure #2 Front Panel Orion 710Aplus

C. Orion 420Aplus and 710Aplus Check-Out Procedure

1. Perform the self-test.
2. After completing the self-test the meter will be in MEASURE mode. The legend MEASURE will be displayed.
   a. Press **mode** until the pH mode indicator is displayed. Main display should read a steady 7.00 ± 0.02.

      ***NOTE**: If this is the first time this procedure has been performed the reading should be 7.00 ± 0.02.*

   b. If not, press **2nd cal**. "P1" will appear. When "Ready" appears, press **yes**.
   c. Press **measure**. The main display should read 100.0 with the legend SLP in the lower display. If so, press **yes**.
   d. If not, scroll until the display reads 100.0 and then press **yes**. The meter advances to MEASURE and the display should now read steady 7.00.

      ***NOTE**: To change a value, press ▲ or ▼. The first digit will flash, continue scrolling until the first digit equals the correct value, then press **yes.** The second digit will flash. Scroll to the correct value then press **yes**. When all digits have been changed, press **yes** to enter the new value.*

3. Press **mode** to enter millivolt mode. Display should read 0.0 ± 0.2. If not, press **2nd cal** then press **yes** to enter the value 0.0. The meter will return to MEASURE mode.
4. Press **mode** to enter REL mV mode. Display should read 0.0 ± 0.2. If not, press **2nd cal** then press **yes** to enter the value 0.0. The meter will return to MEASURE mode.

For Orion 420Aplus, the meter is now ready for use with electrodes. Remove the shorting cap.

5. **For Orion 710Aplus only**
   With the shorting cap still connected, press **mode** until the concentration mode indicator is displayed. The display should read 1.00.

   NOTE: *If this is the first time this procedure has been performed the reading should be 1.00.*

   a. If not, press **2nd cal.** At the P1 prompt, scroll until the display reads 1.00. Press **yes.**
   b. Press **measure.** SLP and 59.2 should be displayed. If so, press **yes.**
   c. If not, scroll until the display reads 59.2, then press **yes.**

6. After successfully completing steps 1 through 5, the meter is ready for use with electrodes. Remove the shorting cap.

D. Orion 520Aplus and 525Aplus Set Up and Self-Test

***NOTE**: Use this procedure when the instrument is first received and whenever troubleshooting becomes necessary.*

1. Connect BNC shorting cap (Orion 090045) supplied with meter to all sensing electrode input(s).
2. Disconnect the ATC probe.
3. Plug line adapter (Orion 020125 for 110V, Orion 020130 for 220V) into an appropriate wall outlet then securely into meter power receptacle.

   ***NOTE:** Firmly push the power adapter into the jack on the back of the meter.*

4. Hold **yes** while plugging in the line adapter into meter. The instrument automatically performs electronic and hardware diagnostic tests. See the explanation in the Self-Test Section of the troubleshooting guide for a more detailed explanation.
   a. When "press all keys" appears in the lower field, press each key one at a time. A numeric digit will be displayed for each keypress.
   b. During TEST 8, the meter will turn off, then back on.
   c. After completion of the self-test, proceed to the Check-Out Procedure.

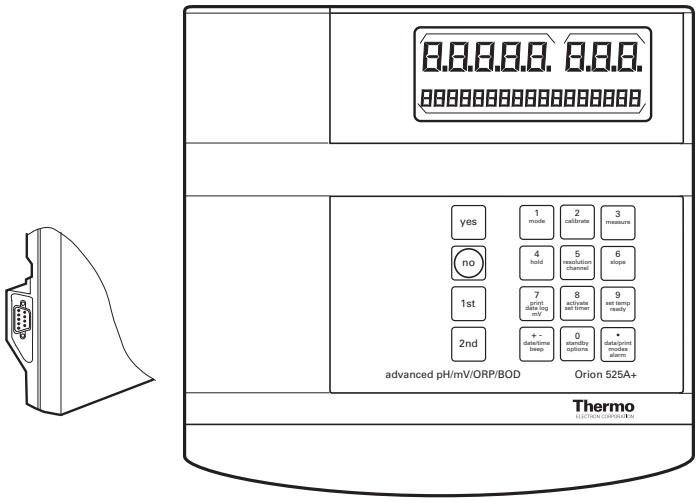


Figure #3 Front Panel Orion 525Aplus

E. Orion 520Aplus and 525Aplus Check-Out Procedure

1. Perform the self-test.
2. **For 525Aplus only**
   Press **2nd channel** until channel 1 is selected
3. After completing the self-test the meter will be in MEASURE mode. The legend MEAS will be displayed.

   NOTE: *If this is the first time this procedure has been performed the reading should be 7.00 ± 0.02.*

4. Press **1st mode** to display pH.
   a. The prompt line on the display should read 25.0˚ C. If not, press **1st set temp** and enter 25.0, then press **yes**.
   b. Press **1st calibrate**. Enter **1** buffer then press **yes**. Display should read 7.00 pH. If not, enter 7.00 and press **yes**.
   c. Meter should display the slope as 100.0 PCT. If not, enter 100.0 and press **yes**.
   d. Meter will return to measure mode. Display should read 7.00 ± 0.02.
5. Press **mode** to display mV. Display should 0.0 ± 0.2 mV. If not, enter 0.0 and press yes.

For Orion 520Aplus the meter is now ready for use with electrodes. Remove the shorting cap.

6. **For 525Aplus only**
   a. Press **2nd channel** to select input channel 2.
   b. Repeat steps 4 and 5 for input channel 2.

For Orion 525Aplus the meter is now ready for use with electrodes. Remove the shorting cap.

F. Orion 720Aplus and 920Aplus Set Up and Self-Test

NOTE: *Use this procedure when the instrument is first received and whenever troubleshooting becomes necessary.*

1. Connect BNC shorting cap (Orion 090045) supplied with meter to all sensing electrode input(s).
2. Disconnect the ATC probe.
3. Plug line adapter (Orion 020125 for 110V, Orion 020130 for 220V) into an appropriate wall outlet then securely into meter power receptacle.

   NOTE: *Firmly push the power adapter into the jack on the back of the meter.*

4. Press and hold **yes** while connecting the **power.** The instrument automatically performs electronic and hardware diagnostic tests. See the explanation in the Self-Test Section of the troubleshooting guide for a more detailed explanation.
   a. When "O" appears in the lower field, press each key one at a time. A numeric digit will be displayed for each keypress.
   b. During TEST 8, the meter will turn off, then back on.
   c. After completion of the self-test, proceed to the Check-Out Procedure.

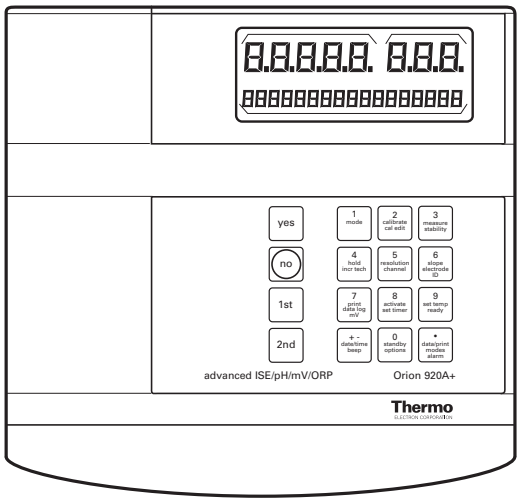


Figure #4 Front Panel Orion 920Aplus

G. Orion 720Aplus and 920Aplus Check-Out Procedure

1. Perform the self-test.
2. After completing the self-test the meter will be in MEASURE mode. The legend MEASURE will be displayed.

   NOTE: *If this is the first time this procedure has been performed the reading should be 7.000 ± 0.02.*

3. Press **mode** until pH is displayed.
   a. Press **2nd channel** until channel 1 is selected.
   b. The prompt line on the display should read 25.0° C. If not, press **1st set temp** and enter 25.0, then press **yes**.
4. **For 920Aplus only**:
   Press **2nd electrode id**. Press **1** for pH and press **yes**.
5. Press **1st calibrate**.
   a. Press **1** buffer, then press **yes**.
   b. Display should read 6.997. If not, enter 6.997 and press **yes** at the READY CAL AS prompt.
   c. Meter should display the slope, 100.0 PCT. If not, enter 100.0 and press **yes**.
   d. Meter will return to measure mode. Display should read 6.997 ± 0.02.
6. Press **mode** to display mV. Display should read 0.0 ± 0.2 mV. If not, enter 0.0 and press **yes.**
7. Press **mode** until CONC is displayed.
   a. **For 920Aplus only**:
   Display should read CON and — . Press **2nd electrode id.** Enter 13, **(Na+)** then press **yes**.
   b. Press **calibrate**. Enter **1** standard and press **yes**.
   c. Meter should display 1.00. If not, enter 1.00 and press **yes** at the READY ENTER VALUE prompt.
   d. Meter should display the slope as 59.2 mV. If not, enter 59.2 and press **yes**.
   e. Meter will return to measure mode. Display should read 1.00 ± 0.01.
8. Press **mode** to select pH.
   a. Press **2nd channel** to select input channel 2.
   b. Repeat steps 3 through 7 for input channel 2.
9. After successful completion of steps 1 through 7, the meter is ready for use with electrodes. Remove shorting caps.

Instrument Set Up

The meter can be adjusted to provide you an optimal viewing angle via the flip stand. To adjust the viewing angle, turn the instrument over and place your thumbs on the inside of the stand sides. As you lift the stand, gently push the sides of the stand out. This will lock the stand at a 90˚ angle, providing easy viewing from across the lab. To adjust to the last viewing angle, continue to gently push the sides of the stand out as you lift the stand to its furthest point.

Chapter IV

Rear Panel and Electrode Connections

A. Rear Panel

Inputs	Use
(1.) Input 1 and 2	Sensing electrode jack. Inputs accept pH, ion selective, and redox electrodes with BNC connectors. (Input 1 illustrated with shorting cap connected, input 2 illustrated with shorting cap disconnected).
(2.) Ref 1 Ref 2	Reference electrode jacks. Inputs accept standard pin-tip connectors.
(3.) Gnd.	Earth ground jack, accepts standard pin-tip connectors.
(4.) ATC	Automatic Temperature Compensator jack, accepts thermistor-type ATC probe with DIN connector.
(5.) KF	Polarizing current source for Karl Fischer titrations. Jack accepts standard pin-tip connectors.
(6.) Rec	Recorder jack. Accepts 2.5 mm audio jack for strip chart recorder connection. Tip is output, ring is ground.
(7.) Power	Power receptacle. Accepts input connector from Orion supplied line converter.
(8.) BNC	BNC Shorting Cap.

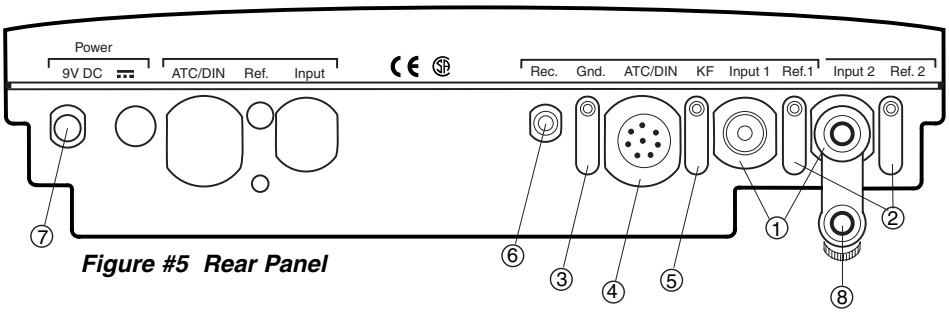


Figure #5 Rear Panel

***NOTE**: The Orion 410Aplus, 420Aplus, 520Aplus and 710Aplus contain only Sensing Electrode Input 1 and Reference Electrode Input 1. On the Orion 410Aplus, 420Aplus, and 710Aplus the inputs are found on the left side of the rear panel.*

B. Electrode Connections

1. Attach electrodes with BNC connectors to sensor input by sliding connector onto input, pushing down and turning clockwise to lock into position. Connect reference electrodes with pin tip connectors by pushing connector straight into reference input.

   NOTE: *If using a combination electrode with a BNC connector, a reference electrode is not used.*

2. Attach the ATC probe to the ATC jack by sliding the connector straight on until it is firmly in place. The connector has a special sealing mechanism, which is engaged, when the connector is properly attached.

Chapter V

Calibration and Measurement of pH

A. General Information on pH Calibration

A one, two or multipoint (where available) calibration should be performed using fresh buffers before pH is measured. It is recommended that a two buffer calibration, using buffers that bracket the expected sample range, be performed at the beginning of each day to determine the slope of the electrode. This serves a dual purpose, determining if the electrode is working properly and storing the slope value in memory. Perform a one buffer calibration every two hours to compensate for electrode drift, using a fresh aliquot from one of the calibration buffers used in the initial calibration.

The instruments use a point-to-point calibration scheme, i.e. the meter stores in memory the different electrode slopes for each portion of the calibration curve. When measuring in a particular region of the curve, the electrode slope for that region is employed in the calculation of sample pH. After calibration, the average electrode slope for all the segments of the entire calibration curve is displayed. Use of this scheme increases accuracy in the different regions of the calibration curve. However, the electrode slope may be lower than normal, especially if buffers from the pH extremes < 2.00 or > 12.00 are used. See Appendix C.

There are two ways of calibrating Orion Benchtop Meters, autocalibration or manual calibration. The following are descriptions and instructions of each method, for each model.

For Best Results

It is recommended that an ATC probe be used. If an ATC probe is not used, all samples and standards should be at the same temperature or manual temperature compensation should be used. Stir all buffers and samples with a magnetic stirrer while a measurement is being made.

> ***NOTE:*** *Some magnetic stirrers generate enough heat to change solution temperature. To avoid this, place a piece of cardboard, foam rubber or other insulating material between the stir plate and beaker.*

Always use fresh aliquots of buffers whenever calibrating.

Temperature Compensation

pH measurements on the Orion 410Aplus are made with Automatic Temperature Compensation. pH measurements on the Orion 420Aplus, 520Aplus, 525Aplus, 710Aplus, 720Aplus, and 920Aplus may be made with either Automatic or Manual Temperature Compensation.

For Automatic Temperature Compensation, an ATC probe must be used. Plug in the ATC probe and the meter will display temperature corrected pH results in the main display.

For Manual Temperature Compensation with **Orion 520Aplus, 525Aplus, 720Aplus, and 920Aplus** disconnect the temperature probe. Temperature values can be entered manually by pressing **set temp.** Temperature corrected pH values, based on the manually entered temperature, will be displayed in the main field.

For Manual Temperature Compensation with **Orion 420Aplus and 710Aplus** disconnect the temperature probe. Temperature values can be entered manually by pressing ▲or ▼while in measure mode. The value will be displayed in the lower field. Temperature corrected pH values based on the manually entered temperature will be displayed in the main field.

B. Orion 410Aplus pH Calibration and Measurement

Autocalibration

Autocalibration is a feature of the Orion 410Aplus Meter that automatically recognizes the standard buffers, 4.01, 7.00 and 10.01, within a range of ± 0.5 pH units. Simply select the buffer sequence that best fits your application. Results greater than ± 0.5 pH units from the theoretical value will trigger an operator assistance code. During calibration, the user waits for a stable pH reading. Once the electrode is stable, the meter automatically recognizes and displays the temperature-corrected value for that buffer. Pressing **yes** enters the value into memory.

Manual Calibration

To calibrate with buffers other than 4.01, 7.00, or 10.01, use the manual calibration technique. The chosen buffers must be greater than one (1) pH unit but less than four (4) pH units from the next closest buffer. Manual calibration is selected through SETUP mode. The calibration sequence is the same as autocalibration except that the buffer values are scrolled in and then entered.

> ***NOTE:*** *For manual calibration use* ***yes*** *to accept or* ***no*** *to change each digit until the correct value, then press* ***yes*** *to accept.*

Three Point pH Calibration

Up to a three (3) point calibration can be performed on the Orion 410Aplus Meter. Simply select the buffer sequence that best fits your application.

pH Calibration Procedure

1. Connect electrode(s) to meter. Choose buffers that will bracket the expected sample pH.
2. Rinse electrode(s) and place into buffer.
3. Press **mode** until CALIBRATE is displayed.
4. The last buffer sequence used will be displayed. Press **yes** to use this sequence or **no** to scroll through choices.
5. Buffer indicator along bottom of the display will indicate the buffer chosen. P1 will be displayed in lower display field and buffer reading will be displayed in the main field. When READY is displayed, indicating electrode stability, press **yes** to accept the displayed value. If performing a manual calibration, press **no** to change each digit until the correct pH value is displayed then press **yes** to accept.
6. The temperature corrected value for that buffer is automatically entered into the memory of the meter. P2 will be displayed in the lower display field indicating the meter is ready for the second buffer. The buffer indicator along the bottom of the display will indicate the second buffer of the calibration sequence selected.
7. Repeat steps 2 and 5 for each buffer.
8. After the buffer value for the last buffer has been entered, press **measure**. The electrode slope will be displayed. SLP appears in the lower field while the actual electrode slope, in percent, appears in the main field. Press **yes**, the meter will automatically advance to the measure mode. MEASURE is displayed above the main field.
9. Rinse electrode(s) and place into sample. Record pH directly from the main meter display when READY is displayed. Temperature is displayed in the lower field.

C. Orion 420Aplus pH Calibration and Measurement

Autocalibration

Autocalibration is the feature of the Orion 420Aplus Meter that automatically recognizes three buffers, 4.01, 7.00, and 10.01, within a range of ± 0.5 pH units. Results greater than ± 0.5 pH units from the correct value will trigger an operator assistance code. At this point, a manual calibration can be performed or the calibration can be ended and repeated with fresh buffers. During calibration the user waits for a stable pH reading. Once the electrode is stable, the meter automatically recognizes and displays the temperature-corrected value for that buffer. Pressing **yes** enters the value into memory.

> ***NOTE:*** *Do not scroll when using autocalibration. If you want to exit the menu at any time, press* **measure.**

Manual Calibration

To calibrate with buffers other than 4.01, 7.00, or 10.01, use the manual calibration technique. The chosen buffers must be greater than one (1) pH unit but less than four (4) pH units from the next closest buffer. The calibration sequence is the same as autocalibration except that the buffer values are scrolled in and then entered.

> ***NOTE:*** *For manual calibration you must use▲ or▼. Even if the value displayed is the correct value for your buffer, you must press a* ***scroll*** *key to start the editing process. Press* **yes** *to accept each digit. Otherwise the meter assumes autocalibration is being performed.*

Three Point pH Calibration

Up to a three (3) point calibration can be performed on the Orion 420Aplus Meter. Both autocalibration and manual calibrations may be used within the same calibration curve. For example, autocalibration may be used with the 7.00 and 10.01 buffers while manual calibration would be used with a 3.78 buffer.

pH Calibration Procedure

1. Connect electrode(s) to meter. Choose buffers that will bracket the expected sample pH.
2. Press **mode** until the pH mode indicator is displayed.
3. Rinse electrode(s) and place into buffer.
4. Press **2nd** then **cal** to begin calibration. The date and time of the last calibration will be displayed.
5. When READY is displayed next to the reading, indicating electrode stability, the reading will flash. Press **yes**. For manual calibration use ▲ or ▼ to select the correct value, then press **yes** to accept each digit. After accepting each digit, press **yes** store buffer value. The meter display freezes for three seconds. The meter automatically switches to buffer two, indicated by the P2 on the display.
6. Repeat steps 3 through 5 for each buffer.
7. After entering the final buffer value, press **measure**. The electrode slope will be displayed. SLP appears in the lower field while the actual electrode slope, in percent, appears in the main field. After the third buffer point, the meter automatically displays the calibration slope and advances to the measure mode. MEASURE is displayed above the main field.
8. Rinse electrode(s) and place into sample. Record pH directly from the main meter display. Temperature is displayed in the lower field when the READY prompt displays.

D. Orion 520Aplus pH Calibration and Measurement

Autocalibration

Autocalibration is the feature of the Orion 520Aplus Meter that automatically recognizes five buffers, 1.68, 4.01, 7.00, 10.01, and 12.46, within a range of ± 0.5 pH units. Results greater than ± 0.5 pH units from the correct value will trigger the prompt NO AUTOBUFFER and require operator intervention. At this point, a manual calibration can be performed or the calibration can be ended and repeated with fresh buffers. During calibration, the user waits for a stable pH reading. Once the electrode is stable, the meter automatically recognizes and displays the temperature corrected value for that buffer. Press **yes** to the READY CAL AS prompt to enter the value in memory.

Manual Calibration

To calibrate with buffers other than 1.68, 4.01, 7.00, 10.01, or 12.46, use the manual calibration technique. The calibration sequence is the same as autocalibration except that the buffer values are manually entered using the numeric keypad. At the “READY CAL AS” prompt enter the value for the buffer and press **yes** to enter.

Three Point pH Calibration

Up to a three (3) point calibration can be performed on the Orion 520Aplus Meter. Both autocalibration and manual calibrations may be used within the same calibration curve. For example, autocalibration may be used with the 7.00 and 10.01 buffers while manual calibration would be used with a 3.78 buffer.

pH Calibration Procedure

1. Connect electrode(s) to meter. Choose buffer(s), which is closest to or will bracket the expected sample pH.
2. Press **calibrate**. Calibrate is displayed. The time and date of the last calibration are displayed.
3. After a few seconds ENTER NO. BUFFERS is displayed. Enter the number of buffers; **1**, **2**, or **3**, and press **yes**.
4. Rinse electrode(s) and place into first buffer When the electrode signal is stable, the meter will display the temperature corrected value for the buffer.
5. When READY CAL AS is displayed, press **yes** if the value is correct for your buffer. If performing a manual calibration, use the numeric keys to change the value, then press **yes**.
6. If 2 or 3 buffers were selected, repeat steps 4 and 5 for each buffer.

7a. If one buffer was selected, the actual slope value in memory is displayed at the SLOPE prompt. Press **yes** if correct, or enter correct value and then press **yes**. If actual slope is unknown, enter 100.0 or perform a two point calibration.

7b. If two or three buffers were selected, the actual electrode slope is displayed at the SLOPE prompt. If more than two buffers were used, the slope displayed is an average of the different segments.

8. The meter automatically proceeds to measure mode.
9. Rinse electrode(s) and place into sample. Record pH value from the main field when READY is indicated or when the electrode signal is stable. Temperature is displayed on the prompt line.

E. Orion 525Aplus pH Calibration and Measurement

Autocalibration

Autocalibration is the feature of the Orion 525Aplus Meter that automatically recognizes five buffers, 1.68, 4.01, 7.00, 10.01, and 12.46, within a range of ± 0.5 pH units. Results greater than ± 0.5 pH units from the correct value will trigger the prompt NO AUTOBUFFER. At this point, a manual calibration can be performed or the calibration can be ended and repeated with fresh buffers. During calibration, the user waits for a stable pH reading. Once the electrode is stable, the meter automatically recognizes and displays the temperature corrected value for that buffer. Pressing **yes** to the READY CAL AS prompt enters the value in memory.

Manual Calibration

To calibrate with buffers other than 1.68, 4.01, 7.00, 10.01, or 12.46, use the manual calibration technique. The calibration sequence is the same as autocalibration except buffer values are manually entered using the numeric keypad. At the READY ENTER VALUE prompt enter the value for the buffer and press **yes**.

Multipoint pH Calibration

Up to a three (3) point calibration can be performed on the Orion 525Aplus Meter. Both autocalibration and manual calibration may be used within the same calibration curve. For example autocalibration may be used with the 7.00 and 10.01 buffers while manual calibration may be used with a 3.78 buffer.

NOTE: *If you want to exit this menu, at any time, press* ***1st measure.***

pH Calibration Procedure

1. Press **2nd** then **channel** until the correct input channel is selected.
2. Press **mode** until the pH mode indicator is displayed.
3. Press **calibrate**. CALIBRATE is displayed. The time and date of the last calibration are displayed.
4. After a few seconds ENTER NO. BUFFERS is displayed. Enter the number of buffers; **1**, **2**, or **3**, then press **yes**.
5. When the BUFFER 1 prompt appears, rinse electrode(s) and place into first buffer. Wait for a stable display.
6. When the electrode signal has stabilized, the READY CAL AS prompt will appear. Press **yes** if the value is correct for your buffer. If performing a manual calibration, use the numeric keys to change the value, then press **yes**.
7. If more than one buffer was selected, repeat steps 5 and 6 for each buffer.

8a. If one buffer was selected, the current electrode slope in memory is displayed at the SLOPE prompt. Press **yes**, or use numeric keys to enter correct value, then press **yes**. If actual slope is unknown, enter 100.0 or perform a two buffer calibration.

8b. If two or more buffers were selected, the average electrode slope is displayed at the SLOPE prompt.

9. The meter automatically proceeds to MEASURE mode.
10. Rinse electrode(s) and place into sample. Record the pH value when READY is indicated or when the electrode signal is stable. Temperature is displayed in the prompt line.

F. Orion 710Aplus pH Calibration and Measurement

Autocalibration

Autocalibration is the feature of the Orion 710Aplus Meter that automatically recognizes five buffers, 1.68, 4.01, 7.00, 10.01, and 12.46, within a range of ± 0.5 pH units. Results greater than ± 0.5 pH units from the correct value will trigger an operator assistance code. During calibration, the user waits for a stable pH reading. Once the electrode is stable, the meter automatically recognizes and displays the temperature corrected value for that buffer. Pressing **yes** enters the value in memory.

NOTE: *Do not scroll when using autocalibration. If you want to exit this menu at any time, press* ***measure.***

Manual Calibration

To calibrate with buffers other than 1.68, 4.01, 7.00, 10.01, or 12.46, use the manual calibration technique. The calibration sequence is the same as autocalibration except buffer values are scrolled in and then entered.

NOTE: *For manual calibration, you must use the scroll ▲ or ▼ keys. Even if the value displayed is the correct value for your buffer you must press a scroll key to start the editing process. Press* **yes** *to accept each digit. Otherwise, the meter assumes autocalibration is being performed.*

Multipoint pH Calibration

Up to a five (5) point calibration can be performed on the Orion 710Aplus Meter. Both autocalibration and manual calibration may be used within the same calibration curve. For example, autocalibration may be used with the 1.68, 7.00, and 10.01 buffers while manual calibration may be used with 3.78 and 9.18 buffers.

pH Calibration Procedure

1. Connect electrode(s) to meter. Choose buffers that will bracket the expected sample pH.
2. Press **mode** until the pH mode indicator is displayed.
3. Rinse electrode(s) and place into buffer.
4. Press **2nd** then **cal** to begin calibration. CALIBRATE is displayed above the main field. The date and time of the last calibration will be displayed.
5. When the electrode is stable, the READY prompt will be displayed and the temperature corrected value for the buffer is displayed. Press **yes**. If performing a manual calibration, press ▲ or ▼ to change the value, then press **yes**. The buffer value is stored and meter display freezes for three seconds. The meter automatically switches to buffer two, indicated by the "P2" on the display in the lower field.
6. Repeat steps 3 and 5 for each buffer.
7. After the buffer value for the last buffer has been entered, the electrode slope will be displayed automatically. If doing a manual calibration or less than a 5 point autocalibration, press **measure**. SLP appears in the lower field while the actual electrode slope, in percent, appears in the main field. The meter automatically advances to the measure mode. MEASURE is displayed above the main field.
8. Rinse electrode(s) and place into sample. Record pH directly from the main meter display when the READY prompt displays. Temperature is displayed in the lower field.

G. Orion 720Aplus pH Calibration and Measurement

Autocalibration

Autocalibration is the feature of the Orion 720Aplus Meter that automatically recognizes five buffers, 1.68, 4.01, 7.00, 10.01, and 12.46, within a range of ± 0.5 pH units. Results greater than ± 0.5 pH units from the correct value will trigger the prompt NO AUTOBUFFER. At this point, a manual calibration can be performed or the calibration can be ended and repeated with fresh buffers. During calibration, the user waits for a stable pH reading. Once the electrode is stable, the meter automatically recognizes and displays the temperature corrected value for that buffer. Pressing **yes** to the READY CAL AS prompt enters the value into memory.

Manual Calibration

To calibrate with buffers other than 1.68, 4.01, 7.00, 10.01, or 12.46, use the manual calibration technique. The calibration sequence is the same as autocalibration except buffer values are manually entered using the numeric keypad. At the READY ENTER VALUE prompt, enter the value for the buffer and press **yes**.

Multipoint pH Calibration

Up to a five (5) point calibration can be performed on the Orion 720Aplus Meter. Both autocalibration and manual calibration may be used within the same calibration curve. For example, autocalibration may be used with the 1.68, 7.00, and 10.01 buffers while manual calibration would be used with 3.78 and 9.18 buffers.

> ***NOTE:*** *If you want to exit this menu at any time, press* ***1st*** *then* ***measure****.*

pH Calibration Procedure

1. Press **2nd** then **channel** until the correct input channel is selected.
2. Press **mode** until the pH mode indicator is displayed.
3. Press **calibrate**. CALIBRATE is displayed. The time and date of the last calibration are displayed.
4. After a few seconds ENTER NO. BUFFERS is displayed. Enter the number of buffers **1**, **2**, **3**, **4** or **5**, then press **yes**.
5. When the BUFFER 1 prompt appears, rinse electrode(s) and place into first buffer. Wait for a stable display.
6. When the electrode signal has stabilized, the READY CAL AS prompt will appear. Press **yes** if the value is correct for your buffer. If performing a manual calibration, use the numeric keys to change the value. Press **yes**.
7. If more than one buffer was selected, repeat steps 5 and 6 for each buffer.

8a. If one buffer was selected, the current electrode slope in memory is displayed at the SLOPE prompt. Press **yes**, or use numeric keys to enter correct value, then press **yes**. If actual slope is unknown, enter 100.0 or perform a two buffer calibration.

8b. If two or more buffers were selected, the average electrode slope is displayed at the SLOPE prompt.

9. The meter automatically proceeds to measure mode.
10. Rinse electrode(s) and place into sample. Record the pH value when READY is indicated or when the electrode signal is stable. Temperature is displayed in the prompt line.

H. Orion 920Aplus pH Calibration and Measurement

Autocalibration

Autocalibration is the feature of the Orion 920Aplus Meter that automatically recognizes five buffers, 1.68, 4.01, 7.00, 10.01, and 12.46, within a range of ± 0.5 pH units. Results greater than ± 0.5 pH units from the correct value will trigger the prompt NO AUTOBUFFER. At this point, a manual calibration can be performed or the calibration can be ended and repeated with fresh buffers. During calibration, the user waits for a stable pH reading. Once the electrode is stable the meter automatically recognizes and displays the temperature-corrected value for that buffer. Press **yes** to the READY CAL AS prompt to enter the value in memory.

Manual Calibration

To calibrate with buffers other than 1.68, 4.01, 7.00, 10.01, or 12.46, use the manual calibration technique. The calibration sequence is the same as autocalibration except buffer values are manually entered using the numeric keypad. At the READY ENTER VALUE prompt, enter the value for the buffer and press **yes**.

Multipoint pH Calibration

Up to a five (5) point calibration can be performed on the Orion 920Aplus Meter. Both autocalibration and manual calibration may be used within the same calibration curve. For example, autocalibration may be used with the 1.68, 7.00, and 10.01 buffers while manual calibration may be used with 3.78 and 9.18 buffers.

> ***NOTE:*** *If you want to exit this menu at any time, press* ***1st*** *then* ***measure.***

Channel Selection and Electrode Identification

Prior to calibration, select the channel and proper electrode identification.

1. Press **2nd** then **channel** to select the correct channel. The channel in use will be identified in the prompt line. Example: 1-pH.
2. Press **2nd** then **electrode id** to select the electrode identification.
3. The meter will present a series of prompts. Follow the instructions to select the electrode ID noted after the channel in the prompt line. For example: To select pH, press **1** then **yes**.

pH Calibration Procedure

1. Press **mode** until the pH mode indicator is displayed.

   NOTE: *If you want to exit a menu, at any time, press **1st** then **measure.***

2. Press **calibrate**. CALIBRATE is displayed. The time and date of the last calibration are displayed.
3. After a few seconds ENTER NO. BUFFERS is displayed. Enter the number of buffers **1**, **2**, **3**, **4** or **5**, then press **yes**.
4. When the BUFFER 1 prompt appears, rinse electrode(s) and place into first buffer. Wait for a stable display.
5. When the electrode signal has stabilized, the READY CAL AS prompt will appear. Press **yes** if the value is correct for your buffer. If performing a manual calibration, use the numeric keys to change the value. Press **yes** to enter the value.
6. If more than one buffer was selected, repeat steps 4 and 5 for each buffer.

7a. If one buffer was selected, the current electrode slope in memory is displayed at the SLOPE prompt. Press **yes** or use numeric keys to enter correct value then press **yes**. If actual slope is unknown, enter 100.0 or perform a two buffer calibration.

7b. If two or more buffers were selected, the average electrode slope is displayed at the SLOPE prompt.

8. The meter automatically proceeds to measure mode.
9. Rinse electrode(s) and place into sample. Record the pH value when READY is indicated or when the electrode signal is stable. Temperature is displayed in the prompt line.

Chapter VI

Calibration and Measurement of Concentration

Orion 710Aplus, 720Aplus, 920Aplus

A. General Information

A one, two, or multipoint calibration should be performed before concentration is measured. It is recommended that a two point standard calibration be performed at the beginning of each day and every time electrodes are changed to determine the slope of the electrode. This serves a dual purpose, determining if the electrode is working properly and storing the slope value into memory. Perform a calibration with one standard every two hours to compensate for possible electrode drift. Use a fresh aliquot from one of the standards used in the initial calibration. During calibration, always use the most dilute standard first, the meter will automatically recognize slope direction (i.e. will recognize anion or cation electrodes). Standards should bracket the sample range and be in the same concentration units.

Units

Any convenient units of concentration units can be used. For example: molarity, ppm, %, etc.

Temperature

Allow all samples and standards to reach the same temperature before measurement, or use temperature compensation if the electrode isopotential point is known. (Orion 920Aplus only)

Slope

Up to a five point calibration may be performed. The instrument uses a point-to-point calibration scheme. The meter stores, in memory, the different electrode slopes for each portion of the calibration curve. When measuring in a particular region of the curve, the electrode slope for that region is employed in the calculation of sample concentration. The electrode slope, displayed after calibration, is the average slope for all the segments of the entire calibration curve. Use of this scheme increases accuracy in the different regions of the calibration curve. However, the electrode slope displayed may be lower than normal, especially if standards close to the electrode limit of detection are used in the calibration.

Autoblank Correction

Blank correction occurs automatically when calibrating with three or more standards. This feature automatically calculates and corrects for background levels of the species of interest. The standards used for calibration do not need to include a blank. This improves the results because typical blanks contain low levels of the species to be measured, making them unstable and difficult to measure accurately. To take advantage of this feature select three or more standards for calibration. If the profile of the calibration curve does not indicate a background level of ion concentration, then blank correction will not be invoked and the standard point-to-point scheme will be used. Refer to Appendix D for more detailed information.

B. Orion 710Aplus Concentration Calibration and Measurement

Concentration Calibration Procedure

1. Press **mode** until the CONC mode indicator is displayed.
2. Add ionic strength adjuster, or pH adjuster, to the standards and samples as recommended in the appropriate electrode instruction manual.
3. Rinse electrode(s) and place into the least concentrated standard.
4. Press **2nd** then **cal**. CALIBRATE and the time and date of the last calibration will be displayed. After a few seconds P1 will be displayed indicating the meter is ready for the first standard.

   ***NOTE**: If you want to exit this menu, at any time, press **measure**.*

5. When the reading is stable, enter the value of the standard, press the scroll keys ▲ or ▼. The value will flash. Press ▲ or ▼ again. The decimal point will flash. Position the decimal point using ▲ or ▼, then press **yes**. The first digit will flash. Scroll to the desired value, then press **yes.** Continue for each digit on the display. There are 4 1/2 digits plus a polarity sign and decimal point. The display will freeze for three seconds, then P2 will be displayed in the lower field.
6. If two or more standards were selected, rinse electrode(s) and repeat step 5 for each standard. When the reading is stable, enter the value of the standard as above. The reading will freeze for three seconds, then P3 will be displayed in the lower field. The meter is now ready for the third standard.
7. After the last standard, press **measure**. The electrode slope will be displayed for a few seconds, then the meter advances to measure mode. If five (5) standards have been entered, the meter automatically displays the slope, then advances to measure mode.
8. Rinse electrode(s) and place into sample. Wait for the RDY prompt to appear. Record concentration directly from the main meter display. Temperature is displayed in the lower field.

C. Orion 720Aplus Concentration Calibration and Measurement

Concentration Calibration Procedure

1. The number of the electrode input in use will appear on the prompt line. Example: CH-1. To select a different channel press **2nd** then **channel**.
2. Press **mode** until the concentration mode indicator CON appears on the display.
3. Add ionic strength adjuster, or pH adjuster to the standard and samples,as recommended in the electrode instruction manual.

   ***NOTE**: If you want to exit this menu, at any time, press **1st** then **measure**.*

4. Press **calibrate**. CALIBRATE will be displayed as well as the time and date of the last calibration.
5. When ENTER NO. STDS prompt appears enter the number of standards to be used in the calibration and press **yes**.
6. Rinse electrode(s) and place into first standard (the least concentrated standard). Wait for stable display.
7. When the READY ENTER VALUE prompt appears, enter the concentration value of the standard and press **yes**.
8. If two or more standards were selected, repeat steps 6 and 7 for each standard.
9. If one standard was selected, the electrode slope in mV/decade will be displayed at the SLOPE prompt. Press **yes** if correct, or enter the correct value for the electrode.

   ***NOTE**: Make sure the correct polarity sign is entered for the electrode in use during a one point calibration. The sign should be + (positive) for cations, for example, Na^+, and - (negative) for anions, for example F^-.*

10. If two or more standards were entered, the electrode slope is calculated and displayed.
11. The meter then advances to MEASURE mode.
12. Rinse and place electrode(s) into the sample. Record concentration directly from the meter display when the READY prompt appears. Temperature is displayed in the prompt line.

D. Orion 920Aplus Concentration Calibration and Measurement

Channel Selection and Electrode Identification

1. Securely connect electrodes to either input 1 or 2. The number of the electrode input in use appears directly before the electrode ID in the prompt line. Example: 1-X. To select a different channel press **2nd** then **channel**.
2. Identify the electrode correctly. Press **2nd** then **electrode id** to access the electrode ID function. The channel and current electrode identification are displayed. If correct, press **yes**. Press **no** to scroll through choices listed below.

   1-pH 2-O_2 3-F^- 4-Cl^- 5-Br^- 6-I^- 7-NO_3^- 8-CN^-

   9-NH_3 10-Cl_2 11-NO_X 12-CO_2 13-Na^+ 14-K^+

   15-Ag^+ 16-$S^=$ 17-Ca^{++} 18-Cu^{++} 19-Pb^{++} 20- Cd^{++}

   21-ClO_4 22- BF_4^- 23- SCN^- 24-KF 25-REDOX

   26-X^+ 27-X^- 28-X^{++} 29-X^{--}

3. Enter the number of your choice then press **yes**.
4. Meter displays new choice then returns to MEASURE mode.

Concentration Calibration Procedure

1. Press **mode** until the concentration mode indicator, CON appears on the display.
2. Add ionic strength adjuster, or pH adjuster to the standards and samples as recommended in the electrode instruction manual.

   ***NOTE**: If you want to exit this menu, at any time, press **1st** then **measure**.*

3. Press **calibrate**. CALIBRATE will be displayed as well as the time and date of the last calibration.
4. When ENTER NO. STDS prompt appears, enter the number of standards to be used in the calibration and press **yes**.
5. Rinse electrode(s) and place into first standard (least concentrated standard). Wait for stable display.
6. When the READY ENTER VALUE prompt appears, enter the concentration value of the standard and press **yes**.
7. If two or more standards were selected, repeat steps 5 and 6 for each standard.
8. If one standard was selected, the electrode slope in mV/decade will be displayed at the SLOPE prompt. Press **yes** if correct or enter the correct value for the electrode.

   ***NOTE**: Make sure the correct polarity sign is entered for the electrode in use during a one point calibration. The sign should be + (positive) for cations, for example Na^+, and - (negative) for anions, for example F^-.*

9. If two or more standards were entered, the electrode slope is calculated and displayed. The meter then advances to MEASURE mode.
10. Rinse and place electrode(s) into the sample. Record concentration directly from the meter display when the READY prompt appears. Temperature is displayed on the prompt line.

Chapter VII

920Aplus Special Features

A. Calibration Edit

The calibration edit feature allows you to edit a pH or concentration calibration curve without repeating the entire procedure. This is useful in multipoint calibrations if an entry mistake was made on one of the points. The meter will automatically recalculate all calibration values. There are two options in the **cal edit** function: **Remeasure** or **Edit**.

Remeasure allows you to remeasure a particular calibration point by placing electrode(s) in the standard (or buffer), then entering the correct value.

Edit has two choices: change or delete. Select change if a data entry error was made, but electrode(s) were in the correct standard at the time of calibration. Delete removes that point from the calibration curve.

Cal edit presents all calibration points in memory for editing. Respond to the prompts and edit as needed. **Cal edit** may be performed for both pH and ISE calibrations.

If no previous calibration has been performed the meter will prompt, NO CALIBRATION, then return to MEASURE mode. Otherwise, follow the prompts to edit the calibration. The example provided here uses a concentration calibration. A pH calibration would substitute the word BUFFER for STD.

Cal Edit

Prompt	Key Press/Action
1.	Press **2nd** then **cal edit.**
2. STD 1 OK?	The meter displays the current value of standard one. Press **yes** if okay or **no** to edit.
3. If **no** selected: 1-REMEAS 2-EDIT	Press **1** or **2** then press **yes**.
4. If **1** selected: READY ENTER VALUE	Place electrode(s) in the standard and wait for a stable display. Enter the value of the standard and press **yes.**
5. If **2** selected: 1-CHANGE 2-DELETE	Press **1** or **2** then **yes**.
6. If **1** selected: ENTER VALUE	The meter prompts for the new value. Enter value and press **yes**.
7. If **2** selected: STD 2 OK?	The meter deletes the calibration point and continues to the next calibration point. After presenting all calibration points for editing, the meter returns to measure mode.

B. Incremental Techniques General Information

The Orion 920Aplus Meter includes two different incremental techniques: known addition and known subtraction. Both involve adding aliquots of a standard of known concentration to the sample. Single and double incremental techniques can be performed.

Advantages of incremental techniques are:

a. Speed and ease of measuring occasional samples.

b. Ability to analyze samples containing complexing agents.

c. Ability to analyze dilute samples, those varying widely in temperature, and samples for which stable standards do not exist.

d. Use as a quick check of direct measurement results.

Limitations of incremental techniques are:

a. Sample concentration must be known within an order of magnitude so the increment may be correctly chosen.

b. Sample and standard must be volumetrically determined.

c. Any complexing agent must be present in excess (at least 50 to 100 times) or not at all.

Double incremental techniques calculate electrode slope and sample concentration simultaneously. The advantages of the double techniques are that the electrode slope will be determined directly in the sample. This results in greater accuracy for samples with complex matrices, and greater speed with which the analysis may be made.

Known addition is a useful method for measuring samples containing an excess of complexing agent, dilute samples, occasional samples, or as a check of a direct measurement.

Known subtraction is useful as a quick version of a titration, or with species that stable standards do not exist. It is necessary to know the stoichiometric ratio between standard and sample.

The following table is the sequence of keypresses and messages displayed when performing a known addition measurement. (Numbers and electrode ID used are for illustration purposes only.)

Prompt	Key Press/Action
1.	Press **2nd** then **incr tech.**
2. 1-ADDN 2-SUBTR	Press **1**, then **yes.**
3. KNOWN ADDN	The meter verifies your choice. Wait for the next prompt.
4. 1-SINGLE 2-DOUBLE	Press **1**, then **yes**.
5. SINGLE KNOWN ADDN. ELECTRODE SLOPE	The meter verifies your choice then prompts for the electrode slope. Enter the slope of the electrode including polarity sign. Press **yes**.
6. SAMPLE VOLUME?	Enter the volume of the sample. Press **yes**.
7. TOTAL VOLUME?	Enter the total volume in the beaker. For example if you have 100 mL of sample and 10 mL of diluent, enter 110. Press **yes**.
8. STD CONC?	Enter the concentration of the standard to be added to the sample. Press **yes**.
9. 1-NA+ IN SAMPLE?	Rinse electrode(s) and place into sample and press **yes**.
10. MEASURING 1-NA+ SAMP. READY YES TO CONTINUE	When the electrode signal is stable press **yes**.
11. 1ST STD VOLUME?	Enter the volume of standard to be added to the sample. Press **yes**.
12. 1ST STD ADDED?	Add standard to sample then press **yes.**
13. MEAS'G SAMP + STD 1-NA+ READY YES TO CONTINUE	Wait for a stable display then press **yes.**
14. SKA RESULT	Meter displays results of analysis in the main display. Press **yes** to continue.
15. REPEAT TECHNIQUE?	Press **yes** to repeat the technique without leaving incremental techniques mode. Repeat steps 5 through 13. Press **no** to exit and return to measure mode.

Set-up

1. Refer to the appropriate electrode instruction manual for preparation of sensing and reference electrode(s), required solutions (ionic strength adjusters, standards...), and any special requirements.
2. Securely connect electrode(s) to either input 1 or 2. The number of the input in use will appear directly before the electrode ID. For example, 1-Cl^-. Select the appropriate input by pressing **2nd** then **channel.**
3. Identify the electrode in use by pressing **2nd** then **electrode id** and set up other instrument operating parameters.
4. If a single incremental technique is to be performed, determine the electrode slope from a previous calibration or as directed in the electrode instruction manual.

Single Incremental Techniques

Single incremental techniques are useful for occasional samples or samples with complex matrices. Another advantage of the single incremental techniques is that the electrodes are not moved from solution to solution during calibration and measurement. This eliminates errors due to solution carryover and static charge disturbance of the electrode membrane.

It is especially important to be sure that any complexing agent is present in great excess or not at all. The ratio of free ion to complexed ion 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/complexed ion ratio, is an abnormally high or low slope. If this is a suspected problem, an excess of complexing or decomplexing agent may be added to the original solution in the beaker prior to the incremental addition.

Electrode interferences should be at a minimum, the effect of the interference may change as the concentration of the ion of interest changes. This situation may also result in high or low electrode slopes. It is possible to reduce some electrode interferences. Consult the appropriate electrode instruction manual for specific information.

Single Known Addition Measurement Procedure

A standard of known concentration is added to a sample of unknown concentration. Total concentration should approximately double upon the addition of the standard, therefore sample concentration should be known within an order of magnitude.

See the following table to choose the correct standard concentration and volume of addition.

Milliliters of standard to be added per 100 mL of sample	Standard should be X times expected sample concentration
1 mL	100X
5 mL	20X
10 mL	10X

Single Known Subtraction Measurement Procedure

In known subtraction, each addition of standard subtracts an increment of the species to be measured. The known subtraction procedure and meter prompts are the same as the known addition procedure except that the meter asks for the reaction ratio. At this prompt enter the correct reaction ratio of the species to be measured with the standard to be added. For example: A sulfide ($S^{=}$) sample is to be subtracted by the addition of silver (Ag^{+}). Two Ag^{+} ions are required to subtract each $S^{=}$ ion, therefore the reaction ratio is 0.5.

> ***NOTE:*** *Make sure the correct reaction ratio of sample to standard is entered.*

Total concentration of the sample should be approximately halved upon addition of the standard. Therefore sample concentration should be known within an order of magnitude.

See the following table to choose the correct standard concentration and volume of addition.

Milliliters of standard to be added per 100 mL of sample	***Standard should be X times expected sample concentration***
1 mL	50X
5 mL	10X
10 mL	5X

Select 2-SUBTR for the known subtraction procedure then follow the meter prompts.

Double Incremental Techniques

Double incremental techniques allow sample concentration and electrode slope to be determined simultaneously. This eliminates the requirement of performing a calibration or slope check before measurement as required with direct measurement or single incremental techniques.

Double incremental techniques are useful for occasional samples or samples with complex matrices. Another advantage of the double incremental techniques is that the electrodes are not moved from solution to solution during calibration and measurement. This eliminates errors due to solution carryover and static charge disturbance of the electrode membrane.

It is especially important with double incremental techniques to be sure that any complexing agent is present in great excess or not at all. The ratio of free ion to complexed ion must remain constant over both additions. An indication that a complexing agent is present, but not in great enough quantity to maintain a constant free/complexed ion ratio, is an abnormally high or low slope. If this is a suspected problem, an excess of complexing or decomplexing agent may be added to the original solution in the beaker prior to the incremental additions.

Electrode interferences should be at a minimum, the effect of the interference may change as the concentration of the ion of interest changes. This situation may also result in high or low electrode slopes. It is possible to reduce some electrode interferences. Consult the appropriate electrode instruction manual for specific information.

Double Known Addition Measurement Procedure

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

a. Sample volume be 100 mL.
b. The concentration of the standard added be 100 times the expected sample concentration.
c. The volume of the first addition be 1 mL.
d. The volume of the second addition be 10 mL.

The following table is a sequence of key presses and prompts displayed when performing a double known addition. (Numbers and electrode ID are used for illustration purposes only.)

	Prompt	Key Press/Action
1.		Press **2nd** then **incr tech**.
2.	1-ADDN 2-SUBTR	Press **1**, then **yes**.
3.	KNOWN ADDN	The meter verifies your choice. Wait for the next prompt.
4.	1-SINGLE 2-DOUBLE	Press **2**, then **yes**.
5.	DOUBLE KNOWN ADDN	The meter verifies your choice then continues.
6.	SAMPLE VOLUME?	Enter the volume of the sample. Press **yes**.
7.	TOTAL VOLUME?	Enter the total volume in the beaker. For example if you have 100 mL of sample and 10 mL of diluent, enter 110. Press **yes**.
8.	STD CONC?	Enter the concentration of the standard to be added to the sample. Press **yes**.
9.	1-NA+ IN SAMPLE?	Rinse electrode(s) and place into sample and press **yes**.
10.	MEASURING SAMPLE 1-NA+ READY YES TO CONTINUE	When the electrode signal is stable press **yes**.
11.	1ST STD VOLUME?	Enter the volume of standard to be added to the sample. Press **yes**.
12.	ST STD ADDED?	Add standard to sample, then press **yes**.

Prompt	Key Press/Action
13. MEAS'G SAMP+ STD 1-NA+ REA YES TO CONTINUE	Wait for a stable display, then press **yes.**
14. 2ND STD VOLUME?	Enter the volume of the second addition. Press **yes.**
15. 2ND STD ADDED	Add the second standard addition to the sample beaker. Press **yes.**
16. MEAS'G SAMP + STD 1-NA+ READY YES TO CONTINUE	Wait for a stable display and press **yes**.
17. SLOPE	The meter calculates and displays the electrode slope for 5 seconds then continues.
18. DKA RESULT	Meter displays results of analysis in the main display. Press **yes**.
19. REPEAT TECHNIQUE?	Press **yes** to repeat the technique without leaving incremental techniques mode. Repeat steps 6 through 18. Press **no** to exit and return to measure mode.

Double Known Subtraction Measurement Procedure

In double known subtraction, each addition of standard subtracts an increment of the species to be measured. The procedures and meter prompts are the same as for double known addition except the meter prompts for the reaction ratio. Enter the ratio at the meter prompt, then continue as usual.

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

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

a. Sample volume be 100 mL.

b. The concentration of the standard added be 50 times the expected sample concentration.

c. The volume of the first addition of standard be 1 mL.

d. The volume of the second addition of standard be 10 mL.

NOTE: *Make sure the correct reaction ratio of sample to standard is entered.*

For example: A sulfide ($S^{=}$) sample is to be subtracted by the addition of silver (Ag^{+}). Two Ag^{+} ions are required to subtract one $S^{=}$ ion, therefore the reaction ratio is 0.5.

Chapter VIII

Other Measurement Models

A. Temperature Measurement

The meters display temperature in the range -5.0 to +105˚C simultaneously with sample results. Whenever an ATC probe is connected, live temperature measurements are displayed in the prompt line. For results greater than 100˚C the tenth digit is deleted. On the Orion 920Aplus Meter the temperature appears after the channel designation and electrode ID.

Example: 1-pH 25.0˚C RDY.

For Temperature Compensation see pH Calibration.

B. Orion 420Aplus, 710Aplus Millivolt Measurements

The Orion 420Aplus and 710Aplus can be used to measure absolute or relative millivolts. The millivolt modes are useful when performing potentiometric titrations or preparing calibration curves. Detailed instructions for any Orion electrode are given in the electrode instruction manual. Titration instructions are included in the Orion Redox Electrode (Orion 9678 or 9778) Instruction Manual, or in standard analytical chemistry texts.

Absolute Millivolts

Absolute millivolts are displayed with 0.1 mV resolution in the range of -1600.0 to +1600.0 mV.

Access the absolute millivolt mode by pressing **mode** until the mV mode indicator is displayed.

Relative Millivolts

Relative millivolts are displayed with 0.1 mV resolution over the range of -1999.9 to +1999.9 mV. (Absolute millivolt range ± 1600.0).

1. Access relative millivolt mode by pressing **mode** until the REL mV mode indicator is displayed.
2. Set the relative millivolt offset by pressing **2nd** then **cal**. CALIBRATE and the current absolute millivolts will be displayed. Once the signal is stable, the meter displays 0.0. Use▲ or▼ to enter the desired value, or leave the setting at 0.0. Press **yes**. The meter automatically returns to MEASURE and all relative millivolt measurements will be based on the offset.

C. Orion 520Aplus, 525Aplus, 720Aplus, 920Aplus Millivolt Measurements

The Orion 520Aplus, 525Aplus, 720Aplus, and 920Aplus may be used to measure absolute or relative millivolts. These modes may be used for titrations, oxidation/reduction (redox) potential measurements or calibration curves. Detailed instructions for any Orion electrode are given in the appropriate electrode instruction manual. Titration instructions are included in the Orion Redox Electrode (Orion 9678 or 9778) instruction manual, or in standard analytical chemistry texts.

Absolute mV

To measure absolute millivolts, press **mode** until the mV mode indicator is displayed. The millivolt potential will be displayed in the main field and the temperature will be displayed in the prompt line. The range is ±1600.0 mV with a resolution of 0.1 mV.

Relative mV

The range is ± 1999.9 mV with the absolute range being ±1600.0 mV.

Relative mV Calibration

	Prompt	Key Press/Action
1.		Press **mode** until RMV is displayed.
2.	25.0˚C READY	Press **calibrate**.
3.	CALIBRATE RMV	Place electrode(s) in the standard.
4.	READING STANDARD	Wait for a stable electrode response.
5.	READY ENTER VALUE	0.0 will be displayed in the main display. Press **yes** if this is correct. Otherwise enter the desired value for the standard then press **yes.**
6.	OFFSET IS 100.0	The offset is calculated and displayed.
7.	25.0˚C READY	Rinse electrode(s) and place into sample.

NOTE: *For Orion 525Aplus, 720Aplus and 920Aplus, the channel number will be displayed in prompt line. For Orion 920Aplus, the electrode ID will be displayed in prompt line.*

D. Orion 525Aplus, 720Aplus, 920Aplus Redox Measurements

Measurements with redox (oxidation-reduction potential) electrode(s) are performed in the millivolt or relative millivolt modes. Perform the following steps

1. Securely connect electrode(s) to input 1 or 2.
2. **For Orion 920Aplus only:**

   a. Identify the electrode type as REDOX. Press **2nd** then **electrode id.**

   b. Select **25**, redox, then press **yes**
3. Press **mode** until mV is displayed. Measure redox potentials directly from the meter display.
4. To set redox potential to a predetermined value, press **mode** until mV is displayed. Follow instructions for setting the relative millivolt offset.

E. Orion 410Aplus Dissolved Oxygen Measurements

Dissolved Oxygen measurements are displayed in ppm when the Orion 9708 Dissolved Oxygen Electrode (Orion 970899) is used with the Orion 410Aplus Meter. Perform the following steps to prepare the meter and calibrate the electrode.

1. Connect the Orion 9708 to meter and leave electrode mode switch "OFF".
2. Disconnect ATC probe.

   NOTE: *ATC probe must not be connected to the meter and the meter should be calibrated to pH 7 at 25.0˚C.*

3. Press **mode** until MEASURE is displayed, if not already displayed.
4. Turn the mode switch on the electrode to BT CK. Good battery operation is indicated by a reading of 13.40 or greater on the meter.
5. Turn the mode switch on the electrode to ZERO. Use the zero calibration control on the electrode to set the meter to read 0.00.
6. Insert the reservoir (funnel) into a BOD bottle, containing enough water to just cover the bottom. Insert the electrode, making sure that the electrode tip is not immersed in the water and does not have water droplets clinging to the outside of the membrane. Let stand approximately 30 minutes to ensure water saturation of air in the BOD bottle. This bottle should be used for storage between measurements.
7. Turn the electrode mode switch to the AIR position. If measurements are made at sea level, use the AIR calibration control on the electrode to set the pH meter reading to the prevailing barometric pressure in mm Hg (divided by 100). If the barometric pressure is unknown, the elevation is above sea level or the sample has a salinity greater than two parts per thousand, consult **Table 1** found in the *Orion 9708 Instruction Manual* to obtain the correct AIR setting.
8. Turn the electrode mode switch to H_2O for sample analysis.
9. Record direct ppm reading from meter.

F. Orion 420Aplus, 710Aplus Dissolved Oxygen Measurements

Dissolved Oxygen measurements are displayed in ppm when the Orion 9708 Dissolved Oxygen Electrode (Orion 970899) is used with the Orion 420Aplus and 710Aplus Meters. Perform the following steps to prepare the meter and calibrate the electrode.

1. Connect the Orion 9708 to meter and leave electrode mode switch “OFF”.
2. Disconnect ATC probe.

   ***NOTE**: ATC probe must not be connected to the meter and the meter should be calibrated to pH 7 at 25.0˚C.*

3. Press **mode** until the pH mode indicator is displayed.
4. If on, turn the hold feature (1-2 in the setup menu) off.
5. Press **measure**. Using ▼or▲change the temperature value to 25.0˚C.
6. Press **2nd** then **cal**. Enter the value 7.00 and press **yes**.
7. Press **measure**. The slope prompt, SLP, will be displayed in the lower field. Enter 100.0 and press **yes**. The meter automatically enters the measure mode.
8. Turn the mode switch on the electrode to BT CK. Good battery operation is indicated by a reading of 13.40 or greater on the meter.
9. Turn the mode switch on the electrode to ZERO. Use the zero calibration control on the electrode to set the meter to read 0.00.
10. Insert the reservoir (funnel) into a BOD bottle containing enough water to just cover the bottom. Insert the electrode, making sure that the electrode tip is not immersed in the water and does not have water droplets clinging to the outside of the membrane. Let stand approximately 30 minutes to ensure water saturation of air in the BOD bottle. This bottle should be used for storage between measurements.
11. Turn the electrode mode switch to the AIR position. If measurements are made at sea level, use the AIR calibration control on the electrode to set the pH meter reading to the prevailing barometric pressure in mm Hg (divided by 100). If the barometric pressure is unknown, the elevation is above sea level or the sample has a salinity greater than two parts per thousand, consult **Table 1** found in the *Orion 9708 Instruction Manual* to obtain the correct AIR setting.
12. Turn the electrode mode switch to H_2O for sample analysis.
13. Record direct ppm reading from meter.

G. Orion 520Aplus, 525Aplus, 720Aplus Dissolved Oxygen Measurements

Dissolved Oxygen measurements are displayed in ppm when the Orion 9708 Dissolved Oxygen Electrode (Orion 970899) is used with the Orion 520Aplus, 525Aplus and 720Aplus and 920Aplus Meters. Perform the following steps to prepare the meter and calibrate the electrode.

1. Connect the D.O. electrode Orion 9708 to meter. Leave electrode mode switch "OFF".
2. For the Orion 525Aplus and 720Aplus select the correct channel by pressing **2nd** then **channel**.
3. Disconnect ATC probe.

   NOTE: *ATC probe must not be connected to the meter and the meter should be calibrated to pH 7 at 25.0˚C.*

4. Press **mode** until pH mode indicator is displayed.
5. Press **hold**. Turn the **hold** feature off.
6. Press **measure**. Press **set temp**. Enter 25.0 at the prompt and press **yes**.
7. Press **calibrate**. Enter **1** at the ENTER NO. OF BUFFER prompt and press **yes**.
8. Enter 7.00 to the CAL AS prompt and press **yes.**
9. At the slope prompt enter 100.0 and press **yes.** The meter automatically returns to measure mode.
10. Turn the mode switch on the electrode to BT CK. Good battery operation is indicated by a reading of 13.40 or greater on the meter.
11. Turn the mode switch on the electrode to ZERO. Use the zero calibration control on the electrode to set the meter to read 0.00.

12. Insert the reservoir (funnel) into a BOD bottle containing enough water to just cover the bottom. Insert the electrode, making sure that the electrode tip is not immersed in the water and does not have water droplets clinging to the outside of the membrane. Let stand approximately 30 minutes to ensure water saturation of air in the BOD bottle. This bottle should be used for storage between measurements.
13. Turn the electrode mode switch to the AIR position. If measurements are being made at sea level, use the AIR calibration control on the electrode to set the pH meter reading to the prevailing barometric pressure in mm Hg (divided by 100). If the barometric pressure is unknown, the elevation is above sea level or the sample has a salinity greater than two parts per thousand, consult **Table 1** found in the *Orion 9708 Instruction Manual* to obtain the correct AIR setting. Turn the electrode mode switch to H_2O for sample analysis.
14. Record direct ppm reading from meter.

H. Orion 920Aplus Dissolved Oxygen Measurements

Dissolved Oxygen measurements are displayed in ppm when the Orion 9708 Dissolved Oxygen Electrode (Orion 970899) is used with the Orion 920Aplus Meter. Perform the following steps to prepare the meter and calibrate the electrode.

1. Connect the D.O. electrode Orion 9708 to meter. Leave electrode mode switch "OFF".
2. Press **2nd** then **channel** to select the correct channel.
3. Press **2nd** then **electrode id**. Press **2** to select O2. Press **yes**.
4. Disconnect ATC probe.

   NOTE: *ATC probe must not be connected to the meter and the meter should be calibrated to pH 7 at 25.0˚C.*

5. Press **mode** until pH mode indicator is displayed.
6. Press **hold**. Turn the **hold** feature off.
7. Press **measure**. Press **set temp**. Enter 25.0 at the prompt and press **yes**.
8. Turn the mode switch on the electrode to BT CK. Good battery operation is indicated by a reading of 13.40 or greater on the meter.
9. Turn the mode switch on the electrode to ZERO. Use the zero calibration control on the electrode to set the meter to read 0.00.
10. Insert the reservoir (funnel) into a BOD bottle containing enough water to just cover the bottom. Insert the electrode, making sure that the electrode tip is not immersed in the water and does not have water droplets clinging to the outside of the membrane. Let stand approximately 30 minutes to ensure water saturation of air in the BOD bottle. This bottle should be used for storage between measurements.
11. Turn the electrode mode switch to the AIR position. If measurements are being made at sea level, use the AIR calibration control on the electrode to set the pH meter reading to the prevailing barometric pressure in mm Hg (divided by 100). If the barometric pressure is unknown, the elevation is above sea level or the sample has a salinity greater than two parts per thousand, consult **Table 1** found in the *Orion 9708 Instruction Manual* to obtain the correct AIR setting.
12. Turn the electrode mode switch to H_2O for sample analysis.
13. Record direct ppm reading from meter.

I. Karl Fischer Titrations

A 10 microampere polarizing current is available for Karl Fischer or other polarized electrode titrations.

Use the Karl Fischer adapter, Orion 090048.

1. Insert KF electrode pin-tip connector into the KF adapter. Connect the other pin-tip of the electrode into the reference input.
2. Connect the BNC plug of the KF adapter to the BNC meter input.
3. Insert pin-tip connector of the KF adapter into KF input on the meter.
4. Select the mV mode and then press **measure**. On the Orion 920Aplus identify the electrode as KF.
5. Perform titration.

Chapter IX

Use with Accessories

A. Use with Printers and Computers

The Orion 410Aplus and 420Aplus can send information to a printer or computer using the RS232 port.

Orion 520Aplus, 525Aplus, 710Aplus, 720Aplus, and 920Aplus have a bi-directional interface to be used with printers, computers and other serial peripheral devices. Orion provides a cable (Orion 0ACBL0) for interfacing your meter to an IBM PC or compatible device. For other computers and communication devices, a suitable cable must be fabricated. Use the information below to interface your meter and serial peripheral device.

Baud rate: 1200.

Eight data bits, no parity

One start bit, one stop bit.

Meter	Pin	Printer	Pin
RXD	2		
TXD	3	RXD	3
DSR	4		
SIG GND	5	SIG GND	5
DTR	6		
RTS	7		
CTS	8	RTS	8

Jumper 4 and 6 together.

The RS232 port on the meter is a nine pin D-shell subminiature male connector (DB-9 style).

Use with the 900A Printer

When used with the Orion 900A printer, the meter will provide a printed record of results. The 900A printer can be battery operated or connected to line power.

Plug the printer directly into the meter using the nine pin D shell connector on the left side of the meter.

The meters have three print options:

Command Print

Prints current display.

Ready Print

Prints whenever the READY indicator is displayed.

Timed Print

Prints at selected timed intervals.

B. Remote Control for Orion 710Aplus

The Orion 710Aplus can be remotely controlled from an RS232 communication device or PC. After making the physical connection between your meter and computing device, type **rem** into your computer to establish communication.

The following are the remote control commands:

Command	Function or Meaning
+	increase value, scroll up
-	decrease value, scroll down
cal	calibrate
disp	display LCD image
exit	exit remote control
help	displays help menu
meas	measure
mode	change mode
n	no
off	shut down, turn off
setup	setup, go to setup menu
timer	timer, start timer
y	yes
rem	remote log in
mp	prints value, mode, and temperature
pr	print/datalog

NOTE: *help and rem are not displayed in the help menu.*

The following is an example of a program, written in Basic, which monitors pH data every five seconds and prints the data if the pH value is less than five.

For Orion 710Aplus

```
100 '*******************************************************************************
110 '** THIS PROGRAM LOGS ONTO AN ORION BENCHTOP METER AND EVERY 5 SECONDS         **
120 '** WILL CHECK THE CURRENT pH VALUE BY SENDING A "mp" COMMAND.  IF             **
130 '** THE pH VALUE IS ABOVE 5.00, IT WILL SEND A "pr" COMMAND TO REQUEST        **
140 '** A FULL PRINTOUT.  IT WILL ALSO SCAN THE COMPUTER KEYBOARD FOR <ESC>       **
150 '** KEY AND IF DETECTED THE PROGRAM IS TERMINATED.                           **
160 '** THIS PROGRAM SHOULD BE USED AS A GENERAL GUIDE LINE AND CAN BE           **
170 '** CUSTOMIZED TO PERFORM OTHER TASKS SUCH AS STRIPPING THE DATA AND         **
180 '** STORING THE INFORMATION ON FILE OR DIVERTING TO A LINE PRINTER.          **
190 '*******************************************************************************
200 OPEN "COM1:1200,N,8,1" FOR RANDOM AS #1
210 ON COM(1) GOSUB 470: 'CAPTURE ALL INCOMING CHARACTERS IN THIS ROUTINE
220 COM(1) ON: 'ALLOW COM(1) INTERRUPT
230 CLS : PRINT "LOGGING ON.....": LOGFLAG = 1: STPOS = 1
240 PRINT #1, "rem": 'LOG ONTO THE METER BY SENDING A "remOTE" COMMAND
250 WHILE 1
260     TI = TIMER + 5: 'EVALUATE CURRENT READING EVERY 5 SECONDS
270     WHILE TIMER < TI
280         KP$ = "": KP$ = INKEY$
290         IF KP$ = CHR$(27) THEN 350: 'LOOK FOR <ESC> KEY TO END PROGRAM
300     WEND
310     IF LOGFLAG = 2 THEN LOGFLAG = 0: CLS : PRINT LG$
320     PRINT #1, "mp" + CHR$(13): 'SEND THE COMMAND TO REQUEST CURRENT READING
330     IF PH > 5! THEN PRINT #1, "pr" + CHR$(13): 'IF pH IS >5, REQUEST A PRINTOUT
340 WEND
350 PRINT #1, "exit": 'LOG OUT OF THE METER
360 PRINT "END OF PROGRAM."
370 CLOSE #1: COM(1) OFF: 'TURN OFF THE COMMUNICATION INTERRUPT
380 END
390 '
400 '*******************************************************************************
410 '** THIS IS THE INTERRUPT ROUTINE THAT HANDLES ALL INCOMING CHARACTERS       **
420 '** FROM THE COMMUNICATION PORT.  AS THE CHARACTERS COME IN, THEY ARE        **
430 '** BUFFERED UNTIL A LF (LINEFEED) IS RECEIVED.  AT THIS POINT, THE          **
440 '** STRING IS EVALUATED FOR PRINTING.                                        **
450 '*******************************************************************************
460 '
470 A$ = "": LF = 0: 'INITIALIZE THE LOCAL VARIABLES
480 IF NOT EOF(1) THEN A$ = INPUT$(LOC(1), #1)
490 L$ = L$ + A$: 'KEEP ADDING ALL INCOMING CHARS TIL A LF IS RECEIVED
500 IF INSTR(L$, CHR$(10)) = 0 THEN RETURN: 'WE ARE NOT DONE TIL WE GET A LINEFEED
510 IF LOGFLAG = 1 AND INSTR(L$, "THERMO ORION") THEN GOSUB 700
520 IF PHFLAG = 1 THEN GOSUB 600: GOTO 580: '2ND TIME READ THE pH VALUE
530 IF INSTR(L$, "mp") THEN GOSUB 600: GOTO 580: '1ST TIME FILTER OUT ECHO
540 L$ = MID$(L$, 1, LEN(L$) - 1): 'FILTER OUT THE EXTRA LINEFEED
550 IF INSTR(L$, "CH") OR INSTR(L$, "pH") THEN PRFLAG = 1
560 IF PRFLAG = 1 THEN PRINT L$; : 'IF WE ARE ALLOWED TO PRINT, THEN DO IT
570 IF INSTR(L$, ":") THEN PRFLAG = 0: PRINT : 'DATE/TIME IS THE LAST LINE TO PRINT
580 L$ = "": RETURN
590 '
600 '*******************************************************************************
610 '** THIS ROUTINE IS USED TO CAPTURE THE CURRENT pH READING AFTER "mp"        **
620 '** COMMAND HAS BEEN SENT.  THIS VALUE IS LATER EVALUATED FOR PRINTING.      **
630 '*******************************************************************************
640 '
650 IF PHFLAG = 0 THEN PHFLAG = 1: RETURN: 'SET US UP TO CAPTURE pH AT NEXT PASS
660 PH = VAL(MID$(L$, STPOS, 8)): 'THIS STRING MUST HAVE THE pH VALUE
670 PHFLAG = 0: 'MAKE SURE WE DON'T ENDUP HERE TIL ITS TIME AGAIN
680 RETURN
690 '
700 '*******************************************************************************
710 '** THIS ROUTINE IS USED TO DETERMINE THE TYPE OF BENCH TOP METER.           **
720 '*******************************************************************************
730 '
740 LG$ = MID$(L$, 1, 12) + MID$(L$, 23, 11): 'SAVE THIS AS THE LOG MESSAGE
750 LOGFLAG = 2: 'TELL SYSTEM WE HAVE THE LOG MESSAGE TO DISPLAY
760 RETURN
```

C. Remote Control for Orion 520Aplus, 525Aplus, 720Aplus, and 920Aplus

The meters can be remotely controlled from a personal computer or other RS232 communication device. After making the physical connection between your meter and computing device, type **rem** to establish communication. The following list is the remote control commands. All commands are lower case letters.

Command	Function or Meaning
-	minus key
.	decimal point
0 thru 9	numerals or each represents their respective keys
al	Alarm Limits
at	Activate Timer
beep	BEEP toggle
cal	Calibrate
ce	Calibration edit (920Aplus only)
disp	Display reading, value, mode, and temperature
dlz	clear datalog
dpm	set data print mode
dt	set date and time
ech	select electrode channel(920Aplus, 720Aplus and 525Aplus only)
eid	specify electrode I.D.(920Aplus only)
exit	exit remote control
fir	First key
help	display list of commands

Command	Function or Meaning
hold	hold toggle
it	Incremental techniques mode (920Aplus only)
meas	measure
mode	change modes
mv	millivolt display
n	No
opt	select options menu
pr	print or datalog
ready	ready function toggle
rem	enter remote control function
res	select resolution
sec	second key
slope	slope
stab	display stability (920Aplus only)
stand	enter standby
temp	Set manual temperature
timer	set timer
y	Yes

NOTE: *help and rem are not displayed in the help menu.*

The following is an example of a program, written in Basic, which monitors pH data every five seconds and prints the data if the pH value is less than five.

For Orion 520Aplus, 525Aplus, 720Aplus, and 920Aplus

```
100 '*******************************************************************************
110 '** THIS PROGRAM LOGS ONTO AN THERMO ORION BENCHTOP METER AND EVERY 5 SECONDS
**
120 '** WILL CHECK THE CURRENT pH VALUE BY SENDING A "disp" COMMAND.  IF                **
130 '** THE pH VALUE IS ABOVE 5.00, IT WILL SEND A "pr" COMMAND TO REQUEST              **
140 '** A FULL PRINTOUT.  IT WILL ALSO SCAN THE COMPUTER KEYBOARD FOR <ESC>             **
150 '** KEY AND IF DETECTED THE PROGRAM IS TERMINATED.                                  **
160 '** THIS PROGRAM SHOULD BE USED AS A GENERAL GUIDE LINE AND CAN BE                  **
170 '** CUSTOMIZED TO PERFORM OTHER TASKS SUCH AS STRIPPING THE DATA AND                **
180 '** STORING THE INFORMATION ON FILE OR DIVERTING TO A LINE PRINTER.                 **
190 '*******************************************************************************
200 OPEN"COM1:1200,N,8,1" AS #1
210 ON COM(1) GOSUB 470:'CAPTURE ALL INCOMING CHARACTERS IN THIS ROUTINE
220 COM(1) ON:'ALLOW COM(1) INTERRUPT
230 CLS:PRINT "LOGGING ON.....":LOGFLAG=1:STPOS=1
240 PRINT #1,"rem":'LOG ONTO THE METER BY SENDING A "remOTE" COMMAND
250 WHILE 1
260     TI = TIMER+5:'EVALUATE CURRENT READING EVERY 5 SECONDS
270     WHILE TIMER < TI
280             KP$="":KP$=INKEY$
290             IF KP$= CHR$(27) THEN 350:'LOOK FOR <ESC> KEY TO END PROGRAM
300     WEND
310     IF LOGFLAG=2 THEN LOGFLAG=0:CLS:PRINT LG$
320     PRINT #1,"disp"+CHR$(13):'SEND THE COMMAND TO REQUEST CURRENT READING
330     IF PH > 5! THEN PRINT #1,"pr"+CHR$(13):'IF pH IS >5, REQUEST A PRINTOUT
340 WEND
350 PRINT #1,"exit":'LOG OUT OF THE METER
360 PRINT"END OF PROGRAM."
370 CLOSE #1:COM(1) OFF:'TURN OFF THE COMMUNICATION INTERRUPT
380 END
390 '
400 '*******************************************************************************
410 '** THIS IS THE INTERRUPT ROUTINE THAT HANDLES ALL INCOMING CHARACTERS          **
420 '** FROM THE COMMUNICATION PORT.  AS THE CHARACTERS COME IN, THEY ARE           **
430 '** BUFFERED UNTIL A LF (LINEFEED) IS RECEIVED.  AT THIS POINT, THE             **
440 '** STRING IS EVALUATED FOR PRINTING.                                           **
450 '*******************************************************************************
460 '
470 A$="":LF=0:'INITIALIZE THE LOCAL VARIABLES
480 IF NOT EOF(1) THEN A$=INPUT$(LOC(1),#1)
490 L$ = L$+A$:'KEEP ADDING ALL INCOMING CHARS TIL A LF IS RECEIVED
500 IF INSTR(L$,CHR$(10)) = 0 THEN RETURN:'WE ARE NOT DONE TIL WE GET A LINEFEED
510 IF LOGFLAG = 1 AND INSTR(L$,"THERMO ORION") THEN GOSUB 700
520 IF PHFLAG = 1 THEN GOSUB 600:GOTO 580:'2ND TIME READ THE pH VALUE
530 IF INSTR(L$,"disp") THEN GOSUB 600:GOTO 580:'1ST TIME FILTER OUT ECHO
540 L$= MID$(L$,1,LEN(L$)-1):'FILTER OUT THE EXTRA LINEFEED
550 IF INSTR(L$,"CH") OR INSTR(L$,"pH") THEN PRFLAG=1
560 IF PRFLAG = 1 THEN PRINT L$;:'IF WE ARE ALLOWED TO PRINT, THEN DO IT
570 IF INSTR(L$,":") THEN PRFLAG=0:PRINT:'DATE/TIME IS THE LAST LINE TO PRINT
580 L$="":RETURN
590 '
600 '*******************************************************************************
610 '** THIS ROUTINE IS USED TO CAPTURE THE CURRENT pH READING AFTER "disp"         **
620 '** COMMAND HAS BEEN SENT.  THIS VALUE IS LATER EVALUATED FOR PRINTING.        **
630 '*******************************************************************************
640 '
650 IF PHFLAG = 0 THEN PHFLAG = 1:RETURN:'SET US UP TO CAPTURE pH AT NEXT PASS
660 PH = VAL(MID$(L$,STPOS,8)):'THIS STRING MUST HAVE THE pH VALUE
670 PHFLAG = 0:'MAKE SURE WE DON'T ENDUP HERE TIL ITS TIME AGAIN
680 RETURN
690 '
700 '*******************************************************************************
710 '** THIS ROUTINE IS USED TO DETERMINE THE TYPE OF BENCH TOP METER.              **
720 '*******************************************************************************
730 '
740 LG$=L$:íSAVE THIS AS THE LOG MESSAGE
750 LOGFLAG=2'TELL SYSTEM WE HAVE THE LOG MESSAGE TO DISPLAY
760 IF INSTR(LG$,'920Aplus') THEN STPOS = 2'FIND THE METER TYPE
770 RETURN
```

D. Use with Orion 607 Electrode Switchbox

When the Orion 607 electrode switchbox is connected to the 920Aplus Meter, up to seven electrodes can be used. Up to seven different calibrations will be stored in memory until the user repeats a calibration.

1. Connect the BNC cable from the BNC output of the Switchbox to the No. 2 BNC jack on the rear of the 920Aplus Meter. Connect the grounding cable from the switchbox to the meter ground.

   ***NOTE**: Do not connect the RS232 cable that comes with the 607. This cable is not used in this application.*

2. Plug an appropriate line converter into a standard 110V or 220V AC, 50/60 Hz wall outlet into the jack labeled power on the Switchbox.

3. Press **2nd** then **options** on the 920Aplus Meter to access the options menu. Identify the use of a switchbox in the options menu.

Once the instrument and switchbox have been interfaced, pressing **2nd** then **channel** changes channels on the meter. The meter will step through all channels 1 through 7 in turn. Verify the calibration of each channel per the 607 Instruction Manual. To change the channel on the switchbox press **channel selection** on the front of the 607 until the channel indicator matches the one on the meter, except for channel 1 that is not displayed on the switchbox.

The Orion 607 electrode switchbox may also be used with meter Orion 520Aplus, 525Aplus, and 720Aplus. However, these instruments will not store calibration curves in memory. Connect the switchbox to channel one (520Aplus) or two (525Aplus and 720Aplus) then follow steps 1 and 2 above.

E. Use with Strip Chart Recorders

The Orion 520Aplus, 525Aplus, 720Aplus, and 920Aplus can be used with a strip chart recorder. The audio jack on the rear panel provides an output for a strip chart recorder of absolute millivolts independent of operating mode. On the 525Aplus, 720Aplus and 920Aplus this output is for channel one only.

The voltage provided is a direct uncompensated readout of the electrode response, set at a one to one ratio.

To interface your recorder to the meter, a 2.5 mm phone plug is required. The tip (inner) connection should be wired to the high side of the recorder and the sleeve (outer) connection should be wired to the low side of the recorder. A Switchcraft type 850 or equivalent phone plug is suggested.

F. Use with DataCOLLECT™

DataCOLLECT can be used with Orion 520Aplus, 525Aplus, 720Aplus, and 920Aplus.

DataCOLLECT is a program that can be easily installed for your unattended PC to collect data from Orion's family ISE, pH, Conductivity and Dissolved Oxygen (DO) meters from up to 4 serial ports simultaneously.

This software operates in Windows® 3.1†, Windows 95 an Windows NT version 4 Platforms.

DataCOLLECT collects the data generated by the meter, which is passed to the PC via RS232 output. The required computer interface cable, Orion 0ACBLO, is included with the DataCOLLECT software package. DataCOLLECT also allows you to export the data received into programs such as Excel†, Lotus††, and Access† for your convenience.

(†Registered Trademark of Microsoft Corporation)
(††Registered Trademark of Lotus Development Corporation)

Chapter X

Troubleshooting

A. Self-Test

The self-test is performed by holding **yes** down while the meter is being powered on.

***NOTE**: Before starting the self-test securely attach the shorting cap to the electrode input(s).*

During the self-test the meter will display the number of the test being performed. If any problems are found, an operator assistance code corresponding to the test that failed will be displayed. See Table 1 under operator assistance codes. Should an operator assistance code appear during self test, press **yes** to acknowledge and continue the test. Check to make sure the shorting cap is securely attached then repeat the test. If the problem persists, contact Technical Service Department at 1-800-225-1480.

Orion 410Aplus, 420Aplus and 710Aplus: During the self-test the meter displays the code 7E57 in the main display and the number of the test being performed in the lower display. Additional meter displays occur depending on the test being performed.

Orion 520Aplus, 525Aplus, 720Aplus, and 920Aplus: During the self test the meter displays the number of the test in the prompt line. Example: TEST 1

***NOTE**: Ensure shorting cap is on the meter prior to self-test.*

Test	Function/Display	Sequence
TEST #1	Segment Display	Checks meter display. Ensure all segments are lit at this time.
TEST #2	RAM Check	Verifies the external RAM is functioning properly.
TEST #3	External Input 1	Checks the electrode input channel 1. The shorting cap must be connected for this test to pass properly.
TEST #4	External Input 2	Checks the electrode input channel 2. The shorting cap must be connected for this test to pass properly.
TEST #5	Internal Reference	Checks the internal reference on the meter.
TEST #6	Ground Reference	Checks the meter ground.

Test	Function/Display	Sequence
TEST #7	Keypad Test	Checks that the keypad is functioning properly. During this test, each key must be pressed, one at a time, at the 0 prompt for Orion 410Aplus, 420Aplus and 710Aplus, and PRESS ALL KEYS for Orion 520Aplus, 525Aplus, 720Aplus and 920Aplus. If no keys are pressed, or there is a problem with a key, the meter will recognize an error and display E-7 for Orion 420Aplus and 710Aplus, and ERROR 7 for Orion 520Aplus, 525Aplus, 720Aplus, and 920Aplus. Press **yes** to continue.
TEST #8	Autoshutoff Test	Checks the meter autoshutoff feature. The display clears then the meter shuts off. After a brief interval the meter will turn on again and resume normal operation.

***NOTE**: If any operator assistance codes appear make a note of each, then press* **yes** *to continue.*

B. Operator Assistance Codes

Operator Assistance Codes are used to inform the user of an out of range value or meter problem. The following tables outline the operator assistance codes available.

The meter has a self-test circuit that verifies proper electronic operation. During self-test a special series of codes, E-1 through E-8 indicate a problem with the meter hardware. See Table I. Should one of these codes appear contact Technical Service Department at 1-800-225-1480.

Table I Operator Assistance Codes

Self Test

Error	Code
E-1	Segment Display Error
E-2	Ram Check Error
E-3	Input Channel 1 Error: Check to make sure the shorting cap is securely in place on the input connector and repeat self-test.
E-4	Input Channel 2 Error: Check to make sure the shorting cap is securely attached and repeat the self-test.
E-5	Internal Reference Error
E-6	Internal Ground Error
E-7	Keypad Error: Press each key one at a time while in self-test. If code persists contact Technical Service Group.
E-8	Instrument Shutdown Error - for Orion 520Aplus, 525Aplus, 720Aplus and 920Aplus only.

The Operator Assistance Codes E-20 through E-32 alert the user to a potential problem while calibrating or measuring. Several steps can be taken to eliminate the problem in each case. If the error code persists after trying the suggested remedies, contact Technical Service Group.

Table II Operator Assistance Codes

Error Code	Problem	Probable Remedy
E-20	out of range pH,mV, Rel mV, or conc.	1. If this occurs when electrode(s) are out of solution, code will disappear when electrode(s) are returned to solution. 2. Verify electrode(s) are properly connected. 3. Sample may be out of range. Check buffer or standard. 4. Check slope value and the isopotential point setting. 5. Recalibrate using fresh buffer or standards. 6. Check that the ATC probe is connected properly and make sure temperature is within -5.0 to +105˚C.
E-21	ABR error pH autocalibration error	Electrode voltage being measured is > ±0.5 pH units from the nominal value for the pH buffer, therefore the meter does not recognize it as an autobuffer. 1. Verify buffer as 1.68, 4.01, 7.00, 10.01, or 12.46. For Orion 410Aplus and 420Aplus verify buffer as 4.01, 7.00, or 10.01. 2. Press any key and recalibrate using fresh buffer. . 3. Clean electrode(s) and refill reference electrode. Recalibrate. 4. Perform a manual calibration. Some electrode(s) may operate outside of the range for pH autocalibration. This may be a sign for an electrode aging and is normal.

Error Code	Problem	Probable Remedy
E-22	Calibration Std Error	The millivolts being measured are the same for two different standards. Check that two different standards or buffers are being used and that the correct one is being measured. 1. Make fresh standards or buffers and repeat the last calibration point or the entire calibration.
E-23	Bad Slope	pH electrode slope not in the range of 80% to 120%. 1. Press any key to acknowledge and repeat calibration using fresh buffers. 2. Clean electrode(s) and refill reference electrode(s). 3. Refer to electrode instruction manual for instructions on how to check electrode operation.
E-26	Datalog Full	The datalogger is full and cannot store any more points. A maximum of 25 points may be stored. 1. Transfer data to a printer or computer. 2. Clear data from memory . For Orion 710Aplus: a. Go to 6-3 in the setup menu and transfer data to the printer or computer by pressing ▲▼ then **yes.** b. Go to 6-4 in the setup menu and press ▲▼then **yes.** Once the data has been cleared additional points may be logged. c. For Orion 520Aplus, 525Aplus, 720Aplus, and 920Aplus: Press **2nd** then **options** to access the options menu. Follow the prompts to transfer and clear the datalogger.

Error Code	Problem	Probable Remedy
E-27	Data Transfer Error	There is a problem in transferring data from the datalogger to a printer or computer. 1. Press any key to acknowledge the error. 2. Check to make sure the printer or other device is securely plugged into the RS232 port on the meter. 3. Check to make sure your printer or computer is on and ready to receive information from the meter. 4. Check your cable to make sure it matches the pin configuration of the meter. Use Orion 0ACBL0 for IBM PC or compatible devices.
E-28	Incremental Techniques (920Aplus only)	The concentration of the unknown cannot be calculated. This can occur during both single and double incremental techniques. 1. Press any key to acknowledge the error. 2. The millivolt differences may not be great enough to permit calculation of the unknown. Increase standard concentration used or dilute the sample. 3. The concentration of the unknown is calculated to be less than 0.0001. a. If unknown has been diluted use a fresh aliquot of undilited unknown or one that is not so dilute. b. Use different unit of measurement, for example use ppm instead of M.

Error Code	Problem	Probable Remedy
		4. Make sure electrode(s) are properly identified, connected and filled. 5. If error persists, measure a standard of known concentration with the same background as the sample to be measured. Adjust the standard concentrations and volumes until results are obtained. 6. If the sample contains complexing agents, add an excess of the agent prior to analysis.
E-29	Printer Error	The meter is sending information to a printer and there is no printer plugged into the meter or the printer is not turned on. 1. Plug in the printer and turn it on. 2. If printer is not available, select manual print under the set data print modes. Press **data/print** to access.
E-31	Bad Value	A value has been entered that is not within the acceptable range for that function. 1. Press any key to acknowledge the error. 2. Re-enter a new value within the allowable range. Acceptable values are as follows: **pH:** -2.000 to +19.999 **pH slope:** 80% to 120% **timer interval:** 5 seconds to 23 hours, 59 minutes and 59 seconds **relative millivolts:** -1999.9 to +1999.9 **concentration:** 0.0000 to 19900

Error Code	Problem	Probable Remedy
E-32	Blank Error. Orion 710Aplus, 720Aplus, and 920Aplus	The meter is unable to calculate a blank value. This error occurs during a three or more point calibration, when one solution has been defined as zero concentration and the actual concentration of the blank is substantially greater than the least concentrated standard. This can also occur during a one or two point calibration if one of the standards is defined as zero. 1. Check to make sure electrode(s) were placed in the proper standards and blank solution and recalibrate. 2. Repeat calibration using fresh blank and standards. 3. Recalibrate using two standards of known concentration other than zero.

C. Meter Operation Problem

Table III – Meter Operation Problem

Problem	Probable Cause	Remedy
No Display	No power to meter	For Orion 410Aplus, 420Aplus, 710Aplus press the power key. For all models, check that the line converter is plugged in securely.
	Autoshutoff may be turned on	When the Autoshutoff feature is on, the meter will automatically shut down if no keys have been pressed within 10 minutes. For Orion 410Aplus, 420Aplus and 710Aplus press the power key to turn the meter on. For Orion 520Aplus, 525Aplus, 720Aplus and 920Aplus, press any key. If this feature is not desired, turn autoshutoff off.
Erratic Readings or Reading out of Range	Meter or electrode failure	Follow the meter check out procedure. Check electrode operation by following the instructions in the electrode instruction manual.

Problem	Probable Cause	Remedy
Trouble Calibrating in Autocalibration	Some electrodes may operate outside the limits of ± 0.5 pH units.	Perform a manual calibration Buffers used may be out of specification. Repeat calibration using fresh buffers or from a different lot.
Meter display Locks	Meter failure	For Orion 420Aplus, 710Aplus, reset meters as described in set-up menu 2-4. For Orion 520Aplus, 525Aplus, 720Aplus 920Aplus, unplug meter, hold 0 key down and plug meter in. Press **yes** at the prompt “RESET METER?”

Chapter XI

Service and Repair

After troubleshooting all components of your measurement system, contact The Technical Edge℠ for Orion products. Within the United States call 1.800.225.1480, outside the United States call 978.232.6000 or fax 978.232.6031. In Europe, the Middle East and Africa, contact your local authorized dealer. For the most current contact information, visit www.thermo.com.

Chapter XII

Notice of Compliance

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference.

“This digital apparatus does not exceed the (Class A) limits for radio noise emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.”

“Le présent appareil numérique n’ émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques (de la class A) prescrites dans le Règlement sur le brouillage radioélectrique édicté par le ministère des Communications du Canada.”

Declaration of Conformity

Thermo Electron Corporation

Manufacturer:

Thermo Electron Corporation
166 Cummings Center
Beverly, MA 01915 U.S.A.

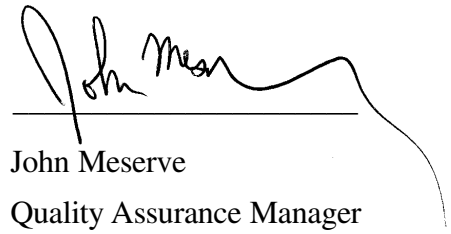
hereby declares that the products

Benchtop Meter Orion 920Aplus 720Aplus
710Aplus 525Aplus
520Aplus 420Aplus
410Aplus

conforms with the following standards and documents

Safety:	EC Direcive 72/23/EEC Low Voltage Directive DIN VDE 0700 Transformers EN 61010-1: 1990 Laboratory Equipment UL 1310 Class 2 Power Units CSA C22.2 No. 223 Extra-Low Voltage Transformers. CSA C22.2 No. 151-M1986 Laboratory Equipment UL Std. No. 1262 Laboratory Equipment	
EMC:	EC 89/336/EEC Electromagnetic Compatibility	
Emissions:	EN 55022 Emissions Class A FCC Part 15 Class A	
Immunity:	EN 50082-1 IEC 801-2 IEC 801-3 IEC 801-4	Generic Immunity ESD Susceptibility Radiated Susceptibility Conducted Susceptibility

These Orion products have been manufactured in compliance with the provisions of the relevant Thermo Electron manufacturing and test documents and processes. Further, these documents and processes are recognized as complying with ISO 9000:2000 by QMI, listed as File # 001911.



Place and date of issue:

Beverly, MA.

June, 2003

John Meserve

Quality Assurance Manager

Chapter XIII

Instrument Warranty

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

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

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

Any product sold by a U.S. or Canadian distributor must be returned to Thermo for any warranty work. Please contact our Technical Service department for further information. A Return Authorization Number must be obtained from The Technical EDGE℠ 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™, EZ Flash® GC Accessory and TEA Analyzer®. Contact our Field Service department for details on quotations and service, other field service-related activities.

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

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

- Waterproof Meters (Orion 630, 635, 830A, 835A, 260A, 261S, 265A, 266S, 130A, 131S, 135A and 136S), Conductivity Meters (Orion 105Aplus, 115Aplus, 125Aplus, 145Aplus, 150Aplus and 162A), PerpHect® pH/ISE Meters (Orion 310, 320, 330, 350, 370) pH/ISE Meters (Orion 210Aplus, 230Aplus, 250Aplus, 290Aplus, 410Aplus, 420Aplus, 520Aplus, 525Aplus, 710Aplus, 720Aplus and 920Aplus), pHuture MMS™ Meters (Orion 535A and 555A), pH/Conductivity Meter (Orion 550A), Dissolved Oxygen Meters (Orion 805Aplus, 810Aplus, 850Aplus and 862A).

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

- Orion ROSS Ultra® Electrodes, 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

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.

Chapter XIV

Ordering Information

Orion	Description
0410A0	Orion 410Aplus pH/mV/Temperature Meter, 110V. Includes Orion Sure-Flow Combination pH probe.
0410A1	Orion 410Aplus pH/mV/Temperature Meter, 220V. Includes Orion Sure-Flow Combination pH probe.
0420A0	Orion 420Aplus pH/mV/Temperature Meter, 110V. Includes Orion Triode pH/ATC probe.
0420A1	Orion 420Aplus pH/mV/Temperature Meter, 220V. Includes Orion Triode pH/ATC probe.
0520A0	Orion 520Aplus pH/mV/Temperature Meter with custom vacuum fluorescent display, 110V. Includes Orion combination ROSS electrode, 8102BN.
0520A1	Orion 520Aplus pH/mV/Temperature Meter with custom vacuum fluorescent display, 220V. Includes Orion combination ROSS electrode, 8102BN.
0520A3	Orion 520Aplus Benchtop pH/mV/Temperature Meter includes Orion Triode 3 in 1 combination pH/ATC probe, 110V wall adapter, benchtop meter starter kit (OBCHSK).
0525A0	Orion 525Aplus pH/mV/Temperature Meter with custom vacuum fluorescent display, 110V. Includes Orion combination ROSS electrode, 8156BN.
0525A1	Orion 525Aplus pH/mV/Temperature Meter with custom vacuum fluorescent display, 220V. Includes Orion combination ROSS electrode, 8156BN.
0525A3	Orion 525Aplus Benchtop pH/mV/Temperature Meter includes Orion Triode 3 in 1 combination pH/ATC probe, 110V wall adapter, benchtop meter starter kit (OBCHSK).
0710A1	Orion 710Aplus Portable pH/ISE/mV/Temperature Meter, 110V. Includes Orion combination ROSS electrode, 8102BN.
0720A0	Orion 720Aplus pH/ISE/mV/Temperature Meter with custom vacuum fluorescent display, 110V. Includes Orion combination ROSS electrode, 8102BN.
0720A1	Orion 720Aplus pH/ISE/mV/Temperature Meter with custom vacuum fluorescent display, 220V. Includes Orion combination ROSS electrode, 8102BN.

Orion	Description
0720A3	Orion 720Aplus pH/ISE/mV/Temperature Meter includes electrode holder and stand, 110V wall adapter.
0920A0	Orion 920Aplus pH/ISE/mV/Temperature Meter with incremental techniques and custom vacuum fluorescent display, 110V. Includes Orion combination ROSS electrode, 8102BN.
0920A1	Orion 920Aplus pH/ISE/mV/Temperature Meter with incremental techniques and custom vacuum fluorescent display, 220V. Includes Orion combination ROSS electrode, 8102BN.
0920A3	Orion 920Aplus pH/ISE/mV/Temperature Meter, includes electrode holder and stand, 110v wall adapter and instruction manual.
0BCHSK	Benchtop Meter starter kit, includes electrode holder and stand, ATC probe, one 475 mL bottle each of pH 4, pH 7, and pH 10 buffer solution and one 475 mL bottle of electrode storage solution.
0900A0	Portable Printer for Orion Meters. Includes Rechargeable battery and one roll of printer paper. 110V.
0900A1	Portable Printer for Orion Meters. Same as above except 220V. DTCL20 DataCOLLECT for window®
0ACBL0	RS232 Interface Cable for use with computers and other RS232 devices. IBM PC or compatible device.
DTCL20	DataCollect for Windows®
090070	Electrode Holder and Stand.
9157BN	Orion Triode Combination pH/ATC Probe for Orion A Series Meters.
9107BN	Orion Low Maintenance Triode Combination pH/ATC probe for Orion A Series Meters.
917005	Epoxy ATC Probe for Orion A Series Meters.
917006	Glass ATC Probe for Orion A Series Meters.
8102BN	Ross Combination Glass pH Electrode.
8156BN	ROSS Combination Epoxy pH Electrode.
8172BN	Ross SURE-FLOW Combination Glass pH Electrode.
8165BN	Ross SURE-FLOW Epoxy-Body Combination pH Electrode.

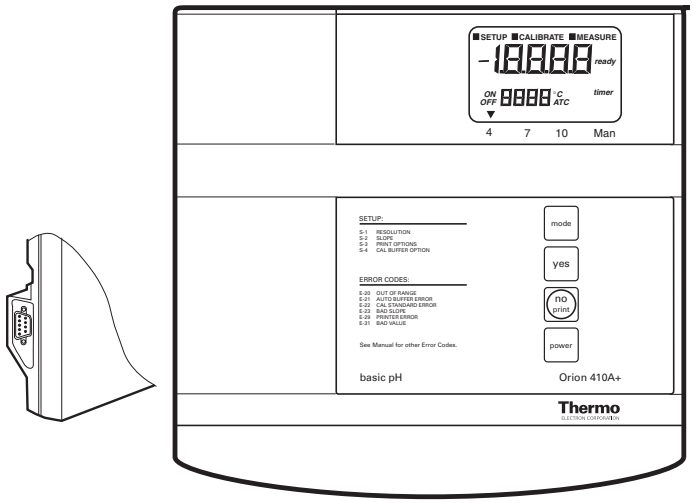
Orion	Description
8175BN	Ross SURE-FLOW Semi-Micro Epoxy-Body Combination pH Electrode
020125	Line Converter, 110V.
020130	Line Converter, 220V.
020135	Line Converter, 240V
910104	pH 4 Buffer Solution, 475 mL
910105	pH 5 Buffer Solution, 475 mL
910107	pH 7 Buffer Solution, 475 mL
910110	pH 10 Buffer Solution, 475 mL
910410	perpHect®Buffer Solution pH 4, 10 pk
910425	perpHect Buffer Solution pH 4, 25 pk
910710	perpHect Buffer Solution pH 7, 10 pk
910725	perpHect Buffer Solution pH 7, 25 pk
910110	perpHect Buffer Solution pH 10, 10 pk
910125	perpHect Buffer Solution pH 10, 25 pk
911110	perpHect Electrode Rinse , 10 pk
911125	perpHect Electrode Rinse , 25 pk
910001	pH Electrode Storage Solution, 475 mL

***NOTE**: A wide selection of pH, Ion Selective Electrodes and replacement parts are available. Contact Thermo Electron Corporation or your local authorized distributor for more information.*

Appendix A

Overview of Meter Functions

Orion 410Aplus



Front Panel Of 410Aplus

Operating Mode Indicates instrument operating mode.

SETUP Indicates meter is in the SETUP mode, accessed by pressing **mode**.

CALIBRATE Indicates meter is in the CALIBRATION mode, accessed by pressing **mode**.

MEASURE Indicates the meter is in the MEASURE mode, accessed by pressing **mode.**

Main Field Displays pH when in the measure mode.

Secondary Displays temperature in degrees Celsius. The ˚C display designation is displayed when temperature is displayed.

ATC Displayed when a temperature probe is attached.

ready Displayed when the electrode is stable.READY may be turned on or off in the SETUP menu.

Primary Key Pad Functions, Orion 410Aplus

yes Press to enter a value during calibration or setup. May also be used to scroll through the setup menu without changing any parameters.

no Press to cancel or to change to a parameter before entering.

print Press to print pH value at ready prompt.

mode Press to change operating modes. The options are MEASURE, SET UP or CALIBRATE

power Press to turn meter on or off.

Set-up menu for Orion 410Aplus

The SETUP menu is used to identify and change instrument operating parameters. While in setup **yes** is used to scroll through the menu without changing any parameters, **no** is used to scroll through the changes for that parameter. To enter the setup menu press **mode**. After changing a setting, press **yes**. Pressing **no** reverts the parameter to its former state (if done before entering the new setting).

Scroll through the SETUP menu accepting or changing parameters as desired.

To exit the SETUP menu, press **mode** to begin calibration or to analyze samples.

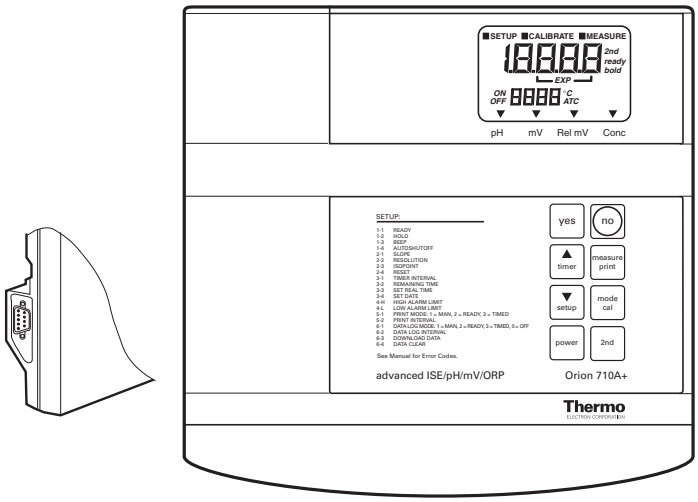
AUTOSHUTOFF

To turn the AUTOSHUTOFF feature off, press and hold **mode** during power up of the meter. After a power interruption or failure, this procedure must be repeated.

Appendix B

Overview of Meter Functions

Orion 420Aplus, 710Aplus



Front Panel Of 710Aplus

Operating Mode Indicates instrument operating mode.

SETUP Indicates meter is in the SETUP mode. accessed by pressing **2nd** then **Setup.**

CALIBRATE Indicates meter is in the CALIBRATION mode, accessed by pressing **2nd** then **cal**.

MEASURE Indicates the meter is in the MEASURE mode, accessed by pressing **measure**.

Main Field Displays pH, millivolts, or relative millivolts depending on the meter operating mode.

ON/OFF During SETUP on/off indicates if a particular feature is active or not.

Secondary Displays temperature in degrees Celsius. The ˚C designation is displayed when temperature is displayed.

ATC Displayed when a temperature probe is attached.

2nd	Displayed when **2nd** has been pressed, indicating the meter is ready to perform a second function, **cal, timer**, **setup**, or **print**.
ready	Displayed when the electrode is stable. READY may be turned on or off in the SETUP menu.
hold	Displayed when the pH reading is frozen after reaching stability. The HOLD feature may be turned on or off in the SETUP menu.
timer	Displayed when the timer function has been activated.
Mode Indicator	Designates instrument operating mode in pH, millivolts (mV), Relative millivolts (Rel mV), Concentration (conc.) (with 710Aplus Meter only).

Primary Key Pad Functions, Orion 420Aplus, 710Aplus

yes Press to enter a value during calibration or setup. May also be used to scroll through the setup menu without changing any parameters.

no Press to cancel or to change to a parameter before entering.

measure Press for sample analysis. Instrument will remain in **measure** mode until another key is pressed. Press to unlock HOLD during sample analysis or to exit SETUP menu.

mode Press to change operating modes. The options are pH, mV, or REL mV. (conc with 710Aplus Meter only)

2nd Press to access second functions (cal, timer, setup or print).

▲ Press to increase value.

▼ Press to decrease value.

power Press to turn meter on or off.

Secondary Key Pad Functions, Orion 420Aplus, 710Aplus

All second functions are accessed by first pressing **2nd** then pressing one of the following:

cal Press to start calibration.

timer Press to start the timer. When the preset time has elapsed the instrument will beep for 1 minute (or until a key is pressed).

setup Press to access the setup menu. This is used for setting instrument operating parameters.

print Press to print current display data and/or enter data into the internal datalogger (Orion 710Aplus only). Selection of either option or both can be made in the setup menu. At the end of each calibration all data is printed automatically. (Pressing print during calibration will cause data from the previous calibration to be printed until the calibration sequence is completed.)

Set-up menu for Orion 420Aplus and 710Aplus

The SETUP menu is used to identify and change instrument operating parameters. While in setup **yes** is used to scroll through the menu without changing any parameters.

To enter the SETUP menu press **2nd** then **setup**. 1-1 and READY will be displayed. The on or off indicator flashes indicating the current status. Press **yes** to accept and continue through the menu. Press ▲or▼, to change. After changing a setting, press **yes**. Pressing **no** reverts the parameter to its former state (if done before entering the new setting).

To change a numeric value press ▲or▼,the first digit will start flashing. Scroll until the first digit is the desired value, then press **yes**. The second digit will flash, scroll until the desired value is displayed then press **yes**. Continue in this manner until all digits have been changed to the desired value.

Scroll through the SETUP menu accepting or changing parameters as desired.

To exit the SETUP menu, press **2nd cal** to begin calibration or **measure** to analyze samples.

The following parameters are accessed in the setup menu:

Code	*Function*	*Description*
1-1	**READY**	Turning on READY will cause the ready indicator to be displayed when the electrode signal is stable. The default setting is on.
1-2	**HOLD**	Turning HOLD on will cause the display to freeze during sample measurements when the electrode signal is stable. Pressing measure unlocks hold and returns the meter to live displays during sample measurement. The default setting is off.
1-3	**BEEP**	Turning BEEP on will cause an audible signal to sound on ready, when a key is pressed, and when an operator assistance code appears. The default setting is on.
1-4	**AUTO SHUTOFF**	Turning AUTOSHUTOFF on will cause the meter to turn off if no keys have been pressed for 10 minutes. This feature will increase meter life. The default setting is on.
2-1	**SLOPE**	Allows review of electrode slope in memory at any time. The slope value cannot be changed in the setup menu.
2-2	**RESOLUTION**	Allows selection of resolution. For pH choose from 0.1 to 0.01 to 0.001 press ▼or ▲ to change the resolution, then press **yes** and continue through the menu. For Orion 710Aplus if in Concentration mode select 3, 2, or 1 significant digits. Example: pressing the ▼or ▲changes the concentration value from 19900 –19000–1000 –19900. Select the number of digits desired then press **yes.** The default setting is 0.01 for pH and 3 digits for concentration.

Code	Function	Description
2-3	**ISOPOTENTIAL POINT**	Use to change the isopotential point for a particular pH electrode. In pH mode the default value is 7.00. The isopotential point may not be changed in any other mode.
		NOTE: *Setup function 2-3 Isopotential point is only accessible in pH mode. SETUP Functions 2-1 Slope and 2-2 Resolution are only accessible in pH and concentration modes (710Aplus).*
2-4	**RESET**	Allows all the setup options and calibration data to be set to factory default values. This is particularly useful during troubleshooting or prior to calibrating with new electrode. To RESET press ▲,ON will flash and the audio signal will ring rapidly. Press **yes.**
3-1	**TIMER INTERVAL**	Sets the timer interval. The maximum interval that can be set is 23 hours, 59 minutes, and 59 seconds. The minimum interval is five (5) seconds. When the TIMER INTERVAL code, 3-1, is displayed the current interval hours setting is displayed in the main field (H 00). Press **yes** to accept, or press ▲to change, then press **yes**. Next the current interval minutes: seconds will be displayed (00:00). Press **yes** to accept current setting or press ▲to desired value, then press **yes**. The default setting is 5 seconds.
3-2	**TIME**	Allows review of the time remaining before the timer is set to go off.
3-3	**SET REAL**	Set the actual time of day. The meter TIME uses a 24 hour clock. When the code 3-3 is displayed in the lower field, the current time (hours:minutes) is displayed in the main field. If correct press **yes**, otherwise change as required and then press **yes**.

Code	Function	Description
3-4	**SET DATE**	Sets the current date. When the code 3-4 is displayed in the lower field, the current date (month: day) is displayed in the main field. Press **yes**, or change the date as needed, then press **yes**. Next the current year is displayed. Press **yes** or change as required, then press **yes**.
4-1	**HIGH ALARM LIMIT (710Aplus only)**	Sets the high alarm limit for the current measurement mode. When the reading exceeds the set limit the alarm will ring. The maximum limits are 19.999 for pH, 19900 for concentration, +1600.0 for mV, and +1999.9 for relative millivolts. Press ▲or▼to change, then press **yes**.
4-2	**LOW ALARM LIMIT (710Aplus only)**	Sets the low alarm limit for the current measurement mode. When the reading falls below the set limit the alarm will ring. The minimum limits are -2.000 pH, 0.0 for Concentration, -1600.0 for mV and -1999.9 for relative millivolts. Press▲or▼ to change, then press **yes**.
5-1	**PRINT MODE**	Sets the print mode. When 5-1 is displayed in the lower field the current print mode is displayed in the main field. The options are: 1: manual print, indicates no automatic output to the printer and the user may print on command by pressing **2nd** then **print.** 2: Print on Ready, the meter will send information to the printer whenever the electrode signal reaches stability. 3: Print on a timed interval, printing occurs at a preset timed interval. Press ▲or▼to change, then press **yes.** The default setting is 1: manual print.

Code	Function	Description
5-2	**SET PRINT**	Sets the timed print interval. The maximum print INTERVAL is 23 hours, 59 minutes, and 59 seconds. The minimum print interval is 5 seconds. When the code 5-2 is displayed in the lower field, the current print interval hours will flash in the main display. Press **yes** or press ▲ or ▼ to change, then press **yes**. For the print interval minutes: seconds will be displayed in the main field. Press **yes** or change, then press **yes**. The default setting is 1 minute.

The following set-up modes apply to the 710Aplus model only:

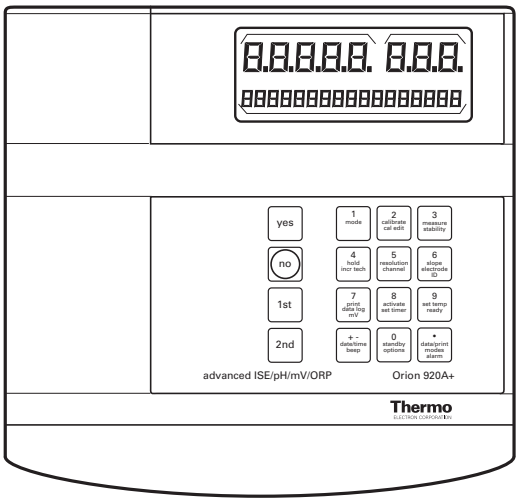
6-1	**DATA-LOGGERS**	Sets the datalogger mode. Up to 25 points may be stored in mode memory at any one time. When the code 6-1 is displayed in the lower field the current datalogger mode will flash in the main display. Use ▲ or ▼ to change, then press **yes**. The four options are: **0** Off, when 0 is selected no datalogging of any kind will take place. **1** Manual datalog, no automatic output to the datalogger will occur, the user may datalog on command by pressing **2nd** then **print**. **2** Datalog on READY, datalogging occurs when the electrode signal is stable. **3** Datalog on a timed interval. Datalogging occurs at user selected intervals. The default setting is 0: OFF.

Code	Function	Description
6-2	**DATALOG INTERVAL**	Sets the timed datalogger interval. The maximum interval is Interval 23 hours, 59 minutes, and 59 seconds. The minimum interval is five (5) seconds. When the code 6-2 is displayed in the lower field, the current datalogger interval hours are displayed in the main field indicated by an H in the left position. Press ▲ or ▼ to change the setting, then press **yes**. For the current datalogger interval minutes: seconds will be displayed in the main field. Press ▲ or ▼ to change, then press **yes**. The default setting is (5) seconds.
6-3	**TRANSFER DATA**	Transfers data from the datalogger to a printer or a computer. When the code 6-3 is displayed the OFF will flash. To transfer the data, press ▲ or ▼ until ON is displayed, then press **yes**. Once the data has been transferred, the meter advances to the next setup option.
		***NOTE**: Downloading the data does not clear the memory. To clear memory, see step 6-4 below.*
6-4	**CLEAR DATA**	Clears all data from the datalogger memory. When the code 6-4 is displayed, the OFF will flash. To clear the data, press ▲ or ▼ until ON is displayed. The alarm will ring rapidly to indicate the memory is about to be erased. Press **yes**.

Appendix C

Overview of Meter Functions

Orion 520Aplus, 525Aplus, 720Aplus, and 920Aplus



Front Panel Of 920Aplus

yes Press to accept displayed text in the prompt line or to enter a numeric value.

no Press to reject displayed text or numeric entry in the prompt line.

1st Press to access primary functions.

2nd Press to access secondary functions.

numeric keys Press to enter a numeric value. The instrument knows when to expect a numeric value and will allow the use of numeric at this time only. Otherwise, the primary functions are active.

Key 1 Mode

Pressing **mode (1)** changes the instrument operating mode. The current operating mode designation is displayed to the right of the main display.

Key 2 Calibrate

Pressing **calibrate (2)** starts a calibration. The time and date of the last calibration are displayed, then the instrument starts the calibration sequence. See the individual meter sections for instructions on calibration and measurement.

Cal Edit (920Aplus only)

Pressing **2nd** then **cal edit(2)** allows you to change or delete a calibration point after the calibration has been completed. This is useful for multipoint calibrations. See the Orion 920Aplus (special features) section for more information.

Key 3 Measure

Pressing **measure (3)** returns the meter to measure mode for sample analysis. While in measure mode, the sample temperature, ready, and hold are displayed. The Orion 525Aplus, 720Aplus and 920Aplus include channel designation. The 920Aplus also displays the electrode I.D. When using hold, pressing **measure** will unlock hold for additional sample analysis.

Stability (920Aplus only)

Pressing **2nd** then **stability (3)** accesses the stability function on the 920Aplus. The main readout will display the absolute drift rate of the electrode in mV/minute. The prompt line displays mV/min and a graphic depiction of stability in the form of a bar. As the electrode becomes more stable, more of the bar will be filled in. When the electrode reaches stability READY replaces mV/min and the bar is completely filled.

Key 4 Hold

Pressing **hold (4)** acts as a toggle changing the hold setting. This function freezes the display when the electrode signal is stable. The prompt line verifies your selection then returns to the measure mode.
Example: *HOLD ON*.

When hold is turned on, the ready mode is automatically turned on. When the display is frozen, press **measure** to reactivate the display and analyze another sample.

The hold designation appears as HOLD (520Aplus) or HLD (525Aplus, 720Aplus and 920Aplus) in the prompt line and replaces the *RDY* when it is displayed on the 920Aplus.

Incremental Techniques (920Aplus only)

Pressing **2nd** then **inc tech (4)** accesses incremental techniques on the 920Aplus. Incremental techniques are additional measurement techniques for analysis with ion selective electrodes. Both Single and Double Known Addition and Known Subtraction can be performed using this function. See the 920Aplus (special features) section for a complete description.

Key 5 Resolution

Press **resolution (5)** for selection of resolution in pH mode. Up to three places beyond the decimal may be selected. For example, the pH display will change from 7.000 to 7.0 to 7.00 to 7.000 with each keypress.

On the 720Aplus and 920Aplus, press **resolution (5)** for resolution selection in concentration mode. Select up to three significant digits. For example, the display will change as follows: 1.45 to 1 to 1.5 to 1.45.

The lower the resolution selected, the faster the **ready** indicator will be displayed. The choice of greater accuracy, i.e. higher resolution, or greater speed, is up to the user and may be changed to suit the analysis being performed.

It is recommended that the display resolution be selected prior to calibration and measurement. Calibration and measurement should take place at the same resolution. Calibrating at one resolution, then selecting a higher resolution for measurement is not recommended.

Channel (525Aplus, 720Aplus and 920Aplus only)

Press **2nd** then **channel (5)** to change the electrode channel. On the 525Aplus and 720Aplus the channels are designated as CH-1 or CH-2. For the 920Aplus, the channel designation appears before the electrode I.D., for example, *1-pH or 2-F-*. The instrument maintains separate calibration curves for each channel.

Key 6 Slope

Press **slope (6)** to display the electrode slope in memory for the current operating mode. After displaying the slope for a few seconds, the isopotential point will be displayed. The meter then returns to its measure mode. The Orion 920Aplus is the only meter that displays an isopotential point in concentration mode. See Appendix E for information pertaining to changing an isopotential point in concentration mode.

The prompt line identifies the slope or isopotential point along with the electrode channel (525Aplus, 720Aplus and 920Aplus), and electrode I.D. (920Aplus). Reviewing the slope and isopotential point is useful when diagnosing measurement problems.

Electrode I.D. (920A only)

Press **2nd** then **electrode ID (6)** to change the electrode identification on the Orion 920Aplus. A series of numbered choices are presented. The user types in the number of choice, then press **yes**. Press **no** to scroll through choices. This is a useful feature for keeping track of which electrode is currently in use. It is particularly useful when using an electrode switchbox.

Key 7 Print/Datalog

Press **print /datalog(7)** to print or datalog the current display data. Along with the operating mode and results, the temperature, millivolt output, time, and date are recorded. If the datalog function is turned off, only printing will occur. Printing or datalogging on a keypress will occur even when another print or datalog function is selected. Whenever printing or datalogging is set to take place at a preset timed interval, the hold function is automatically turned off.

mV

Press **2nd** then **mV (7),** to display the current millivolt output of the electrode without changing modes. This is useful if you want to check a millivolt value during calibration or measurement. Press any key to return to the previous function.

Key 8 Activate

Press **activate (8)** to start the timer interval. An audible signal will sound at the completion of the timer interval.

Activate Timer

Once the timer interval has been set, it is easily activated by pressing **activate (8)**. The meter verifies the action with the following prompts.

	Prompt	Keypress/Action
		Press **Activate** (**8)**
1.	Activate Timer?	Press **yes**
2.	TIMER ON	Meter returns to measure mode.
3.	Time remaining turn off?	Displayed when the timer has been previously activated but has not yet completed the interval. The meter displays the actual time in the main display. Press **yes**.
4.	Timer off	
6.	Timer on	Press **no** to continue with the current interval and return to measure mode.

Set Timer

To set the timer interval press **2nd** then **set timer (8).** The meter will present a series of prompts as follows:

	Prompt	Keypress/Action
	Timer interval	Press **2nd** then set timer (**8)**.
1.	Timer Interval hour	Press **yes** to accept the hours setting, or change as desired.
2.	Timer interval Minute	Enter the correct setting and press **yes**.
3.	Timer interval second	Enter the correct setting using the numeric keys then press **yes**.
4.	Timer interval	The meter displays the new timer interval in the main display then returns to measure mode.

Key 9 Set Temp

Press **set temp (9)** to access the **set temp** function to manually set the temperature. This is used for manual temperature compensation in pH mode and in concentration mode on the Orion 920Aplus. If a temperature probe is in use, the meter will not allow a temperature to be set manually. If no temperature probe is in use, the main display will show 25.0 DEG and the prompt line will show ENTER VALUE. Use the numeric keys to enter the temperature of your solution, then press **yes**. The meter verifies your entry, then returns to measure mode. See temperature compensation section for more information on temperature.

Ready

Press **2nd** then **ready** to access the ready function, which identifies when the electrode signal is stable. The ready signal may be turned on or off. The prompt line verifies your selection then returns to measure mode. Example: READY OFF.

The ready function is tied to the resolution selected. The less resolution selected the faster the ready signal will be displayed.

The ready signal appears in the prompt line as READY (520Aplus) or RDY (525Aplus, 720Aplus or 920Aplus).

Key +/- Date/Time

Setting the Date and Time

Press **date/time (+/-)**, then follow the prompts to set the current date & time.

Prompt	Keypress/Action
	Press **date/time** (±)
1. ENTER MONTH	Enter the current month, then press **yes**.
2. ENTER DAY	Enter the current day, then press **yes**.
3. ENTER YEAR	Enter the current year, then press **yes**.
4. 12-31-90	The date is verified then continue to enter time.
5. ENTER HOUR	Enter the current hour, then press **yes**.
6. ENTER MINUTE	Enter the current minutes setting and press **yes**.
7. 23-59	The time is verified then the meter returns to measure mode.

NOTE: *The meter uses a twenty-four hour clock.*

Beep

Press **2nd** then **Beep ±** to turn the beep on or off. Turning the beep on will cause the meter to beep when a key is pressed, when an operator assistance code occurs, and when the electrode signal becomes stable (if ready is on). Turning the beep off disables the audible feedback function except when the alarm or timer is set.

Key Decimal Point Data/print modes

Press the **decimal point** to set the datalog function and the print mode. See the descriptions below for instructions. Print mode is presented first, then the datalog function.

Printing

Press **data/print modes** to select a print option, then follow the prompts:

	Prompt	Keypress/Action
		Press **data/print modes**.
1.	MANUAL PRINT	The current print mode is displayed. Wait for the prompt.
2.	SET PRINT MODE?	Press **yes**.
3.	1-RDY 2-TIM 3-MAN	The three print options are displayed along with current setting: 1 For Print on ready. 2 For Print at a timed interval. 3 For manual Print. Enter **1**, **2**, or **3** and press **yes**.
4.	MANUAL PRINT	Your choice is verified, then the meter proceeds to steps 6-10 if timed print selected.
5.	PRT INTRVL HRS	Enter the print interval hours setting, 00 to 23, then press **yes**.
6.	PRT INTRVL MIN	Enter the print interval minutes setting, 00 to 59, then press **yes.**
7.	PRT INTRVL SEC	Enter the print interval seconds setting, 00 to 59, then press **yes**.
8.	PRINT INTERVAL	The print interval is verified then the meter continues.
9.	SET LOG MODE?	Press **yes** to continue (see below) or **no** to exit.

Automatic Datalog Function

The meters have an internal datalogger that will record and store a maximum of 25 points automatically. The data points remain in memory until cleared.

	Prompt	Keypress/Action
		Press **data/print** modes
1.	MANUAL PRINT	The current print mode is displayed. Wait for the prompt.
2.	SET PRINT MODE ?	Press **no**.
3.	DATALOG MANUAL	The current datalog setting is displayed. Wait for prompt.
4.	SET LOG MODE	Press **yes**.
5.	0-DISABLE 1-RDY 2-TIM 3-MAN	The datalog setting options are presented two at a time. Press **no** to display the other two. Enter **0**, **1**, **2** or **3**, then press **yes.** 0 To disable datalogging. 1 For datalogging on ready. 2 For datalogging at present time interval. 3 For manual datalogging when print is pressed.
6.	DATALOG MANUAL	The meter verifies the setting and returns to measure mode.
7.	TIMED LOG	If **2** (datalog at a preset time interval) is selected the interval must be entered at the following prompts.
8.	DATALOG INT HR	Enter the datalog interval hours setting, from 0 to 23, then press **yes**.
9.	DATALOG INT MIN	Enter the datalog interval minutes setting, from 0 to 59, then press **yes**.
10.	DATALOG INT SEC	Enter the datalog interval seconds setting from 0 to 59, then press **yes**. Logging can not take place faster than every 5 seconds.
11.	DATALOG INTERVAL	The datalog interval is displayed then the meter returns to MEASURE mode.

Alarm

The Orion 520Aplus, 525Aplus, 720Aplus, and 920Aplus have an alarm function. Separate alarms can be set for each mode and for channels 1 and 2 (on the 525Aplus, 720Aplus and 920Aplus). The alarm limits can be set at the limits of each measuring range, -2.000 to +19.999 pH, -1600.0 to +1600.0 mV, -1999.9 to +1999.9 relative mV, and 0.0 to 19900 for concentration (720Aplus and 920Aplus only).Press **2nd** then **alarm** to access the set alarm function, then follow the prompts.

Prompt	Keypress/Action
	Press **2nd** then **alarm**.
1. 1-PH LIMIT HI MEASUREMENT	The current high alarm limit for the mode and channel is displayed. Change as desired then press **yes.**
2. 1-PH LIMIT LO MEASUREMENT	The current low alarm limit for the mode is displayed. Change as desired, then press **yes.** Meter then returns to MEASURE mode.

Repeat sequence for each channel. Select the other channel by pressing **2nd**, then **channel**, then set alarms.

***NOTE**: The prompts above are for the Orion 920Aplus.*

Key 0 Standby

Press **standby (0)** to place meter into standby mode. When in standby mode, the display of the meter is illuminated at half intensity. This feature prolongs display life. The prompt is STANDBY: ANY KEY. Press any key to restart meter operation. See Autoshutoff section to take advantage of another meter saving feature.

Options

Press **2nd** then **options (0)** to change the isopotential point, clear or transfer data from the datatlogger, select the autoshutoff feature, or identify the use of a switchbox (920Aplus only) The menu loop is as follows:

OPTIONS MENU
CHANGE ISO PT?
TRANSFER DATA?
DATA CLEAR?
AUTOSHUTOFF ON
SWITCHBOX IN USE?

See details below on each function.

Changing the Isopotential Point

The isopotential point may be changed for pH electrodes on all meters and ISE electrodes on the 920Aplus. For pH the default value is 7.000. For ISE's the default value is - - - (No ISO). Identifying an isopotential point for an ISE electrode will provide temperature compensated concentration measurements when using the direct measurement technique.

To change an isopotential point follow the keypress/prompt sequence below. Always recalibrate after changing an isopotential point.

> ***NOTE**: The CHANGE ISO PT option can only be accessed while in pH or concentration mode. If meter is in mV or RmV mode TRANSFER DATA will be the first option displayed.*

First make sure your electrode I.D.(920Aplus) and channel selection (920Aplus, 525Aplus, and 720Aplus) are correct.

Prompt	Keypress/Action
	Press **2nd** then **options**.
1. OPTIONS MENU CHANGE ISO PT.?	Press **yes**.
2. ISO-ENTER VALUE	Enter the isopotential point value for the electrode then press **yes**.
3. ISO EQUALS 7.000	The isopotential point is verified then the meter proceeds to the next item in the options menu.
4. TRANSFER DATA	Press **1st** then **calibrate** to exit and start the calibration or **1st** then **measure** to exit to measure mode.

Transfer Data

To transfer data from the internal datalogger to a printer or computer press **yes** in response to the TRANSFER DATA? prompt. While the data is being transferred the prompt line will display DATA TRANSFER. On completion the DATA TRANSFERRED prompt will be displayed followed by the next option in the menu.

Data Clear

Transferring data from the datalogger **does not** clear the memory. Pressing **yes** to the DATA CLEAR? prompt will clear the datalogger memory. DATA CLEARING followed by DATA CLEARED will be displayed. The meter then displays the next option in the menu, AUTOSHUTOFF.

***NOTE**: Prior to using the datalogger for the very first time, it will be necessary to clear datalogger memory with the DATA CLEAR option.*

Autoshutoff Feature

The meters have a special feature that will help to prolong meter life called autoshutoff. When autoshutoff has been activated the meter will enter standby mode if no keys have been pressed for ten minutes. To start the meter again, press any key.

Prompt	Keypress/Action
	Press **2nd** then **Options**.
1. OPTIONS MENU CHANGE ISO PT?	Press **no**.
2. TRANSFER DATA?	Press **no**.
3. DATA CLEAR?	Press **no**
4. AUTOSHUTOFF ON	Press **yes**.
5. AUTOSHUTOFF OFF	The meter verifies your selection then proceeds to the next item in the options menu. (The 520Aplus, 525Aplus, and 720Aplus return to measure mode).

Use of a Switchbox (920Aplus)

The 920Aplus stores in memory calibration data for seven channels. Additional channels can be accessed when using the 920Aplus with the Orion 607 electrode switchbox. Press the channel selection switch on the Orion 607. Press **2nd,** then **channel (5)** on the Orion 920Aplus, until the desired channel is selected on both the instrument and switchbox. Use of a switchbox must be identified in the options menu to access the additional channels on the 920Aplus.

Prompt	*Keypress/Action*
	Press **2nd** then **Options**.
1. OPTIONS MENU CHANGE ISO POINT?	Press **no**.
2. TRANSFER DATA?	Press **no**.
3. DATA CLEAR?	Press **no**.
4. AUTOSHUTOFF ON	Press **yes**.
5. SWITCHBOX IN USE?	Press **yes**.
6. SWITCHBOX ENABLED	The meter verifies the use of a switch box then returns to measure mode.

Appendix D

Meter Default

pH electrode slope	100.0%
pH isopotential point	7.000
pH resolution	.001
temperature	25.0ºC
ready	on
hold	off
beep	on
autoshutoff	on
timer interval	5 seconds
print mode	1-manual print
print interval	1 minute
datalog mode	0-off (520Aplus, 525Aplus, 710Aplus, 720Aplus, and 920Aplus)
measurement channel	Channel 1 (525Aplus, 720Aplus and 920Aplus)
electrode ID	pH (920Aplus)
high alarm limit	off (520Aplus, 525Aplus, 710Aplus, 720Aplus and 920Aplus)
low alarm limit	off (520Aplus, 525Aplus, 710Aplus, 720Aplus and 920Aplus)

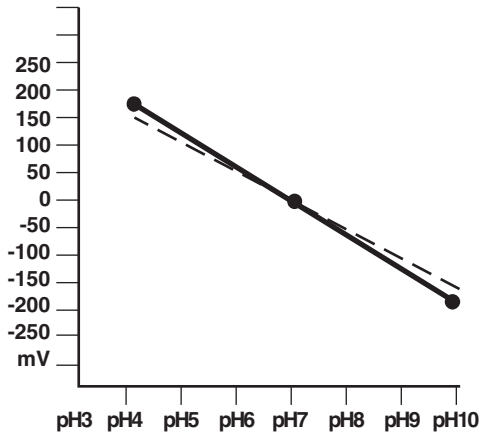
Appendix E

Multipoint Calibration Curve

Orion 410Aplus, 420Aplus, 520Aplus, 525Aplus, 710Aplus, 720Aplus, and 920Aplus utilize a "point-to-point" scheme for multipoint calibrations in both pH and CONCENTRATION modes. In this technique, straight line segments are "drawn" between each successive pair of calibration points. Separate slope and E_o values are calculated using the adjacent pair of data points. For example, in a five point calibration, four slopes and five E_o's are calculated to correspond to the four line segments that connect the data. Concentration or pH values for samples are calculated according to which segment 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.

See Figure below for an example of a typical calibration curves using this method.



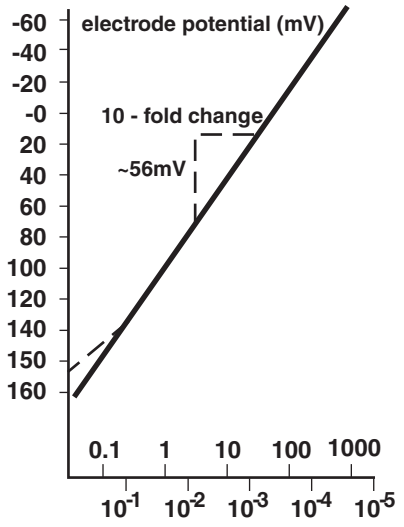
Segmented Calibration (——) and Best Fit Line (- - - - -)

Appendix F

Automatic Blank Correction

The Orion 710Aplus, 720Aplus, and 920Aplus 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 Figure below.



Calibration Curve
(Electrode Potential vs. Concentration)

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 interferent 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:

$E = Eo + S \times \log(C + b)$ where b 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:

$E1 = Eo + S \times \log (C1 + b)$

$E2 = Eo + S \times \log (C2 + b)$

$E3 = Eo + S \times \log (C3 + b)$

The meter evaluates the relationships between the three potentials E1, E2, and E3 and the three concentrations C1, C2, and C3. 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: $E3 - E1 > 10$ 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 x C3.

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 above are not met, the calibration data is handled by the multipoint calibration method described earlier.

> ***NOTE**: When a calibration standard is defined as zero and the meter cannot calculate a blank, the operator assistance code E-32 will be displayed. See Troubleshooting section.*

In calibrations with more than three points, a combination of methods are 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.

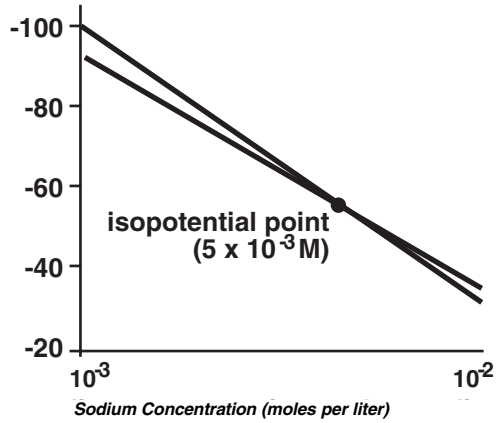
Appendix G

Determining Isopotential Points

To take advantage of the temperature compensation feature for concentration measurements in the Orion 920Aplus, it is necessary to experimentally determine the isopotential point of the electrode in use.

The slope of all electrodes changes with temperature. This is due in fact to the slope term, S, in the Nernst equation. The slope is actually 2.3RT/nF, where R and F are constants, n is the charge on the measured species, and T is the temperature in degrees Kelvin. Examples of calibration curves at varying temperatures are shown in Figure below.

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, such as the Orion 920Aplus, has the means of adjusting the isopotential point, temperature compensation for an ion selective electrode is possible. Temperature compensation can be performed for one and two point calibrations.



Isopotential Point Determination

Determining an Isopotential Point

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, i.e. 20-25°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, as any calibration curve would be drawn (see Figure on previous page).
6. The lines will intersect at the isopotential point. Read the concentration off the graph for this point from the log axis. This value is the isopotential point.
7. See previous instructions on how to adjust the isopotential point on the Orion 920Aplus.

SPECIFICATIONS

	410Aplus	420Aplus	520Aplus	525Aplus
pH range	-2.000 to 19.999	-2.000 to 19.999	-2.000 to 19.999	-2.000 to 19.999
resolution	0.001/0.01/0.1pH	0.001/0.01/0.1pH	0.001/0.01/0.1pH	0.001/0.01/0.1pH
relative accuracy	±0.005	±0.005	±0.005	±0.005
slope	80 to 120%	80 to 120%	80 to 120%	80 to 120%
concentration range	NA	NA	NA	NA
resolution	NA	NA	NA	NA
relative accuracy	NA	NA	NA	NA
temperature	-5.0 to 105.0^{o}C	-5.0 to 105.0 ^{o}C	-5.0 to 105.0 ^{o}C	-5.0 to 105.0 ^{o}C
resolution	0.1 ^{o}C	0.1 ^{o}C	0.1 ^{o}C	0.1 ^{o}C
relative accuracy	±1.0 ^{o}C	±1.0 ^{o}C	±1.0 ^{o}C	±1.0 ^{o}C
millivolt range	NA	-1600.0 to +1600.0	-1600.0 to +1600.0	-1600.0 to +1600.0
resolution	NA	0.1 mV	0.1 mV	0.1 mV
relative accuracy	NA	±0.2 mV or±0.05% of reading which ever is greater	±0.2 mV or ±0.05% of reading which ever is greater	±0.2 mV or ±0.05% of reading whichever is greater
relative millivolt range	NA	-1999.9 to +1999.9	-1999.9 to +1999.9	-1999.9 to +1999.9
resolution	*NA*	0.1 mV	0.1 mV	0.1 mV
relative accuracy	*NA*	±0.2 mV or ±0.05% of reading whichever is greater	±0.2 mV or ±0.05% of readings whichever is greater	±0.2 mV or ±0.05% of reading whichever is greater
display	Custom LCD	Custom LCD	Custom 2-color vacuum fluorescent with17 character prompt line	Custom 2-color vacuum fluorescent with17 character prompt line
inputs	One BNC, One pin tip, ATC, power, RS232	One BNC, One pin tip, ATC, power	One BNC, One pin tip, ATC, power, RS232, Karl Fischer	Two BNC, Two pin tip, ATC, power, RS232, Karl Fischer
outputs	RS232	RS232	RS232, 2.5 mm pin recorder	RS232, 2.5 mm pin recorder
power requirements	9 VDC line converter 110 or 220 VAC. 50/60 Hz walloutlet.	9 VDC line converter 110 or 220 VAC. 50/60 Hz walloutlet.	9 VDC line converter for either 110 or 220 VAC. 50/60 Hz wall outlet.	9 VDC line converter for either 110 or 220 VAC, 50/60 Hz wall outlet.
input impedance	>10^{12} ohms	>10^{12} ohms	>10^{12} ohms	>10^{12} ohms
instrument drift	< 50 microvolts/^{o}C	< 50 microvolts/^{o}C	< 50 microvolts/^{o}C	< 50 microvolts/^{o}C
input bias current	< ± 1 picoamp at 25^{o}C and < ± 4 picoamps over full operating range			
environmental requirements	5 to 45 ^{o}C and 5 to 85% relative humidity, non-condensing			
meter dimensions	8.08 x 3.26 x 1.90 inches			
case	Dust and Splash Resistant, Chemical Resistant			

SPECIFICATIONS

	710Aplus	720Aplus	920Aplus
pH range	-2.000 to 19.999	-2.000 to 19.999	-2.000 to 19.999
resolution	0.001/0.01/0.1pH	0.001/0.01/0.1pH	0.001/0.01/0.1pH
relative accuracy	± 0.005	±0.002	±0.002
slope	80 to 120%	80 to 120%	80 to 120%
concentration range	0.000 to 19900	0.000 to 19900	0.000 to 19900
resolution	± one least significant digit	± one least significant digit	± one least significant digit
relative accuracy	±0.05% of reading	±0.5% of reading	±0.5% of reading
temperature	-5.0 to 105.0 ^{O}C	-5.0 to 105.0 ^{O}C	-5.0 to 105.0 ^{O}C
resolution	0.1 ^{O}C	0.1 ^{O}C	0.1 ^{O}C
relative accuracy	±1.0 ^{O}C	±1.0 ^{O}C	±1.0 ^{O}C
millivolt range	-1600.0 to +1600.0	-1600.0 to +1600.0	-1600.0 to +1600.0
resolution	0.1 mV	0.1 mV	0.1 mV
relative accuracy	±0.2 mV or ±0.05% of readings whichever is greater	±0.2 mV or ±0.05% of reading whichever is greater	±0.2 mV or ±0.05% of reading whichever is greater
relative millivolt range	-1999.9 to +1999.9	-1999.9 to +1999.9	-1999.9 to+1999.9
resolution	0.1 mV	0.1 mV	0.1 mV
relative accuracy	±0.2 mV or ±0.05% of reading whichever is greater	±0.2 mV or ±0.05% of readings whichever is greater	±0.2 mV or ±0.05% of reading whichever is greater
display	Custom LCD	Custom 2-color vacuum fluorescent with 17 character prompt line	Custom 2-color vacuum fluorescent with 17 character prompt line
inputs	two BNC, two pin tip ATC, power, RS232	two BNC, two pin tip ATC, power, RS232, Karl Fischer	two BNC, two pin tip ATC, power, Karl Fischer
outputs	RS232	RS232, 2.5 mm pin recorder,	RS232, 2.5 mm pin recorder
power requirements	9 VDC line converter for either 110 or 220 VAC. 50/60 Hz walloutlet.	9 VDC line converter for either 110 or 220 VAC. 50/60 Hz wall outlet.	9 VDC line converter for either 110 or 2209 VAC. 50/60 Hz waloutlet.
input impedance	>10^{12} ohms	>10^{12} ohms	>10^{12} ohms
instrument drift	< 50 microvolts/^{O}C	< 50 microvolts/^{O}C	< 50 microvolts/^{O}C
input bias current	< ± 1 picoamp at 25^{O}C and < ± 4 picoamps over full operating range		
environmental requirements	5 to 45 ^{O}C and 5 to 85% relative humidity, non-condensing		
meter dimensions	8.08 x 3.26 x 1.90 inches		
case	Dust and Splash Resistant, Chemical Resistant		

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