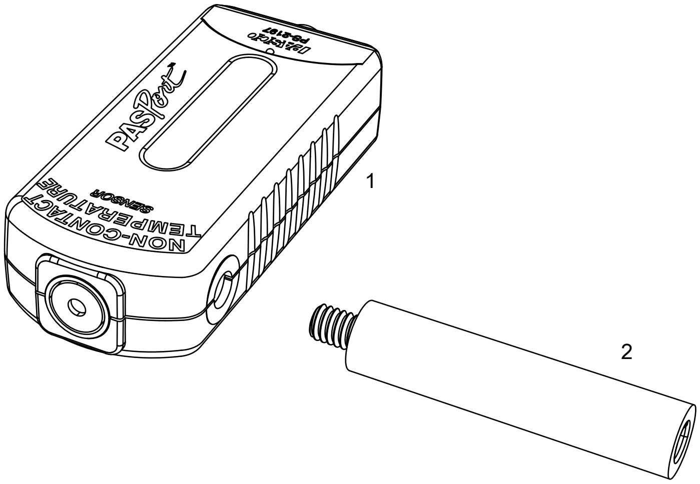
Non-contact Temperature Sensor

PS-2197

For Educational Use Only! Note: This is not a medical device. It is designed for educational use only and should not be used in any medical process such as life support or patient diagnosis. It is also not intended for use in graduate research or industry including industrial control or any type of industrial testing.



Included Equipment

1. Non-contact Temperature Sensor
2. Sensor Handle

Additional Items Required*

- PASCO Interface and Data Collection Software

  (*See the PASCO catalog or web site at www.pasco.com for more information.)

Quick Start

1. Connect the Non-contact Temperature Sensor to a PASCO interface, connect the interface to a computing device, and start the software.
2. Click Record or press Start to begin collecting data.
3. Point the sensor at an object or surface.

The sensor measures the temperature of the surface filling its field of view. The temperature is recorded and displayed on the computing device (such as a computer, tablet, or smart phone).

Introduction

The Non-contact Temperature Sensor measures surface temperature by detecting infrared light emitted by objects. It features the ability to measure objects without touching them, a very fast response (less than 0.1 s), and a wide measurement range (-70 °C to 380 °C).

The Non-contact Temperature Sensor connects to a computer via a PASCO interface. Measurements are recorded and displayed by the computer or datalogger. The sensor can be used for continuous recording and discrete measurements.

Set-up

Connecting the Sensor

1. Plug the sensor into a PASPORT input port on the interface. You can connect the sensor directly to the port or use a PASPORT Extension Cable (PASCO part PS-2500).
2. Connect the PASCO interface to a computing device and start the PASCO Software.

Positioning the Sensor

Point the aperture of the sensor at the surface or object to be measured. Ensure that the object fills the senor’s field of view (see Figure 1.2); smaller objects need to be closer to the sensor.

Unit of Measure

By default, the sensor reads temperature on the Celsius scale. Change the unit-of-measure setting in the software to read absolute temperature in units of K or temperature on the Fahrenheit scale.

Sample Rate

By default, the sensor collects data at the rate of 10 samples per second. This rate can be changed in the software.

Attaching the Sensor Handle

The included sensor handle allows the sensor to be held in a clamp or other device. Attach the handle to the sensor as illustrated in Figure 1.1.

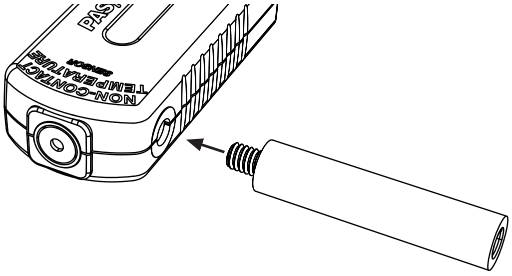


Figure 1.1: Attaching the sensor handle

Collecting Data

Click Record or press Start in the software. The computing device begins to collect data.

About the Sensor

Field of View

The sensor's field of view is ±35°, as illustrated in Figure 2. The object or surface being measured should fill the field of view.

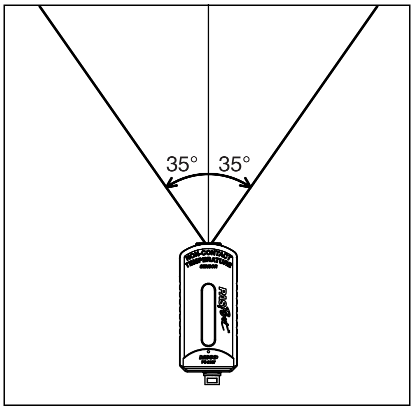
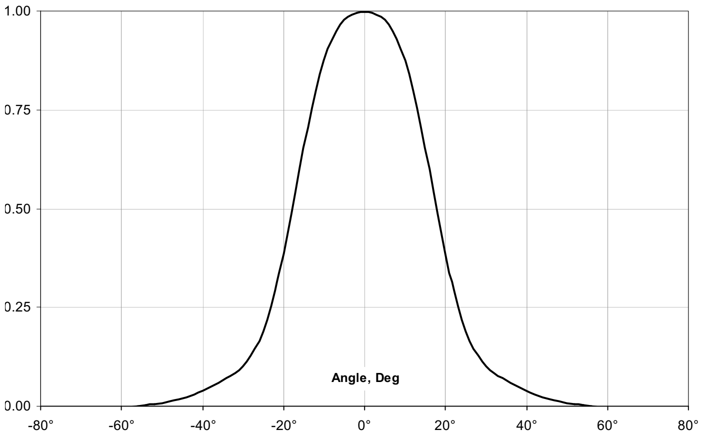


Figure 1.2: Field of view



How the Sensor Calculates Temperature

All objects emit infrared radiation. The radiated power per unit area of an object is given by the Stefan-Boltzmann law:

$$I = \varepsilon\sigma T^4$$

Where T is the objects' absolute surface temperature, and σ is the Stefan-Boltzmann constant. The emissivity, ε, is a property of the object's surface and can range from 0 to 1. An object with $\varepsilon = 1$ is described as a blackbody.

Consider a blackbody of temperature T_o whose surface can be approximated as an infinite plane, and a flat detector surface of area A. The surfaces are parallel to each other. Because radiation from an infinite plane propagates as a plane wave, the power flow from the object to the detector (P_{od}) equals the radiation emitted by a part of the object surface whose area equals the detector's area, regardless of the distance between the object and detector.

$$P_{od} = A\sigma T_o^4$$

The detector itself also radiates in accordance to the Stefan-Boltzmann law. If the detector's temperature is T_a, then power radiating from the detector is

$$P_a = A\sigma T_a^4$$

Therefore, the *net* power absorbed by the detector due to radiation is

$$P = A\sigma(T_o^4 - T_a^4)$$

A thermopile in the sensor produces a voltage, V, which is proportional to P. The above equations combine to give

$$V = k(T_o^4 - T_a^4)$$

Where k is a constant.

The sensor measures V and T_a internally. A microprocessor in the sensor uses these values to calculate T_o.

Object Emissivity

The sensor calculates temperature based on the assumption that the object has an emissivity of 1. This is a good approximation for surfaces, such as paint, wood, paper, plastic, water, ice, human skin, and asphalt, that have emissivities greater than 0.9.

Other surfaces, especially polished metals, have lower emmisivites. An object with emissivity significantly less 1 will radiate less power per unit area than a blackbody of the same temperature. A low-emissivity object will also reflect more radiation from other sources. These combined effects may cause the temperature reported by the sensor to differ from the actual object temperature for low-emissivity objects. If you know the values of T_a and ε_o, you can approximate actual temperature using

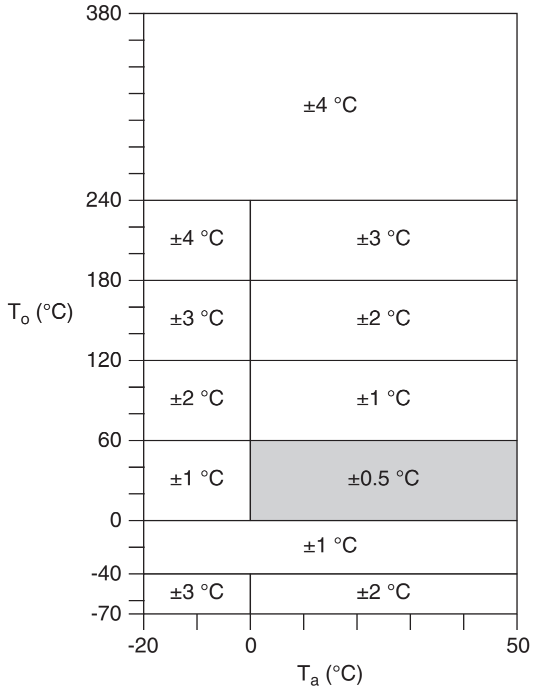
$$T_o^4 = T_R^4/\varepsilon_o + T_a^4(1-1/\varepsilon_o)$$

Where T_R is the object temperature as reported by the sensor, and T_o is the actual object temperature. The detector temperature, T_a, can be assumed equal to ambient temperature.

A more practical way to measure the temperature of a low-emissivity object is to apply paint or tape to the surface, creating a surface that has the same temperature as the object but a higher emissivity.

Measurement Accuracy

The table below gives the sensor's accuracy for a blackbody object over a range of sensor temperature (T_a) and object temperature (T_o). Under typical conditions, the accuracy is ±0.5 °C.



Demonstrations

- Measure the temperatures of your hand, face, clothes, and the inside of your mouth (Figure 1.3).
- Measure the temperatures of various outdoor ground surfaces (Figure 1.4).
- Place the sensor horizontally on a table and start recording data. Display the data on a temperature versus time graph. Walk quickly past the sensor (Figure 1.5).
- Take a block of ice directly from a freezer and record the temperature as it warms and melts. Display the data on a temperature versus time graph (Figure 1.6).

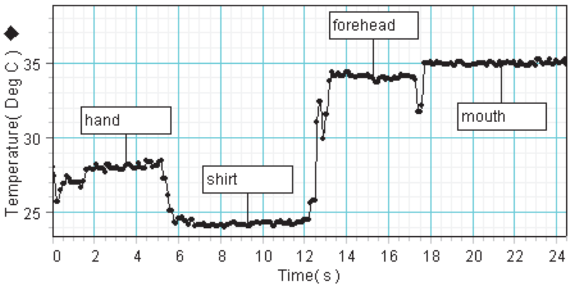


Figure 1.3: Various body parts

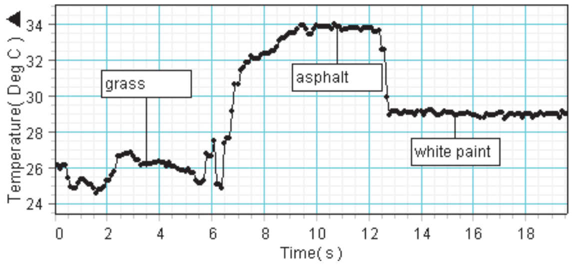


Figure 1.4: Various ground surfaces

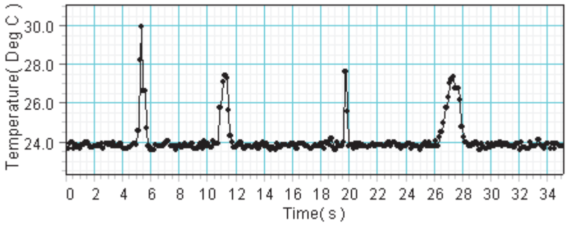


Figure 1.5: People walking past the sensor

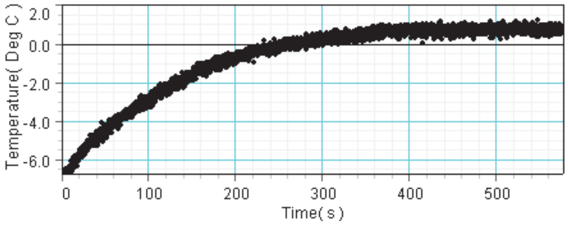


Figure 1.6: Melting ice

Specifications

Accuracy	±0.5 °C (blackbody object under typical conditions)
Range	-70 °C to 380 °C
Response time	less than 0.1 s
Field of view	±35°
Maximum Sample Rate	200 samples/s

Technical Support

For assistance with any PASCO product, contact PASCO at:

Address: PASCO scientific
10101 Foothills Blvd.
Roseville, CA 95747-7100

Phone: +1 916 462 8384 (worldwide)
800-772-8700 (U.S.)

Web: www.pasco.com

Email: support@pasco.com

For more information about the Non-contact Temperature Sensor and the latest revision of this Instruction Sheet, visit the PASCO web site at www.pasco.com and enter “PS-2197” or the product name in the “Search” window.

Limited Warranty

For a description of the product warranty, see the PASCO catalog.

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Product End of Life Disposal Instructions:

This electronic product is subject to disposal and recycling regulations that vary by country and region. It is your responsibility to recycle your electronic equipment per your local environmental laws and regulations to ensure that it will be recycled in a manner that protects human health and the environment. To find out where you can drop off your waste equipment for recycling, please contact your local waste recycle/disposal service, or the place where you purchased the product.

The European Union WEEE (Waste Electronic and Electrical Equipment) symbol (to the right) and on the product or its packaging indicates that this product **must not** be disposed of in a standard waste container.