Stainless Steel Temperature Probe

(Order Code TMP-BTA)

The Stainless Steel Temperature Probe is a rugged, general-purpose laboratory temperature sensor. It is designed to be used as you would use a thermometer for experiments in chemistry, physics, biology, Earth science, and environmental science. **Note:** Do not completely submerge the sensor. The handle is not waterproof. Typical uses include the following:

- heat of fusion experiments
- monitoring endothermic and exothermic reactions
- weather studies
- specific heat experiments
- insulation studies

Collecting Data with the Stainless Steel Temperature Probe

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 Stainless Steel Temperature Probe:

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

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, and 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.

Specifications

Temperature range:		–40 to 135°C (–40 to 275°F)
Maximum temperature that the sensor can tolerate without damage:		150°C
13-bit resolution (SensorDAQ):		
	0.09°C	(–40 to 0°C)
	0.02°C	(0 to 40°C)
	0.05°C	(40 to 100°C)
	0.13°C	(100 to 135°C)
12-bit resolution (LabPro, LabQuest 2, LabQuest, LabQuest Mini, TI-Nspire™ Lab Cradle):		
	0.17°C	(–40 to 0°C)
	0.03°C	(0 to 40°C)
	0.1°C	(40 to 100°C)
	0.25°C	(100 to 135°C)
10-bit resolution (CBL 2™):		
	0.68°C	(–40 to 0°C)
	0.12°C	(0 to 40°C)
	0.4°C	(40 to 100°C)
	1.0°C	(100 to 135°C)
Temperature sensor:		20 kΩ NTC Thermistor
Accuracy:		±0.2°C at 0°C, ±0.5°C at 100°C
Response time (time for 90% change in reading):		10 seconds (in water, with stirring)
		400 seconds (in still air)
		90 seconds (in moving air)

Probe dimensions:

Probe length (handle plus body): 15.5 cm
Stainless steel body: length 10.5 cm, diameter 4.0 mm
Probe handle: length 5.0 cm, diameter 1.25 cm

This sensor is equipped with circuitry that supports auto-ID. When used LabQuest 2, LabQuest, LabQuest Mini, LabPro, Go! Link, TI-Nspire™ Lab Cradle, SensorDAQ, 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.

How the Stainless Steel Temperature Probe 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, $K_o = 1.02119 \times 10^{-3}$, $K_1 = 2.22468 \times 10^{-4}$, and $K_2 = 1.33342 \times 10^{-7}$. Our programs perform this conversion and provide readings in °C (or other units, if you load a different calibration).

Chemical Tolerance

The Stainless Steel Temperature Probe body is constructed from grade 316 stainless steel.[1] This high-grade stainless steel provides a high level of corrosion resistance for use in the science classroom. Here are some general guidelines for usage:

- The probe handle is constructed of molded plasticized Santoprene®. While this material is very chemical resistant, we recommend that you avoid submerging the probe beyond the stainless steel portion.
- Always wash the probe thoroughly after use.

Maximum acid exposure time	
1 M HCl	20 min
2 M HCl	10 min
3 M HCl	5 min
1 M H_2SO_4	48 hours
2 M H_2SO_4	20 min
3 M H_2SO_4	10 min
1 M HNO_3	48 hours
2 M HNO_3	48 hours
3 M HNO_3	48 hours
1 M CH_3COOH	48 hours
2 M CH_3COOH	48 hours
3 M CH_3COOH	48 hours
1 M H_3PO_4	48 hours
2 M H_3PO_4	48 hours
3 M H_3PO_4	48 hours

[1] Grade 316 stainless steel has a composition of 0.08% carbon, 2.0% manganese, 0.75% silicon, 0.04% phosphorus, 0.03% sulfur, 16-18% chromium, 10-14% nickel, 2-3% molybdenum, and 0.1% nitrogen.

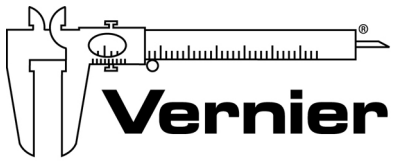
- The probe can be left continuously in water at temperatures within the range of –40° to 150°C. Continuous usage in saltwater will cause only minor discoloration of the probe, with no negative effect on performance.
- You can leave the probe continuously in most organic compounds, such as methanol, ethanol, 1-propanol, 2-propanol, 1-butanol, n-hexane, lauric acid, paradichlorobenzene, phenyl salicylate, and benzoic acid. The probe should not be left in n-pentane for more than 1 hour.
- The probe can be left in strong basic solutions, such as NaOH, for up to 48 hours, with only minor discoloration. We do not recommend usage in basic solutions that are greater than 3 M in concentration.
- The chart provides the maximum length of time we recommend for probe exposure to some common acids. Probes left in an acid longer than these times may bubble and/or discolor, but will still be functional. We do not recommend probes be left to soak in any acid longer than 48 hours.

Optional Calibration Procedure

In most cases, the Stainless Steel Temperature Probe will not need to be calibrated. It is calibrated extremely well before it ships. However, if the need arises to calibrate the sensor, and you are using Logger *Pro* 3.3 or newer, the sensor can be custom-calibrated. See www.vernier.com/til/1310 for more information. **Note:** this can only be done on computers, and can not be done from DataMate, EasyData (calculators), DataQuest, or the LabQuest App.

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. Broken clips do not compromise the performance of the sensor. For proper storage, see www.vernier.com/til/2377/



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