Chloride Ion-Selective Electrode

(Order Code CL-BTA)

The Vernier Chloride Ion-Selective Electrode is used to measure the concentration of chloride (Cl^-) ions in aqueous samples.

Note: Vernier products are designed for educational use. Our products are not designed nor are they 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.

What's Included

- Chloride Ion-Selective Electrode, packed in a storage bottle
- 30 mL bottle of High Standard solution with SDS (1000 mg/L Cl^-)
- 30 mL bottle of Low Standard solution with SDS (10 mg/L Cl^-)
- Short-Term ISE Soaking Bottle

Compatible Software and Interfaces

See **www.vernier.com/manuals/cl-bta** for a list of software compatible with the Chloride Ion-Selective Electrode.

Getting Started

1. Prepare the electrode by soaking it in the High Standard solution for 30 minutes. Refer to the next section for more information.
2. Connect the sensor to the interface (LabQuest Mini, LabQuest 3, etc.)
3. Start the appropriate data-collection software (Logger *Pro*®, LabQuest® App, or Vernier Graphical Analysis®) if not already running, and choose New from File menu. The software will identify the sensor and load a default data-collection setup.
4. Perform a two-point calibration using the High and Low Standard solutions. Refer to the next section for more information.

If you are collecting data using a Chromebook™, mobile device such as iPad® or Android™ tablet, or a Vernier wireless sensor or interface, please see the following link for up-to-date connection information:

www.vernier.com/start/cl-bta

Preparing the Chloride ISE for Use

Note: Follow this two-part process before taking measurements with your ISE.

Part I: Soak the Electrode

Soak the electrode in the High Standard solution (included with the ISE) for approximately 30 minutes. The ISE should not rest on the bottom of the container, and the small white reference contacts near the tip of the electrode should be immersed. Make sure no air bubbles are trapped below the ISE. **Important**: Do not leave the ISE soaking for more than 24 hours. **Important**: If you plan to use the electrode outside the range of the standards provided, you will need to prepare your own standards and use those for soaking.

Note: If the ISE needs to be transported to the field during the soaking process, use the Short-Term ISE Soaking Bottle. Remove the cap from the bottle and fill it 3/4 full with High Standard. Slide the bottle's cap onto the ISE, insert it into the bottle, and tighten.

For long-term storage, greater than 24 hours, make sure the sensor is stored in its storage bottle with the sponge slightly damp.

Part II: Calibrate the ISE

Calibrating the Chloride ISE in Graphical Analysis

1. Connect the sensor according to the Getting Started section.
2. Click or tap the live readouts meter and choose Calibrate.
3. **High Standard Calibration Point**: The Chloride ISE should still be soaking in the High Standard. The ISE should not rest on the bottom of the container, and the 2 small white reference contacts near the tip of the electrode should be immersed. Make sure no air bubbles are trapped below the ISE.
4. Enter the concentration value of the High Standard (e.g., **100** for 100 mg/L) in the edit box and click or tap Keep.
5. **Low Standard Calibration Point**: Remove the ISE from the High Standard, rinse well with distilled water, and gently blot the ISE dry with a paper towel. Place the ISE into the Low Standard. Make sure the ISE is not resting on the bottom of the container, the white reference contacts near the tip of the electrode are immersed, and no air bubbles are trapped below the ISE.
6. Enter the concentration value for the Low Standard (e.g., **1** for 1 mg/L) and click or tap Keep .
7. Click or tap Apply to complete the calibration process.

Calibrating the Chloride ISE in Logger *Pro* 3

1. Connect the sensor according to the Getting Started section.
2. Choose Calibrate from the Experiment menu and then click Calibrate Now.
3. **High Standard Calibration Point**: The Chloride ISE should still be soaking in the High Standard. The ISE should not rest on the bottom of the container, and the 2 small white reference contacts near the tip of the electrode should be immersed. Make sure no air bubbles are trapped below the ISE.
4. Enter the concentration value of the High Standard (e.g., **100** for 100 mg/L) in the edit box.
5. After the voltage reading for Reading 1 stabilizes (~2 minutes), click Keep.
6. **Low Standard Calibration Point**: Remove the ISE from the High Standard, rinse well with distilled water, and gently blot the ISE dry with a paper towel. Place the ISE into the Low Standard. Make sure the ISE is not resting on the bottom of the container, the white reference contacts near the tip of the electrode are immersed, and no air bubbles are trapped below the ISE.
7. Enter the concentration value for the Low Standard (e.g., **1** for 1 mg/L).
8. After the voltage reading stabilizes, click Keep.

9. To save the calibration to the sensor, follow the steps below:
   a. Click the Calibration Storage tab at the top of the dialog box.
   b. Click [Set Sensor Calibration]. Click [Set].
   c. Click [Done] to continue. Click [Write] to complete the process.

Calibrating the Chloride ISE with LabQuest App

1. Connect the Chloride ISE to LabQuest. Choose Calibrate from the Sensors menu and select Calibrate Now.
2. **High Standard Calibration Point**: The Chloride ISE should still be soaking in the High Standard. The ISE should not rest on the bottom of the container, and the small white reference contacts near the tip of the electrode should be immersed. Make sure no air bubbles are trapped below the ISE.
3. Enter the concentration of the High Standard (e.g., **100** for 100 mg/L) for Reading 1.
4. After the voltage reading stabilizes (~2 minutes), tap Keep.
5. **Low Standard Calibration Point**: Remove the ISE from the High Standard, rinse well with distilled water, and gently blot the ISE dry with a paper towel. Place the ISE into the Low Standard. Make sure the ISE is not resting on the bottom of the container, the white reference contacts near the tip of the electrode are immersed, and no air bubbles are trapped below the ISE.
6. Enter the concentration of the Low Standard (e.g., **1** for 1 mg/L) for Reading 2.
7. After the voltage reading stabilizes, tap Keep.
8. To save the calibration to the sensor, follow the steps below:
   a. Tap Storage.
   b. Tap Save Calibration to Sensor. Tap OK.
   c. Tap OK to complete the process.

Using the Product

Chloride ions are found in freshwater samples as a result of water flowing over salt-containing minerals. These salts might include either sodium chloride (NaCl) or potassium chloride (KCl). The EPA maximum contamination level for chloride concentration in drinking water is 250 mg/L. The chloride ion concentration in seawater is approximately 19,400 mg/L—well below the upper limit of the Chloride ISE of 35,500 mg/L.

When the response of the Chloride ISE begins to slow, the membrane may need polishing. Cut a small piece (about 1 inch square) from a polishing strip. Wet the end of the electrode and the dull side of the polishing strip thoroughly with distilled water. Using only moderate pressure, polish the end of the electrode by gently rubbing it in a circular motion. This will remove the inactive layer of the membrane which impedes measurement. Rinse thoroughly with distilled water and recalibrate in the usual manner.

Sampling Freshwater Samples for Chloride Concentration

For best results, calibrate the Chloride ISE using the 10 mg/L and 1000 mg/L standards.

How Can I Have My ISE Read mV Output Instead of mg/L?

For most LabQuest ISEs (order codes end in -BTA), there is an experiment file within Probes & Sensors–>ISE folder in Logger *Pro* (version 3.4 or newer) that converts the output to mV.

If you are using software other than Logger *Pro*, the mV output of the electrode can be calculated using the following equation:

$$23.907*(18.415 - \ln(\text{“Chloride (mg/L)”})) - 168.23 = \text{Chloride (mV)}$$

This equation provides the mV output of the electrode, before amplification. If you want post-amplification Volts, the equation is

$$V = 0.00727*mV + 1.223$$

Measuring Chloride Concentration of Saltwater or Brackish Water

When measuring chloride concentration in seawater or brackish water, calibrate the Chloride ISE using the 1000 mg/L standard included with your Chloride ISE for one calibration point (or 1.806 parts per thousand, or ppt). For the second calibration point, prepare a standard that is 20,000 mg/L Cl^- by adding 35.96 g of solid NaCl to enough distilled water to prepare 1 L of solution:

$$\frac{20{,}000\ \text{mg Cl}^-}{1\ \text{L}} \times \frac{1\ \text{g Cl}^-}{1{,}000\ \text{mg Cl}^-} \times \frac{58.5\ \text{mg NaCl}}{35.5\ \text{g Cl}^-} = 35.96 \frac{\text{NaCl}}{\text{L}}\ \text{solution}$$

If you are calibrating in ppt, call this solution 36.13 ppt.

Determining Salinity of Saltwater or Brackish Water

Salinity is the total of all salts dissolved in water, expressed either as mg/L (equal to parts per million, ppm) or in parts per thousand (ppt). Seawater contains a fairly constant quantity of chloride ions. From your measurement of chloride ion concentration (in the previous section), salinity can be calculated using the following formula:

$$\text{Salinity (mg/L or ppm)} = 1.8066 \times [Cl^- \text{ concentration, mg/L}]$$

Using this formula, the salinity of saltwater is calculated to be:

$$\text{Salinity (mg/L or ppm)} = 1.8066 \times (19400\ \text{mg/L}) = 35{,}000\ \text{mg/L}$$

The level of salinity of seawater in parts per thousand, or ppt, would be:

$$\text{Salinity (ppt)} = 35{,}000 / 1{,}000 = 35\ \text{ppt}$$

Collecting Data

1. Make sure the sensor is properly calibrated. If the meter has a reading of 1.0 mg/L and the sensor is not in a 1.0 mg/L solution, you need to calibrate. After calibration, rinse off the tip of the ISE and blot it dry with a paper towel.
2. Insert the tip of the ISE into the aqueous sample to be tested.
   Important: Make sure the ISE is not resting on the bottom of the container, the white reference contacts near the tip of the electrode are immersed, and no air bubbles are trapped below the ISE. **Note:** Do not completely submerge the sensor. The handle is not waterproof.

3. Hold the ISE still until the reading stabilizes and record the displayed reading. **Note:** With some aqueous samples, especially those at high concentrations, it could take several minutes for the reading of the Chloride ISE to stabilize. If you know the approximate concentrations of your samples, it is best to analyze them from lowest concentration to highest.

Using the Chloride ISE 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. For more information, see **www.vernier.com/til/638**

Using Ionic Strength Adjuster Solutions to Improve Accuracy

For optimal results at low concentrations of chloride ions, a standard method for taking measurements with the Chloride Ion-Selective Electrode (ISE) is to add ionic strength adjuster (ISA) solutions to each of your standard solutions and samples.

Adding an ISA ensures that the total ion activity in each solution being measured is nearly equal, regardless of the specific ion concentration. This is especially important when measuring very low concentrations of specific ions. The ISA contains no ions common to the Chloride ISE itself. **Note:** The additions of ISA to samples or standards described below do not need to have a high level of accuracy—combining the ISA solution and sample solution counting drops using a disposable Beral pipet works fine.

Use an ISA with the Chloride ISE by adding 5.0 M $NaNO_3$ ISA solution (42.50 g $NaNO_3$/ 100 mL solution) to the Cl^- standard or to the solution being measured, in a ratio of 1 part of ISA (by volume) to 50 parts of the total solution (e.g., 1 mL of ISA to 50 mL of total solution, or 2 drops of ISA to 5 mL of total solution).

Videos

View videos related to this product at **www.vernier.com/cl-bta**

Specifications

Range (concentration)	1 to 35,000 mg/L (or ppm)
Reproducibility (precision)	±10% of full scale (calibrated 10 to 1000 mg/L)
Interfering ions	CN^-, Br^-, I^-, OH^-, S^{2-}, NH_3
pH range	2–12 (no pH compensation)
Temperature range	0–80°C (no temperature compensation)
Electrode slope	–56 ±3 mV/decade at 25°C
Calibration voltages, typical	2.0 V (1000 mg/L), 2.8 V (10 mg/L)
Electrode resistance	1 to 5 MΩ
Minimum sample size	Must be submerged 2.8 cm (1.1 in)
Electrode length	155 mm
Body diameter	12 mm
Cable length	100 cm

Care and Maintenance

Storing the Ion-Selective Electrode

Proper care and storage are important for optimal longevity of your Chloride ISE.

- Long-term storage of the ISE (longer than 24 hours): Moisten the sponge in the bottom of the long-term storage bottle with distilled water. When you finish using the ISE, rinse it off with distilled water and blot it dry with a paper towel. Loosen the lid of the long-term storage bottle and insert the ISE. **Note:** The tip of the ISE should NOT touch the sponge. Also, make sure the white reference mark is inside the bottle. Tighten the lid. This will keep the electrode in a humid environment, which prevents the reference junctions from completely drying out.
- Short-term wet storage (less than 24 hours): Fill the Short-Term ISE Soaking Bottle 3/4 full with High Standard. Loosen the cap, insert the electrode into the bottle, and tighten.

Maintaining and Replacing the ISE Standard Calibration Solutions

Having accurate standard solutions is essential for performing good calibrations. The two standard solutions that were included with your ISE can last a long time if you take care not to contaminate them. At some point, you will need to replenish your supply of standard solutions. Vernier sells replacement standards in 500 mL volumes. Order codes are:

- CL-LST: Chloride Low Standard , 10 mg/L
- CL-HST: Chloride High Standard, 1000 mg/L

To prepare your own standard solutions, use the information in the following table. **Note:** Use glassware designed for accurate volume measurements, such as volumetric flasks or graduated cylinders. All glassware must be very clean.

Standard Solution	Concentration (mg/L or ppm)	Preparation Method using High-Quality Distilled Water
Chloride (Cl^-) ISE High Standard	1000 mg/L as Cl	1.648 g NaCl/ 1 L solution
Chloride (Cl^-) ISE Low Standard	10 mg/L as Cl	Dilute the High Standard by a factor of 100 (from 1000 mg/L to 10 mg/L).*

*Perform two serial dilutions as described below.

a. Combine 100 mL of the High Standard with 900 mL of distilled water. Mix well.
b. Combine 100 mL of the solution made in the previous step with 900 mL of distilled water. Mix well.

Do not wrap the cable tightly around the sensor for storage. Repeatedly doing so can irreparably damage the wires and is not covered under warranty.

How the Sensor Works

The Vernier Chloride Ion-Selective Electrode (ISE) is a membrane-based electrode that measures a specific ion (Cl^-) in an aqueous solution. When the membrane of the electrode is in contact with a solution containing the specific ion, a voltage, dependent on the level of that ion in solution, develops at the membrane. The ISE is a combination style electrode. The voltage develops in relation to an internal Ag/AgCl reference electrode. The ISE measures for the specific ion concentration directly. Samples need to be aqueous to avoid contaminating or dissolving the membrane. The Vernier Chloride Ion-Selective Electrode has a solid polymer membrane. The membrane is a porous plastic disk, permeable to the ion exchanger, but impermeable to water. It allows the sensing cell to contact the sample solution and separates the internal filling solution from the sample.

The voltage developed between the sensing and reference electrodes is a measure of the concentration of the reactive ion being measured. As the concentration of the ion reacting at the sensing electrode varies, so does the voltage measured between the two electrodes.

As described in the Nernst Equation, ISE response is a linear equation:

$$E = E_o + m(ln\ a)$$

where E is the measured voltage, E_o is the standard potential for the combination of the two half cells, m is the slope, ln is the natural logarithm, and a is the activity of the measured ion species.

Assuming the ionic strength is fairly constant, the Nernst equation may be rewritten to describe the electrode response to the concentration, C, of the measured ion species:

$$E = E_o + m(ln\ C)$$

Troubleshooting

For troubleshooting and FAQs, see **www.vernier.com/til/1433**

Repair Information

If you have watched the related product video(s), followed the troubleshooting steps, and are still having trouble with your Chloride Ion-Selective Electrode, contact Vernier Technical Support at support@vernier.com or call 888-837-6437. Support specialists will work with you to determine if the unit needs to be sent in for repair. At that time, a Return Merchandise Authorization (RMA) number will be issued and instructions will be communicated on how to return the unit for repair.

Accessories/Replacements

Additional Vernier Ion-Selective Electrodes

Vernier sells Ion-Selective Electrodes that measure the concentration of ammonium (NH_4^+), calcium (Ca^{2+}), nitrate (NO_3^-), and potassium (K^+) ions in aqueous solutions. Order codes are:

Item	Order Code
Ammonium Ion-Selective Electrode	NH4-BTA
Calcium Ion-Selective Electrode	CA-BTA
Nitrate Ion-Selective Electrode	NO3-BTA
Potassium Ion-Selective Electrode	K-BTA
Electrode Storage Bottles, pkg of 5	BTL-ES
Standard High Chloride ISE Solution	CL-HST
Standard Low Chloride ISE Solution	CL-LST

Warranty

Warranty information for this product can be found on the Support tab at **www.vernier.com/cl-bta**

General warranty information can be found at **www.vernier.com/warranty**

Disposal

When disposing of this electronic product, do not treat it as household waste. Its disposal is subject to regulations that vary by country and region. This item should be given to an applicable collection point for the recycling of electrical and electronic equipment. By ensuring that this product is disposed of correctly, you help prevent potential negative consequences on human health or on the environment. The recycling of materials will help to conserve natural resources. For more detailed information about recycling this product, contact your local city office or your disposal service.

Battery recycling information is available at **www.call2recycle.org**

 The symbol, shown here, indicates that this product must not be disposed of in a standard waste container.

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