

Conductivity Probe

(Order Code NavCT)

The Conductivity Probe can be used to measure either solution conductivity or total ion concentration of aqueous samples in the field or in the laboratory.

Collecting Data with the Conductivity Probe

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

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

Taking Measurements with the Conductivity Probe

- Rinse the tip of the Conductivity Probe with distilled water. Shake the Conductivity Probe like a thermometer to remove water droplets or carefully 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 probe into the sample to be tested. **Important:** Be sure the electrode surfaces in the elongated cell are completely submerged in the liquid.
- While gently swirling the probe, wait for the reading on LabNavigator™ to stabilize. This should take no more than 5 to 10 seconds. **Note:** Do not completely submerge the sensor. The handle is not waterproof.
- 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 conductivity 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.

Storage and Maintenance of the Conductivity Probe

- When you have finished using the 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. **Important** Avoid scratching the inside electrode surfaces of the elongated cell.

This sensor is equipped with circuitry that supports auto-ID.

Specifications

Range of Conductivity Probe:

- Low Range: 0 to 200 $\mu\text{S/cm}$ (0 to 100 mg/L TDS)
- Mid Range: 0 to 2000 $\mu\text{S/cm}$ (0 to 1000 mg/L TDS)
- High Range: 0 to 20,000 $\mu\text{S/cm}$ (0 to 10,000 mg/L TDS)

Resolution

- Low Range: 0.1 $\mu\text{S/cm}$ (0.05 mg/L TDS)
- Mid Range: 1 $\mu\text{S/cm}$ (0.5 mg/L TDS)
- High Range: 10 $\mu\text{S/cm}$ (5 mg/L TDS)

Accuracy: $\pm 1\%$ of full-scale reading for each range

Response time: 98% of full-scale reading in 5 seconds,
100% of full-scale in 15 seconds

Temperature compensation: automatic from 5 to 35°C

Temperature range (can be placed in): 0 to 80°C
Cell constant: 1.0 cm⁻¹
Description: dip type, ABS body, parallel carbon (graphite) electrodes
Dimensions: 12 mm OD and 150 mm length

Do I Need to Calibrate the Conductivity Probe?

You should not have to perform a new calibration when using the Conductivity Probe in the lab. We have set the sensor to match our stored calibration before shipping it. You can simply use the appropriate calibration file that is stored in your data-collection program from Forston Labs

If you are using the Conductivity Probe for water quality analysis, you may choose to calibrate for more accurate readings. The Conductivity Probe can be easily calibrated at two known levels. The calibration units can be $\mu\text{S}/\text{cm}$, mg/L as TDS, mg/L as NaCl, or salinity, in ppt.

- Select the conductivity range setting on the probe box: low = 0 to 200 μS , medium = 0 to 2000 μS , and high = 0 to 20,000 μS .
- **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. Call this value 0 μS or 0 mg/L.
- **Standard Solution Calibration Point:** Place the Conductivity Probe into a standard solution (solution of known concentration), such as the sodium chloride standard that is supplied with your probe. 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., 1000 μS , 491 mg/L as NaCl, or 500 mg/L as TDS). For further information on preparing and interpreting standard solutions, see subsequent sections on calibration.

For even better results, the two-point calibration can 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.

Maintaining and Replacing the Sodium Chloride Standard Calibration Solution

If you choose to calibrate the Conductivity Probe, you will want accurate standard solutions. The 1000 $\mu\text{S}/\text{cm}$ Standard that shipped with the Conductivity Probe will last a long time if you take care not to contaminate it with a wet or dirty probe. This is a good concentration to calibrate your Conductivity Probe in the middle range (0 to 2000 $\mu\text{S}/\text{cm}$). Forston Labs sells three Conductivity Standards, one appropriate for each range of the Conductivity Probe. They come in 500 mL bottles. Order codes are:

Low Range (150 $\mu\text{S}/\text{cm}$)	NavCT-011
Medium Range (1413 $\mu\text{S}/\text{cm}$)	NavCT-012
High Range (12880 $\mu\text{S}/\text{cm}$)	NavCT-010

To prepare your own standard solutions using solid NaCl or KCl:

- Use a container with accurate volume markings (e.g., volumetric flask) and add the amount of solid shown in the first column of Table 1. This standard can be used to calibrate using the amount shown in mg/L as NaCl (first column), mg/L as TDS (second column), or $\mu\text{S}/\text{cm}$ (third column).

Table 1

Add this amount of NaCl to make 1 liter of solution	TDS and Conductivity values equivalent to the NaCl concentration in the first column:	
	total dissolved solids (TDS)	conductivity (microsiemens/cm)
0.0474 g (47.4 mg/L)	50 mg/L as TDS	100 μ S/cm
0.491 g (491 mg/L)	500 mg/L as TDS	1000 μ S/cm
1.005 g (1005 mg/L)	1000 mg/L as TDS	2000 μ S/cm
5.566 g (5566 mg/L)	5000 mg/L as TDS	10,000 μ S/cm

- Note also that standard solutions of lower concentration can be prepared by diluting standard solutions of higher concentration. For example, if you have a solution that is 1000 mg/L, and want to dilute it to obtain a solution that is 200 mg/L, simply take 100 mL of the 1000 mg/L solution and add enough distilled water to it to yield 500 mL of solution (~400 mL of water is added). The new solution has a concentration of $1000 \text{ mg/L} \times (100 \text{ mL} / 500 \text{ mL}) = 200 \text{ mg/L}$.

Automatic Temperature Compensation

Your Forston Labs Conductivity Probe 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 extends into the space between the graphite electrodes. Readings are automatically referenced to a conductivity value at 25°C—therefore the 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 away from the laboratory.

Using the Conductivity Probe with Other Forston Labs Sensors

It is very important to know that the Conductivity Probe will interact with some other Forston Labs sensors and probes, *if* they are placed in the same solution (in the same aquarium or beaker, for example), *and* they are connected to the same interface box (e.g., the same LabNavigator). This situation arises because the Conductivity Probe outputs a signal in the solution, and this signal can affect the reading of another probe.

The following probes *cannot* be connected to the *same interface* as a Conductivity Probe and placed in the same solution:

- Dissolved Oxygen Probe
- pH Electrode
- Ion Selective Electrodes

If you wish to take simultaneous readings using any of the probe combinations listed above, here are some alternative methods:

- To take simultaneous conductivity and dissolved oxygen or conductivity and pH readings, you can connect the probes to *two different* instruments. If the two probes in question are connected to separate instruments, the two probes will read correctly in the same solution.
- If you are sampling a lake, stream or cooling tower and want to use two of the probes with a single instrument, you can connect the two probes in question to the same LabNavigator™ and load their respective calibrations. Place one probe in the water first and take its reading. Then remove it and place the second probe in the solution to take its reading.

The Stainless Steel Temperature Probe can be used in the same sample alongside with the Conductivity Probe.

Sampling in Streams and Lakes

It is best to sample away from shore and below the water surface, if possible. In free-flowing streams, there will usually be good mixing of the water, so that samples taken near the current will be quite representative of the stream as a whole. If you are sampling an impounded stream or a lake, there will be very little mixing—therefore, it is important to sample away from shore and at different depths, if possible. We do not recommend that you drop the Forston Labs Conductivity Probe so that the entire electrode is

submerged. The electrode is not constructed to withstand being submerged, so seepage into electronic components of the electrode might result. Although it is better to take readings at the collection site, readings of total dissolved solids or conductivity 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.

Sampling in Ocean Salt Water or Tidal Estuaries: SALINITY

Salinity is the total of all non-carbonate salts dissolved in water, usually expressed in parts per thousand (1 ppt = 1000 mg/L). Unlike chloride (Cl^-) concentration, you can think of salinity as a measure of the total salt concentration, comprised mostly of Na^+ and Cl^- ions. Even though there are smaller quantities of other ions in seawater (e.g., K^+ , Mg^{2+} , or SO_4^{2-}), sodium and chloride ions represent about 91% of all seawater ions. Salinity is an important measurement in seawater or in estuaries where freshwater from rivers and streams mixes with salty ocean water. The salinity level in seawater is fairly constant, at about 35 ppt (35,000 mg/L), while brackish estuaries may have salinity levels between 1 and 10 ppt.

The salinity range of the Conductivity Probe is 0 to 13 ppt. Seawater has a salinity of 35 ppt, so any seawater samples will need to be diluted before making measurements with this sensor. We recommend that you dilute seawater samples (or other samples that initially give readings above 13 ppt) to 1/4 of their original concentration, then multiply their measured salinity reading by 4 to obtain a final salinity value, in ppt. Brackish water in coastal estuaries is often in the range of 0 to 10 ppt, well within the high range of the probe. Note: Forston Labs also sells a Salinity Sensor (order code NavSA) with a range of 0 to 50 ppt.

Since there is no stored salinity calibration for a Conductivity Probe, perform a two-point calibration using 5-ppt and 10-ppt salinity standards. Write down the displayed intercept and slope calibration values after the calibration is completed. You can immediately use the calibration, save the calibration along with an experiment file if you are using a computer, or load the calibration manually at a later time if you are using a calculator.

You will need to prepare two standard solutions to calibrate for salinity:

Low Standard (5 ppt salinity)

- Add 4.60 g of NaCl to enough distilled water to prepare 1 liter of solution.

High Standard (10 ppt salinity)

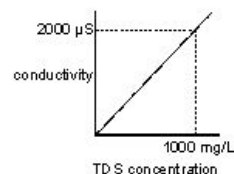
- Add 9.20 g of NaCl to enough distilled water to prepare 1 liter of solution.

More about Conductivity

Conductivity is an easy and informative water quality test. It is sometimes used as a “watchdog” environmental test—any change in the ionic composition of a stream or lake can quickly be detected using a conductivity probe. Conductivity values will change when ions are introduced to water from salts (e.g., Na^+ , Cl^-), acids (H^+), bases (OH^-), hard water (Ca^{2+} , HCO_3^- , CO_3^{2-}), or soluble gases that ionize in solution (CO_2 , NO_2 , or SO_2). However, a conductivity probe will not tell you the *specific* ion responsible for the increase or decrease in conductivity. It simply gives a general indication of the level of total dissolved solids (TDS) in the stream or lake. Subsequent tests can then help to determine the specific ion or ions that contributed to the initial conductivity reading (e.g., pH for H^+ , a titration for hard water as Ca^{2+} , or a colorimetric test for NO_3^-).

State and local regulations often place upper limits on the level of total dissolved solids in drinking water. A conductivity probe can give a quick and accurate reading for such a determination.

Since there is a nearly linear relationship between conductivity and concentration of a specific ion or salt, the Conductivity Probe can be used to determine the concentration of an ion. A curve similar to the one shown here can be obtained if you prepare or purchase standard solutions (solutions with known concentrations). Note in this figure the 2:1 ratio between conductivity in $\mu\text{S}/\text{cm}$ and TDS concentration in mg/L .



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 1 shows some corresponding values for conductivity ($\mu\text{S}/\text{cm}$), concentration (mg/L as NaCl), and concentration (mg/L TDS).

Conductivity probes can provide important clues as to the ionic or molecular nature of compounds. Non-ionizing molecular compounds, such as methanol, will give readings of nearly zero conductivity. Note: Solutions that give a zero conductivity reading will be rare. Even in very pure distilled water, ions will be produced from dissociation of water into H^+ and OH^- ions or carbon dioxide dissolving and producing HCO_3^- ions. Water-soluble ionic compounds will give significant conductivity values, the size of which depends on such factors as ionic radius, charge of ions, and mobility of ions. Ionizing molecular compounds such as weak acids will yield conductivity values that can be used to relate the relative strength of these acids—an aqueous solution of a strong acid such as hydrochloric acid will give a much higher conductivity value than a weak acetic acid solution of equal concentration.

Table 2

Sodium chloride concentration (mg/L)	Total dissolved solids (TDS) (mg/L)	Conductivity ($\mu\text{S}/\text{cm}$)
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

Forston Labs 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.



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