ULTRAMETER III™

Operation Manual

MODEL 9PTK

MYRON L® COMPANY
Water Quality Instrumentation
Accuracy • Reliability • Simplicity

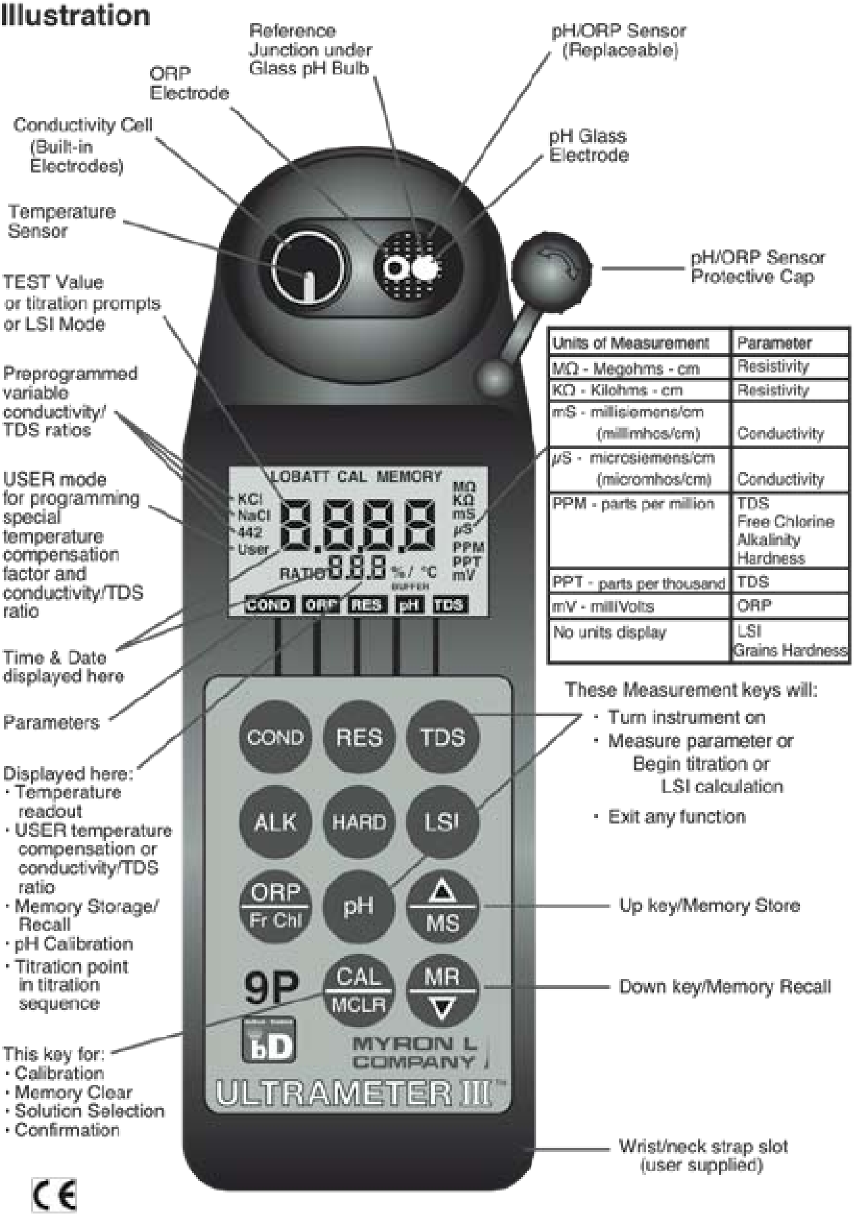
18 February 2016

THE 9P TITRATION KIT (WITH BLUDOCK OPTION) COMES WITH EVERYTHING YOU SEE HERE

PLEASE CHECK THE CONTENTS OF YOUR KIT!

1. Ultrameter III™ *Model 9P*
2. Cell Extender *Model TKCE*
3. Foam-lined hard carry case
4. M’PET 100μL fixed volume pipette *Model FVMP-100*
5. 12 disposable pipette tips
6. 2oz. bottle of Alkalinity Standard Solution *Model ALK-1002OZ*
7. 2oz. bottle of Hardness Standard Solution *Model HARD-2002OZ*
8. 2oz. bottle of pH 4 buffer *Model PH42OZ*
9. 2oz. bottle of pH 7 buffer *Model PH72OZ*
10. 2oz. bottle of pH 10 buffer *Model PH102OZ*
11. 2oz. bottle of pH/ORP Sensor Storage Solution *Model SS2OZ*
12. 2oz. bottle of alkalinity Reagent A1 *Model H2SO4-12OZ*
13. 2oz. bottle of hardness Reagent C1 *Model HCL-32OZ*
14. 2oz. bottle of hardness Reagent H1 *Model NAOH2OZ*
15. 2oz. bottle of hardness Reagent H2 *Model EDTA-LC2OZ*
16. 2oz. bottle of hardness Reagent H3 *Model EDTA-HC2OZ*
17. 1oz. bottle of ORP ISA Sensor Conditioner *Model ORPCOND1OZ*
18. 2oz. bottle of KCl-7000 *Model KCL-70002OZ*
19. 2oz. bottle of 442-3000 *Model 442-30002OZ*
20. Titration T-plunger *Model TPLUNGER*
21. Wireless USB Adapter (dongle) for 9Ps ordered with bluDock™ option installed *Model BDDO*
22. U2CI software CD for 9Ps ordered with bluDock™ option installed

Instrument Illustration



Units of Measurement	Parameter
MΩ - Megohms - cm	Resistivity
KΩ - Kilohms - cm	Resistivity
mS - millisiemens/cm (millimhos/cm)	Conductivity
µS - microsiemens/cm (micromhos/cm)	Conductivity
PPM - parts per million	TDS Free Chlorine Alkalinity Hardness
PPT - parts per thousand	TDS
mV - milliVolts	ORP
No units display	LSI Grains Hardness

CE

MODEL 9P
Shown with bluDock™ option installed

For detailed explanations see Table of Contents

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I. INTRODUCTION

Thank you for selecting the feature-packed Ultrameter III™, one of the Myron L® Company's latest in an increasing line of instruments utilizing advanced microprocessor-based circuitry and SMT manufacturing processes. This circuitry makes the instrument extremely accurate, reliable and very easy to use.

The Ultrameter III™ has been designed to include titration measurements for Alkalinity, Hardness and LSI and an LSI Calculator for water balance analysis. The Ultrameter III also features Myron L® Company's exclusive Free Chlorine Equivalent (FC^E) function for making ORP-based free chlorine measurements, as well as optional Bluetooth® wireless data transfer. Other features include a clock with time and date, memory of up to 100 locations with time and date stamp, the ability of the user to adjust the timeout "Auto OFF", and enhanced performance. See Features and Specifications on pages 2-3.

The most exciting feature is data logging with the ability to wirelessly download the memory or stored test data with its corresponding time, date and unit name. This feature allows the user to create spreadsheets and graphs with ease, and quickly and accurately manipulate data more effectively. The optional bluDock™ and accompanying U2CI software is compatible with most computers using either Microsoft Windows XP, 2000, 2007 or Vista™ or Macintosh OS9.2 or OSX™. The data may be imported into a variety of spreadsheet formats like Microsoft Excel CSV™.
Please Note: Although the Myron L® Company has performed extensive testing, we cannot guarantee compatibility of all applications and formats. We suggest testing your application and format for compatibility before relying on it.

For your convenience, a brief set of instructions is provided on the bottom side of your Ultrameter III. A small waterproof card with abbreviated instructions is also included with the instrument as a quick reference.

Special note ... Conductivity, resistivity, and TDS require mathematical correction to 25°C values (ref. Temperature Compensation, pg. 58). On the left of the Ultrameter III's liquid crystal display is shown an indicator of the salt solution characteristic used to model temperature compensation of conductivity and its TDS conversion. The indicator may be KCl, NaCl, 442™ or User. Selection affects the temperature correction of conductivity and the calculation of TDS from compensated conductivity (ref. Conductivity Conversion to Total Dissolved Solids (TDS), pg. 61). The selection can affect the reported conductivity of hot or cold solutions and will change the reported TDS of a solution. Using KCl for conductivity, NaCl for resistivity, and 442™ (Natural Water characteristic) for TDS is consistent with present industry practice for standardization. This is how your instrument, as shipped from the factory, is set to operate. For use in seawater desalination for example, both the conductivity and TDS may easily be changed to NaCl.

II. FEATURES and SPECIFICATIONS

A. Features

- ORP-based FC^{E} Free Chlorine measurement; displays as ppm concentration
- Alkalinity and Hardness Conductometric Titrations
- Langelier Saturation Index (LSI) Titrations and Calculator
- Superior resolution 4 digit LCD displays full 9999 μS/ppm
- Cond/TDS Accuracy of ±1% of READING / ±0.1% at calibration point
- All electrodes are internal for maximum protection
- Improved 4-electrode sensor technology
- Waterproof to 1 meter/3 feet
- Autoranging conductivity/TDS/resistivity
- Prompts for easy pH calibration
- Factory calibrations stored in microprocessor
- 3 conductivity/TDS solution conversions preprogrammed into microprocessor
- User mode feature allows:
  - Programming your own Cond/TDS conversion factor
  - Programming your own temperature compensation factor
  - Disabling temperature compensation
- Real Time Clock with Time and Date
- Data Logging with TIME and DATE in memory
- Memory stores 100 readings
- User adjustable timeout "**Auto OFF**"
- Bluetooth® wireless download capability with optional bluDock™ accessory package

B. General Specifications

Display	4 Digit LCD
Dimensions (LxWxH)	196 x 68 x 64 mm/ 7.7 x 2.7 x 2.5 in.
Weight	352 g/12.4 oz.
Case Material	VALOX*
Cond/Res/TDS Cell Material	VALOX*
Cond/TDS Electrodes (4)	316 Stainless Steel
Cond/Res/TDS Cell Capacity	5 ml/0.17 oz.
pH/ORP Sensor Well Capacity	1,2 ml/0.04 oz.
Power	9V Alkaline Battery
Battery Life	>100 Hours/5000 Readings
Operating/Storage Temperature	0-55°C/32-131°F
Protection Ratings	IP67/NEMA 6 (waterproof to 1 meter/3 feet)
CE EMI/EMC Ratings (Conformité Européenne)	EN61326-1: 2006 + Annex A: 2008 (hand-held devices) CISPR 11: 2003 IEC 61000-4-2: 2001 and, IEC 61000-4-3: 2002

* ™ SABIC Innovative Plastics IP BV

Additional information is available on our website:
www.myronl.com
MADE IN USA

C. Specification Chart

Parameters	Ranges	Resolution	Accuracy	Auto Temperature Compensation	Adjustable Temperature Compensation	Cond/TDS Ratios Preprogrammed	Adjustable Cond/ TDS Ratio Factor
Conductivity	0-9999μS/cm 10-200mS/cm in 5 autoranges	0.01(<100μS) 0.1(<1000μS) 1.0(<10mS) 0.01(<100mS) 0.1(<200mS)	±1% of reading	0-71ºC 32-160ºF	0-9.99%/ºC	KCl, NaCl, 442™	0.20-7.99
TDS	0-9999ppm 10-200ppt in 5 autoranges	0.01(<100ppm) 0.1(<1000ppm) 1.0(<10ppt) 0.01(<100ppt) 0.1(<200ppt)	±1% of reading	0-71ºC 32-160ºF	0-9.99%/ºC		
Resistivity	10KΩ-30MΩ	0.01(<100KΩ) 0.1(<1000KΩ) 0.1(>1MΩ)	±1% of reading	0-71ºC 32-160ºF	0-9.99%/ºC		
pH	0-14pH	±.01pH	±.01pH*	0-71ºC 32-160ºF			
ORP	±999mV	±1mV	±1mV*				
Free Chlorine (FC^E)	0.00-9.99ppm** 350≤ORPmV<725 and 0.0≤pH<9.9 725≤ORPmV<825 and 0.0≤pH<8.9	0.01ppm	±0.3ppm <1.00ppm* ±0.2ppm ≥1.00ppm*	0-71ºC 32-160ºF			
Alkalinity Titration	10-800ppm	0.1(<100 ppm) 1(<800 ppm)					
Hardness Titration	0-1710ppm (0-100 grains)	0.1(<100 ppm) 1(<1710 ppm)					
LSI Titration	-10 to +10	0.1					
Temperature	0-71ºC 32-160ºF	0.1ºC/F	±0.1ºC				

***EM Susceptibility:** When Measuring 10.0 pH Reference Solution
±0.2 pH in the presence of RF fields ≥ 3 V/m.
±0.37 pH in the presence of RF fields at 300 MHz (±30MHz)
**If either ORP or pH is outside the specified limits, the instrument will display "-Or-".

D. Warranty/Service

The Myron L Ultrameter III, excluding the pH/ORP sensor, has a Two (2) Year Limited Warranty. The pH/ORP sensor has a Six (6) Month Limited Warranty for materials and workmanship. If an instrument fails to operate properly, see Troubleshooting Chart, pgs. 54-55. The battery, pH/ORP sensor and cell extender are user-replaceable. For other service, return the instrument prepaid to the Myron L® Company.

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If, in the opinion of the factory, failure was due to materials or workmanship, repair or replacement will be made without charge. A reasonable service charge will be made for diagnosis or repairs due to normal wear, abuse or tampering. This warranty is limited to the repair or replacement of the Ultrameter III only. The Myron L® Company assumes no other responsibility or liability.

E. Ultrameter III Model

Ultrameter III Model	**9P**
PARAMETERS	Conductivity/Resistivity/TDS/Alkalinity/Hardness/LSI/ORPmV/ Free Chlorine Equivalent (FC^E) ppm/pH/Temperature

PLEASE NOTE:
Because of our commitment to product improvement, the substance and style of this manual may change. When changes are made, the updated manual is posted for download in PDF format from the Myron L Website:
www.myronl.com

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III. RULES of OPERATION

A. Operation

NOTE: The cell extender does not interfere with normal operation. Using the instrument is simple:

- Individual or multiple parameter readings may be obtained by filling individual sensors or entire cell cup area.
- Rinse the conductivity cell and/or pH/ORP sensor well with test solution 3 times and refill. Temperature and/or measurement extremes will require additional rinses for maximum accuracy.
- Press the desired measurement key to start measurement.
- For titrations, user intuitive display prompts guide you through the addition of reagents and measurements.
- Pressing any parameter key again in measurements restarts the 15 second “**Auto off**” timer. Pressing any parameter key again during titrations will cancel the titration in progress.
- Note the value displayed and/or press the **MS** key to store the reading (ref. Memory Storage, pg. 38). It’s that simple!

B. Characteristics of the Keys

- Though your Ultrameter III has a variety of sophisticated options, it is designed to provide quick, easy, accurate measurements by simply pressing a key.
- All functions are performed one key at a time.
- THERE IS NO “OFF” KEY. If the instrument remains inactive for 15 seconds after you press any parameter key (user adjustable up to 75 seconds), the instrument turns itself off. The instrument turns itself off after 60 seconds of inactivity in CAL mode, 3 minutes of inactivity in each titration screen and 60 seconds of inactivity in each LSI calculator value screen.
- Rarely is it necessary to press and hold a key (as in Procedure to Select a Solution, pg. 25; Conductivity or TDS Calibration, pg. 29; and ORP/FC^E Mode Selection, pg. 21).

C. Operation of the Keys (See Instrument Illustration, pg. ii)

1. Measurement Keys in General

Any of the 8 measurement keys turns on the instrument in the mode selected. The mode is shown at the bottom of the display for COND, RES, TDS, ORP and pH. The ORP mode is indicated by the units displayed, mV for ORP or ppm for free chlorine. Measurement units appear at the right. Pressing any measurement key puts the unit in that measurement mode even if you are in a calibration sequence and also serves to cancel a change (ref. Leaving Calibration, pg. 28).

2. COND, RES and TDS Keys

These 3 keys are used with solution in the Conductivity Cell.

Precautions:

- While filling cell cup, ensure no air bubbles cling on the cell wall.
- If the proper solution is not selected (KCl, NaCl, 442 or User), refer to Why Solution Selection is Available, pg. 24 and Procedure to Select a Solution, pg. 25.

a. COND Key

Solution to be tested is introduced into the conductivity cell and a press of COND displays conductivity with units on the right. On the left is shown the solution type selected for conductivity.

b. RES Key

A press of RES displays resistivity with units on the right. On the left is shown solution type selected for resistivity (ref. Solution Selection, pg. 24). The range of display of resistivity is limited to between 10 kilohms (KΩ) and 30 megohms (MΩ). A solution outside that range will only show [- - - -] in the display.

c. TDS Key

A press of TDS displays Total Dissolved Solids with units on the right. This is a display of the concentration of ionized material calculated from compensated conductivity using the characteristics of a known material. On the left is shown solution type selected for TDS (ref. Solution Selection, pg. 24).

3. Alkalinity, Hardness and LSI Keys

These 3 keys enter the unit in the titration measurement functions. The LSI key also allows you to access the LSI Calculator.

NOTE: All titration measurements require the installation of the cell extender.

a. Alkalinity Key

A press of ALK enters the Alkalinity titration function.

b. Hardness Key

A press of HARD enters the unit in the Hardness titration function.

c. LSI Key

A press of LSI enters the unit in LSI calculator mode, which can be used to measure LSI by pulling the most recent alkalinity, hardness, pH and temperature values or for hypothetical water balance adjustments.

4. pH and ORP/Fr Chl Keys

Measurements are made on solution held in the pH/ORP sensor well (ref. pH and ORP/Free Chlorine, pg. 64). The protective cap is removed and the sensor well is filled and rinsed with the sample enough times to completely replace the storage solution.

After use, the pH/ORP sensor well must be refilled with Myron L Storage Solution, and the protective cap reinstalled securely (ref. Maintenance of the pH/ORP Sensor, pg. 11 and Cleaning Sensors, 2. pH/ORP, pg. 52).

a. pH Key

A press of (pH) displays pH readings. No units are displayed on the right.

b. ORP/Fr Chl Key

In ORP mode, a press of (ORP/Fr Chl) displays Oxidation-Reduction Potential /REDOX reading in millivolts; "mV" is displayed. When the FC^E mode is activated, a press of (ORP/Fr Chl) displays the Free Chlorine Equivalent reading in "ppm" alternating with the FC^E predictive ORP reading in "mV".

5. CAL/MCLR Key

While measuring conductivity, TDS, or pH, a press of (CAL/MCLR) allows you to enter the calibration mode. Once in CAL mode, a press of this key accepts the new value. If no more calibration options follow, the instrument returns to measuring (ref. Leaving Calibration, pg. 28).

If (CAL/MCLR) is held down for about 3 seconds, CAL mode is not entered, but "**SEL**" appears to allow Solution Selection (ref. pg. 24) with the Up or Down keys. As in calibration, the **CAL** key is now an "accept" key.

While measuring ORP or Free Chlorine, holding **CAL** down for about 3 seconds allows ORP/FC^E mode selection (ref. pg. 21).

For titrations and LSI Calculator, the **CAL** key steps you through the procedure and accepts values for final calculations.

Once in **CAL** mode, a press of this key accepts the new value.
While reviewing stored records, the **MCLR** side of the key is active to allow clearing records (ref. Clearing a Record/Memory Clear, pg. 39).

6. UP or DOWN Keys

While measuring in any parameter, the (▲/MS) or (MR/▼) keys activate the Memory Store and Memory Recall functions. A single press steps the display and holding either key scrolls the value rapidly.

While in calibration or calculator mode, the keys step or scroll the displayed value up or down.

While in Memory Recall, the keys scroll the display up and down through the stack of records (ref. Memory Recall, pg. 39).

IV. AFTER USING THE ULTRAMETER III

A. Maintenance of the Conductivity Cell

Rinse out the cell cup with clean water. Do not scrub the cell. For oily films, squirt in a foaming non-abrasive cleaner and rinse (ref. Cleaning Sensors, pg. 52). Even if a very active chemical discolors the electrodes, this does not affect the accuracy; leave it alone.

B. Maintenance of the pH/ORP Sensor

The sensor well must be kept wet with a saline solution. Before replacing the rubber cap, rinse and fill the sensor well with Myron L pH Sensor Storage Solution. If unavailable, you can use an almost saturated KCl solution, pH 4 buffer or a saturated solution of table salt and tap water (ref. pH and ORP/Free Chlorine Practices to Maintain Calibration, pg. 38). **NEVER USE DISTILLED WATER.**

If all ORP solutions are reporting approximately the same value, clean ONLY the platinum ORP electrode with an MLC ORP conditioner-soaked cotton swab, being careful not to touch the swab to the glass bulb of the pH sensor.

V. SPECIFIC RECOMMENDED MEASURING PROCEDURES

A. Parameter Methods

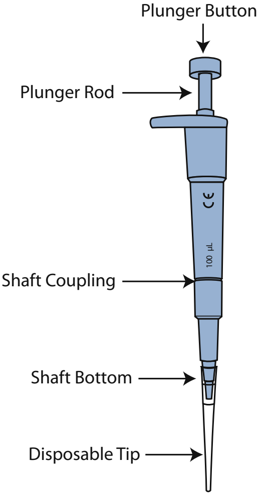
For Conductivity and Total Dissolved Solids measurements, if the proper solution is not selected (KCl, NaCl, 442 or User), see Solution Selection, pg. 24.

NOTE: After sampling high concentration solutions or temperature extremes, more rinsing may be required. When sampling low conductivity solutions, be sure the pH cap is well seated so that no solution washes into the conductivity cell from around the pH cap.

B. Titration Methods

For Alkalinity, Hardness titrations, assemble the required materials before you begin: a pipette with 100μL tips, the required reagents, the cell extender, and the T-plunger.

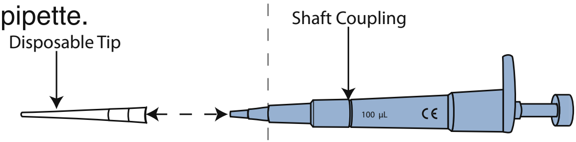
NOTE: The accuracy of titration measurements is affected by your technique. Be careful when removing the cap of the cell extender to add reagents. Flicking the cap or popping it off can cause solution to spill out of the cell extender. Always use a new pipette tip when changing solutions to avoid contamination.



Fully Assembled Pipette

1. Pipette Instructions

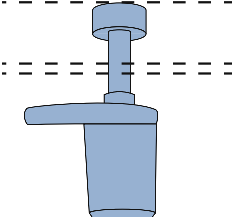
Always use a clean tip when changing solutions! To install a tip, press the wide end of the tip on the end of the pipette until it is secure. To remove a tip, simply pull it off the end of the pipette.



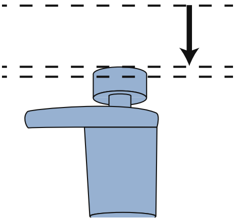
Pipette Assembly

NOTE: Do NOT twist the cap off as this may unscrew the shaft bottom from the pipette.

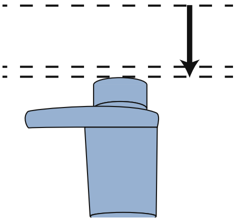
The pipette has 3 positions: REST, FIRST STOP, and SECOND STOP. Practice pushing in and letting up on the pipette to feel the different positions.



Rest Position: The plunger is all the way UP.

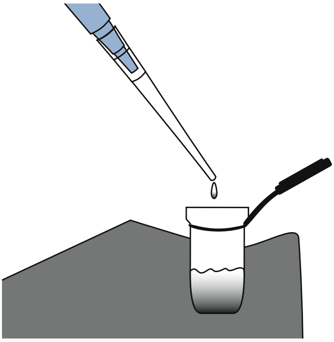


First Stop: The plunger is depressed until resistance is felt.



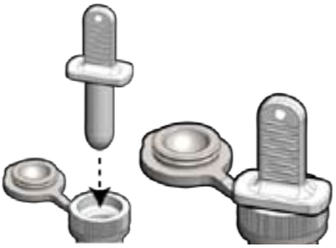
Second Stop: The plunger is depressed all the way DOWN.

a. To DRAW a sample: Grasp the pipette by the shaft with your hand. Rest your thumb on top of the plunger button. Use your thumb to depress the top of the pipette to the FIRST STOP. Insert the tip end down into sample until only the tip is submerged, about 2-3mm/ ⅛". Slowly release the top and let it return to the REST position being careful to keep the tip submerged.



Do not allow the pipette tip to touch the cell wall or the sample.

b. To DISPENSE a sample: With the pipette in the REST position, place the tip end over the conductivity cell **being careful not to touch the tip to the existing solution**. Depress the top of the pipette to the SECOND STOP (all the way down) being careful to keep the tip over the cell. Release the plunger button and let it return to the REST position.



2. T-Plunger Instructions

To PLUNGE the cell:

With the cell extender installed and solution in the cell, insert the tip of the T-plunger in the cell extender until the arms of the T-plunger are flush against the rim of the cell extender. Solution will overflow the cell.

Insert the T-plunger all the way down into the cell extender then rotate it from side to side.

Keeping the arms of the T-plunger flush against the rim of the cell extender, rotate the T-plunger from side to side, allowing the arms of the T-plunger to slide along the rim of the cell extender.

Remove the T-plunger from the cell by lifting it straight up out of the cell, being careful to keep it centered over the mouth of the cell extender. When the T-plunger is completely out of solution, tap the T-plunger once firmly on the rim of the cell extender to dispel any clinging solution back into the cell.

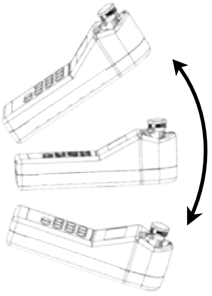
Hold the T-plunger over the cell then tap firmly so that solution is dispelled back into the cell cup.

Remove the T-plunger completely from the cell area.

3. Mixing Solution in Cell

a. Agitate

When the display says to agitate ("**AGit**"): Grasp the instrument on both sides of the keypad (keypad facing up) with your hands so you don't accidentally drop or release it. Agitate the solution in the cell by swinging the cell cup area of the unit up and down 3 times. Do NOT shake the instrument vigorously as this could create bubbles in the sample solution.



"**AGit**": When "**AGit**" displays, swing the cell end of the 9P up and down 3 times.

b. Hold

When the display says to hold ("**HOLd**"):
Hold the instrument steady in the horizontal position while the instrument records a measurement.

Agitate and hold as many times as prompted. Allow the display to cycle through all screens, e.g., "**EdTA**", "**AGit**" and "**HOLd**", at least once. Continue holding steady until "**PrES CAL**" displays.

Hold the unit steady before pressing **CAL** to accept readings.

"**HOLd**": When "**HOLd**" displays, hold the 9P still with bottom of case parallel to the ground.

C. Measuring Conductivity & Total Dissolved Solids (TDS)

1. Rinse cell cup 3 times with sample to be measured. (This conditions the temperature compensation network and prepares the cell.)
2. Refill cell cup with sample.
3. Press COND or TDS.
4. Take reading. A display of [- - - -] indicates an overrange condition.

D. Measuring Resistivity

Resistivity is for low conductivity solutions. In a cell cup the value may drift from trace contaminants or absorption from atmospheric gasses, so measuring a flowing sample is recommended.

1. Ensure pH protective cap is secure to avoid contamination.
2. Hold instrument at 30° angle (cup sloping downward).
3. Let sample flow continuously into conductivity cell with no aeration.
4. Press RES key; use best reading.

NOTE: If reading is lower than 10 kilohms, display will be dashes: [- - - -]. Measure solution Conductivity instead.

E. Measuring Alkalinity

Prepare the materials required for titration: Reagent: A1, cell extender, T-plunger, and 100 μL pipette with a clean tip installed.

NOTE: If you do not complete each titration point within the 3-minute timeout period, the unit exits the Alkalinity function. Between titrations, the unit will automatically power off after the period of inactivity defined in the AUTO OFF setting (ref. AUTO OFF, pg. 45). Press **ALK** to start the titration process over from step 1.

If you make a gross error in your titration method, e.g., you forget to add sample to the cell, "**Err**" will display. Start the titration over from Step 1 to obtain a reading.

1. Ensure pH protective cap is secure to avoid contamination.
2. Install the cell extender by pushing the base of the cell extender into the conductivity cell until it is fully seated.

3. Rinse the conductivity cell cup and cell extender 3 times with solution to be measured.
4. Refill cell cup and cell extender with sample solution.
5. Insert T-plunger into open cell extender until the "T" rests flush on the lip of the cell extender. This will cause fluid beyond what is required for titration to overflow the cell extender.

6. Rotate the T-plunger from side to side, allowing the arms of the T-plunger to slide along the rim of the cell extender.

7. Carefully remove the T-plunger so as not to flick or spill remaining sample. Tap the T-plunger on the side of the cell extender to remove sample that may be stuck to the T-plunger.
8. Press ALK. "**AL**" alternating with "**tdS**" briefly displays along with the "**PPM**" value of the sample. "**PrES CAL**" will display when the reading stabilizes.
9. Press **CAL** to accept and advance to the first titration prompt. "**Add**" alternating with "**A1**" displays; then "**AGit t1**" alternating with "**HOLd**" displays. (The number after "**t**" indicates which titration point you are on. The number "**1**" here indicates this is the first titration point. Subsequent titration points are sequenced numerically: 2, 3, 4, etc.)
10. Using the pipette, add 100 μL of Reagent: A1, close the cell extender cap securely, then agitate and hold. Repeat as prompted. "**PrES CAL**" will display.
11. Press **CAL** to advance to the next titration point. "**Add**" alternating with "**A1**" displays; then "**AGit t2**" alternating with "**HOLd**" displays.
12. Tap the cell extender cap to dispel any solution clinging to the cap back into the cell. Carefully open the cell extender cap so as not to spill any solution.
13. Continue adding 100μL of Reagent A1, agitating and holding the

unit as prompted, then pressing **CAL** as prompted. An alkalinity value will display when the titration measurement is complete.

14. Note the value for your records or press **MS** to store the value. You can begin another Alkalinity titration by pressing **ALK**.

    The unit will automatically power off after the period of inactivity defined in the AUTO OFF setting (ref. AUTO OFF, pg. 45).

F. Measuring Hardness

1. Hardness Unit Selection

The 9P offers the ability to set the hardness unit preference to either "**PPM**" $CaCO_3$ or grains of hardness. To change hardness units, press **HARD**, then press and hold **CAL** down until "**HArd**" and "**SEL**" are displayed. Press **UP** or **DOWN** to toggle between "**PPM**" and grains (no units are displayed for grains). Press **CAL** to accept. This also sets the hardness unit preference for the LSI Titration function and the LSI Calculator simultaneously.

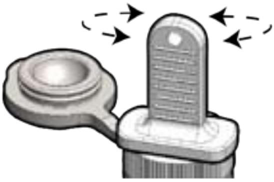
2. Hardness Titration Procedure

Prepare the materials required for titration: Reagent: C1, Reagent: H1, Reagent: H2, Reagent: H3, cell extender, T-plunger, 100 μL pipette with a clean tip installed, and two extra clean tips.

NOTE: If you do not complete each titration point within the 3-minute timeout period, the unit exits the Hardness function. Press **HARD** to start the titration process over from step 1. Between titrations, the unit will automatically power off after the period of inactivity defined in the AUTO OFF setting (ref. AUTO OFF, pg. 45).

1. Ensure pH protective cap is secure to avoid contamination.
2. Install the cell extender by pushing the base of the cell extender into the conductivity cell until it is fully seated.
3. Rinse the conductivity cell cup and cell extender 3 times with solution to be measured.
4. Refill cell cup and cell extender with sample solution.
5. Insert T-plunger into open cell extender until the "T" rests flush on the lip of the cell extender. This will cause fluid beyond what is required for titration to overflow the cell extender.

6. Rotate the T-plunger from side to side, allowing the arms of the T-plunger to slide along the rim of the cell extender.



7. Carefully remove the T-plunger so as not to flick or spill remaining sample. Tap the T-plunger on the side of the cell extender to remove sample that may be stuck to the T-plunger.

8. Press HARD. "**CA**" alternating with "**tdS**" displays along with "**PPM**" sample value. "**PrES CAL**" displays when the reading stabilizes.

9. Press **CAL**. "**Add**" alternating with "**C1**" will display; then "**AGit**" alternating with "**HOLd**" will display.

10. Using the pipette, add 100μL of Reagent C1 to the sample, close the cell extender cap securely, then agitate and hold. Repeat as prompted. "**OPEn CAP**" alternating with "**PrES CAL**" will display.

11. Tap the cell extender cap to dispel any solution clinging to the cap back into the cell. Carefully open the cell extender cap so as not to spill any solution.

12. Press **CAL** to start 120 second timer. The display will count down from "**120**" to "**0**", allowing time for CO_2 to escape. Using your index finger, firmly tap the side of the instrument closest to the conductivity cell to release any CO_2 bubbles clinging to the conductivity cell/cell cup extender wall. This effectively reduces any bicarbonate alkalinity in the sample and prepares it for titration. After 120 seconds, "**Add**" alternating with "**H1 1**" will display. (The "**1**" indicates the first addition of sodium hydroxide.) Then "**AGit**" alternating with "**HOLd**" will display.

13. Change the pipette tip.

14. Using the pipette, add 100μL of Reagent H1 to the cell, close the cell extender cap securely to prevent any solution from spilling out, then agitate and hold. Repeat as prompted. "**PrES CAL**" will display.

15. Press **CAL**. "**Add**" alternating with "**H1 2**" will display. (The "**2**" indicates the second addition of sodium hydroxide.) Then "**AGit**" alternating with "**HOLd**" will display.

16. Tap the cell extender cap to dispel any solution clinging to the cap back into the cell. Carefully open the cell extender cap so as not to spill any solution.

17. Using the pipette, add a second 100 μL of Reagent H1 to the

cell, close the cell extender cap securely to prevent any solution from spilling out, then agitate and hold. Repeat as prompted. "**PrES CAL**" will display.

18. Press **CAL** to advance to first titration prompt. "**Add**" alternating with either "**EdTA LC**" (Reagent H2) or "**EdTA HC**" (Reagent H3) will display; then "**AGit t1**" alternating with "**HOLd**" will display. The number after "**t**" indicates which titration point you are on. The number "**1**" here indicates this is the first titration point. Subsequent titration points are sequenced numerically: 2, 3, 4, etc.
19. Tap the cell extender cap to dispel any solution clinging to the cap back into the cell. Carefully open the cell extender cap so as not to spill any solution.
20. Change the pipette tip.
21. Using the pipette, add 100µL of Reagent H2 if "**EdTA LC**" is displayed, or H3 if "**EdTA HC**" is displayed.
22. Close the cell extender cap securely to prevent any solution from spilling out. Then agitate and hold. Repeat as prompted. "**PrES CAL**" will display.
23. Press **CAL** to advance to the next titration point. Continue adding 100µL of Reagent H2 or H3 using the pipette, agitating and holding the unit as prompted, then pressing **CAL** as prompted. A hardness value will display when the titration measurement is complete.
24. Note the hardness value for your records or press **MS** to store the value. You can begin another Hardness titration by pressing **HARD**. The unit will automatically power off after the period of inactivity defined in the AUTO OFF setting (ref. AUTO OFF, pg. 45).

NOTE: If there is a gross error in your titration method, e.g., you forgot to add sample to the cell, "**rEAd Err**" will alternate with "**rEPt tit**". Repeat the titration from step 1 to obtain a reading. If the reading is over range, the display indicates "**Or**". If the reading is under range, the display indicates "**0.00**".

G. LSI Calculator Functions

The Ultrameter III features an LSI Calculator that can be used to perform actual LSI titration measurements or for hypothetical water balance calculations.

The LSI Calculator computes a Langelier Saturation Index value using measured, default, or user-adjusted values for alkalinity, hardness, pH and temperature.

If you have stored alkalinity, hardness or pH and temperature values, the calculator will automatically display the most recent stored value.

All other values will display as default. You can adjust any or all of the values displayed to determine the effect of the change(s) on the LSI value.

1. Measuring LSI

NOTE: The unit will automatically power off after the period of inactivity defined in the AUTO OFF setting (ref. AUTO OFF, pg. 45).

To compute the actual saturation index of a solution:

Before you enter the calculator function, you must measure and store values for all water balance variables used by the calculator to compute saturation index.

1. Perform an alkalinity titration of the sample solution (ref. Measuring Alkalinity, pg. 14). Press **MS** to store the reading in memory.
2. Perform a hardness titration of the sample solution (ref. Measuring Hardness, pg. 16). Press **MS** to store the reading in memory.
3. Measure the pH of the sample solution (ref. Measuring pH, pg. 20) Press **MS** to store the reading in memory.
4. Press LSI.
5. The last stored alkalinity value is displayed.
6. Press **CAL** to accept value and advance to the hardness value screen. The last stored hardness value is displayed.
7. Press **CAL** to accept value and advance to the pH value screen. The last stored pH value is displayed.
8. Press **CAL** to accept value and advance to the temperature value screen. The last stored temperature value (taken from the last stored hardness or alkalinity titration) is displayed.
9. Press **CAL** to accept and calculate LSI. The saturation index value will display. Press **MS** to store the reading. The unit will automatically power off after the period of inactivity defined in the AUTO OFF setting (ref. AUTO OFF, pg. 45).

If you want to modify any of the input values and recalculate LSI based on those changes, press **CAL** again and repeat steps 5-9. If you want to change hardness units (ppm/grains), you must do so in the hardness parameter. See Hardness Unit Selection, pg. 16.

2. Hypothetical LSI Calculations

NOTE: The unit will automatically power off after the period of inactivity defined in the AUTO OFF setting (ref. AUTO OFF, pg. 45).

To compute saturation index using hypothetical alkalinity, hardness, pH or temperature values:

1. Press LSI.
2. Either the last stored value or the default value of "**120**" is displayed.
3. Press the **UP** or **DOWN** keys to adjust the alkalinity value or leave as displayed.
4. Press **CAL** to accept and advance to the hardness value screen. Either the last stored value or the default value of "**166**" is displayed.
5. Press **CAL** to accept hardness value and advance to the pH value screen. Either the last stored value or the default value of "**7.20**" is displayed.
6. Press **UP** or **DOWN** to adjust the pH value or leave as displayed.
7. Press **CAL** to accept pH value and advance to the temperature value screen. Either the last stored value (taken from the last stored hardness or alkalinity titration) or the default value of "**25 ºC**" is displayed.
8. Press **UP** or **DOWN** to adjust the temperature value or leave as displayed.
9. Press **CAL** to accept and calculate LSI. A saturation index value will display.

If you want to modify any of the input values and recalculate LSI based on those changes, press **CAL** again and repeat steps 3-9. If you want to change hardness units, you must do so in the hardness parameter. See Hardness Unit Selection, pg. 16.

H. Measuring pH

1. Remove protective cap by rotating while grasping and pulling up.
2. Rinse pH/ORP sensor well and conductivity cell cup 3 times with sample to be measured. Shake out each sample to remove any residual liquid.
3. Refill both sensor well and cell cup with sample.
4. Press pH.
5. Note value displayed.
6. **IMPORTANT:** After use, fill pH/ORP sensor well with Myron L pH Sensor Storage Solution and replace protective cap. If Myron L pH Sensor Storage Solution is unavailable, you can use a strong KCl solution, a pH 4 buffer, or a saturated solution

of table salt and tap water (ref. Cleaning Sensors, 2. pH/ORP, pg. 52). Do not allow pH/ORP sensor to dry out.

I. Measuring ORP

The Ultrameter III features the ability to measure the activity of oxidizing or reducing chemicals in solution as ORP mV. The instrument also includes an innovative Free Chlorine Equivalent (FC^{E}) feature (Measuring Free Chlorine Using FC^{E}, pg. 22) that uses ORP and pH to measure free available chlorine (FAC) concentration in ppm. ORP mV and ppm of free available chlorine (FAC) are the two most commonly used sanitizer units of measure in water quality management.

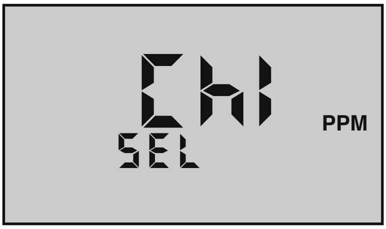
1. ORP / FC^{E} Mode Selection

The Ultrameter III allows the user to choose between measuring oxidizing sanitizers using either ORP mV or as parts per million (ppm) of equivalent free chlorine. Use ORP to directly measure the activity of all sanitizers like ozone, bromine, peracetic acid or chlorine. Use FC^{E} to measure the strength of oxidizing sanitizers as ppm of equivalent free chlorine. To select between ORP and Free Chlorine modes:

1. Press ORP/Fr Chl.
2. Press and hold CAL/MCLR for approximately 3 seconds.

The current preference for ORP units of measure is displayed. Factory setting for this preference is ORP mV.

3. Press the ▲/MS or MR/▼ keys to toggle between mV (standard ORP mode) and FC^{E} ppm. The setting chosen is displayed.



4. Press any parameter key to exit ORP unit preference selection or let the unit time out. ORP unit preference will be saved.

2. Measuring ORP

1. Ensure the 9P is in ORP mode (ref. ORP/FC^{E} Mode Selection, pg. 21).

2. Remove protective cap by rotating while grasping and pulling up.

3. Rinse sensor well and cell cup 3 times with sample to be measured. Shake out each sample to remove any residual liquid.
4. Refill both sensor well and cell cup with sample.

5. Press ORP/Fr Chl .

6. Take reading.

7. Press **MS** to store reading in memory, if desired.

   IMPORTANT: After use, fill pH/ORP sensor well with Myron L pH Sensor Storage Solution and replace protective cap. If Myron L pH Sensor Storage Solution is unavailable, you can use a strong KCl solution, a pH 4 buffer, or a saturated solution of table salt and tap water (ref. Cleaning Sensors, 2. pH/ORP, pg. 52). Do not allow pH/ORP sensor to dry out.

J. Measuring Free Chlorine Using FC^{E}

The FC^{E} function can be used to measure discrete samples, flowing solution and bodies of water. Measurement technique is particular to the type of sample. For accurate results, use the FC^{E} Flow Method described in section 2 below to measure discrete or flowing samples. Use the FC^{E} Immersion Method described in section 3 below in situations where the 9P can be dipped to obtain a sample. Read through section 4. FC^{E} Best Practices before you begin.

1. Prepare for FC^{E} Measurement

1. For ease of measurement, set the instrument's Auto oFF feature to 75 sec (ref. Auto oFF, pg. 45).

2. Ensure the FC^{E} mode has been activated (ref. ORP/FC^{E} Mode Selection, pg. 21).

3. Remove protective cap from the pH/ORP sensor by rotating while grasping and pulling up.

2. FC^{E} Flow Method

1. Empty the pH/ORP sensor well of all storage solution.

2. Hold the 9P at a 30° angle (cup sloping downward).

3. Thoroughly flush the sensor well and cell cup with a steady stream of the solution you intend to measure by allowing the

solution to flow into and out of the sensor well and cell cup for at least 10 seconds.

4. Let sample flow continuously into conductivity cell with no aeration.

5. Allow both the sensor well and cell cup to remain filled with sample.

6. Press ORP/Fr Chl. The instrument will begin alternating between a predicted final ORP value and a free chlorine equivalent concentration in ppm. Both readings will change rapidly at first.

7. Wait for the readings to stabilize. When the mV and ppm values are unchanging for 5 consecutive readings, the FC^E reading has reached a stable level. This may take 1 to 2 minutes. **NOTE:** If the reading takes more than 1 minute to stabilize, press the ORP/Fr Chl after 1 minute to prevent Auto oFF feature from disturbing the measurement process. Annunciators will alert you when either the pH or ORP of the final FC^E ppm value are Out of Range (“**-Or-**”).

8. Press **MS** to store reading in memory if desired.

3. FC^E Immersion Method

NOTE: Use this method for pools, spas and other large standing bodies of water.

1. Hold instrument beneath the surface of the water to avoid surface effects on the water’s chemistry.

2. Swirl the instrument around for at least 10 seconds to thoroughly rinse the cell cup and sensor well.

3. Continue holding the instrument under the surface while taking the reading.

4. Press ORP/Fr Chl.

5. The instrument will begin alternating between a predicted final ORP value and a free chlorine equivalent concentration in ppm. Both readings will change rapidly at first.

6. Wait for the readings to stabilize. When the mV and ppm values are unchanging for 5 consecutive readings, the FC^E reading has reached a stable level. This may take 1 to 2 minutes.

NOTE: If the reading takes longer than 1 minute to stabilize, press ORP/Fr Chl after 1 minute to prevent Auto-OFF feature from disturbing the measurement process. Annunciators will alert you when either the pH or ORP of the final FC^E ppm value are Out of Range ("**-Or-**").

7. Press **MS** to store reading in memory if desired.

4. FC^E Best Practices

For best results it is recommended that you:

1. Take 3 consecutive FC^E measurements and record the readings.
2. Calculate the average of the 3 measurements. Use this value.
3. Ignore measurements that are significantly different from the others. Ex: 3.20 ppm, ~~1.15 ppm~~, 3.10 ppm

IMPORTANT: After use, fill pH/ORP sensor well with Myron L pH Sensor Storage Solution and replace protective cap. If Myron L pH Sensor Storage Solution is unavailable, you can use a strong KCl solution, a pH 4 buffer, or a saturated solution of table salt and tap water (ref. Cleaning Sensors, 2. pH/ORP, pg. 52). Do not allow pH/ORP sensor to dry out.

VI. SOLUTION SELECTION

A. Why Solution Selection is Available

Conductivity, resistivity, and TDS require temperature correction to 25°C values (ref. Standardized to 25°C, pg. 59). Selection determines the temperature correction of conductivity and calculation of TDS from compensated conductivity (ref. Cond. Conversion to TDS, pg. 61).

B. The 4 Solution Types

On the left side of the display is the salt solution characteristic used to model temperature compensation of conductivity and its TDS conversion. Generally, using KCl for conductivity, NaCl for resistivity, and 442 (Natural Water characteristic) for TDS will reflect present industry practice for standardization. This is how your instrument is shipped from the factory (ref. Solution Characteristics, pg. 61).

The User selection allows a custom value to be entered for the temperature compensation of conductivity and also the conversion ratio if measuring TDS.

C. Calibration of Each Solution Type

There is a separate calibration for each of the 4 solution types. Note that calibration of a 442 solution does not affect the calibration of a NaCl solution. For example: Calibration (ref. Conductivity or TDS Calibration, pg. 29) is performed separately for each type of solution one wishes to measure (ref. Conductivity/TDS Standard Solutions, pg. 56).

D. Procedure to Select a Solution

NOTE: Check display to see if solution displayed (KCl, NaCl, 442 or User) is already the type desired. If not:

1. Press (COND), (RES) or (TDS) to select the parameter on which you wish to change the solution type.
2. Press and hold (CAL/MCLR) key for 3 seconds to make "**SEL**" appear (see Figure 1). For demonstration purposes, all 4 solution types are shown simultaneously.

Figure 1

3. Use the (▲/MS) or (MR/▼) key to select type of solution desired (ref. Solution Characteristics, pg. 61). The selected solution type will be displayed: KCl, NaCl, 442 or User.
4. Press (CAL/MCLR) to accept new solution type.

E. Application of User Solution Type

1. User Programmable Temperature Compensation (Tempco)

This feature allows you to change your Ultrameter III's temperature compensation factor to another factor between 0-9.99%/°C (ref. Temperature Compensation, pg. 58). This feature does not apply to pH or ORP.

a. As in Procedure to Select a Solution, above, select User mode.

b. With User mode now selected, press (CAL/MCLR). You may now adjust a temperature compensation from .00%/°C to 9.99%/°C, by pressing (▲/MS) or (MR/▼). See example in Figure 2, pg. 26.

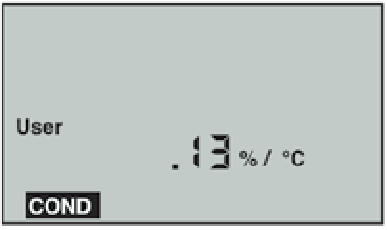


Figure 2

c. Press CAL/MCLR twice to skip calibration adjustment and accept the new tempco (3 times if in TDS mode). You are now ready to measure samples with your new temperature compensation factor.

2. Disabling Temperature Compensation

a. Select User mode (ref. Procedure to Select a Solution, pg. 25).

b. With "**User**" selected, press CAL/MCLR. If the display does not show .00%/°C, hold MR ▼ long enough to bring the tempco to .00%/°C (see Figure 3).

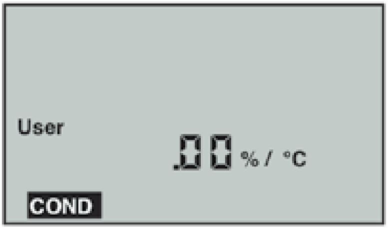


Figure 3

c. Press CAL/MCLR twice (3 times if in TDS mode). Temperature compensation is now disabled (=0) for measurements in User mode.

3. User Programmable Conductivity to TDS Ratio

This feature allows you to select a custom conductivity to TDS conversion ratio within the range of 0.20-7.99 for User mode measurements.

To determine the conversion ratio for a custom solution of **known** TDS ppm value, measure the solution conductivity **at 25°C** with the Ultrameter III and divide the ppm value by the μS value. For example, a solution of known 75 ppm TDS and measured 100 μS conductivity at 25°C would have a conversion ratio of 75/100 or 0.75. Enter the new conversion ratio as follows:

a. While in User mode, press TDS.

b. Press CAL/MCLR twice (to skip over tempco adjustment) and "**RATIO**" will appear (see Figure 4).

Figure 4

c. Adjust with ▲/MS or MR/▼ key until new conversion ratio is displayed.

d. Press CAL/MCLR twice (to skip over calibration adjustment) to accept new conversion ratio. You are now ready to measure samples with the new conductivity/TDS ratio.

In these first six sections, you have learned all you need to make accurate measurements. The following sections contain calibration, advanced operations and technical information.

VII. CALIBRATION

A. Calibration Intervals

Generally, calibration is recommended about once per month with Conductivity or TDS solutions. Calibration with pH solutions should be checked twice a month. Calibration of ORP is not necessary (ref. CALIBRATION INTERVALS TABLE under Calibration Steps, pg. 28).

B. Rules for Calibration of the Ultrameter III

1. Calibration Steps

The following table lists measurement functions and their corresponding calibration requirements:

CALIBRATION INTERVALS TABLE:

Function	KCl, NaCl or 442	User
Cond	Gain Only	Tempco, then Gain
Res	Done in Conductivity	Done in Conductivity
TDS	Gain Only	Tempco, Ratio, then Gain
pH	7, acid and/or base	
ORP	Zero set with pH 7 automatically	
Alkalinity	Gain Only	
Hardness	Gain Only	

a. Starting Calibration

For Alkalinity and Hardness, calibration is begun by pressing CAL/MCLR when the titration is complete and a value displays.

For Conductivity, TDS or pH, calibration is begun by pressing CAL/MCLR while measuring Conductivity, TDS or pH. Measuring continues, but the "**CAL**" icon is on, indicating calibration is now changeable. The reading is changed with the ▲/MS and MR/▼ keys to match the known value.

The calibration for each of the 4 solution types may be performed in either conductivity or TDS mode.

Once in CAL mode, the CAL/MCLR key becomes an "ACCEPT" key for the new calibration.

For pH, at each point, pressing CAL/MCLR accepts the new calibration value and steps you to the next adjustment.

To bypass a calibration, simply press CAL/MCLR to accept the present value as-is.

b. Leaving Calibration

Pressing CAL/MCLR accepts calibration and exits CAL mode if there are no more steps. Calibration is complete when the "**CAL**" icon goes out. Pressing any measurement key during calibration cancels changes not yet accepted and exits calibration mode. Leaving pH after the 2nd buffer results in the same gain being entered in place of the 3rd buffer.

2. Calibration Limits

There are calibration limits for all functions for which calibration is required. For Alkalinity and Hardness, the 9P will not allow you to calibrate beyond its calibration limits. For all other functions, attempts to calibrate too far up or down from the ideal “**FAC**” value stored in the unit by the factory will cause the displayed value to be replaced with “**FAC**”. If you accept it (press the **CAL** key), you will have the original default factory calibration for this measurement. The need to calibrate so far out that “**FAC**” appears indicates a procedural problem, incorrect standard solution, a very dirty cell cup or an aging pH/ORP sensor (ref. Troubleshooting Chart, pg. 54).

C. Calibration Procedures

1. Conductivity or TDS Calibration

a. Rinse conductivity cell 3 times with proper standard (KCl, NaCl, or 442) (ref. Cond/TDS Standard Solutions, pg. 56). For user calibration see User Calibration Conductivity/TDS below.

b. Refill conductivity cell with same standard. KCl-7000 shown.

c. Press COND or TDS , then press CAL/MCLR ; “**CAL**” icon will appear on the display (see Figure 5).

Figure 5

d. Press ▲/MS or MR/▼ to step the displayed value toward the standard’s value (7032 > 7000) or hold a key down to scroll rapidly through the reading.

e. Press CAL/MCLR once to confirm new value and end the calibration sequence for this particular solution type. If another solution type is also to be measured, change solution type now and repeat this procedure.

2. User Calibration Conductivity/TDS

Instrument must be in User mode, see Solution Selection, pg. 24.

a. Rinse conductivity cell three times with YOUR standard.

b. Refill conductivity cell with same standard.

c. Press COND or TDS , then press CAL/MCLR twice in COND/ three times in TDS. The “**CAL**” icon will appear on the display.

d. Press ▲ MS or MR ▼ to step the displayed value toward the standard's value or hold a key down to scroll rapidly through the reading.

e. Press CAL MCLR once to confirm new value and end the calibration sequence for this particular solution type.

3. Resistivity Calibration

Resistivity is the reciprocal of Conductivity. To calibrate resistivity, calibrate conductivity for the solution type you wish to measure (ref. Conductivity or TDS Calibration, pg. 29).

4. Reloading Factory Calibration (Cond or TDS)

If calibration is suspect or known to be incorrect, and no standard solution is available, the calibration value can be replaced with the original factory value for that solution. This "FAC" value is the same for all Ultrameter IIIs, and returns you to a known state without solution in the cell. The "FAC" internal electronics calibration (which bypasses the electrodes and cell) is not intended to replace calibration with conductivity/TDS standard solutions. If another solution type requires resetting, change solution type and repeat this procedure.

a. Press COND or TDS .

b. Press CAL MCLR . (If in "**User**" solution mode — press **CAL** key twice if in Conductivity, and three times if in TDS to skip over tempco and ratio adjustments.)

c. Press ▲ MS key until "**FAC**" appears and release.

d. Press CAL MCLR to accept the factory calibration setting.

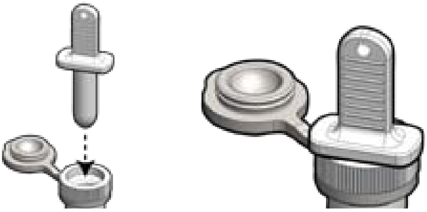
5. Alkalinity Calibration

Prepare the materials required for titration: Alkalinity Standard Solution 100PPM, Reagent: A1, cell extender, T-plunger, and 100 μL pipette with a clean tip installed.

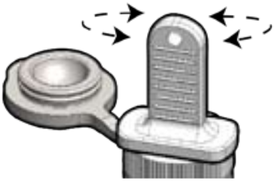
NOTE: If you do not complete each titration point within the 3-minute timeout period, the unit exits the Alkalinity function. Between titrations, the unit will automatically power off after the period of inactivity defined in the AUTO OFF setting (ref. AUTO OFF, pg. 45). Press **ALK** to start the titration process over from step 1.

If you make a gross error in your titration method, e.g., you forget to add sample to the cell, "**Err**" will display. Start the titration over from Step 1 to obtain a reading.

1. Ensure pH protective cap is secure to avoid contamination.
2. Install the cell extender by pushing the base of the cell extender into the conductivity cell until it is fully seated.
3. Rinse the conductivity cell cup and cell extender 3 times with Alkalinity Standard 100PPM.
4. Refill cell cup and cell extender with Alkalinity Standard 100PPM.
5. Insert T-plunger into open cell extender until the “T” rests flush on the lip of the cell extender. This will cause fluid beyond what is required for titration to overflow the cell extender.



6. Rotate the T-plunger from side to side, allowing the arms of the T-plunger to slide along the rim of the cell extender.



7. Carefully remove the T-plunger so as not to flick or spill remaining sample. Tap the T-plunger on the side of the cell extender to remove sample that may be stuck to the T-plunger.
8. Press ALK. “**AL**” alternating with “**tdS**” briefly displays along with the “**PPM**” value of the sample. “**PrES CAL**” will display when the reading stabilizes.
9. Press **CAL** to accept and advance to the first titration prompt. “**Add**” alternating with “**A1**” displays; then “**AGit t1**” alternating with “**HOLd**” displays. (The number after “**t**” indicates which titration point you are on. The number “**1**” here indicates this is the first titration point. Subsequent titration points are sequenced numerically: 2, 3, 4, etc.)
10. Using the pipette, add 100 μL of Reagent: A1, close the cell extender cap securely, then agitate and hold. Repeat as prompted. “**PrES CAL**” will display.
11. Press **CAL** to advance to the next titration point. “**Add**” alternating with “**A1**” displays; then “**AGit t2**” alternating with “**HOLd**” displays.

12. Tap the cell extender cap to dispel any solution clinging to the cap back into the cell. Carefully open the cell extender cap so as not to spill any solution.

13. Continue adding 100µL of Reagent A1, agitating and holding the unit as prompted, then pressing **CAL** as prompted. An alkalinity value will display when the titration measurement is complete.

14. Press **CAL**. The “**CAL**” icon will display.

15. Adjust the displayed value to “**100”** using the UP or DOWN key. The unit will not allow you to scroll up or down to “**100**” if it is beyond ±10% of the reading. Ref. Total Return to Factory Settings “FAC SEL”, pg. 43 to reset the Alkalinity Calibration to the “FAC” setting along with all other calibrations.

16. Press **CAL** to accept. The unit will automatically power off after the period of inactivity defined in the AUTO OFF setting (ref. AUTO OFF, pg. 45).

6. Hardness Calibration

Prepare the materials required for titration: Hardness Standard Solution 200PPM, Reagent: C1, Reagent: H1, Reagent: H2, Reagent: H3, cell extender, T-plunger, 100 µL pipette with a clean tip installed, and two extra clean tips.

NOTE: If you do not complete each titration point within the 3-minute timeout period, the unit exits the Hardness function. Press **HARD** to start the titration process over from step 1. Between titrations, the unit will automatically power off after the period of inactivity defined in the AUTO OFF setting (ref. AUTO OFF, pg. 45).

1. Ensure pH protective cap is secure to avoid contamination.

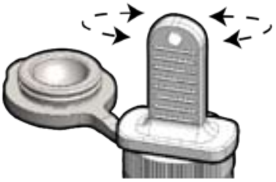
2. Install the cell extender by pushing the base of the cell extender into the conductivity cell until it is fully seated.

3. Rinse the conductivity cell cup and cell extender 3 times with Hardness Standard 200PPM.

4. Refill cell cup and cell extender with Hardness Standard 200PPM.

5. Insert T-plunger into open cell extender until the “T” rests flush on the lip of the cell extender. This will cause fluid beyond what is required for titration to overflow the cell extender.

6. Rotate the T-plunger from side to side, allowing the arms of the T-plunger to slide along the rim of the cell extender.



7. Carefully remove the T-plunger so as not to flick or spill remaining sample. Tap the T-plunger on the side of the cell extender to remove sample that may be stuck to the T-plunger.
8. Press HARD. "**CA**" alternating with "**tdS**" displays along with "**PPM**" sample value. "**PrES CAL**" displays when the reading stabilizes.
9. Press **CAL**. "**Add**" alternating with "**C1**" will display; then "**AGit**" alternating with "**HOLd**" will display.
10. Using the pipette, add 100μL of Reagent C1 to the sample, close the cell extender cap securely, then agitate and hold. Repeat as prompted. "**OPEn CAP**" alternating with "**PrES CAL**" will display.
11. Tap the cell extender cap to dispel any solution clinging to the cap back into the cell. Carefully open the cell extender cap so as not to spill any solution.
12. Press **CAL** to start 120 second timer. The display will count down from "**120**" to "**0**", allowing time for CO_2 to escape. Using your index finger, firmly tap the side of the instrument closest to the conductivity cell to release any CO_2 bubbles clinging to the conductivity cell/cell cup extender wall. This effectively reduces any bicarbonate alkalinity in the sample and prepares it for titration. After 120 seconds, "**Add**" alternating with "**H1 1**" will display. (The "**1**" indicates the first addition of sodium hydroxide.) Then "**AGit**" alternating with "**HOLd**" will display.
13. Change the pipette tip.
14. Using the pipette, add 100μL of Reagent H1 to the cell, close the cell extender cap securely to prevent any solution from spilling out, then agitate and hold. Repeat as prompted. "**PrES CAL**" will display.
15. Press **CAL**. "**Add**" alternating with "**H1 2**" will display. (The "**2**" indicates the second addition of sodium hydroxide.) Then "**AGit**" alternating with "**HOLd**" will display.
16. Tap the cell extender cap to dispel any solution clinging to the cap back into the cell. Carefully open the cell extender cap so as not to spill any solution.

17. Using the pipette, add a second 100 μL of Reagent H1 to the cell, close the cell extender cap securely to prevent any solution from spilling out, then agitate and hold. Repeat as prompted. "**PrES CAL**" will display.

18. Press **CAL** to advance to first titration prompt. "**Add**" alternating with either "**EdTA LC**" (Reagent H2) or "**EdTA HC**" (Reagent H3) will display; then "**AGit t1**" alternating with "**HOLd**" will display. The number after "**t**" indicates which titration point you are on. The number "**1**" here indicates this is the first titration point. Subsequent titration points are sequenced numerically: 2, 3, 4, etc.

19. Tap the cell extender cap to dispel any solution clinging to the cap back into the cell. Carefully open the cell extender cap so as not to spill any solution.

20. Change the pipette tip.

21. Using the pipette, add 100μL of Reagent H2 if "**EdTA LC**" is displayed, or H3 if "**EdTA HC**" is displayed.

22. Close the cell extender cap securely to prevent any solution from spilling out. Then agitate and hold. Repeat as prompted. "**PrES CAL**" will display.

23. Press **CAL** to advance to the next titration point. Continue adding 100μL of Reagent H2 or H3 using the pipette, agitating and holding the unit as prompted, then pressing **CAL** as prompted. A hardness value will display when the titration measurement is complete.

24. Press **CAL.** The "**CAL**" icon will display.

25. Adjust the displayed value to "**200**" using UP or DOWN key. The unit will not allow you to scroll up or down to "**200**" if it is beyond ±10% of the reading. Ref. Total Return to Factory Settings "**FAC SEL**", pg. 43 to reset the Hardness Calibration to the "**FAC**" setting along with all other calibrations.

26. Press **CAL** to accept.

    The unit will automatically power off after the period of inactivity defined in the AUTO OFF setting (ref. AUTO OFF, pg. 45).

7. <u>pH Calibration</u>

IMPORTANT: Always "zero" your Ultrameter III with a pH 7 buffer solution before adjusting the gain with acid or base buffers, i.e., 4 and/or 10, etc.

a. <u>pH Zero Calibration</u>

1. Rinse sensor well and cell cup 3 times with 7 buffer solution.
2. Refill both sensor well and cell cup with 7 buffer solution.
3. Press pH to verify the pH calibration. If the display shows 7.00, skip the pH Zero Calibration and proceed to section b. pH Gain Calibration.
4. Press CAL/MCLR to enter calibration mode. The “**CAL**”, “**BUFFER**” and “**7**” annunciators will appear (see Figure 6). Displayed value will be the uncalibrated sensor.

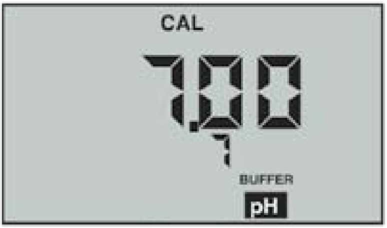


Figure 6

NOTE: If a wrong buffer is added (outside of 6-8 pH), “**7**”and “**BUFFER**” will flash, and the Ultrameter III will not adjust. The uncalibrated pH value displayed in step 4 will assist in determining the accuracy of the pH sensor. If the pH reading is above 8 with pH 7 buffer solution, the sensor well needs additional rinsing or the pH sensor is defective and needs to be replaced.

5. Press ▲ MS or MR ▼ until the display reads “**7.00**”.

NOTE: Attempted calibration of >1 pH point from factory calibration will cause “**FAC**” to appear. This indicates the need for sensor replacement (ref. Troubleshooting pg. 54) or fresh buffer solution. <u>The “FAC” internal electronic calibration is not intended to replace calibration with pH buffers. It assumes an ideal pH sensor</u> Each “FAC” indicates a factory setting for that calibration step (i.e., 7, acid, base).

You may press CAL/MCLR to accept the preset factory value, or you may reduce your variation from factory setting by pressing ▲ MS or MR ▼.

6. Press CAL/MCLR to accept the new value. The pH Zero Calibration

is now complete. You may continue with pH Gain Calibration or exit by pressing any measurement key.

b. pH Gain Calibration

IMPORTANT: Always calibrate or verify your Ultrameter III with a pH 7 buffer solution before adjusting the gain with acid or base buffers, i.e., 4 and/or 10, etc. Either acid or base solution can be used for the 2nd point "Gain" calibration and then the opposite for the 3rd point. The display will verify that a buffer is in the sensor well by displaying either "**Acd**" or "**bAS**".

1. The pH calibration mode is initiated by either completion of the pH Zero Calibration, or verifying 7 buffer and pressing the CAL/MCLR key twice while in pH measurement mode.
2. At this point the "**CAL**", "**BUFFER**" and "**Acd**" or "**bAS**" annunciators will be displayed (see Figures 7 and 8).

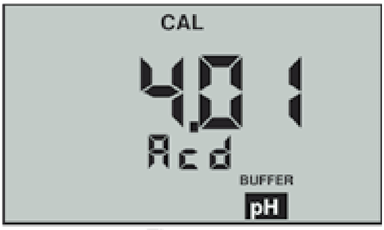


Figure 7

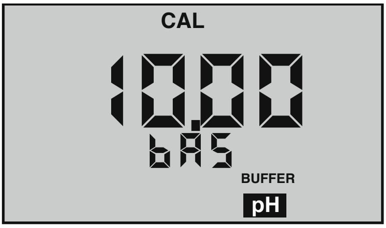


Figure 8

NOTE: If the "**Acd**" and "**bAS**" indicators are blinking, the unit is indicating an error and needs either an acid or base solution present in the sensor well.

3. Rinse sensor well 3 times with acid or base buffer solution.
4. Refill sensor well again with same buffer solution.
5. Press ▲/MS or MR/▼ until display agrees with buffer value.
6. Press CAL/MCLR to accept 2nd point of calibration. Now the display indicates the next type of buffer to be used.

Single point Gain Calibration is complete. You may continue for the 3rd point of Calibration (2nd Gain) or exit by pressing any measurement key. Exiting causes the value accepted for the buffer to be used for both acid and base measurements.

To continue with 3rd point calibration, use basic buffer if acidic buffer was used in the 2nd point, or vice-versa. Again, match the display to the known buffer value as in step 2 and continue with the following steps:

7. Repeat steps 3 through 6 using opposite buffer solution.
8. Press CAL MCLR to accept 3rd point of calibration, which completes the Calibration procedure. Fill sensor well with Myron L Storage Solution and replace protective cap.

8. ORP Calibration

ORP electrodes rarely give false readings without problems in the reference electrode. For this reason, and because calibration solutions for ORP are highly reactive and potentially hazardous, your Ultrameter III has an electronic ORP calibration. This causes the zero point on the reference electrode to be set whenever pH 7 calibration is done.

9. Temperature Calibration

Temperature calibration is not necessary in the Ultrameter III.

VIII. CALIBRATION INTERVALS

There is no simple answer as to how often one should calibrate an instrument. The Ultrameter III is designed to not require frequent recalibration. The most common sources of error were eliminated in the design, and there are no mechanical adjustments. Still, to ensure specified accuracy, any instrument must be checked against chemical standards occasionally.

A. Suggested Intervals

On the average, we expect calibration need only be checked monthly for the Conductivity, RES or TDS functions. The pH function should be checked every 2 weeks to ensure accuracy. Measuring some solutions will require more frequent intervals.

B. Calibration Tracking Records

To minimize your calibration effort, keep records. If adjustments you are making are minimal for your application, you can check less often. Changes in conductivity calibration should be recorded in percent. Changes in pH calibration are best recorded in pH units.

Calibration is purposely limited in the Ultrameter III to ±10% for the conductivity cell, as any change beyond that indicates damage, not drift. Likewise, calibration changes are limited to ±1 pH unit, as any change beyond that indicates the end of the sensor’s lifetime and replacement is recommended.

C. Conductivity, RES, TDS, Practices to Maintain Calibration

1. Clean oily films or organic material from the cell electrodes with foaming cleaner or mild acid. Do not scrub inside the cell.

2. Calibrate with solutions close to the measurements you make. Readings are compensated for temperature based on the type of solution. If you choose to measure tap water with a KCl compensation, which is often done (ref. An Example of 2 different solution selections and the resulting compensation, pg. 59), and you calibrate with 442 solution because it is handy, the further away from 25°C you are, the more error you have. Your records of calibration changes will reflect temperature changes more than the instrument's accuracy.

3. Rinse out the cell with pure water after taking measurements. Allowing slow dissolving crystals to form in the cell contaminates future samples.

4. For maximum accuracy, keep the pH sensor cap on tight so that no fluid washes into the conductivity cell.

D. pH and ORP/Free Chlorine Practices to Maintain Calibration

1. Keep the sensor wet with Myron L Storage Solution.

2. Rinse away caustic solutions immediately after use.

ORP calibration solutions are caustic, and ±5% is considered very accurate. By using the pH zero setting (0 mV = 7 pH) for ORP and precision electronics for detection, the Ultrameter III delivers better accuracy without calibration than a simpler instrument could using calibration solutions.

IX. MEMORY

This feature allows up to 100 readings with their temperatures to be stored simultaneously for later recall. At the same time, the TIME and DATE are also recorded. To download the memory to a computer, ref. bluDock™ WIRELESS DATA TRANSFER INSTRUCTIONS, pg. 49.

A. Memory Storage

1. While displaying a measurement, press ▲ MS to record the displayed value.

2. "**MEMORY**" will appear and the temperature display will be momentarily replaced by a number (1-100) showing the position of the record. Figure 9 shows a reading of 1806 μS stored in memory record #4.

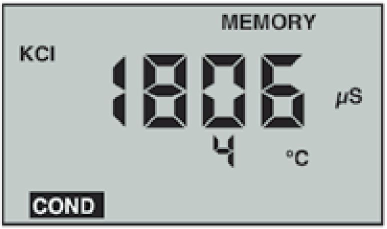


Figure 9

B. Memory Recall

1. Press any measurement key.
2. Press (MR ▼); "**MEMORY**" will appear, and the display will show the last record stored.
3. Press (▲ MS) or (MR ▼) to scroll to the record location desired (the temperature display alternates between temperature recorded and location number).
4. Press (CAL MCLR) to display time and date stamp.
5. Press any measurement key to leave memory recall or allow to automatically turn off.

C. Clearing a Record/Memory Clear

After recalling a certain record location, press and HOLD (CAL MCLR) to clear that memory. This space will be the place for the next memory record, unless you scroll to another empty position before ending the recall sequence. The next memory stored will go into the next highest available memory location.

Example: You have locations 1-7 filled and wish to clear the conductivity reading stored in record location #**3** and replace it with a pH reading.

1. Press (MR ▼) and scroll to location #**3**.
2. Press and HOLD (CAL MCLR) to clear old record #**3**.
3. Fill pH/ORP sensor well with sample.
4. Press (pH) to measure sample and press (▲ MS) to store reading in location #**3**.

5. The next memory stored will go into location #**8**.

6. To clear **all** records: After pressing MR ▼, scroll down. "**CLr ALL**" will be displayed (see Figure 10).

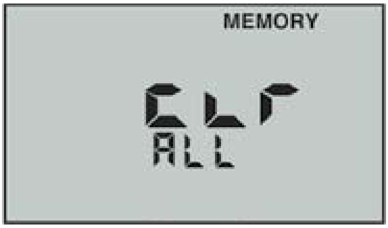


Figure 10

7. Press CAL/MCLR. All records will be cleared.

X. TIME and DATE

The Time and Date may easily be changed as you travel.

A. Setting TIME

Time is always displayed in 24 hour time.
Example shown in Figure 11, 16:05 equals 4:05 PM.

1. Press COND.

2. Press MR ▼ until the time is displayed (scrolling through stored readings, "**PC OFF**", and "**CLr ALL**" to time, e.g., "**16:05**").

3. Press CAL/MCLR to initiate. "**CAL**" will be displayed along with the time (see Figure 11).

Figure 11

4. Press ▲ MS or MR ▼ to change the time.

5. Press CAL/MCLR to accept the change (new time).

B. Setting DATE

Example shown in Figure 12 is in US format, i.e., mo/dy/yr.

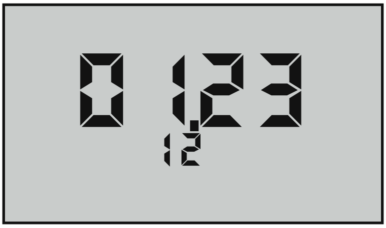


Figure 12

NOTE: The default format is US. Date format may be changed (ref. Date Format “US and International (Int)”, pg. 42).

1. Press COND.
2. Press MR/▼ repeatedly until the date is displayed (scrolling through stored readings, “**PC OFF**”, “**CLr ALL**” and time to the date, e.g., “**01.23 12**” (Figure 12), January 23, 2012).
3. Press CAL/MCLR to initiate. “**CAL**” will be displayed along with the YEAR (see Figure 13).

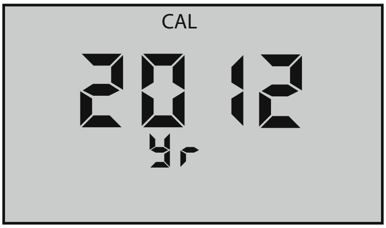


Figure 13

4. Press ▲/MS or MR/▼ to change the YEAR.
5. Press CAL/MCLR to accept the change (new year).
6. Press ▲/MS or MR/▼ to change the month.
7. Press CAL/MCLR to accept the change (new month), (see Figure 14, pg. 42).

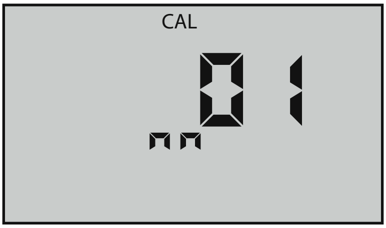


Figure 14

8. Press the ▲ MS or MR ▼ to change the day.

9. Press CAL MCLR to accept the change (new day) (see Figure 15).

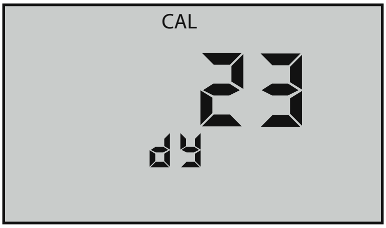


Figure 15

C. <u>DATE FORMAT "US & International (Int)"</u>

1. Press COND .

2. Press MR ▼ repeatedly until the format is displayed (scrolling through stored readings, "**PC OFF**", "**CLr ALL**", time and date to date **format**).

3. Press CAL MCLR to change. Display will now indicate other format (see Figures 16 & 17).

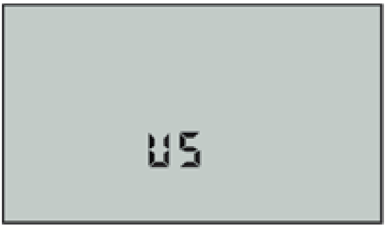


Figure 16

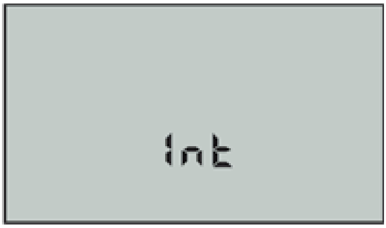


Figure 17

4. Press any measurement key or allow to automatically turn off.

XI. TEMPERATURE FORMAT “Centigrade & Fahrenheit”

1. Press COND.

2. Press MR ▼ to display the stored memory records.

3. Press MR ▼ repeatedly until you pass the “**US**” or “**Int**” date format location. The display will show a “**C**” or “**F**” (see Figures 18 and 19).

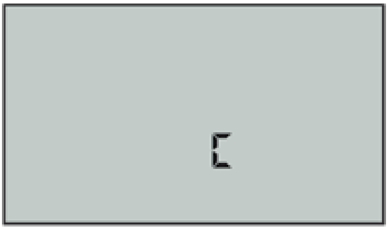


Figure 18

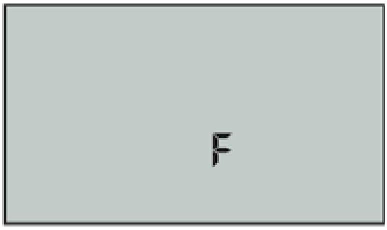


Figure 19

4. Press CAL/MCLR to switch units.

5. Press COND to accept unit preference for all temperature readings.

NOTE: Tempco will still be shown in %/°C.

XII. TOTAL RETURN to FACTORY SETTINGS “FAC SEL”

There may come a time when it would be desirable to quickly reset all the recorded calibration values in the instrument back to the factory settings. This might be to ensure all calibrations are set to a known value, or to give the instrument to someone else free of adjustments or recorded data for a particular application.

NOTE: All stored data will be lost.

1. Press COND.

2. Press MR ▼ to display the stored memory records.

3. Press MR ▼ repeatedly until you pass the “**CLr ALL**” and the C-F locations. The display will show a “**FAC SEL**” (see Figure 20, pg. 44).

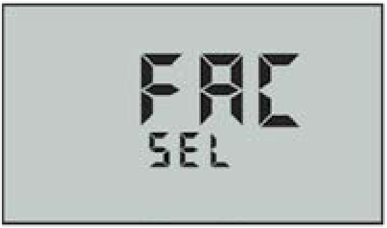


Figure 20

4. Press CAL MCLR to accept the resetting. Display will return to Conductivity.

XIII. CELL CHECK

The cell check verifies the cleanliness of the conductivity/TDS/resistivity sensor. In normal use the cell may become dirty or coated and require cleaning. If the display is showing "**.00**" when the cell cup is dry, the sensor is probably clean. However, when testing high purity water in resistivity ("**RES**") mode improved accuracy may be desired. No matter what a manufacturer claims, a sensor can and will become contaminated or coated and, therefore, require cleaning. A true 4-wire sensor, as in the Ultrameter III, helps to mitigate contamination, but NO SENSOR IS 100% IMMUNE.

1. Press COND.

2. Press MR ▼ to display the stored memory records.

3. Press MR ▼ repeatedly until you pass the FAC SEL location.

   The display will show a "**CELL ch**" (see Figure 21).

Figure 21

4. Press CAL MCLR to test. If cell is clean, "**Good**" will momentarily be displayed (see Figure 22). If cell is dirty, "**CELL cLn**" will be displayed (see Figure 23) (ref. Cleaning Sensors, pg. 52).

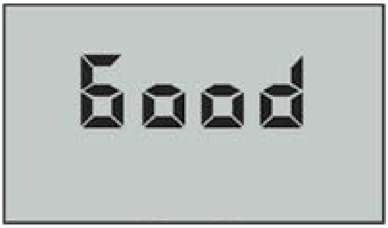


Figure 22

Figure 23

XIV. AUTO OFF

Auto off allows the user to adjust the time the instrument is ON (up to 75 seconds) after each press of a key. Default time is 15 seconds with 60 seconds in “**CAL**” (calibration) mode.

1. Press COND .
2. Press MR/▼ to display the stored memory records.
3. Press MR/▼ repeatedly until you pass the “**CELL ch**” location. The display will show “**Auto oFF**” (see Figure 24).

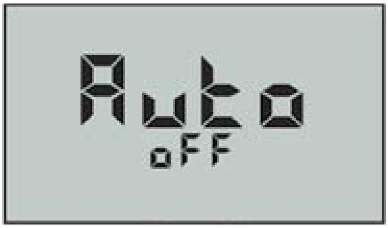


Figure 24

4. Press CAL/MCLR to initiate. “**CAL**” will be displayed along with “**15 SEC**” or current Auto oFF value (see Figure 25).

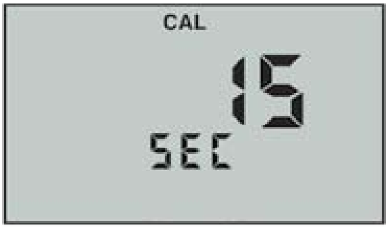


Figure 25

5. Press ▲ MS or MR ▼ to change the amount of time (see Figure 26). Maximum time of 75 seconds is shown.

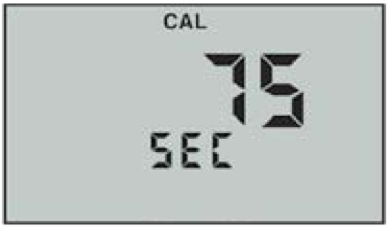


Figure 26

6. Press CAL MCLR to accept the change (new time).

XV. <u>USER Mode CALIBRATION LINC™ FUNCTION</u>

The Linc™ function allows easy calibration when in <u>User mode</u> and the user does not have a user standard solution to calibrate the instrument. This function will ensure more repeatable and accurate measurements than many other calibration methods. It is recommended that this function be used to provide the highest degree of confidence when the Ultrameter III is used in User mode. When Linc is used, the User mode is linked to another standard, i.e., if User and KCl are linked, a KCl standard solution is used to calibrate the instrument. It is that simple.

A. <u>Calibration of Ultrameter III for use in User mode</u>

1. Press COND or TDS key.

2. Calibrate the unit using a Standard Solution (ref. CALIBRATION, pg. 27).

3. Place the Ultrameter III in User mode (ref. SOLUTION SELECTION, pg. 24).

4. Verify/Set the calibration linc. (See below – Setting “User” Mode Calibration “Linc”.)

B. <u>Setting User mode Calibration “Linc”</u>

The Linc function sets or “links” the calibration gain factor of a Standard Solution to the User solution mode. Once set, the “**Linc**” will stay intact with future calibrations unless the Linc has been canceled. For more information on canceling the User mode Calibration Linc refer to the section C. Canceling User mode Calibration “**Linc**”, pg. 48.

Follow the steps below to set either the KCl, NaCl or 442 calibration factor to the User solution mode.

1. Press measurement key desired to be "Linked", i.e., COND, RES or TDS.

2. Place the Ultrameter III in User mode (ref. SOLUTION SELECTION, pg. 24, for selecting the User mode).

3. Press MR ▼ arrow key until the menu "**Linc**" appears (see Figure 27).

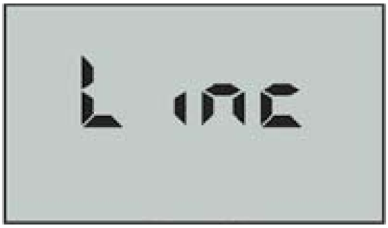


Figure 27

4. Press CAL MCLR key. The instrument will display "**SEL**" and the "**User**" Icon (see Figure 28).

Figure 28

Any additional display of KCl, NaCl or 442 icons indicates a "Linc" between the User solution and the other solution displayed.

5. Press ▲ MS or MR ▼ keys to select a Standard Solution to be linked to the User mode calibration constant. In Figure 29, pg. 48, the display indicates that "**User**" is linked to "**KCl**".

Figure 29

If none of the Solution Selection icons are displayed (i.e., KCl, NaCl or 442), nothing has been linked to User mode.

6. Press CAL/MCLR key to accept the setting. Pressing any of the measurement keys will exit without changing the setting. User mode "**Linc**" is now complete. The User mode will now use the calibration gain constant used for the calibration of the Standard Solution as outlined above.

C. <u>Canceling User mode Calibration "Linc"</u>

The Ultrameter III must be in User linked mode in order to cancel the "**Linc**" (ref. Solution Selection, pg. 24).

1. Press "Linked" measurement key COND, RES or TDS.

   Two solution icons will be shown in the left side of display — "**User**" and another, e.g., "**KCl**".

2. Press MR/▼ key until the menu "**Linc**" appears (see Figure 27).
3. Press CAL/MCLR key; the instrument will display both "**SEL**" and the "**User**" Icon.
4. Press MR/▼ key until "**User**" is the only solution icon being displayed.
5. Press CAL/MCLR key.
6. The User mode calibration "**Linc**" has now been canceled.

NOTES:

1. To maintain repeatability, use the same standard solutions for future calibrations.

2. Calibration of the Ultrameter III Gain Factor for User mode is not available when the calibration linc has been established. The other calibration functions (i.e., Temperature Compensation %/C settings and TDS Ratio settings) are still intact. To perform a calibration of the User mode as described in User Calibration Conductivity/TDS, pg. 29, the User mode Linc should be canceled. See above, "Canceling User mode calibration "**Linc**"".

3. Once a "**Linc**" has been established for User mode, the "**Linc**" will apply to all measurement modes using User solution selection (i.e., TDS/User, Cond/User or Res/User).

XVI. bluDock™ WIRELESS DATA TRANSFER INSTRUCTIONS

NOTE: Bluetooth® is a registered trademark of Bluetooth SIG. The bluDock Bluetooth module is a registered Bluetooth device.

Requires Myron L bluDock™ accessory package, Model # BLUDOCK. Package includes Ultrameter III hardware modification that allows the unit to communicate wirelessly with a personal computer configured for wireless device communication. Package also includes U2CI software application that will operate on Windows XP, Vista and 7*, and Macintosh OSX** based computer systems and Bluetooth USB adapter (dongle) for computers that do not have Bluetooth capability.

A. Software Installation

1. Place Myron L Ultrameter III U2CI Installation CD v2.0.0 & later into your computer or download U2CI application from the Myron L website:
http://myronl.com/main/U2CI_Application_DL.htm

2. Upon opening, select the folder for your operating system.

3. Install U2CI application. See detailed installation instructions on CD or Myron L website:
http://myronl.com/main/U2CI_Application_DL.htm

4. Additional drivers may be required. See our website for the latest information.

B. Hardware Setup

For a computer without Bluetooth® capability:
If you don't have the dongle that came with the BLUDOCK, one can be ordered separately from the Myron L® Company. Order Model # BDDO.
Plug in your dongle and install per manufacturer's instructions.

For computers with Bluetooth capability/Bluetooth dongle installed:

First time use of the bluDock:

1. Press any parameter button to turn the Ultrameter III on.
2. Put the Ultrameter III in "**PC On**" mode by pressing the MR/▼ key until "**PC OFF**" appears (see Figure 30).

Figure 30

3. Then press the CAL/MCLR key. "**PC On**" will be displayed (see Figure 31).

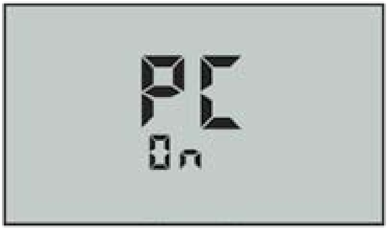


Figure 31

NOTE: "**PC Ini**" may momentarily be displayed while initializing (see Figure 32).

Figure 32

4. Add bluDock to your Bluetooth devices per your operating system procedure. **<u>THE BLUDOCK DEVICE PASSKEY IS 1234.</u>**
5. After pairing, note the number of the COM port assigned by the computer. In Windows XP, note the number of the outgoing COM port assigned by the computer.

NOTE: The unit will automatically power down after 60 sec. If the unit powers down during pairing, repeat steps 1-3 above and continue.

C. <u>Memory Stack Download</u>

1. With the Ultrameter III in "**PC On**" mode, open the U2CI

software application.

2. Verify that the port selected matches the COM port number noted (first time only). This is the outgoing COM port on Windows XP.

3. In the U2CI application, click on the data download button. A data transfer bar will appear while the data is being downloaded.

Once downloaded, the data may be manipulated, printed or stored within the Myron L U2CI application, or the data may be exported to another more powerful spreadsheet, such as Excel*.

Please Note: Although the Myron L® Company has performed extensive testing, we cannot guarantee compatibility of all applications and formats. We suggest testing your application and format for compatibility before relying on it.

Additional features such as assigning a name to the unit, setting time and date and erasing data are available. See U2CI software installation CD or visit our website for the latest instructions:
http://myronl.com/main/U2CI_Application_DL.htm

4. Upon completion, click on the “disconnect” icon.

5. Turn off Ultrameter III PC download mode by selecting any measurement function. Failure to do so will reduce battery life.

* Windows 2000, 2007, XP & Vista are registered trademarks of Microsoft Corporation.

** Macintosh OS9.2 & OSX are registered trademarks of Apple Computer Inc.

XVII. CARE and MAINTENANCE

- Ultrameter IIIs should be rinsed with clean water after use.
- Solvents should be avoided.
- Do not drop, throw or otherwise strike the instrument. Shock damage may cause instrument failure.

A. Temperature Extremes

Solutions in excess of 71°C/160°F should not be placed in the cell cup area; this may cause damage. The pH sensor may fracture if the Ultrameter III temperature is allowed to go below 0°C/32°F. Care should be exercised not to exceed rated operating temperature.

Leaving the Ultrameter III in a vehicle or storage shed on a hot day can easily subject the instrument to over 66°C/150°F. This will void the warranty.

B. Battery Replacement

Dry Instrument THOROUGHLY. Remove the four (4) bottom screws. Open instrument carefully. Carefully detach battery from circuit board. Replace with 9 Volt alkaline battery. Replace bottom, ensuring the sealing gasket is installed in the groove of the top half of case. Re-install screws, tighten evenly and securely.

NOTE: Because of nonvolatile EEPROM circuitry, all data stored in memory and all calibration settings are protected even during power loss or battery replacement. However, loss of time and date may occur if battery is removed for longer than 3 minutes (180 seconds).

C. pH/ORP Sensor Replacement

Order model RPR. When ordering, be sure to include the model and serial number of your instrument to ensure receipt of the proper type. Complete installation instructions are provided with each replacement sensor.

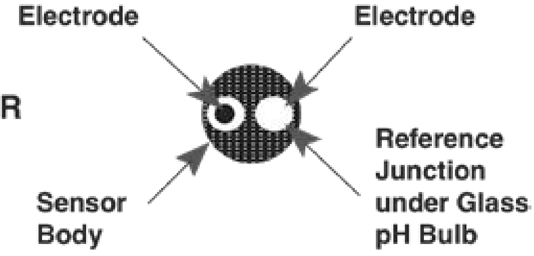
D. Cleaning Sensors

1. Conductivity/TDS/Resistivity

The conductivity cell cup should be kept as clean as possible. Flushing with clean water following use will prevent buildup on electrodes. However, if very dirty samples — particularly scaling types — are allowed to dry in the cell cup, a film will form. This film reduces accuracy. When there are visible films of oil, dirt, or scale in the cell cup or on the electrodes, use isopropyl alcohol or a foaming non-abrasive household cleaner. Rinse out the cleaner and your Ultrameter III is again ready for accurate measurements.

2. pH/ORP

The unique pH/ORP sensor in your Ultrameter III is a nonrefillable combination type that features a porous liquid junction. It should not be allowed to dry out. However, if this occurs, the sensor may sometimes be rejuvenated by first cleaning the sensor well with Isopropyl alcohol or a liquid spray cleaner such as Windex™ or Fantastic™ and rinsing well. Do not scrub or wipe the pH/ORP sensor.



pH/ORP SENSOR
Top View

Then use one of the following methods:

1. Pour a HOT salt solution ~60°C/140°F — a potassium chloride (KCl) solution such as Myron L pH/ORP Sensor Storage Solution is preferable, but HOT tap water with table salt (NaCl) will work fine — in the sensor well and allow to cool. Retest.

or

2. Pour DI water in the sensor well and allow to stand for no more than 4 hours (longer can deplete the reference solution and damage the glass bulb). Retest.

If neither method is successful, the sensor must be replaced.

"Drifting" can be caused by a film on the pH sensor bulb and/or reference. Use isopropyl alcohol (IPA) or spray a liquid cleaner such as Windex™ or Fantastic™ into the sensor well to clean it. The sensor bulb is very thin and delicate. Do not scrub or wipe the pH/ORP sensor.

Leaving high pH (alkaline) solutions in contact with the pH sensor for long periods of time is harmful and will cause damage. Rinse such liquids from the pH/ORP sensor well and refill it with Myron L Storage Solution to extend the useful life of the sensor. If unavailable, you can use a saturated KCl solution, pH 4 buffer, or a saturated solution of table salt and tap water.

Samples containing chlorine, sulfur, or ammonia can "poison" any pH electrode. If it is necessary to measure the pH of any such sample, thoroughly rinse the sensor well with clean water immediately after taking the measurement. Any sample element that reduces (adds an electron to) silver, such as cyanide, will attack the reference electrode.

Replacement sensors are available only from the Myron L® Company or its authorized distributors (ref. Replacement pH/ORP Sensor, pg. 58).

It is possible to desensitize the ORP sensor when measuring high ORP solutions. To check the ORP sensor functioning, take an ORP reading of Myron L pH/ORP sensor storage solution. If the reading is outside the range of 350-400 mV, clean ONLY the platinum ORP electrode with Myron L ORP Conditioner solution-soaked cotton swab, being careful not to touch the swab to the glass bulb of the pH sensor.

XVIII. TROUBLESHOOTING CHART

Symptom	Possible Cause
No **display**, even though measurement key pressed	Battery weak or not connected.
Inaccurate **pH** readings	1. pH calibration needed. Ref. pH Cal., pg. 34. 2. Cross-contamination from residual pH buffers or samples in sensor well. 3. Calibration with expired pH buffers.
No response to **pH** changes	Sensor bulb is cracked or an electromechanical short caused by an internal crack.
Will not adjust down to **pH** 7	pH/ORP sensor has lost KCl.
pH readings drift or respond slowly to changes in buffers/samples or "**FAC**" is displayed repeatedly	1. Temporary condition due to memory" of solution in pH sensor well for long periods. 2. Bulb dirty or dried out. 3. Reference junction clogged or coated.
Unstable **Conductivity/TDS/ Resistivity** readings	1. Dirty electrodes. 2. Actual resistance is changing due to atmospheric contamination.
Unable to calibrate **Conductivity/TDS**	Film or deposits on electrodes.
Resistivity readings much lower than expected	1. Contamination from previous sample or from pH sensor well. 2. Carbon dioxide in test sample.
Alkalinity or **Hardness** titration with calibration solution value not as stated on bottle	1. Method error. 2. Dirty Cell Cup. 3. Dirty pipette. 4. Faulty pipette. 5. Contaminated calibration solution.
Low **ORP** Reading Slow or no response to **ORP** changes	ORP platinum electrode is dirty.
FC^E responds very slowly or returns an atypically high Predictive **ORP** value	1. Dirty platinum electrode (see above). 2. ORP sensor memory/battery effect. Some ORP sensors exhibit a residual charge when measuring LOW Free Chlorine concentrations soon after measuring a HIGH Free Chlorine concentration.

Corrective Action
Check connections or replace battery. Ref. Battery Replacement, pg. 52.
1. Recalibrate instrument. 2. Thoroughly rinse sensor well. 3. Recalibrate using fresh buffers. Ref. pH Buffer Solutions, pg. 57.
Replace pH/ORP sensor. Ref. Replacement pH/ORP Sensor, pg. 58.
Clean and rejuvenate sensor (ref. Cleaning Sensors, pg. 52) and recalibrate. If no improvement, replace pH/ORP sensor (ref. Replacement pH/ORP Sensor, pg. 58).
Clean and rejuvenate sensor (ref. Cleaning Sensors, pg. 52) and recalibrate. If no improvement, replace pH/ORP sensor (ref. Replacement pH/ORP Sensor, pg. 58).
1. Clean cell cup and electrodes. Ref. Cleaning Sensors, pg. 52. 2. Minimize test sample exposure to air by taking a flowing sample. Ref. Measuring Resistivity, pg. 14.
Clean cell cup and electrodes. Ref. Cleaning Sensors, pg. 52.
1. Rinse cell cup more thoroughly before measurement. Ensure pH cap is snugly in place. 2. See Measuring Resistivity, pg. 14.
1. Repeat titration. 2. Clean cell cup and electrodes. Ref. Cleaning Sensors, pg. 52. 3. Clean pipette per manufacturer's instructions. 4. Use a new pipette. 5. Use fresh calibration solution. Be sure to use a new tip for each type of solution measured.
Check the ORP sensor functioning. Take an ORP reading of Myron L pH/ORP Sensor Storage Solution (ref. pH Sensor Storage Solution, pg. 57). If the reading is outside the range of 350-400 mV, clean ONLY the platinum ORP electrode with Myron L ORP Conditioner solution-soaked cotton swab (ref. ORP Sensor Conditioner Solution, pg. 57), being careful not to touch the swab to the glass bulb of the pH sensor.
1. Rinse the pH/ORP sensor well briefly with a small amount of ORP Sensor Conditioner Solution. **<u>DO NOT</u>** leave the conditioning solution in the sensor well for more than 10 seconds. 2. Rinse the pH/ORP sensor 3 times with Sensor Storage Solution. 3. Fill the sensor well with Sensor Storage Solution and let rest for 5 minutes.

XIX. ACCESSORIES

NOTE: MSDSs are available on the Myron L website for all solutions: **http://www.myronl.com/main/Material_Safety_DS_DL.htm**

A. Conductivity/TDS Standard Solutions

Your Ultrameter III has been factory calibrated with the appropriate Myron L® Company NIST traceable KCl, NaCl, and our own 442™ standard solutions. Most Myron L conductivity standard solution bottles show three values referenced at 25°C: Conductivity in microsiemens/micromhos, the ppm/TDS equivalents (based on our 442 Natural Water™) and NaCl standards. All standards are within ±1.0% of reference solutions. Available in 2 oz., quarts/liters, and gallon/~3.8 liter bottles.

1. Potassium Chloride (KCl)

The concentrations of these reference solutions are calculated from data in the International Critical Tables, Vol. 6. The 7000 μS is the recommended standard. Order KCL-7000.

2. 442 Natural Water™

442 Natural Water Standard Solutions are based on the following salt proportions: 40% sodium sulfate, 40% sodium bicarbonate, and 20% sodium chloride, which represent the three predominant components (anions) in freshwater. This salt ratio has conductivity characteristics approximating fresh natural waters and was developed by the Myron L® Company over four decades ago. It is used around the world for measuring both conductivity and TDS in drinking water, ground water, lakes, streams, etc. 3000 ppm is the recommended standard. Order 442-3000.

3. Sodium Chloride (NaCl)

This is especially useful in seawater mix applications, as sodium chloride is the major salt component. Most Myron L standard solution labels show the ppm NaCl equivalent to the conductivity and to ppm 442 values. The 14.0 mS is the recommended standard. Order NACL-14.0.

B. Titration Standard Solutions

Myron L titration standard solution bottles show both the actual chemical in solution and the ppm calcium carbonate ($CaCO_3$) equivalent. All standards are within ±1.0% of reference solutions. Available in 2 oz., and quart/liter bottles.

1. Alkalinity Standard Solution

ALK($NaHCO_3$)-100 is a solution of sodium bicarbonate ($NaHCO_3$) equivalent to 100 ppm calcium carbonate that is used for the alkalinity calibration: Order ALK-100.

2. Hardness Standard Solution

HARD($CaCl_2$)-200 solution is a solution of calcium chloride ($CaCl_2$) equivalent to 200 ppm calcium carbonate that is used for the hardness calibration: Order HARD-200.

C. Titration Reagent Solutions

Titration reagents are required for all conductometric titrations — alkalinity, hardness and LSI. LSI titrations require both alkalinity and hardness reagents. Reagents are available in 2 oz. and quarts/liters.

1. Reagent: A1

Reagent: A1 is a ≤1%WV solution of sulfuric acid (H_2SO_4-1) required for alkalinity titration: Order H2SO4-1.

2. Reagent: C1

Reagent: C1 is a ≤3%WV solution of hydrochloric acid (HCl-3) required for hardness titration: Order HCL-3.

3. Reagent: H1

Reagent: H1 is a ≤4%WV solution of pH buffer sodium hydroxide (NaOH) required for hardness titration: Order NAOH.

4. Reagent: H2

Reagent: H2 is a low concentration ≤5%WV solution of Ethylenediaminetetraacetic acid (EDTA) required for hardness titration: Order EDTA-LC.

5. Reagent: H3

Reagent: H3 is a high concentration ≤10%WV solution of Ethylenediaminetetraacetic acid (EDTA) required for hardness titration: Order EDTA-HC.

D. pH Buffer Solutions

pH buffers are available in pH values of 4, 7 and 10. Myron L® Company buffer solutions are traceable to NIST certified pH references and are color-coded for instant identification. They are also mold inhibited and accurate to within ±0.01 pH units @ 25°C. Order 4, 7 or 10 Buffer. Available in 2 oz., quarts/liters, and gallon/~3.8 liter bottles.

E. pH Sensor Storage Solution

Myron L pH Sensor Storage Solution prolongs the life of the pH sensor. Available in 2 oz., quarts/liters, and gallon/~3.8 liter bottles. Order SS.

F. ORP Sensor Conditioner Solution

Myron L ORP Conditioner Solution removes contaminants and conditions the ORP electrode. Available in 1 oz. Order ORPCOND1OZ.

G. Soft Protective Carry Cases

Padded Nylon carrying case features a belt clip for hands-free mobility. Two colors to choose from;
Blue - Model #: UCC
Desert Tan - Model #: UCCDT

H. Hard Protective Carry Cases

Large, foam-lined case without UMIII 9P includes the 100 μL pipette, 12 disposable pipette tips, 3 buffers (pH 4, 7, and 10), pH/ORP sensor storage solution, ORP Conditioner solution, reagents A1, C1, H1, H2, H3, and standard solutions, KCI-7000, 442-3000, ALK-100 and HARD-200. All bottles are 2 oz/59 ml. Model: TK9

Small case (no calibration standard solutions) - Model #: UPP

I. Replacement pH/ORP Sensor

pH/ORP sensor is gel filled and features a unique porous liquid junction. It is user-replaceable and comes with easy to follow instructions.
Model #: RPR

J. Pipette Kit with Replacement Tips

4 color coded M'Pet micropipettes with 48 replacement tips. This allows you to have a dedicated pipette for each titration reagent. Colored dots on each pipette match the colored dots on reagent solution bottles to help you avoid confusion and contamination. Model #: PROKIT

K. Replacement M'Pet Micropipette

1 replacement 100μL fixed volume micropipette. Model #: FVMP-100

L. M'Pet Micropipette Replacement Tips

Bag of 48 micropipette tips. Model #: PTIP100-48

M. bluDock™ Wireless Data Transfer Accessory Package

This accessory allows the operator to download the Ultrameter III memory stack to a spreadsheet on a computer. The package includes bluDock modified circuit board in the unit, software CD, installation and operating instructions, and dongle. Model #: BLUDOCK

XX. TEMPERATURE COMPENSATION (Tempco) of Aqueous Solutions

Electrical conductivity indicates solution concentration and ionization of the dissolved material. Since temperature greatly affects ionization, conductivity measurements are temperature dependent and are normally corrected to read what they would be at 25°C.

A. Standardized to 25°C

Conductivity is measured with great accuracy in the Ultrameter III using a method that ignores fill level, electrolysis, electrode characteristics, etc., and features a microprocessor to perform temperature compensation. In simpler instruments, conductivity values are usually assigned an average correction similar to that of KCl solutions for correction to 25°C. The correction to an equivalent KCl solution is a standard set by chemists that standardizes the measurements and allows calibration with precise KCl solutions. In the Ultrameter III, this correction can be set to other solutions or tailored for special measurements or applications.

B. Tempco Variation

Most conductivity instruments use an approximation of the temperature characteristics of solutions, perhaps even assuming a constant value. The value for KCl is often quoted simply as 2%/°C. In fact, KCl tempco varies with concentration and temperature in a non-linear fashion. Other solutions have more variation still. The Ultrameter III uses corrections that change with concentration and temperature instead of single average values. See Chart 1.

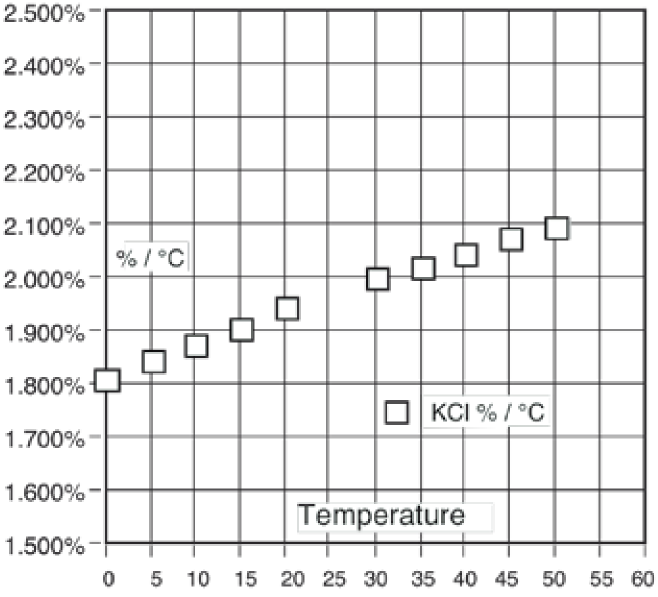


Chart 1

C. An Example of 2 different solution selections and the resulting compensation

How much error results from treating natural water as if it were KCl at 15°C?

A tap water solution should be compensated as 442 with a tempco of 1.68 %/°C, where the KCl value used would be 1.90 %/°C.
Suppose a measurement at 15°C/59°F is 900 microsiemens of true uncompensated conductivity.

Using a 442 correction of 10 (degrees below 25) x 1.68% indicates the solution is reading 16.8% low. For correction, dividing by (.832) yields 1082 microsiemens as a compensated reading.

A KCl correction of 10 (degrees below 25) x 1.9% indicates the solution is reading 19% low. Dividing by (.81) yields 1111 microsiemens for a compensated reading. The difference is 29 out of 1082 = 2.7%.

D. A Chart of Comparative Error

In the range of 1000 μS, the error using KCl on a solution that should be compensated as NaCl or as 442, is illustrated in the graph below.

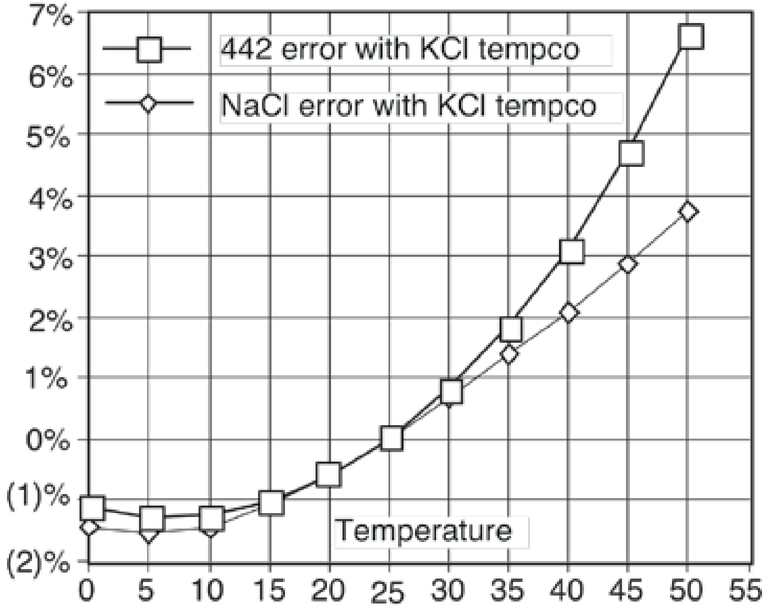


Chart 2

Users wanting to measure natural water based solutions to 1% would have to alter the internal compensation to the more suitable preloaded “442” values or stay close to 25°C. Users who have standardized to KCl-based compensation may want to stick with it, regardless of increasing error as you get further from 25°C. The Ultrameter III will provide the repeatability and convertibility of data necessary for relative values for process control.

E. Other Solutions

A salt solution like seawater or liquid fertilizer acts like NaCl. An internal correction for NaCl can be selected for greatest accuracy with such solutions. Many solutions are not at all similar to KCl, NaCl or 442. A sugar solution, or a silicate, or a calcium salt at a high or low temperature may require a “User” value peculiar to the application to provide readings close to the true compensated conductivity.

Clearly, the solution characteristics should be chosen to truly represent the actual water under test for rated accuracy of ±1%. Many industrial applications have historically used relative measurements seeking a number to indicate a certain setpoint or minimum concentration or trend. The Ultrameter III gives the user the capability to collect data in “KCl conductivity units” to compare to older published data, in terms of NaCl or 442, or as appropriate. The Ultrameter III can be used to reconcile data taken with other compensation assumptions, especially with its ability to allow custom characteristics through the User mode.

XXI. CONDUCTIVITY CONVERSION to TOTAL DISSOLVED SOLIDS (TDS)

Electrical conductivity indicates solution concentration and ionization of the dissolved material. Since temperature greatly affects ionization, conductivity measurements are temperature dependent and are normally corrected to read what they would be at 25°C (ref. Temperature Compensation, pg. 58).

A. How it’s Done

Once the effect of temperature is removed, the compensated conductivity is a function of the concentration (TDS). Temperature compensation of the conductivity of a solution is performed automatically by the internal processor with data derived from chemical tables. Any dissolved salt at a known temperature has a known ratio of conductivity to concentration. Tables of conversion ratios referenced to 25°C have been published by chemists for decades.

B. Solution Characteristics

Real world applications have to measure a wide range of materials and mixtures of electrolyte solutions. To address this problem, industrial users commonly use the characteristics of a standard material as a model for their solution, such as KCl, which is favored by chemists for its stability.

Users dealing with seawater, etc., use NaCl as the model for their concentration calculations. Users dealing with freshwater work with mixtures including sulfates, carbonates and chlorides, the three predominant components (anions) in freshwater that the Myron L®

Company calls “natural water”. These are modeled in a mixture called “442™” which the Myron L® Company markets for use as a calibration standard, as it does standard KCl and NaCl solutions.

The Ultrameter III contains algorithms for these 3 most commonly referenced compounds. The solution type in use is displayed on the left. Besides KCl, NaCl, and 442, there is the “User” choice. The benefit of “User” is that one may enter the temperature compensation and TDS ratio by hand, greatly increasing accuracy of readings for a specific solution. That value remains a constant for all measurements and should be reset for different dilutions or temperatures.

C. When does it make a lot of difference?

First, the accuracy of temperature compensation to 25°C determines the accuracy of any TDS conversion. Assume we have industrial process water to be pretreated by RO. Assume it is 45°C and reads 1500 μS uncompensated.

1. If NaCl compensation is used, an instrument would report 1035 μS compensated, which corresponds to 510 ppm NaCl.

2. If 442 compensation is used, an instrument would report 1024 μS compensated, which corresponds to 713 ppm 442.

   The difference in values is 40%.

In spite of such large error, some users will continue to take data in the NaCl mode because their previous data gathering and process monitoring was done with an older NaCl referenced device.

Selecting the correct Solution Type on the Ultrameter III will allow the user to attain true TDS readings that correspond to evaporated weight. If none of the 3 standard solutions apply, the User mode must be used. Temperature Compensation (Tempco) and TDS Derivation below, details the User mode.

XXII. TEMPERATURE COMPENSATION (Tempco) and TDS DERIVATION

The Ultrameter III contains internal algorithms for characteristics of the 3 most commonly referenced compounds. The solution type in use is displayed on the left. Besides KCl, NaCl, and 442, there is the User choice. The benefit of User mode is that one may enter the tempco and TDS conversion values of a unique solution via the keypad.

A. Conductivity Characteristics

When taking conductivity measurements, the Solution Selection determines the characteristic assumed as the instrument reports what a measured conductivity would be if it were at 25°C. The characteristic is represented by the tempco, expressed in %/°C. If a solution of 100 μS at 25°C increases to 122 μS at 35°C, then a 22% increase has occurred over this change of 10°C. The solution is then said to have a tempco of 2.2 %/°C.

Tempco always varies among solutions because it is dependent on their individual ionization activity, temperature and concentration. This is why the Ultrameter III features mathematically generated models for known salt characteristics that also vary with concentration and temperature.

B. Finding the Tempco of an Unknown Solution

One may need to measure compensated conductivity of some solution unlike any of the 3 standard salts. In order to enter a custom fixed tempco for a limited measurement range, enter a specific value through the User function. The tempco can be determined by 2 different methods:

1. Heat or cool a sample of the solution to 25°C, and measure its conductivity. Heat or cool the solution to a typical temperature where it is normally measured. After selecting User function, set the tempco to 0 %/°C as in Disabling Temperature Compensation, pg. 26 (No compensation). Measure the new conductivity and the new temperature. Divide the % decrease or increase by the 25°C value. Divide that difference by the temperature difference.

2. Heat or cool a sample of the solution to 25°C, and measure its conductivity. Change the temperature to a typical measuring temperature. Set the tempco to an expected value as in User Programmable Temperature Compensation, pg. 25. See if the compensated value is the same as the 25°C value. If not, raise or lower the tempco and measure again until the 25°C value is read.

C. Finding the TDS Ratio of an Unknown Solution

Once the effect of temperature is removed, the compensated conductivity is a function of the concentration (TDS). There is a ratio of TDS to compensated conductivity for any solution, which varies with concentration. The ratio is set during calibration in **User** mode as in User Programmable Conductivity to TDS Ratio, pg. 26. A truly unknown solution has to have its TDS determined by evaporation and weighing. Then the solution whose TDS is now known can be measured for conductivity and the ratio calculated. Next time the same solution is to be measured, the ratio is known.

XXIII. pH and ORP/FREE CHLORINE

A. pH

1. pH as an Indicator

pH is the measurement of Acidity or Alkalinity of an aqueous solution. It is also stated as the Hydrogen Ion activity of a solution. pH measures the effective, not the total, acidity of a solution.

A 4% solution of acetic acid (pH 4, vinegar) can be quite palatable, but a 4% solution of sulfuric acid (pH 0) is a violent poison. pH provides the needed quantitative information by expressing the degree of activity of an acid or base.
In a solution of one known component, pH will indicate concentration indirectly. However, very dilute solutions may be very slow reading, just because the very few ions take time to accumulate.

2. pH Units

The acidity or alkalinity of a solution is a measurement of the relative availabilities of hydrogen (H^+) and hydroxide (OH^-) ions. An increase in (H^+) ions increases acidity, while an increase in (OH^-) ions increases alkalinity. The total concentration of ions is fixed as a characteristic of water, and balance would be 10^{-7} mol/liter (H^+) and (OH^-) ions in a neutral solution (where pH sensors give 0 voltage).

pH is defined as the negative logarithm of hydrogen ion concentration. Where (H^+) concentration falls below 10^{-7}, solutions are less acidic than neutral, and therefore are alkaline. A concentration of 10^{-9} mol/liter of (H^+) would have 100 times less (H^+) ions than (OH^-) ions and be called an alkaline solution of pH 9.

3. The pH Sensor

The active part of the pH sensor is a thin glass surface that is selectively receptive to hydrogen ions. Available hydrogen ions in a solution will accumulate on this surface and a charge will build up across the glass interface. The voltage can be measured with a very high impedance voltmeter circuit; the dilemma is to connect the voltmeter to solution on each side.

The glass surface encloses a captured solution of potassium chloride holding an electrode of silver wire coated with silver chloride. This is the most inert connection possible from a metal to an electrolyte. It can still produce an offset voltage, but using the same materials to connect to the solution on the other side of the membrane causes the 2 equal offsets to cancel.

The problem is, on the other side of the membrane is an unknown test solution, not potassium chloride. The outside electrode, also called the

Reference Junction, is of the same construction with a porous plug in place of a glass barrier to allow the junction fluid to contact the test solution without significant migration of liquids through the plug material. Figure 33 shows a typical 2 component pair. Migration does occur, and this limits the lifetime of a pH junction from depletion of solution inside the reference junction or from contamination. The junction may be damaged if dried out because insoluble crystals may form in a layer, obstructing contact with test solutions.

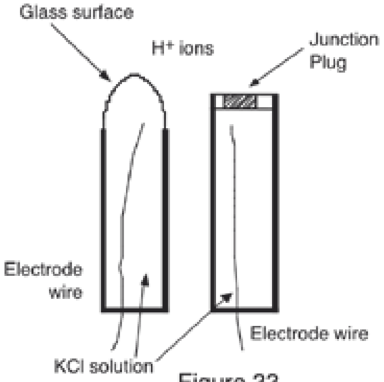


Figure 33

4. <u>The Myron L Integral pH Sensor</u>

The sensor in the Ultrameter III (see Figure 34) is a single construction in an easily replaceable package. The sensor body holds an oversize solution supply for long life. The reference junction “wick” is porous to provide a very stable, low permeable interface, and is located under the glass pH sensing electrode. This construction combines all the best features of any pH sensor known.

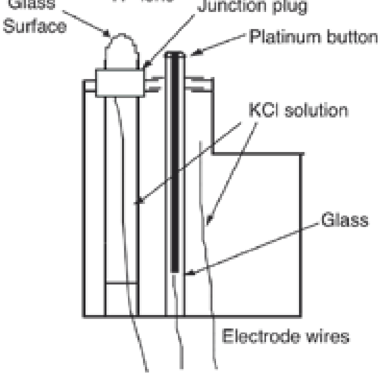


Figure 34

5. Sources of Error

The basics are presented in pH and ORP/FREE CHLORINE, pg. 64.

a. Reference Junction

The most common sensor problem will be a clogged junction because a sensor was allowed to dry out. The symptom is a drift in the “zero” setting at 7 pH. This is why the Ultrameter III 9P does not allow more than 1 pH unit of offset during calibration. At that point the junction is unreliable.

b. Sensitivity Problems

Sensitivity is the receptiveness of the glass surface. A film on the surface can diminish sensitivity and cause a long response time.

c. Temperature Compensation

pH sensor glass changes its sensitivity slightly with temperature, so the further from pH 7 one is, the more effect will be seen. A pH of 11 at 40°C would be off by 0.2 units. The Ultrameter III 9P senses the sensor well temperature and compensates the reading.

B. ORP/Oxidation-Reduction Potential/REDOX

1. ORP as an Indicator

ORP is the measurement of the ratio of oxidizing activity to reducing activity in a solution. It is the potential of a solution to give up electrons (oxidize other things) or gain electrons (reduce).

Like acidity and alkalinity, the increase of one is at the expense of the other, so a single voltage is called the Oxidation-Reduction Potential, with a positive voltage showing, a solution wants to steal electrons (oxidizing agent). For instance, chlorinated water will show a positive ORP value.

2. ORP Units

ORP is measured in millivolts, with no correction for solution temperature. Like pH, it is not a measurement of concentration directly, but of activity level. In a solution of only one active component, ORP indicates concentration. Also, as with pH, a very dilute solution will take time to accumulate a readable charge.

3. ORP Sensors

An ORP sensor uses a small platinum surface to accumulate charge without reacting chemically. That charge is measured relative to the solution, so the solution “ground” voltage comes from a reference junction - same as the pH sensor uses.

4. The Myron L ORP Sensor

Figure 34, pg. 65, shows the platinum button in a glass sleeve. The same reference is used for both the pH and the ORP sensors. Both pH and ORP will indicate 0 for a neutral solution. Calibration at zero compensates for error in the reference junction.

A zero calibration solution for ORP is not practical, so the Ultrameter III uses the offset value determined during calibration to 7 in pH calibration (pH 7 = 0 mV). Sensitivity of the ORP surface is fixed, so there is no gain adjustment either.

5. Sources of Error

The basics are presented in pH and ORP/Free Chlorine, pg. 64, because sources of error are much the same as for pH. The junction side is the same, and though the platinum surface will not break like the glass pH surface, its protective glass sleeve can be broken. A surface film will slow the response time and diminish sensitivity. It can be cleaned off with detergent or acid, as with the pH glass.

C. Free Chlorine

1. Free Chlorine as an Indicator

Chlorine, which kills bacteria by way of its power as an oxidizing agent, is the most popular germicide used in water treatment. Chlorine is not only used as a primary disinfectant, but also to establish a sufficient residual level of Free Available Chlorine (FAC) for ongoing disinfection.

FAC is the chlorine that remains after a certain amount is consumed by killing bacteria or reacting with other organic (ammonia, fecal matter) or inorganic (metals, dissolved CO_2, Carbonates, etc) chemicals in solution. Measuring the amount of residual free chlorine in treated water is a well accepted method for determining its effectiveness in microbial control.

The Myron L® Company FC^E method for measuring residual disinfecting power is based on ORP, the specific chemical attribute of chlorine (and other oxidizing germicides) that kills bacteria and microbes.

2. Free Chlorine Units

The 9P is the first handheld device to detect free chlorine directly, by measuring ORP. The ORP value is converted to a concentration reading (ppm) using a conversion table developed by Myron L® Company through a series of experiments that precisely controlled chlorine levels and excluded interferants.

Other test methods typically rely on the user visually or digitally interpreting a color change resulting from an added reagent-dye. The reagent used radically alters the samples pH and converts the various chlorine species present into a single, easily measured species. This ignores the effect of changing pH on free chlorine effectiveness and disregards the fact that some chlorine species are better or worse sanitizers than others.

The Myron L® Company 9P avoids these pitfalls. The chemistry of the test sample is left unchanged from the source water. It accounts for the effect of pH on chlorine effectiveness by including pH in its calculation. For these reasons, the Ultrameter III's FC^E feature provides the best reading-to-reading picture of the rise and fall in sanitizing effectivity of free available chlorine.

The 9P also avoids a common undesirable characteristic of other ORP-based methods by including a unique Predictive ORP value in its FC^E calculation. This feature, based on a proprietary model for ORP sensor behavior, calculates a final stabilized ORP value in 1 to 2 minutes rather than the 10 to 15 minutes or more that is typically required for an ORP measurement.

XXIV. ALKALINITY, HARDNESS AND LSI FUNCTIONS

A. Alkalinity and Hardness Titrations

The 9P uses a conductometric method of titration. This means that instead of measuring a color or pH change, it measures the change in conductivity when reagent is added. The way the sample solution behaves is compared to the behavior of solutions of known alkalinity or hardness under the same conditions. The equivalence point is determined from the known data curve that best matches the experimental data.

B. Langelier Saturation Index

The LSI calculator and titration functions use a calcium carbonate saturation index algorithm developed by Dr. Wilfred Langelier in 1936:

SI = PH + TF + CF + AF – 12.1

Where:
PH = pH value
TF = 0.0117 x Temperature value – 0.4116
CF = 0.4341 x ln(Hardness value) – 0.3926
AF = 0.4341 x ln(Alkalinity value) – 0.0074

The following is a general industry guideline for interpreting LSI values:

- An index between -0.5 and +0.5 indicates balanced water
- An index of more than +0.5 indicates scale-forming water
- An index below -0.5 indicates corrosive water

You can use the calculator to adjust any of the water balance parameter variables used in the calculation to analyze the effect of the change on water balance.

The LSI titration function generates an accurate saturation index value that indicates the state of the system at the time the calculation is made.

C. Hardness Units

NOTE: The 9P MUST be in the HARDNESS FUNCTION or the hardness screen (“**Hrd**”) in LSI CALCULATOR or LSI TITRATION mode for hardness unit preference selection.

The hardness unit preference is set simultaneously for all three functions that capture a hardness value. That means when you set the preference in one function, it is set for the other two functions at the same time.

The LSI Calculator allows you to select either ppm or grains of hardness units.

The hardness unit conversion is based on the following equivalency:

17.1 ppm (mg/L) = 1 grain

XXV. SOFTWARE VERSION

Contact the Myron L® Company to see if a software upgrade is available.

1. Press any parameter key.

2. Press MR ▼ key until three numbers are displayed as shown in Figure 35.

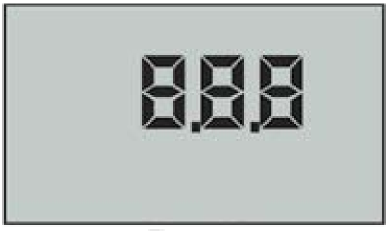


Figure 35

3. Press any parameter key; instrument will time out in ~15 seconds.

XXVI. GLOSSARY

Anions	Negatively charged ions. See Solution Characteristics, pg. 61.
Algorithm	A procedure for solving a mathematical problem. See Temperature Compensation (Tempco) and TDS Derivation, pg. 62.
FAC	Free Available Chlorine. The amount of chlorine that remains active in solution and is available for ongoing disinfection. See Free Chlorine as an Indicator, pg. 67.
FC^{E}	FC^{E}™ directly measures ORP, the germ killing property of chlorine and other oxidizing germicides. It displays both the ORP reading (in mVDC) as well as an equivalent free chlorine concentration (in familiar ppm). For more information see ***FCE™: Groundbreaking Measurement of Free Chlorine Disinfecting Power in a Hand-Held Instrument*** on the Myron L® Company website.
Logarithm	An arithmetic function. The inverse of an exponential function. See pH Units, pg. 64.
ORP	Oxidation-Reduction Potential or REDOX, See ORP/ Oxidation-Reduction Potential/REDOX, pg. 66.
REDOX Reaction	An abbreviation for Reduction-Oxidation reactions. This is the basic electrochemical process by which chlorine destroys microbes by grabbing electrons from the microbe's proteins, denaturing the protein and killing the organism. ORP directly measures the strength of a solutions' REDOX potential and, therefore, sanitizing strength.
TDS	Total Dissolved Solids or the Total Conductive Ions in a solution. See Conductivity Conversion to Total Dissolved Solids (TDS), pg. 61.
Tempco	Temperature Compensation See Temperature Compensation of Aqueous Solutions, pg. 58.
User	A mode of operation that allows the instrument user (operator) to set a tempco and/or a TDS factor for their specific solution type. See Temperature Compensation of Aqueous Solutions, pg. 58 and Temperature Compensation (Tempco) and TDS Derivation, pg. 62.

For details on specific areas of interest refer to the Table of Contents.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