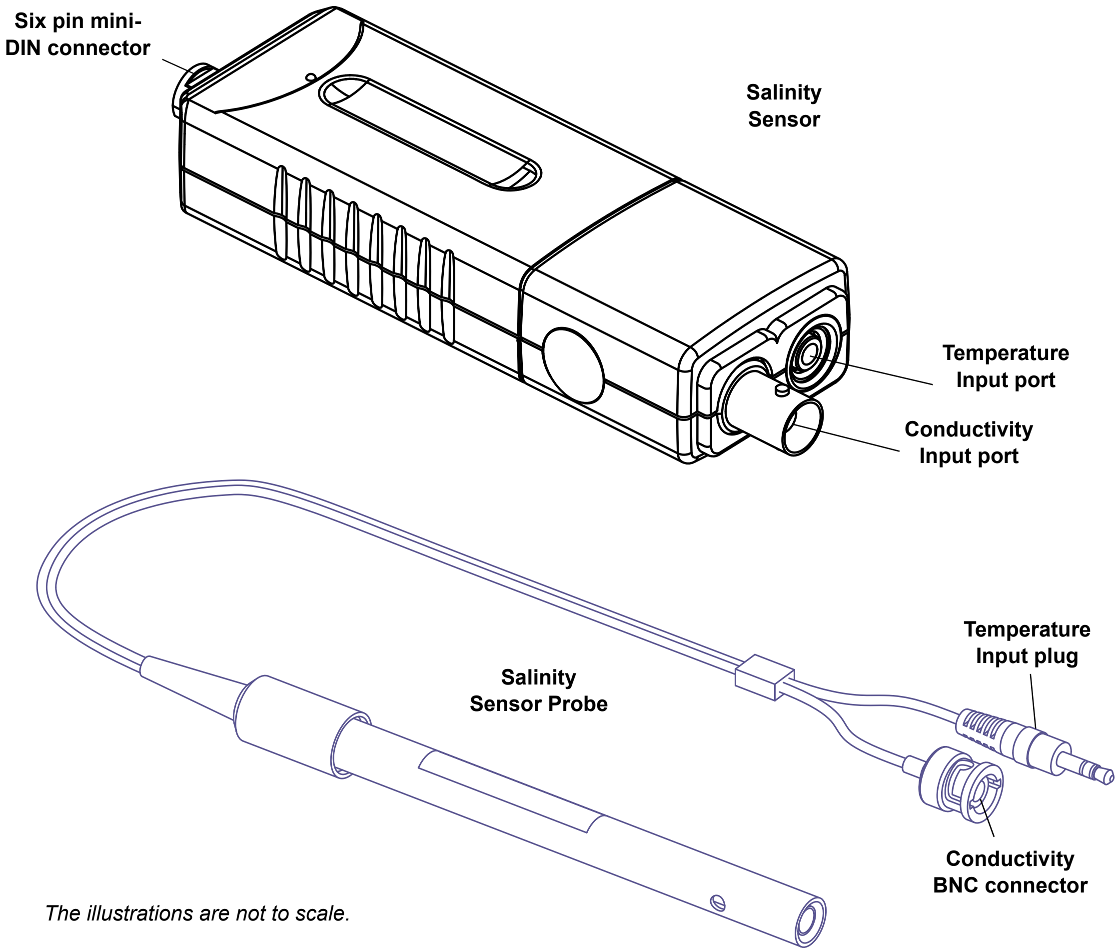
PASPort™

Instruction Sheet
012-10546A

Salinity Sensor

PS-2195



The illustrations are not to scale.

Included Equipment	**Part Number**
Salinity Sensor	PS-2195
Salinity Sensor Probe, 10 X, Conductivity/Temperature	699-11064
Recommended Items	
PASPORT Extension Cable	PS-2500
PASCO Interface	Catalog or web site*
Data Acquisition Software	Catalog or web site*

**See the PASCO catalog or web site at www.pasco.com for compatible PASPORT interfaces and Data Acquisition Software..*

Introduction

Salinity is an ecological factor of considerable importance, influencing the types of organisms that live in a body of water. Salinity also influences the kinds of plants that can grow in a body of water, or on land fed by the body of water. A quantity of water is considered saline if it contains moderate or relatively high amounts of dissolved salts. The term is most often employed to describe water that would, if evaporated fully, leave behind salts incorporating sodium, calcium, or magnesium. *Salinity* is the degree to which a water is saline.

The PASPORT Salinity Sensor works with the 10X Salinity Sensor Probe to measure salinity, conductivity, and temperature. The sensor determines salinity based on electrical conductivity. The sensor has a built in calculation to compensate for the change in conductivity due to temperature change based on the Practical Salinity Scale (PSS). Essentially the conductivity increases as the temperature increases because ions in solution are more mobile. It is possible to approximate a calculation of total dissolved solids (TDS) using data from the sensor.

PS-2500 PASPORT Extension Cable

The Salinity Sensor can be connected to any PASPORT interface (such as the Xplorer GLX or PowerLink). The sensor can be used with the PASPORT Extension Cable. This cable is 2 meters in length, extending the distance a sensor can reach from a computer or portable datalogger.

Salinity is often expressed as parts per thousand (ppt) which is approximately equal to grams of salt per liter of solution. However, salinity is the sum weight of many different elements within a given volume of water; not just sodium from sodium chloride. In the 1970's, salinity was redefined as the conductivity ratio of a water sample to a standard potassium chloride (KCl) solution.

Water Salinity

<0.5 ppt - fresh water

0.5 to 30 ppt - brackish water

30 to 50 ppt - saline water

>50 ppt - brine

Ocean Water

Ocean water is about 3.5% salt, or 35 ppt, and the salt is 90% sodium chloride.

Usage

One use for the sensor is to explore the salinity of local water sources. Another use for the sensor is to explore the interrelationship of salinity, temperature, and conductivity. The sensor can be used to measure the change in the salinity of saltwater as the water evaporates.

About the Sensor

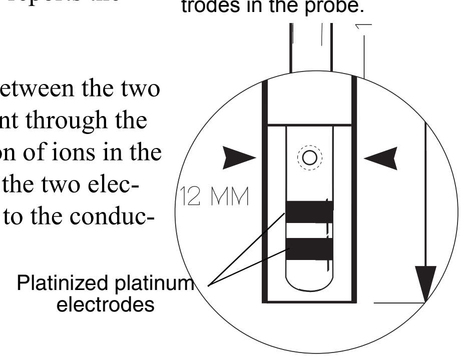
The PS-2195 Salinity Sensor's conductivity range is from 1,000 microsiemens (μS) to 100,000 μS. The temperature range is from 0 celsius (C) to 50 °C. The salinity range is from 1 part per thousand (ppt) to 55 ppt ±10% without calibration.

The sensor actually measures *conductance*, the inverse of resistance, expressed in *siemens*. Conductivity depends on the conductance and the *cell constant* of the probe. The cell constant depends on the geometry of the electrodes in the probe.

The temperature compensation is ±0.5 ppt from 0 C to 45 C at 33 ppt.

If the temperature of the solution is out of range, the sensor reports the salinity as 0 ppt. If the conductivity of the solution is below 1,000 μS, the sensor reports the conductivity as 0 μS.

The Salinity Sensor measures the electric current through a solution between the two platinized platinum electrodes in the Salinity Sensor Probe. The current through the solution is due to the movement of ions, so the higher the concentration of ions in the solution, the higher its conductivity. A voltage (AC) is applied across the two electrodes in the tip of the probe and the measured current is proportional to the conductivity of the solution.



Setup

Hardware Setup

The following steps can be performed in any order.

1. Connect the Salinity Sensor Probe to the Salinity Sensor. Connect the Conductivity BNC connector from the probe to the Conductivity input port on the sensor. Push the BNC connector onto the port and turn the connector clockwise (left-to-right) until the connector locks into place on the port.

2. Connect the Temperature input plug from the probe to the Temperature input port on the sensor.

3. Connect the Salinity Sensor to a PASPORT interface.

4. If you will be using a computer, connect the PASPORT interface to the computer's USB port.

Using the Probe

Before using the Salinity Sensor Probe, soak the probe in distilled water for 5 to 10 minutes. Use a towel to dry any water droplets that are on the probe so that the water will not dilute the sample that is to be measured.

Submerge the tip of the probe at least 5 centimeters (cm) into the sample to be measured. Start recording data. Watch the display in your data acquisition program.

TIPS

DO NOT submerge the entire Salinity Sensor Probe in a liquid. The top end of the probe is not waterproof.

Use distilled water from a wash bottle to rinse the end of the probe before making another measurement.

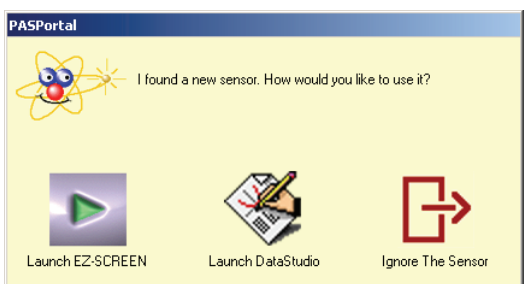
DO NOT put the probe in viscous, organic liquids, such as heavy oils or ethylene glycol. Do not put the probe in acetone or non-polar solvents, such as pentane.

Clean the electrodes when necessary by soaking the tip in acid (e.g., vineagar or diluted hydrochloric acid (muriatic acid)) and then rinsing with water.

If the tip is heavily fouled with organic material, soak the tip in alcohol or bleach and then rinse with water. Gently wipe the tip with a soft, nonabrasive cloth towel.

DataStudio Setup

If you will be using the Salinity Sensor with a computer, install the latest version of DataStudio first. Check the PASCO web site at www.pasco.com for information.



1. When you connect the Salinity Sensor to the computer through a PASPORT interface, the PASPortal window will launch automatically (if DataStudio is not already running).

2. Select *Launch DataStudio* in the PASPortal window.

A Digits display for salinity, temperature, and conductivity will open automatically.

3. Click ▶ Start to begin data collection.

To view and change the sample rate and other sensor properties, click Setup.

Xplorer and Xplorer GLX Setup

If you will be using an Xplorer or Xplorer GLX in logging mode (not connected to a computer), connect the Salinity Sensor to the Xplorer or Xplorer GLX, turn the interface on, and press ▶ to begin data collection.

SPARK Setup

- If the SPARK Science Learning System (SLS) is off, press and hold the power button on the bottom to turn it on and then wait for the SPARK to boot up. The screen will show a message to plug in a sensor.

- Connect the PASPORT sensor to either of the ports on the top of the SPARK. The screen will show the list of quantities measured by the connected sensor.

Graph Display (default)

To open a graph display, touch any quantity in the list and then touch SHOW to open PAGE 1. Touch the right arrow next to PAGE 1 to go to the next display (digits). Touch the **Start** button to begin collecting data.

Start button

Select a Display

To set up a particular display (e.g., digits display), touch BUILD. Touch a quantity from the list, and then touch one of the display icons. Touch OK to open the display, and then touch the **Start** button to begin collecting data.

Calibration

Prepare a salinity calibration solution.

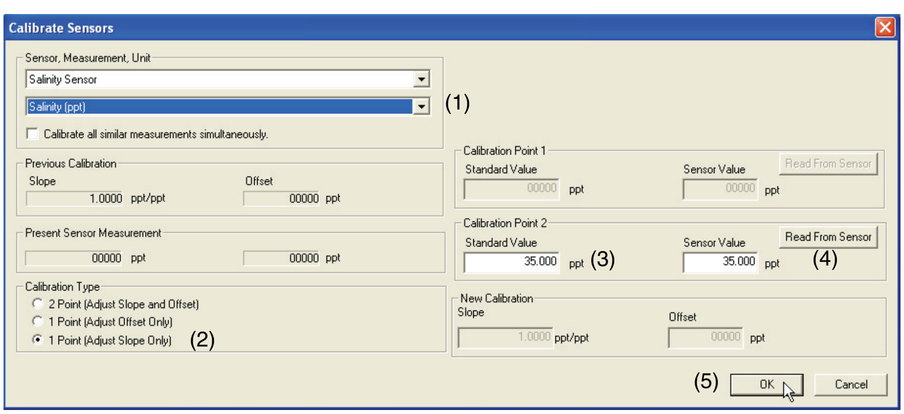
You will need reagent grade sodium chloride (salt), a liter of distilled or deionized water, a stir rod, and a container with accurate volume markings. Pour 500 milliliters (mL) of distilled water into the container. Add 33.03 g sodium chloride (NaCl) and stir the mixture until the salt dissolves. Next, add enough distilled water to make one liter (1000 mL) of solution. This solution has a salinity value of 35 ppt at 25 °C.

See the User's Guides for the Xplorer GLX or the SPARK Science Learning System for calibration instructions.

1 Point Calibration

In DataStudio., click 'Setup' to open the Experiment Setup window and click 'Calibrate Sensors…'. (1) In the Calibrate Sensors window, select 'Salinity (ppt)' as the measurement from the second menu in the upper left corner. (2) Select '1 Point (Adjust Slope Only)' as the Calibration Type in the lower left corner.

Place the Salinity Sensor probe into the calibration solution and wait until the data in the 'Sensor Value' window stabilizes. (3) Make sure that the Standard Value reads 35.000 ppt. (4) Click 'Read From Sensor'.(5) Click 'OK' to close the Calibrate Sensors window.



More About Calibration

You can also calibrate the Salinity Sensor using a standard salinity solution purchased from a company such as Hach (www.hach.com) or Lamotte (www.lamotte.com) that offers water quality testing equipment. A third way is to make a calibration solution from "Instant Ocean® Sea Salt" (www.instantocean.com) which can be purchased at most aquarium supply stores.

Total Dissolved Solids (TDS) and Conductivity

Total dissolved solids (TDS) is a measure of the amount of mineral and salt impurities in a sample of water. TDS is usually measured in parts per million (ppm) and drinking water is typically below 500 ppm. For example, one kilogram of water containing 1 milligram of dissolved solids has a TDS of 1 ppm. One way to measure the amount of TDS in a sample is to measure the electric conductivity of the sample.

A conversion factor is used to convert conductivity to the approximate concentration of TDS. The conversion factor depends on the specific dissolved solids and can vary between 0.40 and 0.96, depending on the dissolved solids. A value of 0.65 is used as an approximation if the dissolved solids are not known. As an example,
TDS (ppm) = 0.65 x Conductivity (μS). Since conductivity varies with temperature, the Salinity Sensor has built-in compensation for temperature.

Table: Conversion Chart to Estimate TDS of Aqueous Solutions at 25 °C

Conductivity (μS)	Parts per Million		
	As Ion	As $CaCO_3$	As NaCl*
1.000	0.650	0.500	0.400
1.250	0.813	0.625	0.500
1.667	1.083	0.833	0.667
2.500	1.625	1.250	1.000
5.000	3.250	2.500	2.000
10.000	6.500	5.000	4.000
20.000	13.000	10.000	8.000
40.000	26.000	20.000	16.000
80.000	52.000	40.000	32.000
158.730	103.175	79.635	63.492
312.500	203.125	156.250	125.000
625.000	406.250	312.500	250.000
1250.000	812.500	625.000	500.000
2500.000	1625.000	1250.000	1000.000
5000.000	3250.000	2500.000	2000.000
10000.000	6500.000	5000.000	4000.000

Specifications

Measurement	Ranges
Conductivity	1,000 to 100,000 μS
Temperature	0 to 50 degrees C
Salinity	1 to 55 ppt ±1%*

Other	Values
Sample rate (maximum)	50 Hz
Temperature compensation	±0.5 ppt from 0 to 45 °C at 33 ppt
Cell constant	10X

(*with calibration)

Storage

The Salinity Sensor Probe can be stored dry. Rinse the tip with distilled water and then dry it using a soft, nonabrasive towel.

Technical Support

For assistance with any PASCO product, contact PASCO at:

Address: PASCO scientific
10101 Foothills Blvd.
Roseville, CA 95747-7100

Phone: 916-786-3800 (worldwide)
800-772-8700 (U.S.)

Fax: (916) 786-3292

Web: www.pasco.com

Email: support@pasco.com

For more information about the Salinity Sensor and the latest revision of this Instruction Sheet, visit:

www.pasco.com/go?PS-2195

Product End of Life Disposal Instructions:

This electronic product is subject to disposal and recycling regulations that vary by country and region. It is your responsibility to recycle your electronic equipment per your local environmental laws and regulations to ensure that it will be recycled in a manner that protects human health and the environment. To find out where you can drop off your waste equipment for recycling, please contact your local waste recycle/disposal service, or the place where you purchased the product.

The European Union WEEE (Waste Electronic and Electrical Equipment) symbol (to the right) and on the product or its packaging indicates that this product **must not** be disposed of in a standard waste container.

Experiment: Temperature Dependence of Conductivity in Dilute Aqueous Solutions

Purpose

The purpose of this experiment is to explore the relationship between temperature and conductivity in aqueous solutions.

Materials and Equipment Needed	Product Number or Quantity
PASPORT Salinity Sensor	PS-2195
Data Acquisition Interface and Software	(See the PASCO web site at www.pasco.com)
Hot plate with magnetic stirrer	
Ohaus triple-beam balance	SE-8723
Base and support rod	ME-9355
Graduated cylinder	SE-7713
250-mL Beaker (4)	SE-7702
1000-mL Beaker	SE-7288
Utility (buret) clamp	SE-9446
Wash bottle	
Apron, gloves and goggles	Per student
Sodium chloride	1000 mg
Sodium hydroxide	200 mg
Distilled or deionized water	1400 mL

Procedure

1. Soak the Salinity Sensor Probe in distilled or deionized water for 5–10 minutes.

2. Prepare solutions:

- Prepare a 0.1% sodium chloride (NaCl) solution by dissolving 200 mg of NaCl in 100 ml of distilled or deionized water and then adding more distilled or deionized water until the volume is 200 ml.

- Prepare a 0.4% NaCl solution by dissolving 800 mg of NaCl in 100 ml of distilled or deionized water and then adding more distilled or deionized water until the volume is 200 ml.

- Prepare a 0.005 M sodium hydroxide (NaOH) solution by dissolving 200 mg of NaOH in 500 ml of distilled or deionized water and then adding distilled or deionized water until the volume is 1000 ml. Pour 200 ml of the solution into a 250 ml beaker.

The distilled or deionized water for the samples should be at or below room tempera ture.

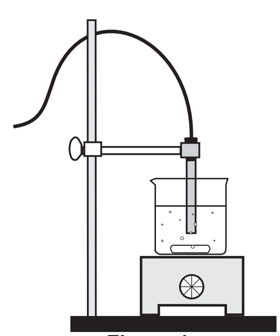


Figure 1

3. Connect the Salinity Sensor to the data acquisition interface. Support the Salinity Sensor Probe with a clamp that is mounted on a base and support rod (see Figure 1). Place the hot plate with magnetic stirrer below the tip of the probe.

4. Start the data acquisition program. Set up a graph display that shows conductivity on the vertical axis and temperature on the horizontal axis.

Calibration is not needed for this experiment.

5. Put the beaker with the first 200 ml sample on the hot plate. Arrange the Salinity Sensor Probe so that at least 5 cm of the tip is in the solution.

6. Turn on the hot plate and magnetic stirrer. The heat and the stirring controls should be set to a mid-range value.

7. Start recording data. Tap the Salinity Sensor Probe occasionally to avoid the formation of air bubbles in the probe's cell. When the temperature of the solution reaches 50 °C, stop recording data.

8. Remove the Salinity Sensor Probe from the first sample. Rinse the end of the probe with distilled water.

9. Repeat the data collection process with the other two samples.

Data Analysis

1. Autoscale the graph display and select Run #1.

2. Use the data analysis features of the data acquisition software to select a "Linear Fit" for the data. Determine the slope of the first run of data.

3. Use the Smart Cursor feature of the software to find the conductivity at the place in the graph where the temperature is 25 °C.

4. Divide the slope by the value of the conductivity at 25 °C. Convert the answer to a percentage to determine 'percent change/°C'. Record your result in the Data Table.

5. Repeat the data analysis process for the other runs of data.

Data Table

Sample	percent change/ °C at 25 °C
0.1% NaCl (1000 ppm)	
0.4% NaCl (4000 ppm)	
0.005 M NaOH (1000 ppm)	

Questions

1. Describe the effect of temperature on the conductivity of the solutions.

2. Compare the experimentally determined values of percent change per degree C at 25 °C for the samples.

3. What are some factors that affect the conductivity of a solution?

Notes on the Experiment

If bubbles form inside the probe, the conductivity reading will be reduced because the bubbles will form an insulating later on one or both of the electrodes. One way to eliminate the bubbles is to tap the probe. Another way is to increase the speed of the magnetic stirrer to allow more solution to flow through the probe.

If time is limited, prepare the solutions before the period begins.

Data Table

Solution	percent change/ °C at 25 °C
0.1% NaCl (1000 ppm)	2.1
0.4% NaCl (4000 ppm)	2.0
0.005 M NaOH (1000 ppm)	1.9

Data Analysis

The table lists typical experimental results. In general, ionic salts at low to moderate concentrations have a temperature dependence of 2% per degree at 25 °C. Acids, bases, and concentrated salt solutions have somewhat lower values, typically 1.5% per °C. In contrast, ultra pure water has a much larger value; 5.2% per °C.

Questions

1. The conductivity increases linearly with temperature over the observed temperature range.

2. The slopes are approximately equal for all the solutions.

3. Temperature, concentration, and solubility will affect the conductivity of a solution.