Platinum-Cell Conductivity Probe

(Order Code CONPT-BTA)

The Platinum-Cell Conductivity Probe can be used to measure either solution conductivity or total ion concentration of aqueous and non-aqueous samples in the field or in the laboratory. It has an epoxy body and platinum cell electrodes to provide accuracy and precision in a rugged body. Even though it does not identify specific ions, it quickly determines the total concentration of ions in a sample. It can be used to perform a wide variety of tests or experiments to determine the total dissolved ion concentrations:

- Allow students to quantitatively see the difference between the ionic and molecular nature of electrolytes in aqueous and non-aqueous solution. This can include differences in strength of weak acids and bases, or the number of ions that an ionic substance dissociates into per formula unit.
- Confirm the direct relationship between conductivity and ion concentration in an aqueous or non-aqueous solution. Concentrations of unknown samples can then be determined.
- Monitor the rate of a chemical reaction in which dissolved ions and solution conductivity varies with time due to an ionic species being consumed or produced.
- Determine the rate at which an ionic species diffuses through a membrane, such as dialysis tubing.

Compatible Interfaces and Software

See www.vernier.com/conpt-bta for a list of interfaces and software compatible with the Platinum-Cell Conductivity Probe.

Here is the general procedure to follow when using the Platinum-Cell Conductivity Probe:

1. Connect the Platinum-Cell Conductivity Probe to the interface.
2. Start the data-collection software or app.
3. The software will identify the Platinum-Cell Conductivity Probe and load a default data-collection setup. You are now ready to collect data.

Note: Vernier products are designed for educational use. Our products are neither 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.

Taking Measurements with the Platinum-Cell Conductivity Probe

1. For best results, condition the electrode in a standard solution for approximately five minutes prior to use.
2. Rinse the tip of the Platinum-Cell Conductivity Probe with distilled water. Optional: Blot the inside and outside of the electrode cell dry to avoid water droplets diluting or contaminating the sample to be tested.
3. Insert the tip of the probe into the sample to be tested. **Important:** Be sure the electrode surfaces in the elongated cell are completely submerged in the liquid and that there are no bubbles around the electrode surface.
4. Wait for the reading on your data-collection device to stabilize. This should take no more than 5 to 10 seconds. **Note:** Do not completely submerge the sensor. The handle is not waterproof.
5. Rinse the tip of the probe with distilled water before taking another measurement.

Storage and Maintenance of the Platinum-Cell Conductivity Probe

- When you have finished using the Platinum-Cell Conductivity Probe, 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.
- If the probe cell surface is contaminated, soak it in water with a mild detergent for 15 minutes. Then soak it in a dilute acid solution (0.1 M hydrochloric acid or 0.5 M acetic acid works well) for another 15 minutes. Then rinse it well with distilled water and blot dry. **Important:** Avoid scratching the inside electrode surfaces of the elongated cell.

Specifications

Range	0 to 2000 µS/cm (0 to 1000 mg/L TDS)
Accuracy using factory calibration	±40 µS/cm
Accuracy using custom calibration	±10 µS/cm
Response time	95% of full-scale in 5 seconds
Temperature compensation	Optional: 2% from 5 to 35°C or none
Temperature range	0 to 80°C
Cell constant	1.0 cm^{-1}
Description	epoxy body, 2-cell platinum-cell electrodes
Shaft dimensions	12 mm OD and 120 mm length

How the Platinum-Cell Conductivity Probe Works

The Vernier Platinum-Cell Conductivity Probe 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 Platinum-Cell Conductivity Probe 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 Platinum-Cell Conductivity Probe is measuring conductance, we are often interested in finding *conductivity* of a solution. Conductivity, *C*, is found using the following formula:

$$C = G \cdot k_c$$

where *G* is the conductance, and k_c is the cell constant. The cell constant is determined for a probe using the following formula:

$$k_c = d/A$$

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

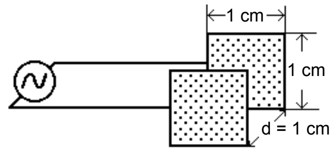

Figure 1

For example, the cell in Figure 1 has a cell constant:

$$k_c = d/A = 1.0\ \text{cm}/1.0\ \text{cm}^2 = 1.0\ \text{cm}^{-1}$$

The conductivity value is found by multiplying conductance and the cell constant. Because the Vernier Platinum-Cell Conductivity Probe also has a cell constant of 1.0 cm^{-1}, its conductivity and conductance have the same numerical value. For a solution with a conductance value of 1000 µS, the conductivity, *C*, would be:

$$C = G \cdot k_c = (1000\ \mu\text{S}) \times (1.0\ \text{cm}^{-1}) = 1000\ \mu\text{S/cm}$$

A potential difference is applied to the two probe electrodes in the Platinum-Cell Conductivity Probe. 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. 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 Platinum-Cell Conductivity Probe 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 platinum cell electrodes.

Calibration Procedure

You do not have to perform a new calibration when using the Platinum-Cell Conductivity Probe for most experiments. Each probe is programmed with a custom calibration prior to shipping. The factory calibration is set while the probe is at room temperature, with the temperature compensation at 2%.

However, if your experimental application requires more accurate readings or if you are testing without temperature compensation, you should calibrate your sensor. The Platinum-Cell Conductivity Probe can be easily calibrated at two known levels, using any of the Vernier data-collection programs. The calibration units can be µS/cm, dS/cm, mg/L, ppm, or ppt. For best results, it is recommended that the two-point calibration be performed using two standard solutions that bracket the expected range of conductivity or concentration values you will be testing. For example, if you expect to measure conductivity in the range of 600 mg/L to 1000 mg/L (TDS),

you may want to use a standard solution that is 500 mg/L for one calibration point and another standard that is 1000 mg/L for the second calibration point.

To Calibrate:

1. Make sure the temperature compensation switch is set to the desired position.
2. Initiate the calibration procedure in the software.
3. First calibration point: Place the Platinum-Cell Conductivity Probe into a known standard solution. Be sure the entire elongated hole with the electrode surfaces is submerged in the solution and that there are no bubbles along the electrode surface. Wait for the displayed voltage to stabilize. Enter the value of the standard solution in the appropriately chosen units for Reading 1. Click Keep. **Note:** Performing a zero point calibration is not recommended with conductivity sensors. It is preferred that you use a low standard calibration standard instead of a zero point. This is particularly important if you plan to take measurements below 200 µS/cm where the low calibration point is most critical.
4. Second calibration point: Place the Platinum-Cell Conductivity Probe into a different standard solution. Be sure the entire elongated hole with the electrode surfaces is submerged in the solution and that there are no bubbles along the electrode surface. Wait for the displayed voltage to stabilize. Enter the value of the standard solution for Reading 2. Click Keep.
5. If you want to use the calibration for the current session only, click Done to complete the calibration process. To save the calibration onto the sensor, click the storage tab and save to sensor.
6. Click Done or tap OK to complete the calibration process.

Standard Calibration Solutions

If you choose to calibrate the Platinum-Cell Conductivity Probe, you will want accurate standard solutions. Prepare solutions that are appropriate for the samples and conductivity range of your experiment. If you are testing aqueous samples, Vernier sells two Conductivity Standards appropriate for the range of the Platinum-Cell Conductivity Probe. These standards are available in 500 mL bottles. The order codes are:

Conductivity Standard Solution (Low) (150 µS/cm)	CON-LST
Conductivity Standard Solution (Middle) (1413 µS/cm)	CON-MST

If you are testing non-aqueous samples, prepare standard solutions of known conductivity that contain similar compounds to those being tested.

Temperature Compensation

The Platinum-Cell Conductivity Probe has two temperature compensation settings: 0% and 2%. The 2% setting is designed for most aqueous salt solutions.

If you select the 2% setting, the sensor reading is automatically temperature compensated between temperatures of 5 and 35°C. Note that the temperature of a solution is being read by a thermistor that is embedded in the electrode. Readings are automatically referenced to a conductivity value at 25°C; therefore, the Platinum-Cell Conductivity Probe 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 you are testing a non-aqueous solution and want temperature-compensated readings, you will have to perform your own temperature standardization curve or research the value. Some values are presented in Table 1. If the 0% temperature compensation setting is selected, the probe is not temperature compensated and you will notice a change in the conductivity reading as temperature changes, even though the actual ion concentration does not change. This setting allows you to investigate conductivity as a function of temperature.

Table 1

A sample of some typical temperature coefficients and corresponding conductivities

Sample	Conductivity, µS/cm	% change/°C (at 25°C)
Ultrapure Water	0.055	4.55
Drinking Water	50–500	2.00
0.1% NaCl	1990	2.12
0.03% NaOH	1780	1.72
20% Acetic Acid	1600	1.56
5% NaOH	223,000	1.72
10% HCl	700,000	1.32

Using the Platinum-Cell Conductivity Probe 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.

Relationship between Conductivity and TDS

Because there is a nearly linear relationship between conductivity and concentration of a specific ion or salt, the Platinum-Cell Conductivity Probe can be used to determine the concentration of an ion. A curve similar to the one shown in Figure 2 can be obtained if you prepare or purchase standard solutions (solutions with known concentrations). Note in this figure that the 2:1 ratio between conductivity in µS/cm and TDS concentration in mg/L.

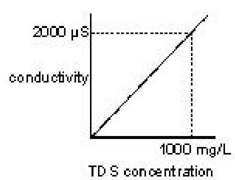

Figure 2

Even though total dissolved solids is often defined in terms of this 2:1 ratio, it should be understood that a TDS reading of 500 mg/L can have a different meaning in a sample that is mostly NaCl than in another sample that is composed primarily of hard water ions such as Ca^{2+} and HCO_3^-. The relationship between conductivity and sodium chloride concentration is *approximately* a 2:1 ratio and is very nearly a direct relationship. Table 2 shows the relationship of sodium chloride concentration in mg/L to TDS and conductivity.

Table 2

Sodium chloride concentration (mg/L)	Total dissolved solids (TDS) (mg/L)	Conductivity (µS/cm)
1.0	1.1	2.2
5.0	5.4	10.8
10	10.7	21.4
20	21.4	42.7
50	52.5	105
100	105	210
150	158	315
200	208	415
500	510	1020
1000	995	1990
1500	1465	2930
2000	1930	3860
5000	4482	8963
10250	9000	18000

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. This warranty covers educational institutions only.

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