Chloride ISE BNC Connector

(Order Code CL-BNC)

The Vernier Chloride Ion-Selective Electrode BNC Connector is used to measure the concentration of chloride (Cl-) ions in aqueous samples. It is designed to be used with the Vernier Electrode Amplifier (order code EA-BTA) or Vernier Go Wireless® Electrode Amplifier (order code GW-EA).

Inventory of Items Included with the Chloride ISE

- Ion-Selective Electrode with BNC-terminated end, packed with a storage bottle
- 30 mL bottle of High Standard solution with SDS (100 mg/L Cl-)
- 30 mL bottle of Low Standard solution with SDS (1 mg/L Cl-)
- Short-Term ISE Soaking Bottle

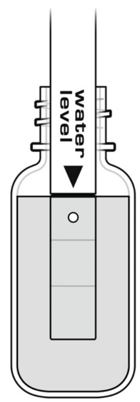
NOTE: Vernier products are designed for educational use. Our products are not designed nor are they recommended for any industrial, medical, or commercial process such as life support, patient diagnosis, control of a manufacturing process, or industrial testing of any kind.

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

Calibration is required for use. Detailed instructions based on your data-collection program can be viewed at these web addresses:

Logger *Pro* 3: www.vernier.com/til/2341/

LabQuest App: www.vernier.com/til/3394/

Graphical Analysis App: www.vernier.com/til/3395/

- **High Standard Calibration Point:** The Chloride ISE should still be soaking in the High Standard from Part I. 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. Enter the concentration of the High Standard (e.g., **100** for 100 mg/L).
- **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. Enter the concentration of the Low Standard (e.g., **1** for 1 mg/L).

Collecting Data

1. Make sure the sensor is connected to a Vernier amplifier and 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/

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.

How the Ion-Selective Electrode 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:

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

Specifications

Range	10 to 20,000 mg/L (or ppm)
Reproducibility (precision)	±10% of full scale (calibrated 10 to 1000 mg/L)
Interfering ions	CN-, Br-, I-, S^{2-}
pH range	2–12 (no pH compensation)
Temperature range	0–40°C (no temperature compensation)
Electrode slope	+28 ±4 mV/decade at 25°C
Calibration voltages, typical	High (1000 mg/L) 2.0 V, Low 2.8 V (10 mg/L)
Electrode resistance	1 to 4 MΩ
Minimum sample size	must be submerged 1.1 in

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, 1 mg/L
CL-HST: Chloride High Standard, 100 mg/L

To prepare your own standard solutions, use the information in the table below. **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 High Standard	1000 mg/L as Cl	1.648 g NaCl / 1 L solution
Chloride Low Standard	10 mg/L as Cl	Dilute the High Standard by a factor of 100

Replacement Modules

The Chloride ISE has a PVC membrane module with a limited life expectancy. The module is warranted to be free from defects for a period of 1 year from the date of purchase. It is possible, however, that a membrane module will work well after the warranty period. If you notice a reduced response (e.g., distinctly different voltages or voltage ranges during calibration), then it is probably time to replace the membrane module. **Important:** Do not order membrane modules far in advance; the process of degradation takes place even when the modules are stored on the shelf.

Using Ionic Strength Adjuster (ISA) Solution 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).

Using the Chloride ISE

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 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.

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 32.96 g of solid NaCl to enough distilled water to prepare 1 L of solution:

$$\frac{20000\,\text{mg}\,Cl^-}{1\,\text{L}} \times \frac{1\,\text{g}\,Cl^-}{1000\,\text{mg}\,Cl^-} \times \frac{58.5\,\text{g NaCl}}{355\,\text{g}\,Cl^-} = 32.96\,\text{g NaCl / L solution}$$

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:

$$\text{Salinity (ppt)} = 35000 / 1000 = 35 \text{ ppt}$$

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

The amplification equation is: V = 0.00727*mV + 1.223

Therefore, the reverse amplification equation, solving for mV, would be:

mV = 137.55*V – 0.1682

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. ISE modules are covered by a one-year warranty.

Additional Vernier Ion-Selective BNC Electrodes

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

- Ammonium Ion-Selective Electrode: NH4-BNC
- Calcium Ion-Selective Electrode: CA-BNC
- Nitrate Ion-Selective Electrode: NO3-BNC
- Potassium Ion-Selective Electrode: K-BNC

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