Go Direct® Potassium Ion-Selective Electrode BNC

(Order Code GDX-K-BNC)

The Go Direct Potassium Ion-Selective Electrode BNC is used to measure the concentration of potassium (K^+) ions in aqueous samples. It is designed to be used with the Go Direct Ion-Selective Electrode Amplifier (order code GDX-ISEA).

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

- Go Direct Potassium Ion-Selective Electrode BNC, packed in a storage bottle with a damp sponge
- 30 mL Bottle of High Standard solution with SDS (1000 mg/L $K^{+)}$
- 30 mL Bottle of Low Standard solution with SDS (10 mg/L K^+)
- Short-Term ISE Soaking Bottle

Using the Product

To prepare the electrode to make measurements, follow this procedure:

- Connect the Ion-Selective Electrode BNC to the Go Direct Ion-Selective Electrode Amplifier. Push the BNC connector of the electrode onto the connector on the amplifier, then turn the BNC connector about one-half turn clockwise.
- Connect the amplifier to your computer, Chromebook™, LabQuest®, or mobile device and run the data-collection software. Change the sensor channel to the appropriate ion or Potential, if necessary.
- Your ISE needs to be prepared before use. This includes a 30-minute soak in the High Standard solution.
- 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 and calibration.
- The ISE should not rest on the bottom of the container.
- The small white reference contacts near the tip of the electrode should be immersed.
- Make sure no air bubbles are trapped below the ISE.
- Do not leave the ISE soaking for more than 24 hours.

Note: Do not completely submerge the sensor. The BNC connection is not waterproof.

Preparing the Potassium ISE for Use

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 contact 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.

Collecting Data

1. Remove the storage bottle from the soaking solution (high standard). Thoroughly rinse the lower section of the probe, especially around the tip, using distilled or deionized water. Blot 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.
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 Potassium ISE to stabilize. If you know the approximate concentrations of your samples, it is best to analyze them from lowest concentration to highest.

Specifications

Range (mV)	–1000 mV to +1000 mV
Range (concentration)	1–39,000 mg/L
Reproducibility (precision)	±30 mV
Interfering ions	$Cs^{+,}$ NH_4^+, H^+, Ag^+, Li^+, Na^+
pH range	2–12 (no pH compensation)
Temperature range	0–40°C (no temperature compensation)
Electrode slope	+56 ±3 mV/decade at 25°C
Electrode resistance	100–200 kW
Minimum sample size	must be submerged 2.8 cm (1.1 in)

Care and Maintenance

Proper care and storage is important for optimal longevity.

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 tissue. Loosen the lid of the bottle and insert the ISE. **Note:** The tip of the ISE should NOT be touching the sponge. Check to be sure the reference mark is inside, rather than outside the bottle or under the grommet. Tighten the lid. This keeps 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 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 bottles. Order codes are:

- Potassium Low Standard: K-LST
- Potassium High Standard: K-HST

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
Potassium (K^+) ISE High Standard	1000 mg/L K^+	1.907 g KCl / 1 L solution
Potassium (K^+) ISE Low Standard	10 mg/L K^+	Dilute the High Standard by a factor of 100 (from 1000 mg/L to 10 mg/L)*
Potassium (K^+) ISE 1 mg/L Standard	1 mg/L K+	Dilute the Low Standard by a factor of 10 (from 10 mg/L to 1 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.
c. Mix well.

**Perform a serial dilution as described below.

a. Combine 100 mL of the Low Standard with 900 mL of distilled water.
b. Mix well.

Potassium ISE Replacement Membrane Modules

The Go Direct Potassium Ion-Selective Electrode BNC has a PVC membrane module with a limited life expectancy. The module is warranted to be free from defects for a period of 12 months from the date of purchase. It is possible, however, that you may get somewhat longer use than the warranty period. If you notice a reduced response, it is probably time to replace the membrane module. **Important:** Do not order membrane modules far in advance of the time you will be using them; the process of degradation takes place even when they are stored on the shelf.

How the Sensor Works

Combination Ion-Selective Electrodes consist of an ion-specific (sensing) half-cell and a reference half-cell. The ion-specific half-cell produces a potential that is measured against the reference half-cell depending on the activity of the target ion in the measured sample. The ion activity and the potential reading change as the target ion concentration of the sample changes. The relationship between the potential measured with the ISE and the ion activity, and thereby the ion concentration in the sample, is described by the Nernst equation:

$$E = E_o - 2.303\frac{RT}{nF}\log(C + C_o)$$

E = measured potential (mV) between the ion-selective and the reference electrode

E_o = standard potential (mV) between the ion-selective and reference electrodes

R = universal gas constant (R = 8.314 J mol^{-1} K^{-1})

T = temperature in K (Kelvin), with T (K) = 273.15 + t °C where t is the temperature of the measured solution in °C.

F = Faraday constant (96485 C mol^{-1})

n = valence of the ion

C = concentration of ion to be measured

C_o = detection limit

Since R and F are constant, they will not change. The electrical charge of the ion (valence) to be measured is also known. Therefore, this equation can be simplified as:

$E = E_o - S \bullet \log(C + C_o)$

where $S = -2.303\frac{RT}{nF}$ is the ideal slope of the ISE.

The following table describes ideal behavior:

Ion Examples	n (valence of ion)	S (at 25 °C), mV/decade
Calcium (Ca^{2+})	+2	+29.58
Potassium (K^+), Ammonium (NH_4^+)	+1	+59.16
Nitrate (NO_3^-), Chloride (Cl^-)	–1	–59.16

Assuming C_0 is near zero, the equation can be rewritten as:

$$C = 10^{\wedge}[(E - E_o) / S]$$

allowing for the calculation of the ion concentration.

It is very important to note that this table reflects ideal behavior. Ion-selective electrodes have slopes that are typically lower than ideal. It is generally accepted that an ISE slope from 88–101% of ideal is allowable. The slope (S) is an indicator of ISE performance. If the slope changes significantly over time, it may indicate that it is necessary to replace the ISE sensor tip.

Convert Potential to Concentration (Optional)

To measure the mV readings from an aqueous sample, calibration is not required. To convert mV readings to concentration (mg/L or ppm), you will use a modified version of the Nernst Equation:

$$C = 10^{\wedge}[(E - E_o) / S_m]$$

C = concentration of ion to be measured (mg/L or ppm)

E = measured potential of sample (mV)

E_o = measured potential (mV) at a C = 1 mg/L K^+ concentration

S_m = measured electrode slope in mV/decade

The value of S_m, the measured electrode slope, is determined by measuring the potential of two standard solutions, and solving the equation below:

$$S_m = – [(\text{Low Standard} – \text{High Standard}) / \#\text{ of decades*}]$$

*A decade is defined as the factor of the difference between the two standard solutions. For example, the difference between a 1mg/L standard and a 100 mg/L standard is 2 decades (a factor of 100 difference, or 1×10^2).

Example Calculation, converting mV to mg/L

For this example, the measured quantities are shown in the chart below:

Solution	Measured Potential
1 mg/L K^+ standard	–8 mV
10 mg/L K^+ standard	50 mV
1000 mg/L K^+ standard	162 mV
unknown sample	138 mV

$$S_m = -\frac{(50\text{ mV} - 162\text{ mV})}{2\text{ decades}} = 56\text{ mV/decade}$$

C = 10^[(138 mV – (–8 mV))/ 56 mV/decade] = 405 mg/L K^+

Troubleshooting

Using Ionic Strength Adjuster Solutions to Improve Accuracy

For optimal results at low concentrations of calcium ions, a standard method for taking measurements with ion-selective electrodes is to add ionic strength adjuster (ISA) solution 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 calcium ions. The ISA contains no ions common to the 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. We receommend using 1 M NaCl solution at the ISA solution for the Potassium ISE.

See general tips for using Ion Selective Electrodes at **www.vernier.com/til/665**

Repair Information

If you have followed the troubleshooting steps and are still having trouble with your Go Direct Potassium Ion-Selective Electrode BNC, 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

Item	Order Code
Standard High Potassium ISE Solution	K-HST
Standard Low Potassium ISE Solution	K-LST
Storage Solution Bottles, pkg of 5	BTL
Potassium Replacement Module	K-MOD

Warranty

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

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

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