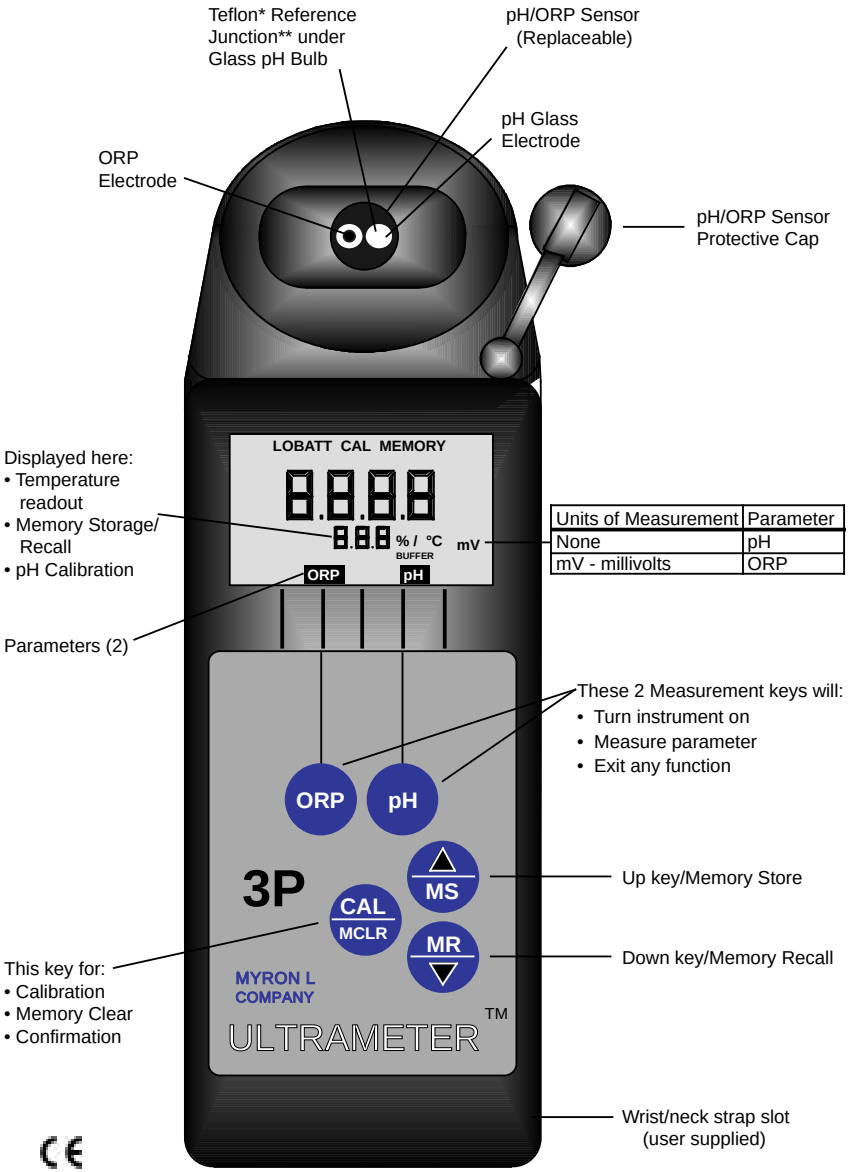
Ultrameter™ Operation Manual

Model 3P

MYRON L COMPANY
10 - 02 (WEB) EG

Instrument Illustration



* ™DuPont Company
** U.S. Patent #4128468

For detailed explanations see Table of Contents

3-23-98

FEATURES and SPECIFICATIONS

A. Features

- Accuracy of ±.01 pH/±1 mV @ calibration point.
- All electrodes are internal for maximum protection.
- Waterproof to 3 feet/1 meter.
- Prompts for easy pH calibration.
- Memory saves 20 readings.
- Factory calibrations stored in microprocessor.

B. General Specifications

Display	4 Digit LCD
Dimensions (LxWxH)	7.7x2.7x2.5 in. 196x68x64 mm
Weight	13oz./369g
Case Material	VALOX*
pH/ORP Sensor Well Capacity	0.04 oz./1.2 ml
Power	9V Alkaline Battery
Battery Life	>100 Hours/5000 Readings
Operating/Storage Temperature	32-132°F/0-55°C
Protection Ratings	IP67/NEMA 6 (waterproof to 3 feet/1 meter)

* ™ GE Corp.

C. Specification Chart

3P	pH	ORP
Ranges	0-14 pH	±999 mV
Resolution	±.01 pH	±1 mV
Accuracy	±.01 pH	±1 mV
Auto Temperature Compensation	0-71°C 32 - 160°F	

Additional information available on our web site at:
www.myronl.com

CE

D. Warranty/Service

All Myron L Ultrameters have a 2 year warranty except for pH sensors which have a 6-month limited warranty. If an instrument fails to operate properly, see the Troublshooting Chart, pg. 18. The battery and pH/ORP sensor are user replaceable. For other service, return the instrument prepaid to the Myron L Company.

MYRON L COMPANY
2450 Impala Drive
Carlsbad, CA 92010
USA
760-438-2021

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 only. The Myron L Company assumes no other responsibility or liability.

E. Ultrameter Models

ULTRAMETER MODELS	3P	4P	6P
PARAMETERS	pH/ORP/Temp.	Conductivity/TDS Resistivity/Temp.	Conductivity/TDS/pH Resistivity/ORP/Temp

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I. INTRODUCTION

Thank you for selecting the Ultrameter™ Model 3P, one of the Myron L Company's latest in a new line of instruments utilizing advanced microprocessor-based circuitry. This circuitry makes it extremely accurate and very easy to use (see pages 2 & 3 for Features and Specifications on this and other models). For your convenience, on the bottom side of your Ultrameter is a brief set of instructions, and a pocket sized card with abbreviated instructions is included with the instrument.

II. RULES of OPERATION

A. Operation

Using the instrument is simple:

- Rinse the pH/ORP sensor well with test solution 3 times and refill.
- Press the desired measurement key to start measurement. Pressing the key again does no harm and restarts the 15 second "off" timer.
- Note the value displayed or press the MS key to store (ref. Memory Storage, pg. 12). It's that simple!

B. Characteristics of the Keys

- Though your Ultrameter has a variety of sophisticated options, it is designed to provide quick, easy, accurate measurements by simply pressing one key.
- All functions are performed one key at a time.
- There is no "off" key. After 15 seconds of inactivity the instrument turns itself off (60 seconds in CAL mode).
- Rarely will a key be required to be held down.

C. Operation of the Keys (See Instrument Illustration on page 1)

1. Measurement Keys in General

Both of the measurement keys in the upper part of the keypad turn on the instrument in the mode selected. The mode is shown at the bottom of the display, and the measurement units appear at the right. Pressing a measurement key does this even if you are in a calibration sequence and also serves to abandon a change. (ref. Leaving Calibration, pg. 9)

2. pH and ORP keys

Measurements are made on solution held in the pH/ORP sensor well (ref. pH and ORP Measuring, pg. 19). The protective cap is removed and the sensor well is filled and rinsed with 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. 7 and Cleaning pH/ORP Sensors, pg. 16).

a. pH key

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

b. ORP key

A press of (ORP) displays Oxidation-Reduction Potential/REDOX reading in millivolts.

3. CAL/MCLR key

A press of (CAL/MCLR) allows you to enter the calibration mode while measuring pH. 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. 9).
While reviewing stored records, the MCLR side of the key is active to allow clearing records (ref. Clearing a Record/Memory Clear, pg. 13).

4. UP or DOWN keys

While measuring in any parameter, the (▲ MS) or (MR ▼) keys activate the Memory Store and Memory Recall functions.
While in CAL mode, the keys step or scroll the displayed value up or down. A single press steps the display and holding either key scrolls the value rapidly.
While in Memory Recall, the keys move the display up and down the stack of records (ref. Memory Recall, pg. 12).

III. AFTER USING the ULTRAMETER

Maintenance of the pH/ORP Sensor

The sensor well must be kept wet with a solution. Before replacing the rubber cap, rinse and fill the sensor well with (in order of preference): Myron L Storage Solution, an almost saturated KCl solution, pH 4 buffer or at least a strong table salt solution. Not distilled water. (ref. Cleaning pH/ORP Sensors, pg. 16).

IV. THE SPECIFIC RECOMMENDED MEASURING PROCEDURES

NOTE After sampling high concentration solutions or temperature extremes, more rinsing may be required.

A. Measuring pH

1. Remove protective cap by squeezing its sides and pulling up.

2. Rinse sensor well 3 times with sample to be measured. Shake out each sample to remove any residual liquid.

3. Refill sensor well with sample.

4. Press **pH**.

5. Take reading.

6. **IMPORTANT**: After use, fill pH/ORP sensor well with Myron L Storage Solution, a strong KCl solution or pH 4 buffer, and replace protective cap. Do not allow pH/ORP sensor to dry out.

NOTE: If none of the above are available, use a saturated solution of table salt and tap water (ref. Cleaning pH/ORP Sensors, pg. 16).

B. Measuring ORP

1. Remove protective cap by squeezing its sides and pulling up.

2. Rinse sensor well 3 times with sample to be measured. Shake out each sample to remove any residual liquid.

3. Refill sensor well with sample.

4. Press **ORP**.

5. Take reading.

6. **IMPORTANT**: After use, fill pH/ORP sensor well with Myron L Storage Solution, a strong KCl solution or pH 4 buffer and replace protective cap. Do not allow pH/ORP sensor to dry out.

NOTE: If none of the above are available, use a saturated solution of table salt and tap water (ref. Cleaning pH/ORP Sensors, pg. 16).

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

V. CALIBRATION

A. Calibration Intervals

Generally, calibration with pH solutions should be checked twice a month. Calibration of ORP is not necessary. (ref. Calibration Intervals, pg. 15)

B. Rules for Calibration in the Ultrameter

1. Calibration Steps

a. Starting Calibration

Calibration is begun by pressing **CAL/MCLR** while measuring pH.

Measuring continues, but the CAL icon is on, indicating calibration is now changeable.

The reading is changed with the **▲/MS** and **MR/▼** to match the known value.

b. Calibration Steps

Depending on what is being calibrated, there may be 1, 2 or 3 steps to the calibration procedures.

The **CAL/MCLR** becomes an “ACCEPT” key. At each point, pressing **CAL/MCLR** accepts the new calibration value and steps you to the next adjustment (or out of CAL mode if there are no more steps).

To bypass a calibration step, just press **CAL/MCLR** to accept the present value as is.

c. Leaving Calibration

You know you are finished when the “**CAL**” icon goes out. Pressing either measurement key abandons 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. A nominal “FAC” value is an ideal value stored by the factory. Attempts to calibrate too far from there will cause the displayed value to be replaced with “FAC”. If you accept it, you will get the original default factory calibration for this measurement. The need to calibrate so far out that “FAC” appears indicates a procedural problem, wrong standard solution, a very dirty cell cup or a dying pH/ORP sensor (ref. Troubleshooting Chart, pg. 18).

C. Calibration Procedures

1. pH Calibration

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

a. pH Zero Calibration

1. Rinse sensor well 3 times with 7 buffer solution.

2. Refill sensor well with 7 buffer solution.

3. Press **pH** to verify the pH calibration. If the display reads 7.0, skip the pH Zero Calibration and proceed to section b. pH Gain Calibration.

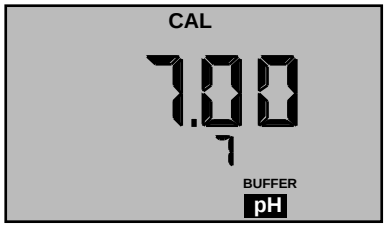


Figure 1

4. Press **CAL MCLR** to enter calibration mode. The "**CAL**", "**BUFFER**" and "**7**" annunciators will appear (see Figure 1). Displayed value will be the uncalibrated sensor.

NOTES: If a wrong buffer is added (outside of 6-8 pH),"7" and BUFFER" will flash, and the Ultrameter 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 7.0.

NOTE: Attempted calibration of >1 pH point from factory calibration will cause "FAC" to appear. This indicates the need for sensor replacement (ref. Troubleshooting Chart, pg. 18) or fresh buffer solution. The "FAC" internal electronic calibration is not intended to replace calibration with pH buffers. It assumes an ideal pH sensor. Each "FAC" indicates a factory setting for that calibration step (i.e., 7, acid, base).

You can press **CAL MCLR** to accept the preset factory value, or you can 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 either measurement key.

b. pH Gain Calibration

Important: Always calibrate or verify your Ultrameter 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** twice while in pH measurement mode.

2. At this point the "**CAL**", "**BUFFER**" and "**Acd**" or "**bAS**" annunciators will be lit (see Figures 2 and 3).

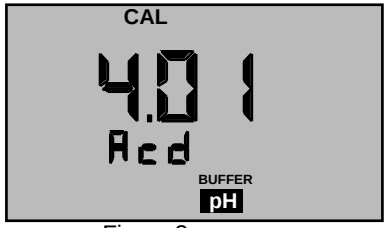


Figure 2

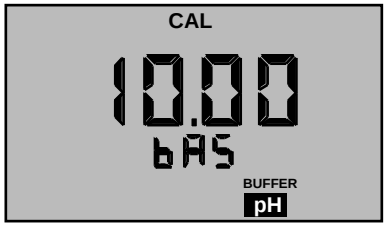


Figure 3

NOTE: If the "Acd" and "bAS" indicators are blinking, the unit is indicating an error and needs either a 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 shows 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 either 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 ends Calibration Procedure. Replace protective cap.

2. 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 has an electronic ORP calibration. This causes the zero point on the reference electrode to be set whenever pH 7 calibration is done.

3. Temperature Calibration

Temperature calibration is not necessary in the Ultrameter.

VI. MEMORY

This feature allows up to 20 readings with their temperatures to be stored simultaneously for later recall.

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 (1-20) showing the position of the record. Figure 4 shows a reading of 10.00 pH stored in memory record #5.

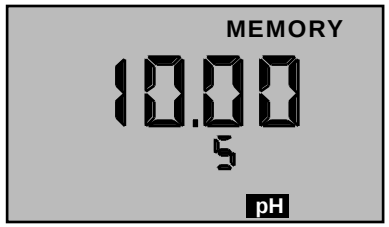


Figure 4

B. Memory Recall

1. Press either measurement key.

2. Press MR, "**MEMORY**" will appear, and the display will show the last record stored.

3. Press the MS or MR to scroll to the record location desired (the temperature display alternates between temperature recorded and location number).

4. Press a 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 CAL/MCLR to clear that memory. This space will be the place for the next memory record, unless you scroll to another 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. You want to clear the ORP reading stored in record location #**3** and replace it with a pH reading.

1. Press MR and scroll to location #**3**.

2. Press 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 to "**CLr ALL**" in measurement and temperature area (see Figure 5).

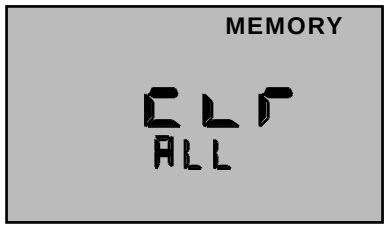


Figure 5

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

VII. CHANGING from CENTIGRADE to FAHRENHEIT

1. Press **pH**.

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

3. Press **MR** ▼ repeatedly until you pass the memory "**CLr ALL**" location". The display will show a "**C**" or "**F**" (see Figures 6 & 7).

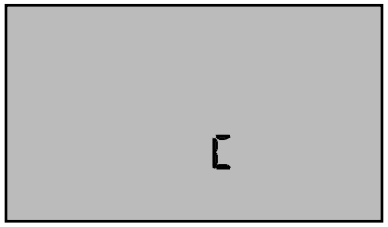


Figure 6

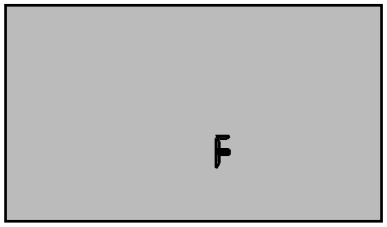


Figure 7

4. Press **CAL/MCLR**; the display will change to the other unit.

5. Press **pH**; all temperature readings are now in degrees last shown.

NOTE: Units symbol "°F" is not displayed in Fahrenheit mode. Tempco will still be shown in %/°C.

VIII. 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.

1. Press **pH**.

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 8).

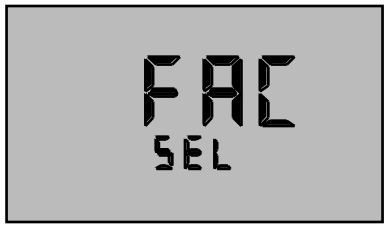


Figure 8

4. Press **CAL/MCLR** to accept the resetting.

IX. CALIBRATION INTERVALS

There is no simple answer to how often one should calibrate an instrument. The Ultrameter 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 has to be checked against chemical standards occasionally.

A. Suggested Intervals

On the average, 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.

Calibration is purposely limited in the Ultrameter to ±1 pH unit because more than that indicates the end of the sensor lifetime and it should be replaced.

C. pH and ORP 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 not only caustic, but 5% is considered very accurate. By using the pH zero setting (0 mV = 7 pH) for ORP and precision electronics for detection, the Ultrameter delivers better accuracy without calibration than a simpler instrument could using calibration solutions.

X. CARE and MAINTENANCE

Ultrameters should be rinsed with clean water after use. Solvents should be avoided. Shock damage from a fall may cause instrument failure.

A. Temperature Extremes

Solutions in excess of 160°F/71°C should not be placed in the cell cup area; this may cause damage. The pH sensor may fracture if the Ultrameter temperature is allowed to go below -10°C (14°F). Care should be exercised not to exceed rated operating temperature.
Leaving the Ultrameter in a vehicle or storage shed on a hot day can easily subject the instrument to over 150°F. This will void the warranty.

B. Battery Replacement

Dry Instrument THOROUGHLY. Remove the four (4) bottom screws. Open instrument carefully; it may be necessary to rock the bottom slightly side to side to release it from the RS-232 connector. 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.

C. pH/ORP Sensor Replacement

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

D. Cleaning pH/ORP Sensors

The unique pH/ORP sensor in your Ultrameter is a nonrefillable combination type which features a porous liquid junction. It should not be allowed to dry out. If it does, the sensor can sometimes be rejuvenated by first cleaning the sensor well with a liquid spray cleaner such as Windex™ or Fantastic™ and rinsing well. Do not scrub or wipe the pH/ORP sensor.

Then use one of the following methods:

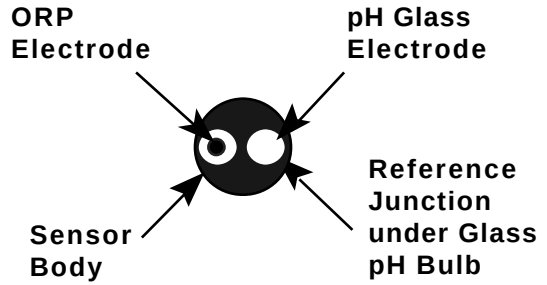
1. Pour a HOT salt solution ~60°C (140°F), preferably potassium chloride (KCl) solution — HOT tap water with table salt (NaCl) will work fine — in the sensor well and allow to cool. Retest.

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, sensor must be replaced.

"Drifting" can be caused by a film on the pH sensor bulb. 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.



pH/ORP Sensor Top View

Leaving high pH (alkaline) solutions in contact with the pH sensor for long periods of time can damage it. Rinsing such liquids from the pH/ORP sensor well and refilling well with Myron L Storage Solution, a saturated KCl solution, pH 4 buffer, or a salty tap water will extend the sensor's useful life.

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 which will reduce (add 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.

XI. TROUBLESHOOTING CHART

Symptom	Possible Cause	Corrective Action
No **display**, even though measurement key pressed	Battery weak or not connected.	Check connections or replace battery. (ref. Battery Replacement, pg. 16)
Inaccurate **pH** readings	1. pH calibration needed. (ref. pH Cal. pg. 10) 2. Cross-contamination from residual pH buffers or samples in sensor well. 3. Calibration with expired pH buffers.	1. Recalibrate instrument 2. Thoroughly rinse sensor well. 3. Recalibrate using fresh buffers (ref. pH Buffer Solutions, pg. 19).
No response to **pH** changes	Sensor bulb is cracked or an electromechanical short caused by an internal crack.	Replace pH/ORP sensor (ref. pH/ORP Sensor Replacement pg. 16).
Will not adjust down to **pH** 7	pH/ORP sensor has lost KCl.	Clean and rejuvenate sensor (ref. Cleaning pH/ORP Sensor, pg. 16) and recalibrate. If no improvement, replace pH/ORP sensor (ref. pH/ORP Sensor Replacement, pg. 16).
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.	Clean and rejuvenate sensor (ref. Cleaning pH/ORP Sensor, pg. 16) and recalibrate. If no improvement, replace pH/ORP sensor (ref. pH/ORP Sensor Replacement, pg. 16).

XII. ACCESSORIES

A. 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.

B. pH Sensor Storage Solution

Myron L Storage Solution prolongs the life of the pH sensor. It is available in quarts and gallons. Order SSQ or SSG.

C. Soft Protective Case

Padded Cordura® Nylon carrying case features a belt clip for hands-free mobility. Model: UCC

® Registered trade mark of DuPont

D. Replacement pH/ORP Sensor

Model RPR is gel filled and features a unique porous liquid junction. It is user-replaceable and comes with easy to follow instructions.

E. Data Port

There is a 4 pin connector marked "Factory Use Only" on the bottom of the Ultrameter. It is used to interrogate the instrument during final inspection. Applications in the future for downloading recorded data are being considered, but not implemented, as of this printing.

F. Conductivity/TDS Standard Solutions

For your other Myron L instruments, our NIST standard solutions are available in a variety of salts and concentrations to fit your needs. Call or write for information.

XIII. pH and ORP MEASURING

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 will increase acidity, while an increase in (OH^-) ions will increase 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 which 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 trick 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 coated with silver chloride. This is as inert a connection as can be made from metal to an electrolyte. It still can produce an offset voltage, but using the same materials to connect to the solution on the other side of the membrane allows the 2 equal offsets to cancel.

The problem is...the other side of the membrane is some 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 9 shows a typical 2 component pair. Migration does occur, and this limits

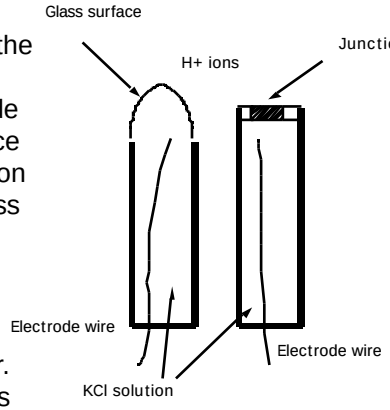


Figure 9

the lifetime of a pH junction from depletion of solution inside the reference junction or from contamination. The junction is damaged by drying out because insoluble crystals may form in a layer, obstructing contact with test solutions. See Cleaning Sensors, pg. 16.

4. The Myron L Integral pH Sensor

The sensor in the Ultrameter (Figure 10) 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 teflon to provide a very stable, low permeability interface. It is formed in a ring around the pH sensing electrode. The construction combines all the best features of any pH sensor known.

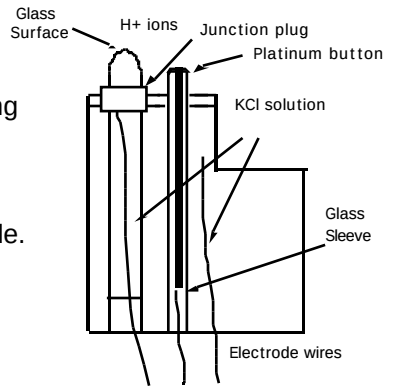


Figure 10

5. Sources of Error

The basics are presented in Cleaning Sensors, pg. 16.

a. Reference Junction

The most common sensor problem will be a clogged junction because a cell was allowed to dry out. The symptom is a drift in the "zero" setting at 7 pH. This is why the Ultrameter 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, which can be diminished by a film on the surface, or a crack in the glass. These problems also cause 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 senses the cell 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). Chlorinated water will show a positive ORP value, for instance.

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 does indicate concentration. Also, as with pH, a very dilute solution will take time to accumulate a readable charge.

3. The ORP Sensor

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 10 pg. 21 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 read out 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 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 Cleaning pH/ORP Sensors, pg. 16 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.

XIV. GLOSSARY

Logarithm - An arithmetic function. pH Units, pg. 20.

ORP - Oxidation-Reduction Potential or REDOX, See ORP/ Oxidation-Reduction Potential/REDOX, pg. 21.

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