Salinity Sensor

(Order Code SAL-BTA)

The Salinity Sensor measures the conductivity of a solution to determine its salinity. The term salinity was originally defined as the mass of dissolved salts in a given mass of solution. The chemical analysis to determine salinity using this definition, however, proved time-consuming and imprecise. In recent years, the preferred methods for measuring salinity are density and electrical conductivity. The Vernier Salinity Sensor uses the latter.

- Use this sensor for an accurate on-site measurement of salinity in ocean or brackish water.
- Allow students to qualitatively see the difference between the ionic and molecular nature of substances in aqueous solution.
- Use the probe to confirm the direct relationship between conductivity and ion concentration in an aqueous solution. Concentrations of unknown samples can then be determined.
- Monitor the rate of reaction in a chemical reaction in which dissolved ions and solution conductivity varies with time due to an ionic specie being consumed or produced.

Collecting Data with the Salinity Sensor

This sensor can be used with the following interfaces to collect data.

- Vernier LabQuest® 2 or original LabQuest® as a standalone device or with a computer
- Vernier LabQuest® Mini with a computer
- Vernier LabPro® with a computer or TI graphing calculator
- Vernier Go! ®Link
- Vernier EasyLink®
- Vernier SensorDAQ®
- CBL 2™
- TI-Nspire™ Lab Cradle

Here is the general procedure to follow when using the Salinity Sensor:

1. Connect the Salinity Sensor to the interface.
2. Start the data-collection software.[1]
3. The software will identify the Salinity Sensor and load a default data-collection setup. You are now ready to collect data.

[1] If you are using Logger *Pro* 2 with either a ULI or SBI, the sensor will not auto-ID. Open an experiment file for the Salinity Sensor in the Probes & Sensors folder.

Data-Collection Software

This sensor can be used with an interface and the following data-collection software.

- **Logger *Pro* 3** This computer program is used with LabQuest 2, LabQuest, LabQuest Mini, LabPro, or Go!Link.
- **Logger Lite** This computer program is used with LabQuest 2, LabQuest, LabQuest Mini, LabPro, or Go!Link.
- **LabQuest App** This program is used when LabQuest 2 or LabQuest is used as a standalone device.
- **EasyData App** This calculator application for the TI-83 Plus and TI-84 Plus can be used with CBL 2, LabPro, and Vernier EasyLink. We recommend version 2.0 or newer, which can be downloaded from the Vernier web site, www.vernier.com/easy/easydata.html, and then transferred to the calculator.
- **DataMate program** Use DataMate with LabPro or CBL 2 and TI-73, TI-83, TI-84, TI-86, TI-89, and Voyage 200 calculators. See the LabPro and CBL 2 Guidebooks for instructions on transferring DataMate to the calculator.
- **DataQuest™ Software for TI-Nspire™** This calculator application for the TI-Nspire can be used with the EasyLink or TI-Nspire Lab Cradle.
- **LabVIEW** National Instruments LabVIEW™ software is a graphical programming language sold by National Instruments. It is used with SensorDAQ and can be used with a number of other Vernier interfaces. See www.vernier.com/labview for more information.

NOTE: Vernier products are designed for educational use. Our products are not designed nor recommended for any industrial, medical, or commercial process such as life support, patient diagnosis, control of a manufacturing process, or industrial testing of any kind.

Specifications

Range of Salinity Sensor:	0 to 50 ppt (0 to 50,000 ppm)
13-bit Resolution (SensorDAQ):	0.01 ppt (10 ppm)
12-bit Resolution (LabPro, LabQuest 2, LabQuest, LabQuest Mini, Go! Link, TI-Nspire™ Lab Cradle):	0.02 ppt (20 ppm)
10-bit Resolution (CBL 2™):	0.08 ppt (80 ppm)
Accuracy:	±1% of full-scale reading
Response time:	98% of full-scale reading in 5 s
Temperature compensation:	automatic from 5 to 35°C
Temperature range (can be placed in):	0 to 80°C
Cell constant:	10 cm^{-1}
Description:	dip type, epoxy body, parallel platinum electrodes
Dimensions:	12 mm OD and 150 mm length
Calibration values	slope: 16.3 ppt/V intercept: 0

How the Salinity Sensor Works

The Vernier Salinity Sensor measures the ability of a solution to conduct an electric current between two electrodes. In solution, the current flows by ion transport; therefore, an increasing concentration of ions in the solution will result in higher conductivity values.

The Salinity Sensor is actually measuring *conductance*, defined as the reciprocal of resistance. When resistance is measured in ohms, conductance is measured using the SI unit, *siemens* (formerly known as a *mho*). Since the siemens is a very large unit, aqueous samples are commonly measured in microsiemens, or µS.

Even though the Salinity Sensor is measuring conductance, we are interested in finding *conductivity* of a solution. Conductivity, *C*, is found using the following formula:

$$C = G \bullet k_C$$

where *G* is the conductance, and k_C is the cell constant. The cell constant is determined for a probe using

$$k_C = d / A$$

where *d* is the distance between the two electrodes, and *A* is the area of the electrode surface.

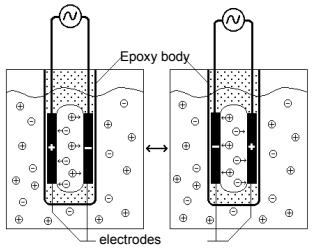
For example, the Salinity Sensor has a cell constant.

$$k_C = d / A = 1.0 \text{ cm} / 0.1 \text{ cm}^2 = 10 \text{ cm}^{-1}$$

The conductivity value is found by multiplying conductance and the cell constant.

A potential difference is applied to the two probe electrodes in the Salinity Sensor. The resulting current is proportional to the conductivity of the solution. This current is converted into a voltage.

Alternating current is supplied to prevent the complete ion migration to the two electrodes. As shown in the figure here, with each cycle of the alternating current, the polarity of the electrodes is reversed, which in turn reverses the direction of ion flow. This very important feature of the Salinity Sensor prevents most electrolysis and polarization from occurring at the electrodes. Thus, the solutions that are being measured for conductivity are not fouled. It also greatly reduces redox products from forming on the electrodes.



This sensor is equipped with circuitry that supports auto-ID. When used with LabQuest 2, LabQuest, LabQuest Mini, LabPro, Go! Link, SensorDAQ, TI-Nspire™ Lab Cradle, EasyLink, or CBL 2™, the data-collection software identifies the sensor and uses pre-defined parameters to configure an experiment appropriate to the recognized sensor.

Taking Measurements with the Salinity Sensor

- Rinse the tip of the Salinity Sensor with distilled water. **Optional**: Blot the inside of the electrode cell dry only if you are concerned about water droplets diluting or contaminating the sample to be tested.
- Insert the tip of the sensor into the sample to be tested. **Important:** Be sure the electrode surfaces in the elongated cell are completely submerged in the liquid.
- **Note:** Do not complete submerge the sensor. The handle is not waterproof.
- Wait for the reading on your computer, calculator screen, or Palm device to stabilize. This should take no more than 5 to 10 seconds.
- Rinse the end of the probe with distilled water before taking another measurement.
- If you are taking readings at temperatures below 15°C or above 30°C, allow more time for the temperature compensation to adjust and provide a stable salinity reading.
- **Important:** Do not place the electrode in viscous, organic liquids, such as heavy oils, glycerin (glycerol), or ethylene glycol. Do not place the probe in acetone or non-polar solvents, such as pentane or hexane.

Optional Calibration Procedure

Each Vernier Salinity Sensor is individually calibrated before it is shipped. This calibration is stored on the sensor and will be used by default.

If you wish to calibrate the Salinity Sensor yourself, you may do so using a two-point calibration.

- **Zero Calibration Point** Simply perform this calibration point with the probe out of any liquid or solution (e.g., in the air). A very small voltage reading will be displayed on the computer or calculator screen. Call this value 0 ppt.
- **Standard Solution Calibration Point** Place the Salinity Sensor into a standard solution (solution of known concentration). Be sure the entire elongated hole with the electrode surfaces is submerged in the solution. Wait for the displayed voltage to stabilize. Enter the value of the standard solution (e.g., 35 ppt). For further information on preparing standard solutions, see the next section.

Storage and Maintenance of the Salinity Sensor

When you have finished using the Salinity Sensor, simply rinse it off with distilled water and blot it dry using a paper towel or lab wipe. The probe can then be stored dry.

Making Standard Calibration Solutions

If you choose to calibrate the Salinity Sensor, you will want an accurate standard solution. Vernier sells a 35 ppt standard solution. To prepare your own 35 ppt standard solution using solid NaCl:

- Use a container with accurate volume markings (e.g., volumetric flask).
- Add 33.03g NaCl to enough distilled water to make 1 liter of solution.
  Important: Do not use iodized salt. Use reagent grade NaCl.
- Note also that standard solutions of lower concentration can be prepared by diluting standard solutions of higher concentration.

Note: The Practical Salinity Scale 1978 was developed relative to a KCl solution. *Standard Methods for the Examination of Water and Wastewater* states that "A seawater with a conductivity at 15°C equal to that of a KCl solution containing a mass of 32.4356 g in a mass of 1 kg of solution is defined as having a practical salinity of 35." A standard solution can be made using this definition, but the sodium chloride standard above is easier and just as accurate.

Automatic Temperature Compensation

The Salinity Sensor is automatically temperature compensated between temperatures of 5 and 35°C. Readings are automatically referenced to a conductivity value at 25°C; therefore, the Salinity Sensor will give the same conductivity reading in a solution that is at 15°C as it would if the same solution were warmed to 25°C. This means you can calibrate your probe in the lab, and then use these stored calibrations to take readings in colder (or warmer) water in a lake or stream. If the probe was not temperature compensated, you would notice a change in the conductivity reading as temperature changed, even though the actual ion concentration did not change.

Using the Salinity Sensor with Other Vernier Sensors

Some combinations of sensors interfere with each other when placed in the same solution. The degree of interference depends on many factors, including which combination of sensors is being used, which interface is being used, and others. For more information, see www.vernier.com/til/638/

Sampling in the Field

It is best to sample away from shore and below the water surface, if possible. We do not recommend that you drop the Vernier Salinity Sensor into the water such that the entire electrode is submerged. The electrode is not constructed to withstand higher pressures, so seepage into electronic components of the electrode might result. Although it is better to take readings at the collection site, salinity readings should not change significantly if you collect samples and take readings at a later time. However, be sure that samples are capped to prevent evaporation. If sample bottles are filled brim full, then a gas such as carbon dioxide, which is capable of forming ionic species in solution, is prevented from dissolving in the water sample.

Since the probe has built-in temperature compensation, you can do your calibration in the lab. This means that even though you will be sampling in water that has a different temperature than your calibration temperature, the probe will take correct readings at the new sampling temperature.

Warranty

Vernier warrants this product to be free from defects in materials and workmanship for a period of five years from the date of shipment to the customer. This warranty does not cover damage to the product caused by abuse or improper use.

Measure. Analyze. Learn.™

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