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TRACEABLE™ CONDUCTIVITY RESISTIVITY TDS SALINITY CONCENTRATION METER INSTRUCTIONS

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1.1 SPECIFICATIONS

Conductivity Range: (range selecting automatic & manual)	0.01 to 19.99 µS (micromhos) 0.1 to 199.9 µS (micromhos) 1 to 1999 µS (micromhos) 0.01 to 19.99 m S (mhos) 0.1 to 199.9 m S (mhos)
Accuracy:	±0.3% + 1 digit
Resistivity Range: (range selecting automatic & manual)	0.001 to 1.999 Megohms 0.01 to 19.99 Megohms
Accuracy:	±0.3% + 1 digit
Total Dissolved Solids: (range selecting automatic & manual)	0.01 to 19.99 mg/L (milligrams per liter) 0.1 to 199.9 mg/L (milligrams per liter) 1 to 1999 mg/L (milligrams per liter) 0.01 to 19.99 g/L (grams per liter) 20.0 to 199.9 g/L (grams per liter)
Accuracy:	±0.3% + 1 digit
Salinity:	2.0 to 42.0 (In accordance with International Oceanographic data, ref UNESCO, IASPO (Technical Papers in Marine Science, No. 36-1981))
Accuracy:	±0.5%
Concentration:	0.000 to 9999
Temperature Range:	-25.0 to 125.0° Celsius, -22.0 to 266.0° Fahrenheit
Accuracy:	±0.3° Celsius
Calibration:	4 points are available for calibrating to known standards. Cell constant and the temperature coefficient may also be set.
Temperature Compensation:	Automatically temperature compensated to the international standard of 25 degrees Celsius, temperature may also be compensated manually.

Temperature Compensation Range:	0.0 to 50.0° Celsius.
Temperature Coefficient:	Default value set at 2.000% per degree Celsius. Fully adjustable in the range of 0.000 to 5.000% per degree Celsius.
Recorder Output:	Range of ±200.0 mV, resolution of 0.2 mV, accuracy of ±0.3 mV
Power:	One 9-volt alkaline battery (supplied)

2.1 INTRODUCTION

This Digital Conductivity Meter is a precision instrument with a state-of-the-art microcomputer. It's unique software program allows four calibration points to ensure complete accuracy over the entire measurement range. All calibration data is saved when the unit is turned off. It has both automatic and manual temperature compensation. The unit displays results in conductivity (micromhos/cm), resistivity (megohms), total dissolved solids (milligrams per liter), salinity, concentration and temperature (Celsius/Fahrenheit). Units are: (microsiemens = micromhos), (micromhos = 1/megohms), and (megohms = 1/micromhos). The probe contains platinum electrodes and a thermistor.

3.1 DISPLAY SYMBOLS

µS/cm	microsiemens or micromhos per centimeter
m S/cm	siemens or mhos per centimeter
MΩ/cm	megohms per centimeter
TDS mg/L	total dissolved solids in milligrams per liter
TDS g/L	total dissolved solids in grams per liter
SALINITY	salinity
C	concentration
°C	temperature
K	cell constant or "K-factor"
CAL	Flashing, indicates arrow keys have been used but the ENTER key has not yet been pressed
CAL	not flashing, indicates the instrument has been calibrated
%/°C	temperature coefficient (percent per degree Celsius)
CHK	instrument is in check function and calibration data is being displayed
	Blinking dash indicates auto-ranging has been disabled

(See additional Display Messages 21.1)

4.1 KEYPAD QUICK REFERENCE

ON/OFF	Turns the unit on and off.
MODE	Changes the mode of the instrument to read Conductivity (uS/cm), Total Dissolved Solids (TDS mg/L), Resistivity (MΩ/cm), Concentration (C), Salinity or Temperature.
↑ ↓	Calibration controls used to adjust the display to known value. Each press of the arrow key increases/decreases the display.
K	Displays the cell constant or "K-factor. The default value is K=1.000. This value can be changed by manually entering a known value.
°C/°F	Displays the temperature coefficient "%/°C". The default temperature coefficient value is 2.000% per degree Celsius. This value can be changed by manually entering a known value.
ENTER	After using the arrow keys to adjust the display to a known solution or a known factor, this key is used to enter the displayed value as a calibration point. If the arrow keys are not in immediate use, this key will act in a toggle fashion to disable/enable Auto-Ranging feature.
CHECK	Displays all calibration data previously entered.

5.1 GENERAL OPERATING TECHNIQUES

1. Use very clean beakers/flasks.

2. Avoid cross-contamination between measurements by rinsing the probe in deionized/distilled water and by rinsing the probe in the solution to be tested.

3. For best results the solution temperature should remain constant during the readings. The ideal temperature is 25.0° Celsius (77.0° Fahrenheit).

4. Make certain to sustain flow through the probe (or move the probe through the solution in a stirring motion) while making your readings. Stirring helps prevent polarization, ensures that the solution is well mixed, and helps to maintain a uniform temperature within the solution.

5. Be aware that very pure water will pick-up contaminates from the air in a relatively short time. In the measurement of extremely pure water consider shielding the measuring vessel. Slight stray electrical signals can change the readings.

6. When finished using the probe, always rinse it in distilled water and store dry or in distilled water. Solutions which are allowed to dry on the probe will eventually block out active sites on the internal platinum electrode, the surface area will be reduced , and a new probe will be required. Do not touch the internal platinum electrode, if the surface is damaged linearity will be affected, specifically in the high conductivity readings, and difficulty may be found in achieving high readings.

6.1 MAKING MEASUREMENTS (WITH OR WITHOUT CALIBRATION)

Connect the probe by placing the connector plug into the keyed instrument socket.

1. Press the ON/OFF key to turn the unit on.

2. Place the unit in the MODE required (conductivity, resistivity, TDS, salinity, concentration or temperature) by pressing the MODE key.

3. Place the probe in the sample solution.

4. Read the answer on the digital display while stirring the probe in the solution.

7.1 CALIBRATION

Prior to calibrating the Digital Conductivity Meter make certain that all previous calibration data has been erased. See "Clearing Calibration Data" 9.1.

The unit may be calibrated the following ways:

1. To known solutions
2. To known cell constants
3. To unknown temperature coefficients
4. To known temperature coefficients

Calibration is achieved by using the arrow keys to adjust the display to read to a known value. The ENTER key is used to store a value as a calibration point. Four calibration points may be entered to ensure accuracy over the entire measurement range.

If no calibration is performed the default of the cell constant is K=1.000 and the default of the temperature coefficient is 2.000% per degree Celsius. All readings displayed are automatically temperature compensated and corrected to the internationally accepted standard of 25.0° Celsius. Non-temperature compensated readings may also be made, see "Absolute Conductivity Measurement" 19.1.

The probe supplied has a standard factor or cell constant of approximately K=1.000. In actual manufacturing the cell constant is always slightly less than or greater than one. For this reason it is advisable to use a known solution to calibrate the instrument. During calibration an electronic adjustment is made to enable the instrument to read the correct result for a known solution.

Calibrate in the MODE (conductivity, resistivity, or concentration) you intend to use. For most accurate results choose a known calibration solution with a value as close as possible to your unknown. Do not calibrate in a 1000 unit range and read samples in a 10 unit range. If possible the calibration solution and your unknown should be at the same temperature. The ideal temperature is 25.0° Celsius (77.0° Fahrenheit).

All calibration data is saved when the unit is turned off.

7.1.1 CALIBRATION WITH KNOWN SOLUTIONS

1. Erase any existing calibration data. See "Clearing Calibration Data" 9.1.

2. Insert the probe into a known solution.

3. Press the MODE key to place the unit in the measurement function desired: Conductivity (uS/cm), Resistivity (MΩ/cm) or Concentration (c).

4. Press the arrow keys to adjust the value on the display to the value of the solution. "CAL" will blink on the display. NOTE: Each press of the arrow key increases/decreases the display by 1 digit. To rapidly increase/ decrease the display, press and hold down the arrow key, the least significant digit is changed until ten digits have been counted, then the next significant digit, etc..

5. With the correct value on the display, press the ENTER key to enter the value as a calibration point.

The instrument is now calibrated. This procedure may be repeated three (3) additional times (total of four calibration points) using different solutions to insure accuracy over the entire measurement range.

6. To now read a sample, see "General Operating Techniques" 5.1 and "Making Measurements" 6.1.

7.1.2 CALIBRATION WITH A KNOWN CELL CONSTANT (K-FACTOR)

If the cell constant or "K-factor" is already known, it may be entered directly. The cell constant may be entered in units per centimeter (S/cm) or units per meter (S/ m). Most cell constants are expressed in units per centimeter.

1. Erase any existing calibration data. See "Clearing Calibration Data" 9.1.

2. Press the K key. "K" will appear on the bottom right corner of the display. Each press of the K key toggles between units per centimeter (S/cm) and units per meter (S/ m).

3. Press the arrow keys to adjust the value on the display to the value of the known cell constant, the cell constant has now been set.

4. Press the MODE key to return the unit to the measurement function desired.

5. To now read a sample, see "General Operating Techniques" 5.1 and "Making Measurements" 6.1.

7.1.3 CALCULATING AND CALIBRATING TO AN UNKNOWN TEMPERATURE COEFFICIENT

All readings displayed are automatically temperature compensated and corrected to the internationally accepted standard of 25.0° Celsius. The default temperature coefficient to achieve this temperature correction is 2.000% per degree Celsius. This is quite satisfactory for most applications particularly where the temperature of test solutions is unlikely to fluctuate. For high accuracy measurement of solutions where temperature is changing, perform the following procedure.

1. Erase any existing calibration data. See "Clearing Calibration Data" 9.1.

2. Place the probe in a solution whose temperature coefficient you would like to calculate.

3. Press the °C/°F key, this will display the current temperature coefficient. The default temperature coefficient of 2.000 %/°C.

4. Press the ENTER key, the "%/°C" symbol will begin to flash.

5. Raise or lower the temperature of the solution by at least 10° Celsius. (The temperature may be monitored by selecting temperature using the MODE key)

6. Return to the temperature coefficient display by pressing the °C/°F key then press the ENTER key. The calculated temperature coefficient will be displayed. This value is now set in the unit.

7. Press the MODE key to return to the desired measurement mode.

8. To now read a sample, see "General Operating Techniques" 5.1 and "Making Measurements" 6.1.

7.1.4 CALIBRATING TO A KNOWN TEMPERATURE COEFFICIENT

If the temperature coefficient of the solution is already known either by previously using the technique above or by some other means, it may be entered directly.

1. Erase any existing calibration data. See "Clearing Calibration Data" 9.1.

2. Press the °C/°F key.

3. Press the arrow keys to adjust the value on the display to the known temperature coefficient, the temperature coefficient has now been set.

4. Press the MODE key to return to the desired measurement mode.

5. To now read a sample, see "General Operating Techniques" 5.1 and "Making Measurements" 6.1.

8.1 REVIEWING CALIBRATION DATA

1. Any time after the unit has been calibrated press the CHECK key once. In a rotating "billboard" readout, the display will first show the calibration number and then the known solution calibration.

An example of the readout:

1	(first calibration)
100 µS	(known solution calibration setting)
2	(second calibration)
250 µS	(known solution calibration setting)
1	(first calibration)... and so on

2. Return to the measuring function desired by pressing the MODE key.

9.1 CLEARING CALIBRATION DATA

If the unit has been calibrated, "CAL" will appear in the top left corner of the display.

To clear previously entered calibration data, perform the following steps:

Note: The cell constant (K-factor) is not calibration data and will not be cleared. The temperature coefficient will be reset to the default value of 2.000%.

1. Press the CHECK key, "CHK" will appear on the top right corner of the display.

2. Press and hold the ENTER key for 10 seconds, "0" zero will be displayed to the far left of the display to indicate that all calibration data has been cleared.

3. Return to the measuring function desired by pressing the MODE key.

10.1 DISPLAYING THE TEMPERATURE COEFFICIENT

1. Press the °C/°F key once to display the temperature coefficient, %/°C will appear on the bottom right side of the display. The default value is 2.000%.

2. Return to the measuring function desired by pressing the MODE key.

11.1 DISPLAYING THE K-FACTOR

1. Press the K key to display the K-factor (cell constant). "K" will appear on the bottom right corner of the display.

2. Return to the measuring function desired by pressing the MODE key.

12.1 AUTO-RANGE/HOLD-RANGE FEATURE

The instrument automatically selects the most appropriate range for the current reading in order to display the best accuracy and resolution. The unit automatically defaults to this Auto-Ranging function.

Hold-Range locks in a specific range. (An example of Hold-Range in use would be a reading of 1 µS in the Hold-Range of 0 to 1999 µS, whereas in the Auto-Ranging function the reading displayed might be 1.37 µS.)

To disable Auto-Ranging and enable the Hold-Range feature:

1. Place the probe in a solution which is in the range you wish to hold. The unit does not have to be calibrated to enable the Hold-Range feature.

The ENTER key behaves as a toggle to enable/disable the Auto-Ranging and Hold-Range functions when the meter is in a measurement mode and the arrow keys are not in immediate use.

2. Press and hold the ENTER key for approximately 6 seconds, a blinking bar to the left of the value on the display indicates that Auto-Ranging is disabled and the instrument will hold the range it is in.

3. To place the unit back in Auto-Ranging, press and hold the ENTER key for approximately 6 seconds, the flashing bar to the left of the value will no longer appear on the display.

13.1 CONDUCTIVITY MEASUREMENT

Micromho is a measurement of conductance. A micromho is the same as a microsiemen (1 micromho = 1 microsiemen).

Be aware that very pure water will pick-up contaminates from the air in a relatively short period of time and yield progressively higher micromho readings.

To make measurements, see "General Operating Techniques" 5.1 and "Making Measurements" 6.1.

14.1 TOTAL DISSOLVED SOLIDS MEASUREMENT

In the TDS/mg/L mode the Digital Conductivity Meter automatically multiplies the micromho reading by 0.666 to display the TDS/mg/L reading. Mg/L (milligrams per liter) is the same value as PPM (parts per million). The user should be aware that this fixed factor is applicable in most cases, but water from different sources could require a factor as low as 0.550 and as high as 0.800. In those cases where the fixed factor is not applicable, the user should establish the factor, make readings in the micromho range, and multiply micromhos by the appropriate factor.

15.1 RESISTIVITY MEASUREMENT

Megohm is a measurement of resistance. Resistivity is the inverse of conductivity (Megohm = 1/Micromho)

1. Pure water or other solutions above 2 megohms is difficult to maintain because of contamination. High purity water is difficult to keep pure for even a short time. Air, plastic containers, glass vessels, etc. can contaminate the water and produce variations in purity readings. Many users take high and low readings of extremely pure water and average them for reporting purposes.

2. Expect constant display changes in the Megohm range. Slight stray electrical signals can change the readings. Any stray signals produced by equipment or even your hand will cause significant changes. For precise results, the measuring vessel should be shielded. When making readings in the higher megohm range, do not hold the probe or unit in your hand.

3. Sensitivity in the Megohm range can be illustrated by observing that in the Micromho range there are five possible different readings between 0.0 and 0.5. In the same measurement range in Megohms, there are 1,800

different possible readings. Although no readings are possible between 0.0 and 0.1 Micromhos, there are 1000 different readings possible in the Megohm range. This increased sensitivity makes the Megohm range appear to be less stable.

To make measurements, see "General Operating Techniques" 5.1 and "Making Measurements" 6.1.

16.1 SALINITY MEASUREMENT

Salinity measurements are made in accordance with International Oceanographic data, ref UNESCO, IASPO Technical Papers in Marine Science, No. 36-1981.

Salinity is used for oceanographic reporting, salinity is not used for measuring salt in food. Refer to the above paper for more information concerning salinity measurement.

17.1 CONCENTRATION MEASUREMENT

This meter can be calibrated for concentration. If the conductivity of your solution changes in relationship to the increase or decrease of some know substance, then you can use the concentration mode to report your answers in whatever units you desire.

17.1.1 CONCENTRATION EXAMPLE-

If you know the following:

1. Solution 1 has 10 grams of "Substance A".
2. Solution 2 has 250 grams of "Substance A".
3. The conductivity of the solution is changed in a linear relationship to the quantity of "Substance A" that is present.

You can then calibrate in the Concentration mode as follows:

1. For Solution 1 calibrate to a value of 10.
2. For Solution 2 calibrate to a value of 250.

Once calibrated, you would be able to measure your unknowns and report your answers in "grams of Substance A".

18.1 TEMPERATURE MEASUREMENT

1. Press the MODE key until you enter the temperature mode indicated by "°C" on the display. The temperature mode is after the Concentration (c) mode.

2. To toggle between °C and °F, press the ENTER key. Note: When reading in Celsius, "°C" appears on the display, when reading in Fahrenheit "°C" is no longer on the display.

19.1 ABSOLUTE CONDUCTIVITY MEASUREMENT

Non-temperature compensated conductivity measurements "absolute conductivity" may be made by setting the Temperature Coefficient to zero. See "Calibrating a Known Temperature Coefficient" 7.1.4.

20.1 RECORDER OUTPUT

1. Plug the recorder into the red and black 4 mm sockets at the top of the unit. The instrument output specifications to the recorder are as follows:

Mode	Range (mV)	Display Reading	Recorder (mV)
Conductivity	0 to 200	1000 µs/cm	100.0
TDS	0 to 200	666 mg/L	66.6
Resistivity	0 to 200	35.0 MΩ/cm	35.0
Salinity	0 to 200	10.0	10.0
Temperature	±200	25.0° C	25.0

Resolution of 0.2 mV, and an accuracy of ±0.3 mV.

21.1 DISPLAY MESSAGES

BAT	Indicates that the battery needs to be replaced.
E6 or E7	Calibration point error. Clear all calibration data and start calibration over. Make certain that the value you are calibrating to is correct.
Sc or Oc	Temperature probe (thermistor) short or open probe.
-L or -H	Salinity measurement is below or above the measurement range.

22.1 BATTERY REPLACEMENT

Erratic readings, no display, or "BAT" on the display are all indications that the battery needs to be replaced or that the battery is not making proper contact. Place your thumb against the word "OPEN" on the back of the unit and slide the battery cover up and off. Replace the battery with a new 9-volt alkaline battery. Make certain that the battery is inserted properly and that proper contact is made. Low battery power can occasionally cause any number of "apparent" operational difficulties. Replacing the batteries will solve most difficulties. For warranty or service contact Control Company at the address below.

23.1 MAINTAINING CALIBRATION

For accreditation, government requirements, and ISO 9000 certification we recommend that this instrument be recalibrated one year from the date this unit is put into service and be calibrated on an annual basis thereafter. For calibration contact:

Control Company
4455 Rex Road
Friendswood, TX 77546
Ph 281-482-1714 Fax 281-482-9448

24.1 ACCESSORIES

Traceable™ Conductivity Calibration Standards (Model 4065-4069)

Reagent grade Traceable™ standard calibrating solutions are available from your dealer. Each bottle is labelled for calibrating conductivity (micromhos), resistivity (megohms), and total dissolved solids (parts per million). Preparation method per ASTM D1125, Jones/Bradshaw, Organization Internationale de Metrologie Legale, APHA, and Robinson/Stokes. Fulfills requirements of CAP, ASTM, NCCLS, ACS, EPA, and water plant regulations. A certificate is provided indicating traceability to standards provided by (NIST) National Institute of Standards and Technology (Reference Material, SRM Potassium Chloride). Traceability information and complete calibration instructions are on each bottle. Supplied in a 16 ounce brown glass bottle.

Control Cat. No.	Micromhos	Megohms	TDS/PPM
4065	10	0.1	6.5
4066	100	0.01	65
4067	1000	0.001	650
4068	10000	0.0001	6500
4069	100000	0.00001	65000

One-Shot™ Traceable™ Conductivity Calibration Standards (Model 4175-4179)

Single-use standards identical to the above bottles. These eliminate concerns about external container contamination. Calibration is made in the standards vial. Extra large opening 1¾" diameter and extra large depth 3½" allow probe calibration to take place in the standard's polyethylene container. Accommodates virtually all conductivity probes. Supplied as a pack of six One-Shot™ standards. Each standard contains 100 ml.

Control Cat. No.	Micromhos	Megohms	TDS/PPM
4175	10	0.1	6.5
4176	100	0.01	65
4177	1000	0.001	650
4178	10000	0.0001	6500
4179	100000	0.00001	65000

Replacement Glass Probe (Model 4062)

Probe with K=1.0. Glass probe identical to probe supplied with the unit. Range of probe is from 0.05 micromho to 200,000 micromhos.

Replacement Plastic Probe (Model 4061)

Probe with K=1.0. Plastic probe is similar to the probe supplied with the unit except the body of the probe is plastic. Range of probe is from 0.1 micromho to 200,000 micromhos.

Accessory Flow-Thru Cell (Model No. 4054)

Probe with K=1.0 electrodes. Flow-Thru Cell has glass inlet and outlet. Cell sample volume is 4 ml.

Accessory Micro-Sampler and Micro Flow-Thru Cell (Model 4055)

Probe with K=0.2 electrodes makes the range of the unit from 0.02 micromhos to 40,000 micromhos. This is a five fold increase in sensitivity in the lower ranges, ie: deionized/distilled water, etc. (In essence, to arrive at the correct reading, the user multiplies the meter reading times 0.2) Cell sample volume is 2 ml. Flow-Thru Cell has glass inlet and outlet. The unit may be used as a continuous flow-thru cell or as a single micro-sampler. A rubber bulb is supplied and may be connected to the outlet end for use as a single micro-sampler.

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