

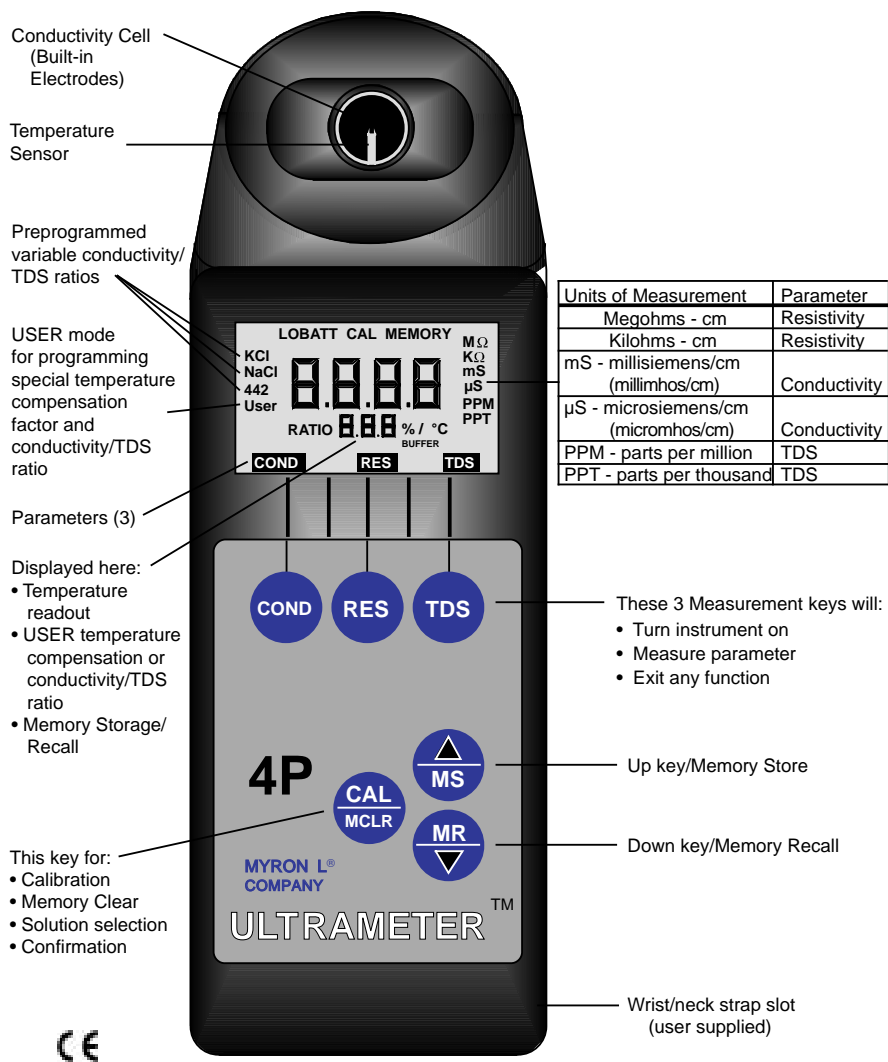
Ultrameter™ Operation Manual

Model 4P



**MYRON L®
COMPANY**
05-24 (WEB) EG

Instrument Illustration



For detailed explanations see Table of Contents

7-11-00

FEATURES and SPECIFICATIONS

A. Features

- Superior resolution 4 digit LCD displays full 9999 $\mu\text{S/ppm}$.
- Accuracy of $\pm 1\%$ of reading (not merely full scale).
- All electrodes are internal for maximum protection.
- Latest 4 electrode cell technology.
- Waterproof to 3 feet/1 meter.
- Autoranging conductivity/TDS/resistivity.
- Memory saves 20 readings.
- Factory calibrations stored in microprocessor.
- 3 conductivity/TDS solution conversions preprogrammed into microprocessor.
- USER feature allows:
 Programming your own cond/TDS conversion factor.
 Programming your own temperature compensation factor.
 Disabling temperature compensation.

B. General Specifications

Display	4 Digit LCD
Dimensions (LxWxH)	7.7x2.7x2.5 in. 196x68x64 mm
Weight	12oz./341g
Case Material	VALOX*
Cond/Res/TDS Cell Material	VALOX*
Cond/Res/TDS Cell Capacity	0.2 oz./5 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)

* TM GE Corp.

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



C. Specification Chart

4P	Conductivity	TDS	Resistivity	Temperature
Ranges	0-9999 μS 10-200 mS in 5 autoranges	0-9999 ppm 10-200 ppt in 5 autoranges	10K - 30M ohms	0-71°C 32 - 160 °F
Resolution	0.01 (<100 μS) 0.1 (<1000 μS) 1.0 (>1000 μS)	0.01 (<100 ppm) 0.1 (<1000 ppm) 1.0 (>1000 ppm)	0.01 (<100K ohms) 0.1 (<1000K ohms) 1.0 (>1 M)	0.1 °C/F
Accuracy	$\pm 1\%$ of reading*	$\pm 1\%$ of reading*	$\pm 1\%$ of reading**	± 0.1 °C
Auto Temperature Compensation	0-71°C 32 - 160°F	0-71°C 32 - 160°F	0-71°C 32 - 160°F	
Adjustable Temperature Compensation	0 - 9.99%/°C	0 - 9.99%/°C	0 - 9.99%/°C	
Cond/TDS Ratios Preprogrammed	KCl, NaCl, 442 TM			
Adjustable Cond/TDS Ratio Factor	0.20 - 7.99			

* up to 100mS/ppt; 100 - 200mS/ppt: $\pm 1 - 2\%$ typ.

**10K ohms - 10M ohms

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 Troubleshooting Chart, pg. 21. 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 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 4P, one of the MyronL® 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, your Ultrameter has a brief set of instructions on its bottom, and a pocket sized card with abbreviated instructions is included with the instrument.

Special note Conductivity, Resistivity, and TDS require mathematical correction to 25°C values (ref. Temperature Compensation, pg. 23). On the left of the Ultrameter'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 can 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. 26). The selection can affect the reported conductivity of hot or cold solutions, and will change the reported TDS of a solution. 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, as shipped from the factory, is set to operate.

II. RULES of OPERATION

A. Operation

Using the instrument is simple:

- Rinse the conductivity cell 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. 16). 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 (as in Procedure to Select a Solution, pg. 10 or Conductivity or TDS Calibration, pg. 14).

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

1. Measurement Keys in General

Any of the 3 measurement keys in the upper part of the keypad turns 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. 14).

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. 10 and Procedure to Select a Solution, pg. 10.


a. COND Key

Solution to be tested is introduced into the conductivity cell and a press

of  displays conductivity with units on the right. On the left is

shown the solution type selected for conductivity. An overrange condition will show only [- - -] (ref. Solution Selection, pg. 10).

b. RES Key

A press of  displays resistivity with units on the right. On the left


is shown solution type selected for resistivity (ref. Solution Selection, pg. 10). The range of display of Resistivity is limited to between 10 kilohms (K) and 30 megohms (M). A solution outside that range will only show [- - -] in the display.

c. TDS key


A press of  displays Total Dissolved Solids with units on the

right. This is a display of the concentration of 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. 10).

3. CAL/MCLR key

A press of  allows you to enter the calibration mode while



measuring conductivity or TDS. 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. 14).

If  is held down for about 3 seconds, CAL mode is not entered, but

“SEL” appears to allow Solution Selection (ref. pg. 10) with the Up or Down keys. As in calibration, the CAL key is now an “accept” key.

While reviewing stored records, the MCLR side of the key is active to allow clearing records (ref. Clearing a Record/Memory Clear, pg. 16).

4. UP or DOWN keys

While measuring in any parameter, the  or  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. 16).

III. AFTER USING the ULTRAMETER

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. Even if a very active chemical discolors the electrodes, this does not affect the accuracy; leave it alone (ref. Cleaning Conductivity/TDS/Resistivity Cell Cup, pg. 20).

IV. THE SPECIFIC RECOMMENDED MEASURING PROCEDURES

If the proper solution is not selected (KCl, NaCl, 442 or USER), see Solution Selection, Pg. 10.

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

A. 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  or .
4. Take reading. A display of [- - -] indicates an overrange condition.

B. 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. Hold instrument at 30° angle (cup sloping downward).
2. Let sample flow continuously into conductivity cell with no aeration.
3. Press **RES** key; use best reading.

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

V. 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. 23). Selection determines the temperature correction of conductivity and calculation of TDS from compensated conductivity (ref. Cond. Conversion to TDS, pg. 26).

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 the setup as shipped from the factory (ref. Solution Characteristics, pg. 26).

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. 14) is performed separately for each type of solution one wishes to measure (ref. Conductivity/TDS Standard Solutions, pg. 22).

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 about 3 seconds to make “SEL” appear (see Figure 1). (For demonstration purposes, all 4 solution types are shown simultaneously.)



Figure 1

3. Use **MS** or **MR** key to obtain type of solution desired (ref. Solution Characteristics, pg. 26). 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 Tempco

This feature allows you to change your Ultrameter's temperature compensating factor to another factor between 0-9.99%/°C (ref. Temperature Compensation, pg. 23).

- a. As in Procedure to Select a Solution, pg. 10, 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.

- 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.

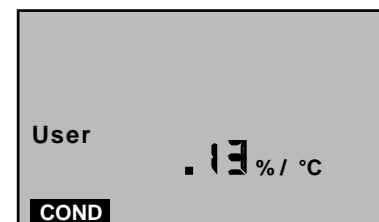





Figure 2

2. Disabling Temperature Compensation

- a. As in Procedure to Select a Solution, pg. 10, select "USER" mode.
- b. With "USER" selected, press . If the display does not show .00%/°C, hold  long enough to bring the tempco to .00%/°C (see Figure 3).
- c. Press  twice (3 times if in TDS mode). Temperature compensation is now disabled (=0) for measurements in USER mode.

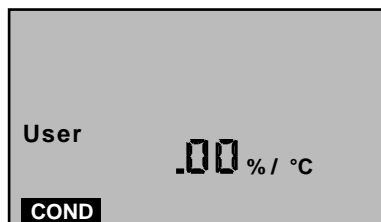







Figure 3

3. User Programmable Conductivity to TDS Ratio

This feature allows you to select a custom conductivity to TDS conversion ratio for USER mode measurements.

For example: The conversion ratio range is 0.20-7.99 (ie., if conductivity is 100 μ S and TDS is 75 ppm, you would adjust to 0.75) (ref. Conductivity Conversion to TDS, pg. 26).

- a. While in "USER" mode, press .
- b. Press  twice (to skip over tempco adjustment), and "RATIO" will appear (see Figure 4).
- c. Adjust with  or  keys until new conversion ratio is displayed.
- d. Press  twice (to skip over calibration adjustment) to accept new conversion ratio. You are now ready to measure samples with the new conductivity/TDS ratio.

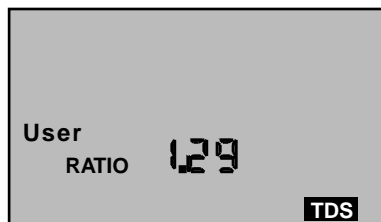


Figure 4

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

VI. CALIBRATION


A. Calibration Intervals

Generally, calibration is recommended about once per month with Conductivity or TDS solutions (ref. Calibration Intervals, pg. 19).

B. Rules for Calibration in the Ultrameter

1. Calibration Steps

a. Starting Calibration

Calibration is begun by pressing  while measuring Conductivity or TDS. Measuring continues, but the CAL icon is on, indicating calibration is now changeable.



The reading is changed with the  and  to match the known

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

b. Calibration Steps

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

	KCl, NaCl or 442	User
Cond	Gain only	Tempco, then Gain
Res	Done in conductivity	Done in conductivity or TDS
TDS	Gain only	Tempco, Ratio, then Gain

The  becomes an "ACCEPT" key. At each point, pressing  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  to accept the present value as is.

c. Leaving Calibration

You know you are finished when the “**CAL**” icon goes out. Pressing any measurement key abandons changes not yet accepted and exits calibration mode.

2. Calibration Limits




There are calibration limits. A nominal “FAC” value is an ideal value stored by the factory. Attempts to calibrate too far, up or down, from there 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, wrong standard solution, or a very dirty cell cup (ref. Troubleshooting Chart, pg. 21).

C. Calibration Procedures

1. Conductivity or TDS Calibration

- a. Rinse conductivity cell three times with proper standard (KCl, NaCl, or 442) (ref. Con./TDS Standard Solutions, pg. 22). For user calibration see User Calibration Cond./TDS, pg. 15.

- b. Refill conductivity cell with same standard.

- c. Press  or , then press , “**CAL**” icon will appear on the display (see Figure 5).

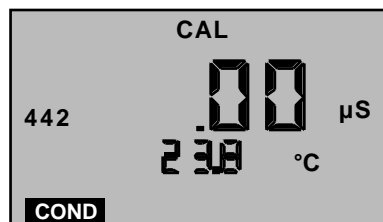











Figure 5

- d. Press  or  to step the displayed value toward the standard's value or hold a key down to cause rapid scrolling of the reading.
- e. Press  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






- a. Rinse conductivity cell three times with your standard.
- b. Refill conductivity cell with same standard.
- c. Press  or , then press  twice in COND/three times in TDS. The “**CAL**” icon will appear on the display.
- d. Press  or  to step the displayed value toward the standard's value or hold a key down to cause rapid scrolling of the reading.
- e. Press  once to confirm new value and end the calibration sequence for this particular solution type.

3. Resistivity Calibration

Resistivity is the reciprocal of Conductivity. Resistivity is calibrated only if conductivity is calibrated for the same solution type.

4. Reloading Factory Calibration (Cond or TDS)

If calibration is suspect or known to be wrong, 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 Ultrameters, 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 standard solutions. If another solution type requires resetting, change solution type and repeat this procedure.

- a. Press  or .
- b. Press . (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  key until “**FAC**” appears and release.
- d. Press  to accept the factory calibration setting.


5. Temperature Calibration

Temperature calibration is not necessary in the Ultrameter.

VII. 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  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 6 shows a reading of 1806 μS stored in memory record #4.

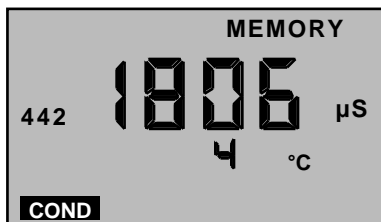






Figure 6

B. Memory Recall

1. Press one of the measurement keys.
2. Press , "MEMORY" will appear, and the display will show the last record stored.
3. Press the  or  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  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 conductivity reading stored in record location #3 and replace it with a TDS reading.










1. Press  and scroll to location #3.
2. Press  to clear old record #3.
3. Fill conductivity cell with sample.
4. Press  to measure sample and press  to store reading in location #3.
5. The next memory stored will go into location #8.
6. To clear all records: After pressing , scroll down to "CLR ALL" in measurement and temperature area (see Figure 7).
7. Press . All records will be cleared.



Figure 7

VIII. CHANGING from CENTIGRADE to FAHRENHEIT

1. Press .
2. Press  to display the stored memory records.
3. Press  repeatedly until you pass the memory "CLR ALL" location. The display will show a "C" or "F" (see Figures 8 & 9).

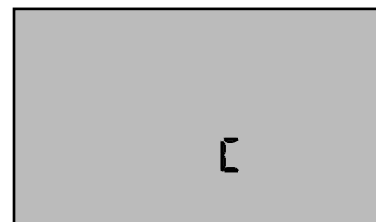


Figure 8

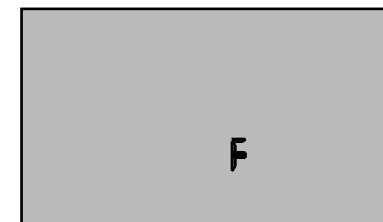




Figure 9

4. Press  ; the display will change to the other unit.
5. Press  ; all temperature readings are now in degrees last shown.

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

IX. 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 .
2. Press  to display the stored memory records.
3. Press  repeatedly until you pass the CLFALL and the C-F locations. The display will show a "FAC SEL" (see Figure 10).
4. Press  to accept the resetting.



Figure 10

X. CALIBRATION INTERVALS

There is no simple answer as 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, we expect calibration need only be checked monthly for the Conductivity, RES or TDS functions. 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.

Calibration is purposely limited in the Ultrameter to $\pm 10\%$ because more than that indicates damage, not drift.

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, pg. 24), 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 making measurements. Allowing slow dissolving crystals to form in the cell contaminates future samples.

XI. 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. 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. Cleaning Conductivity/TDS/Resistivity Cell Cup

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 a foaming non-abrasive household cleaner. Rinse out the cleaner and your Ultrameter is ready for accurate measurements.

XII. 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. 20).
Unstable Conductivity/TDS / Resistivity readings	1. Dirty electrodes. 2. Test samples greater than 1 megohm.	1. Clean cell cup and electrodes (ref. Cleaning Cell Cup, pg. 20). 2. Minimize test sample exposure to air (ref. Measuring Resistivity, pg. 10).
Unable to calibrate Conductivity/TDS	Film or deposits on electrodes.	Clean cell cup and electrodes (ref. Cleaning Cell Cup, pg. 20).
Resistivity readings much lower than expected	1. Contamination from previous sample or from pH sensor well. 2. Carbon dioxide in test sample.	1. Rinse cell cup more thoroughly before measurement. Insure pH cap is snugly in place. 2. See Measuring Resistivity, pg. 10.

XIII. ACCESSORIES

A. Conductivity/TDS Standard Solutions

Your Ultrameter has been factory calibrated with the appropriate MyronL® 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 and the ppm/TDS equivalents based on our 442 Natural Water™ and NaCl standards. All standards are within ±1.0% of reference solutions.

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 three decades ago. It is used around the world for measuring both conductivity and TDS in drinking water, ground water, lakes, streams, etc. The 3000 ppm is the recommended standard. Order 442-3000.

3. Sodium Chloride (NaCl)

This is especially useful in sea water mix applications, as sodium chloride is its 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. Soft Protective Case

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

® Registered trade mark of DuPont

C. 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.

D. pH Buffer Solutions

pH buffers are available for your other Myron L® Company instruments in pH values of 4, 7 and 10. The Myron L 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.

E. 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.

XIV. TEMPERATURE COMPENSATION (Tempco) of Aqueous Solutions

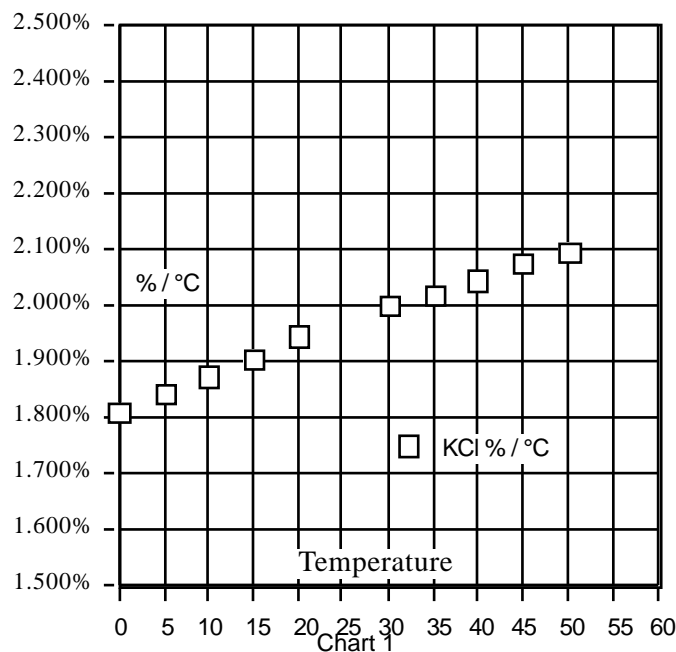
Electrical conductivity indicates solution concentration and ionization of the dissolved material. Since temperature greatly affects ionization, conductivity measurements are temperature dependent and are normally corrected to read what they would be at 25°C.

A. Standardized to 25°C

Conductivity is very accurately measured in the Ultrameter by a method that ignores fill level, electrolysis, electrode characteristics, etc., and uses a microprocessor to perform temperature compensation. In simpler instruments, conductivity values are usually assigned an average correction similar to KCl solutions for correction to 25°C. The correction to an equivalent KCl solution is a standard set by chemists. It standardizes the measurements and allows calibration with precise KCl solutions. In the Ultrameter, 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 uses corrections that change with concentration and temperature instead of single average values. See Chart 1 on next page.



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?

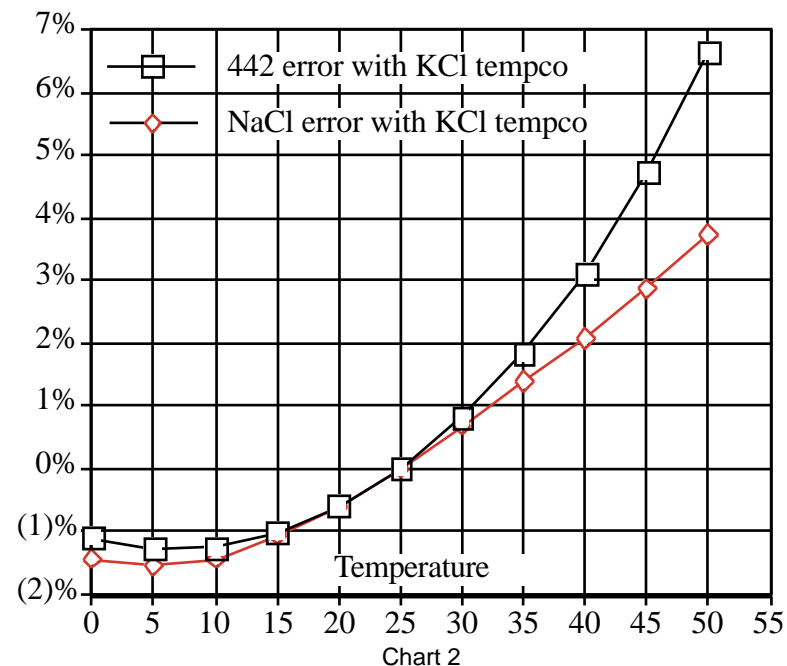
A tap water solution should be compensated as 442 with a tempco of 1.68 %/°C, where the KCl value used would be 1.90 %/°C.

Suppose a measurement at 15°C (or 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 μ S, the error using KCl on a solution that should be compensated as NaCl or as 442, is shown in the graph below.



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. Some 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 will provide the repeatability and convertibility of data needed for relative values for process control.

E. Other Solutions

A salt solution like sea water 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 $\pm 1\%$. Many industrial applications have always been relative measurements seeking a number

to indicate a certain setpoint or minimum concentration or trend. The Ultrameter gives the user the capability to take data in "KCl conductivity units" to compare to older published data, in terms of NaCl or 442, or as may be appropriate. The Ultrameter can be used to reconcile data taken with other compensation assumptions, especially with its ability to allow custom characteristics through the USER mode.

XV. 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. 23).

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, using 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 solve this problem, industrial users commonly use the characteristics of a standard material as a model for their solution, like the KCl favored by chemists for its stability.

Users dealing with sea water, 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 MyronL® 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 contains internal algorithms for these 3 most commonly referenced compounds. In the LCD display, the solution type being used is shown 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 R.O. 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.

Those who want true TDS readings that will correspond to evaporated weight will select the correct Solution Type. 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.

XVI. TEMPERATURE COMPENSATION (Tempco) and TDS DERIVATION

The Ultrameter contains internal algorithms for characteristics of the 3 most commonly referenced compounds. In the display, the solution type being used is shown 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 from the keyboard.

A. Conductivity Characteristics

When making 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 happened over this change of 10°C. The solution is said to have a tempco of 2.2 %/°C.

Another solution would have a different tempco because of its ionization activity. And, that tempco may be a little different at a different concentration or temperature. This is why the Ultrameter uses mathematically generated models for known salt characteristics that 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. 12 (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 Tempco, pg. 11. 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 some with concentration. The ratio is set during calibration in USER as in User Programmable Conductivity to TDS Ratio, pg. 12. 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.

XVII. GLOSSARY

Anions -	Negatively charged ions. See Solution Characteristics, pg. 26.
Algorithm -	A procedure for solving a mathematical problem. See Temperature Compensation and TDS Derivation, pg. 27.
TDS -	Total Dissolved Solids or the Total Conductive Ions in a solution. See Conductivity Conversion to TDS, pg. 26.
Tempco -	Temperature Compensation See Temperature Compensation, pg. 23.
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, pg. 23 and Temperature Compensation (Tempco) and TDS Derivation, pg. 27.

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

Ultrameter™

Operation Manual

Addendum

Models 4P & 6P

Software Versions 2.03, 2.10, 2.51 & Later*

* See page 5 to determine the version of software of your Ultrameter™.

UMMA10-01
WEB

I. ENHANCED HIGH RESISTIVITY MEASUREMENTS

The resistivity calculations in the Ultrameter have been improved for measuring waters greater than 10 Megohms. When the Ultrameter is in one of the solution modes (i.e. KCl, NaCl or 442) and the resistivity reading is greater than 10 Megohms, the Ultrameter performs automatic temperature compensation for high purity water. As such, the maximum possible value that should be displayed for water is 18.2. It may be possible to display readings higher than 18.2 if the instrument is not calibrated or if solutions **other than water** are being measured. To insure proper use of the instrument in this mode, readings greater than 20 Megohms will display "- - - -" indicating an over-range condition. To obtain resistivity readings for solutions **other than water**, the User mode should be selected. In User mode the Ultrameter will display resistivity measurements up to 30 Megohms.

An **Offset Zero Calibration** feature was added to software version 2.03, and must be performed by the user, see below. On all later versions this function is performed at time of manufacture.

A **Cell Check** feature was added to these later versions. See page 2.

Offset Zero Calibration For Instruments with Software Version **2.03**

When performing measurements of waters above 10 Megohms, the accuracy of the Ultrameter may be improved by performing an offset zero calibration. Follow the steps below to perform an offset zero calibration.

1. Press **(RES)** key to power up the unit.
2. Verify that the cell cup is empty of any solution and "- - - -" is displayed by the Ultrameter. If a reading other than "- - - -" is displayed, clean the cell cup and repeat steps 1 & 2. See "Cleaning Sensors".
3. Press the **(MR)** key until "**CAL0**" appears. Fig. 1.
4. Press the **(CAL)** key. The instrument should momentarily display a number of counts, and return to Resistivity mode.
5. If the calibration has failed the display will show "**Err**". If an error occurs during this step, the cell cup is probably contaminated. Rinse the cup with DI water several times to clean and Repeat steps 1-4.



Figure 1

Cell Check For Instruments with Software Version **2.10 & Later.**

In these versions, a **Cell Check** feature has been added to further increase the performance of your instrument. This is especially important when in **RES** mode reading High Resistivity or Ultrapure waters. This feature, utilizing technological improvements, knows when the Conductivity Cell cup is dirty and calls it to your attention. You may then choose to clean the Conductivity Cell cup or ignore it by pressing the CAL key. Follow the steps below to perform a **Cell Check**.

1. Press **(RES)** key to power up the unit.

2. Verify that the cell cup is empty of any solution and "- - - -" is displayed by the Ultrameter. If a reading other than "- - - -" is displayed, clean the cell cup and repeat steps 1 & 2. See "Cleaning Sensors".



Figure 2

3. Press the **(MR)** key until "**CELL ch**" appears. Fig. 2.

4. Press the **(CAL)** key. If the cell is clean, "**Good**" will momentarily be displayed. Fig. 3.

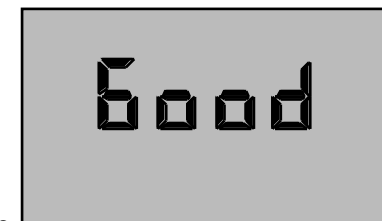


Figure 3

5. If the **Cell Check** has failed the display will show "**CELL cLn**", Fig. 4, alternating with a number such as "**53**", Fig. 5, indicating a relative amount of contamination or dirt in the Conductivity Cell. To insure the highest quality readings, the Conductivity Cell cup should be cleaned before measuring High Resistivity solutions. Rinse the cup with DI water several times to clean, and Shake instrument well to remove excess water. Repeat steps 1-4.



Figure 4

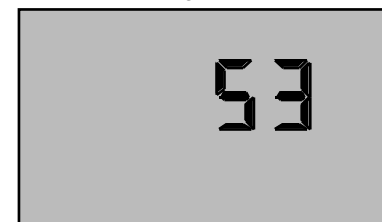




Figure 5

II. USER MODE CALIBRATION LINK




A new function has been added to the Ultrameter that makes calibration of the unit while in "User" mode easier, and more repeatable and accurate than other calibration methods. It is recommended that this calibration method be used to provide the highest degree of confidence when the Ultrameter is used in "User" mode.

A. Calibration of Ultrameter for use in User Mode

1. Press the  or  key to power up the Ultrameter.
2. Calibrate the unit using a Standard Solution. Refer to CALIBRATION in Operation Manual.
3. Place the Ultrameter in User mode. Refer to SOLUTION SELECTION in Operation Manual.
4. Verify/Set the calibration link. (See below – Setting User Mode Calibration Link).

B. Setting User Mode Calibration "Link"

The link function sets or "links" the calibration gain factor of a Standard Solution to the User solution mode. Once set, the "link" will stay intact with future calibrations unless the link has been canceled. For more information on canceling the User Mode Calibration Link refer to the section below "Canceling User Mode Calibration Link". 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., ,  or .

2. Place the Ultrameter in User mode. Refer to SOLUTION SELECTION in Operation Manual for selecting the User Mode.


3. Press the  arrow key until the menu "Linc" appears. Fig. 6.



Figure 6

4. Press the  key. The instrument will display "SEL" and the "User" Icon. Fig. 7.



Figure 7

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




5. Press the   keys to select a Standard Solution to be linked to the User mode calibration constant. (see Fig. 8, **User** linked to **KCl**).








Figure 8



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

6. Press the  key to accept the setting. Pressing any of the measurement keys will exit without changing the setting. User mode "link" 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. Canceling User Mode Calibration "Link"

The Ultrameter must be in **User** linked mode in order to cancel the "link". Refer to SOLUTION SELECTION in Operation Manual.

1. Press "Linked" measurement key   or . Two solution icons will be shown the left side of display - "**User**" and another, i.e., "**KCl**".
2. Press the  key until the menu "Linc" appears. Fig. 5.
3. Press the  key, the unit will display "SEL" and the "User" Icon.

4. Press the  key until "User" is the only solution icon being displayed.
5. Press the  key.
6. The User mode calibration "Link" has now been canceled.



NOTES:

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

2. Calibration of the Ultrameter Gain Factor for User mode is not available when the calibration link 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 the manual, the User Mode Link should be canceled. See above Canceling User Mode calibration "Link".

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


*** CHECKING YOUR INSTRUMENTS SOFTWARE VERSION**

1. Press  key to power up the unit.
2. Press the  key until three numbers are displayed as shown.

in Fig. 9. If one of the listed versions is displayed, the ENHANCED HIGH RESISTIVITY MEASUREMENTS, and the USER MODE CALIBRATION LINK are available.



Figure 9

3. Press  key, instrument will time out in ~15 seconds.

If one of the listed versions is NOT displayed, and these functions are required, contact the Myron L® Company for information on upgrading your instrument.