

Surface Temperature Sensor

(Order Code STS-BTA)



The Surface Temperature Sensor is designed for use in situations in which low thermal mass or flexibility is required. Special features include an exposed thermistor that results in an extremely rapid response time. **Important:** The Surface Temperature Sensor is for use in air and water only. For temperature measurements in harsher environments that require a more durable probe, we recommend our Stainless Steel Temperature Sensor (order code TMP-BTA).

Typical uses for the Surface Temperature Sensor include the following.

- skin temperature measurements
- human respiration studies
- specific heat experiments
- heat transfer experiments
- friction and energy studies

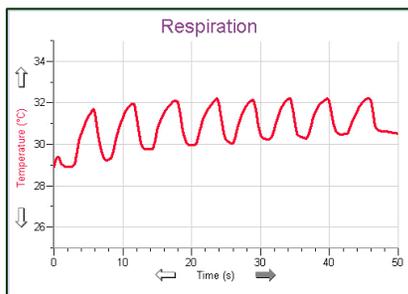
Collecting Data with the Surface Temperature Sensor

This sensor can be used with the following interfaces to collect data.

- Vernier LabQuest[®] 2 or original LabQuest[®] as a standalone device or with a computer
- Vernier LabQuest[®] Mini with a computer
- Vernier LabPro[®] with a computer or TI graphing calculator
- Vernier Go![®] Link
- Vernier EasyLink[®]
- Vernier SensorDAQ[®]
- CBL 2[™]
- TI-Nspire[™] Lab Cradle

Here is the general procedure to follow when using the Surface Temperature Sensor:

1. Connect the Surface Temperature Sensor to the interface.
2. Start the data-collection software.
3. The software will identify the Surface Temperature Sensor and load a default data-collection setup. You are now ready to collect data.



Temperature fluctuation during respiration

Data-Collection Software

This sensor can be used with an interface and the following data-collection software.

- **Logger Pro** This computer program is used with LabQuest 2, LabQuest, LabQuest Mini, LabPro, or Go!Link.
- **Logger Lite** This computer program is used with LabQuest 2, LabQuest, LabQuest Mini, LabPro, or Go!Link.
- **LabQuest App** This program is used when LabQuest 2 or LabQuest is used as a standalone device.
- **EasyData App** This calculator application for the TI-83 Plus and TI-84 Plus can be used with CBL 2, LabPro, or Vernier EasyLink. We recommend version 2.0 or newer, which can be downloaded from the Vernier web site, www.vernier.com/easy/easydata.html, and then transferred to the calculator. See the Vernier web site, www.vernier.com/calc/software/index.html for more information on the App and Program Transfer Guidebook.
- **DataMate program** Use DataMate with LabPro or CBL 2 and TI-73, TI-83, TI-84, TI-86, TI-89, and Voyage 200 calculators. See the LabPro and CBL 2 Guidebooks for instructions on transferring DataMate to the calculator.
- **DataQuest™ Software for TI-Nspire™** This calculator application for the TI-Nspire can be used with the EasyLink or TI-Nspire Lab Cradle.
- **LabVIEW** National Instruments LabVIEW™ software is a graphical programming language sold by National Instruments. It is used with SensorDAQ and can be used with a number of other Vernier interfaces. See www.vernier.com/labview for more information.

NOTE: Vernier products are designed for educational use. Our products are not 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.

How the Sensor Works

This probe uses the 20 kΩ NTC Thermistor. The thermistor is a variable resistor whose resistance decreases nonlinearly with increasing temperature. The best-fit approximation to this nonlinear characteristic is the Steinhart-Hart equation. At 25°C, the resistance is approximately 4.3% per °C. The interface measures the resistance value, R, at a particular temperature, and converts the resistance using the Steinhart-Hart equation:

$$T = [K_0 + K_1(\ln 1000R) + K_2(\ln 1000R)^3]^{-1} - 273.15$$

where T is temperature (°C), R is the measured resistance in kΩ, $K_0 = 1.02119 \times 10^{-3}$, $K_1 = 2.22468 \times 10^{-4}$, and $K_2 = 1.33342 \times 10^{-7}$. Fortunately, the LabPro, Go! Link, or CBL 2 takes care of this conversion for you, and provides readings in °C (or other units, if you load a different calibration).

Optional Calibration Procedure

It should not be necessary to perform a calibration when using this sensor. It provides very accurate temperature readings. Near 0°C, you will see readings that are accurate to $\pm 0.2^\circ\text{C}$; near 100°C, readings will be accurate to $\pm 0.5^\circ\text{C}$.

Note: The Surface Temperature Sensor has a non-linear calibration curve, and can only be re-calibrated using Logger Lite or Logger *Pro* 3.3 or newer. It cannot be recalibrated using the LabQuest App, DataMate, or earlier versions of Logger *Pro*.

Specifications

Temperature range:	-25 to 125°C (-13 to 257°F)
Maximum temperature that the sensor can tolerate without damage:	150°C
13-bit resolution (SensorDAQ):	0.04°C (-25 to 0°C) 0.02°C (0 to 40°C) 0.05°C (40 to 100°C) 0.13°C (100 to 125°C)
12-bit resolution (LabQuest 2, LabQuest, LabQuest Mini, LabPro, TI-Nspire Lab Cradle, Go! Link, or EasyLink):	0.08°C (-25 to 0°C) 0.03°C (0 to 40°C) 0.1°C (40 to 100°C) 0.25°C (100 to 125°C)
10-bit resolution (CBL 2):	0.32°C (-25 to 0°C) 0.12°C (0 to 40°C) 0.4°C (40 to 100°C) 1.0°C (100 to 125°C)
Temperature sensor:	20 k Ω NTC Thermistor
Accuracy:	$\pm 0.2^\circ\text{C}$ at 0°C, $\pm 0.5^\circ\text{C}$ at 100°C
Response time (time for 90% change in reading):	50 seconds (in still air) 20 seconds (in moving air)
Probe dimensions: Probe length (handle plus body)	15.5 cm

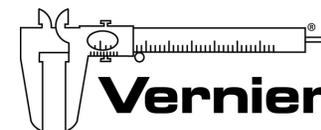
This sensor is equipped with circuitry that supports auto-ID. When used with LabQuest 2, LabQuest, LabQuest Mini, LabPro, Go! Link, SensorDAQ, TI-Nspire™ Lab Cradle, EasyLink, or CBL 2™, the data-collection software identifies the sensor and uses pre-defined parameters to configure an experiment appropriate to the recognized sensor.

Suggested Experiments

The Surface Temperature Sensor may be used in any experiment that measures temperature IN AIR AND WATER ONLY. It may be substituted for the Stainless Steel Temperature Probe in a number of experiments included in our lab manuals.

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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