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# pH Sensor

(Order Code PH-BTA or PH-DIN<sup>1</sup>)



Our pH Sensor can be used for any lab or demonstration that can be done with a traditional pH meter. This sensor offers the additional advantages of automated data collection, graphing, and data analysis. Typical activities using our pH sensor include studies of household acids and bases, acid-base titrations, monitoring pH change during chemical reactions or in an aquarium as a result of photosynthesis, investigations of acid rain and buffering, and investigations of water quality in streams and lakes.

Vernier Software & Technology also publishes the following lab books that offer a wide variety of experiments using the pH Sensor:

- *Chemistry with Computers* and *Chemistry with Calculators*
- *Water Quality with Computers* and *Water Quality with Calculators*
- *Biology with Computers* and *Biology with Calculators*
- *Physical Science with Computers* and *Physical Science with Calculators*
- *Middle School Science with Computers* and *Middle School Science with Calculators*
- *Science with Handhelds*
- *Advanced Chemistry with Vernier*

**NOTE:** This product is to be used for educational purposes only. It is not appropriate for industrial, medical, research, or commercial applications.

## Using the pH Sensor with a Computer

This sensor can be used with a computer and any of the following lab interfaces: Vernier LabPro<sup>®</sup>, Go!<sup>™</sup> Link, Universal Lab Interface, or Serial Box Interface. Here is the general procedure to follow when using the pH Sensor with a computer:

1. Connect the pH Sensor to any of the analog ports on the interface.
2. Start the Logger Pro<sup>®</sup> or Logger Lite<sup>™</sup> software on the computer.
3. You are now ready to collect data. Logger Pro or Logger Lite will identify the pH Sensor and load a calibration.<sup>2</sup> Click on Collect and begin collecting data.
4. If you are using Logger Pro software, an alternative to Step 3 is to open an experiment file for the pH Sensor in the Probes & Sensors folder.
5. Measure the pH of some known solutions or pH buffers.

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<sup>1</sup> The pH System (order code PH-DIN) consists of a separate pH electrode (7120B) and a pH Amplifier box, while the pH sensor (order code PH-BTA) has the amplifier built into the handle.

<sup>2</sup> If your system does not support auto-ID, open an experiment file in Logger Pro, and you are ready to collect data.

6. For the best accuracy, you may want to calibrate your pH sensor. Follow the calibration instructions on the screen. Additional calibration tips are described in the next section.

## Using the pH Sensor with TI Graphing Calculators

This sensor can be used with a TI graphing calculator and any of the following lab interfaces: LabPro, CBL 2<sup>™</sup>, or CBL<sup>™</sup>. Here is the general procedure to follow when using the pH Sensor with a graphing calculator:

1. Use the calculator-to-calculator link cable to connect the interface to the TI graphing calculator using the I/O ports located on each unit. Be sure to push both plugs in firmly.
2. Load a data-collection program onto your calculator:
  - LabPro or CBL 2 - Use the DataMate program. This program can be transferred directly from LabPro or CBL 2 to the TI graphing calculator. Use the calculator-to-calculator link cable to connect the two devices. Put the calculator into the Receive mode, and then press the Transfer button on the interface.
  - Original CBL - Use the CHEMBIO program. This program is available free on our web site at [www.vernier.com](http://www.vernier.com). Load the program into a calculator using TI Connect<sup>™</sup>.
3. Connect the pH Sensor to any of the analog ports on the interface. In most cases, Channel 1 is used.
4. Start the data-collection program, and you are ready to collect data.<sup>3</sup>

## Using the pH Sensor with Palm OS<sup>®</sup> Handhelds

This sensor can be used with a Palm OS handheld and the LabPro.

1. Connect the Palm OS handheld, LabPro and the pH sensor.
2. Start DataPro.
3. Tap New or choose New from the Data Pro menu. Tap New again. Tap Setup and set up a new experiment. The pH Sensor will be identified automatically.<sup>4</sup>
4. You are now ready to collect data.

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<sup>3</sup> If your system does not support auto-ID, choose SETUP and set up an experiment.

<sup>4</sup> If your sensor does not auto-ID, tap Setup and set up an experiment.

## pH Electrode Specifications

Type: Sealed, gel-filled, epoxy body, Ag/AgCl

Response time: 90% of final reading in 1 second

Temperature range: 5 to 80°C

12 mm OD

Range: pH 0-14

12-bit Resolution (LabPro, ULI II, Serial Box Interface) 0.005 pH units

10-bit Resolution (CBL or CBL 2): 0.02 pH units

Isopotential pH: pH 7 (point at which temperature has no effect on output)

Output: 59.2 mV/pH at 25°C

## How the pH Sensor Works

The pH Amplifier inside the handle is a circuit which allows a standard combination pH electrode (such as the Vernier 7120B) to be monitored by a lab interface. The cable from the pH Amplifier ends in a BTA plug or a 5-pin DIN plug for connection to a variety of lab interfaces.

The pH Sensor will produce a voltage of 1.75 volts in a pH 7 buffer. The voltage will increase by about 0.25 volts for every pH number decrease. The voltage will decrease by about 0.25 volts/pH number as the pH increases.

The Vernier gel-filled pH Sensor is designed to make measurements in the pH range of 0 to 14. An epoxy body that extends below the glass sensing bulb of the electrode makes this probe ideal for the demands of a middle school, high school, or university level science class or for making measurements in the environment. The gel-filled reference half cell is sealed—it never needs to be refilled.

The PH-BTA version of this sensor is equipped with circuitry that supports auto-ID. When used with LabPro, Go! Link, or CBL 2, the data collection software identifies the sensor and range switch setting, and uses pre-defined parameters to configure an experiment appropriate to the recognized sensor. This greatly simplifies the setup procedures for many experiments. Auto-ID is required for the Quick Setup feature of LabPro and CBL 2 when the unit operates remotely from the computer or calculator.

If you purchased the PH-DIN, and wish to use it with LabPro, CBL, or CBL 2, you can purchase a DIN-to-BTA adapter (order code DIN-BTA). However, the auto-ID feature will not be supported using this combination.

## Preparing for Use

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

- Remove the storage bottle from the electrode by first unscrewing the lid, then removing the bottle and lid. Thoroughly rinse the lower section of the probe, especially the region of the bulb, using distilled or deionized water.
- When the probe is not being stored in the storage bottle, it can be stored for short periods of time (up to 24 hours) in pH-4 or pH-7 buffer solution. It should never be stored in distilled water.

- Connect the pH Sensor to your lab interface, load or perform a calibration (as described in the next section), and you are ready to make pH measurements.
- When you are finished making measurements, rinse the tip of the electrode with distilled water. Slide the cap onto the electrode body, then screw the cap onto the storage bottle. Note: When the level of storage solution left in the bottle gets low, you can replenish it with small amounts of tap water the first few times you use the probe (but not indefinitely!). A better solution is to prepare a quantity of pH-4 buffer/KCl storage solution (see the section on Maintenance and Storage) and use it to replace lost solution.

## Do I Need to Calibrate the pH Sensor?

We feel that you should not have to perform a new calibration when using the pH Sensor for most experiments in the classroom. 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 Vernier in any of these ways:

1. If you ordered the PH-BTA version of the sensor, and you are using it with a LabPro or CBL 2 interface, then a calibration (in pH) is automatically loaded when the pH Sensor is connected.
2. If you are using Logger *Pro* software (version 2.0 or newer) on a Macintosh or Windows computer, open an experiment file for the pH Sensor, and its stored calibration will be loaded at the same time. **Note:** If you have an earlier version of Logger *Pro*, a free upgrade is available from our web site.
3. Any version of the DataMate program (with LabPro or CBL 2) has stored calibrations for this sensor.
4. Any version of the CHEMBIO or PHYSCI programs (for CBL), version 4/1/00 or newer, has stored calibrations for this sensor. Go to our web site, [www.vernier.com](http://www.vernier.com), to download a current version.
5. Any version of Data Pro has stored calibrations for this sensor.

Stored Calibration Values for the pH Sensor:

Intercept ( $k_0$ ): 13.720      Slope ( $k_1$ ): -3.838

If you are performing a chemistry experiment, or doing water quality testing that requires a very accurate calibration, you can calibrate the Vernier pH Electrode following this procedure:

- Use the 2-point calibration option of the Vernier data collection program. Rinse the tip of the electrode in distilled water. Place the electrode into one of the buffer solutions (e.g., pH 4). When the voltage reading displayed on the computer, calculator or CBL screen stabilizes, enter a pH value, "4".
- For the next calibration point, rinse the electrode and place it into a second buffer solution (e.g., pH 7). When the displayed voltage stabilizes, enter a pH value, "7".
- Rinse the electrode with distilled water and place it in the sample to be measured.

## pH Buffer Solutions

In order to do a calibration of the pH Sensor, or to confirm that a saved pH calibration is accurate, you need to have a supply of pH buffer solutions that cover the range of pH values you will be measuring. We recommend buffer solutions of pH 4, 7, and 10.

- Vernier sells a pH buffer kit (order code PHB, \$10.00). The kit has 10 tablets: two tablets each of buffer pH 4, 7, and 10. Each tablet is added to 100 mL of distilled or deionized water to prepare respective pH buffer solutions.
- Flinn Scientific ([www.flinnsci.com](http://www.flinnsci.com), Tel: 800-452-1261) sells a wide variety of buffer tablets and prepared buffer solutions.
- You can prepare your own buffer solutions using the following recipes:

pH 4.00	Add 2.0 mL of 0.1 M HCl to 1000 mL of 0.1 M potassium hydrogen phthalate.
pH 7.00	Add 582 mL of 0.1 M NaOH to 1000 mL of 0.1 M potassium dihydrogen phosphate.
pH 10.00	Add 214 mL of 0.1 M NaOH to 1000 mL of 0.05 M sodium bicarbonate.

## Maintenance and Storage

Short-term storage (up to 24 hours): Place the electrode in pH-4 or pH-7 buffer solution.

Long-term storage (more than 24 hours): Store the electrode in a buffer pH-4/KCl storage solution in the storage bottle. The pH Electrode is shipped in this solution. Vernier sells 500 mL bottles of replacement pH Storage Solution (order code PH-SS, \$12.00), or you can prepare additional storage solution by adding 10 g of solid potassium chloride (KCl) to 100 mL of buffer pH-4 solution. Flinn Scientific (800-452-1261) sells a Buffer Solution Preservative (order code B0175) that can be added to this storage solution. By storing the electrode in this solution, the reference portion of the electrode is kept moist. Keeping the reference junction moist adds to electrode longevity and retains electrode response time when the unit is placed back into service. If the electrode is inadvertently stored dry (we don't recommend this!), immerse the unit in soaking solution for a minimum of eight hours prior to service.

When testing a pH Sensor, it is best to place it into a known buffer solution. This allows you to see if the sensor is reading correctly (e.g., in a buffer pH 7, is the sensor reading close to pH 7). Do not place your sensor into distilled water to check for readings—distilled water can have a pH reading anywhere between 5.5 and 7.0, due to variable amounts of carbon dioxide dissolved from the atmosphere. Furthermore, due to a lack of ions, the pH values reported with the sensor in distilled water will be erratic.

If your pH Sensor is reading slightly off of the known buffer pH (e.g., reads 6.7 in a buffer 7), you may simply need to calibrate the sensor. You can calibrate the sensor

in two buffer solutions for two calibration points. If you do not remember or know how to perform a calibration, refer to the booklet that came with the pH sensor.

If your readings are off by several pH values, the pH readings do not change when moved from one buffer solution to another different buffer, or the sensor's response seems slow, the problem may be more serious. Sometimes a method called "shocking" is used to revive pH electrodes. To shock your pH Sensor, perform the following:

1. Let the pH Electrode soak for 4-8 hours in an HCl solution between 0.1 and 1.0 M.
2. Rinse off the electrode and let it sit in some buffer pH 7 for an hour or so.
3. Rinse the electrode and give it another try.

Mold growth in the buffer/KCl storage solution can be prevented by adding a commercial growth inhibitor. This mold will not harm the electrode and can easily be removed using a light detergent solution.

Do not use the electrode in solutions containing perchlorate, silver, or sulfide ions. Do not use it in hydrofluoric acid or in acid or base solutions with a concentration greater than 1.0 molar. The electrode may be used to measure the pH of sodium hydroxide solutions with a concentration near 1.0 molar, but should not be left in this concentration of sodium hydroxide for periods longer than 5 minutes. Using or storing the electrode at very high temperatures or very low temperatures (near 0°C) can damage it beyond repair.

## 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.



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