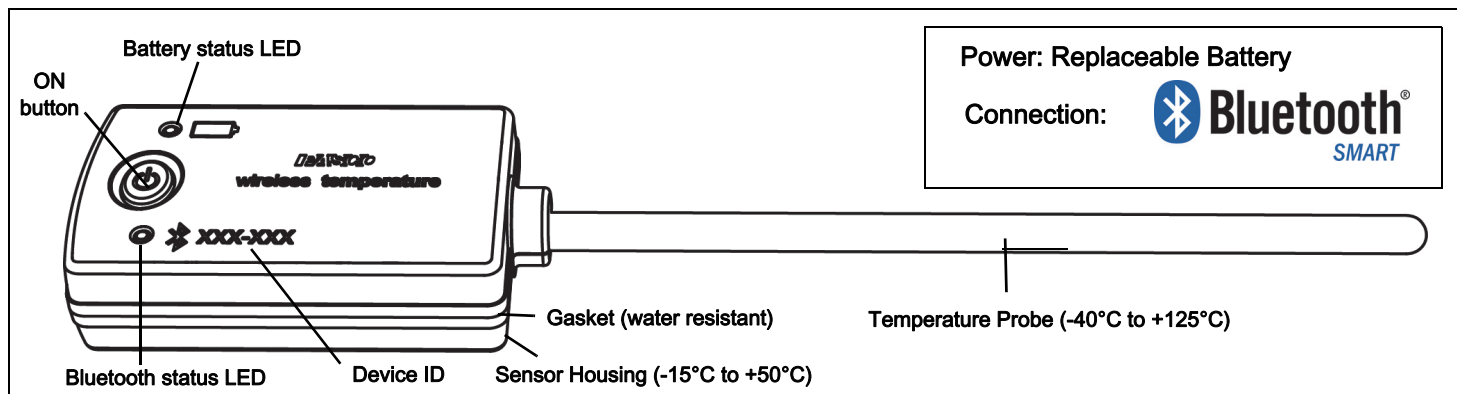


Wireless Temperature Sensor

PS-3201



Hardware

Included Equipment	Part Number
Wireless Temperature Sensor	PS-3201

Introduction

The Wireless Temperature Sensor measures temperature over a range from -40° C to +125°C. The stainless steel temperature probe is more durable than a glass thermometer and is able to work in a variety of situations. The temperature measurement is transmitted wirelessly through Bluetooth and recorded and displayed by the PASCO software on a connected wireless device such as a tablet or computer. The Wireless Temperature Sensor is powered by a replaceable three volt coin cell battery (included) and is well-suited for continuous recording and discrete measurements. The sensor is designed to optimize the battery usage time.

Since each sensor has a unique Device ID number, more than one can be connected to a computer or tablet at the same time.

The sensor housing is water resistant, but immersing it in water may cause a loss of wireless connection. Do not immerse the sensor housing in boiling hot water. Put only the Temperature Probe into the substance being measured.

ON/OFF Information

To turn the sensor on, press and hold the ON button until the status LEDs start blinking. To turn the sensor off, press and momentarily hold the ON button until the status LEDs stop blinking. (See the LED information.)

The sensor puts itself to sleep after several minutes of inactivity if not connected, and after about one hour of inactivity if connected.

Data Collection Software

PASCO Capstone



- Mac OS X
- Windows

SPARKvue



- Mac OS X
- Windows
- iOS
- Android
- Chromebook

See the PASCO web site at www.pasco.com/software for help in selecting the right PASCO software and to check the latest versions.

Software Help

See the SPARKvue Help or PASCO Capstone Help for information about collecting, displaying, and analyzing data.

- In SPARKvue, select the HELP button (?) in any screen including the Home Screen.
- In PASCO Capstone, select **PASCO Capstone Help** from the **Help** menu, or press F1.

Bluetooth[®] Compatibility

Platform	Bluetooth SMART Compatibility
iOS	iPad 3 and later iPhone 4S and later iPod touch 5 and later
SPARK Element	All models
Android	Android 4.3 and later
Chromebook	Chrome OS (requires PS-3500 Adapter*)
Mac OS X	Models introduced July 2011 or later*
Windows	Windows 7 and later (requires PS-3500 Adapter*)

See Appendix A for more information about the PS-3500 Adapter and Mac OS X models.

LED Information

The Bluetooth connection LED (light-emitting diode) and the battery status LED operate as follows:

Bluetooth LED	Status
Red blink	Ready to pair
Green blink	Connected
Yellow blink	Logging*

Battery LED	Status
Red blink	Low power

***Logging:** PASCO wireless sensors can either stream live data to a compatible device or log data (save it to the sensor's memory). The data can then be uploaded to the device for display and analysis at a later time. Logging capability supports long-term or remote data collection while not connected to the device.

Note: Versions of SPARKvue and PASCO Capstone available in 2016 will support logging. Check the PASCO Web page at:

www.pasco.com/software

for the latest software version.

Set-up

Connecting the Sensor to a Wireless Device or a

Computer via Bluetooth

SPARKvue

Software Help

See the SPARKvue Help for information about collecting, displaying, and analyzing data.

- In SPARKvue, select the HELP button (?) in any screen, including the Home Screen.

Connect the Sensor

- In SPARKvue, select the Bluetooth icon. In the **Wireless Devices** list that opens, select the desired sensor that matches the XXX-XXX Device ID number on the sensor. Select **Done**.



Collect Data

- In SPARKvue, select a measurement from the list under the sensor in the Home Screen. A graph of the measurement versus time opens.
- Select the **Start** button to begin collecting data.

PASCO Capstone

Software Help

See the PASCO Capstone Help for information about collecting, displaying, and analyzing data.

- In PASCO Capstone, select **PASCO Capstone Help** from the **Help** menu, or press F1.

Connect the Sensor

- In PASCO Capstone, click **Hardware Setup** in the **Tools** palette to confirm that the sensor is recognized. Select the desired sensor in the **Hardware Setup** window that matches the XXX-XXX Device ID number on the sensor. Close the **Hardware Setup** window.

Collect Data

- In PASCO Capstone, select a display in the main window. In the display, use the **<Select Measurement>** menu(s) to set up the desired measurement in the display.
- Select **Record** to begin collecting data.

Calibrating the Sensor

Calibration is not always necessary, especially if you are measuring a change in temperature rather than absolute temperature values. However, it is possible to calibrate the sensor. For detailed information, see Appendix B.

Battery Usage

The Wireless Temperature Sensor includes a 3 V coin cell battery (CR2032). Battery life is very important to making the sensor simple and always ready to use, so all of the PASCO wireless products are designed for long battery life. For example, the sensor turns itself off after a short time of inactivity.

We expect more than one year of battery life, but the actual amount depends on factors such as the data collection sampling rate.

Sensor Storage

If the sensor will be stored for many months, we recommend that you remove the battery to avoid damaging the sensor in case of a battery leak.

Battery Removal and Replacement

If the sensor's battery status LED blinks red, the battery may need to be replaced. Replacing the small, disk-shaped battery involves removing the Battery Compartment Door on the bottom of the sensor, removing the old battery, installing a new battery of the same type, and replacing the Battery Compartment Door. The procedure needs a coin and a CR2032 three volt battery.

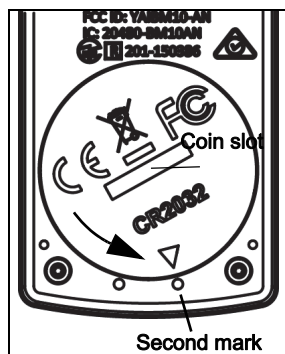
(NOTE: This battery is commonly available in electronic and commercial stores.)

Remove the Battery Compartment Door

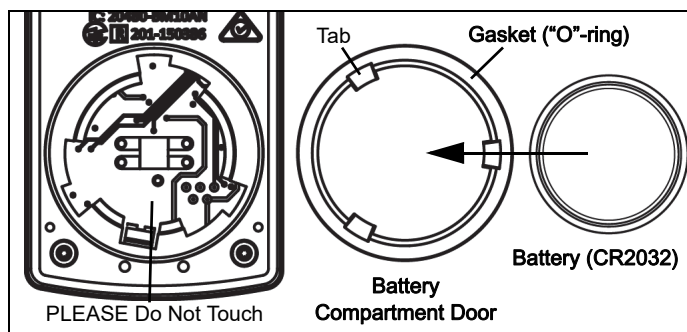
Hold the sensor bottom-side up. Use a coin in the slot to turn the Battery Compartment Door counterclockwise (left-to-right) until the indicator on the door is aligned with the second mark on the sensor.

Turn the sensor bottom-side down so that the Battery Compartment Door can drop into the palm of your hand.

Make sure that the battery door gasket stays on the door. The gasket is an "O-ring" that is held in place by



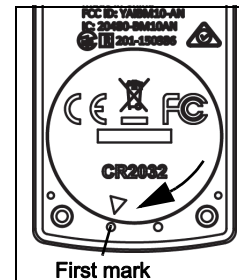
the tabs on the door. Please do not touch the inside of the battery compartment



Remove the used battery from the Battery Compartment Door and replace it with a new identical type battery. *Note that the battery is held in place by the small tabs on the door.* The side of the battery with the "+" on it should be against the door.

Replace the Battery Compartment Door

Put the Battery Compartment Door with the new battery back onto the sensor. Align the indicator on the door with the second mark, and use the coin in the slot to turn the door clockwise (right-to-left) until the indicator is aligned with the first mark on the sensor.



(See "Battery Disposal Instructions" under Technical Support.)

Related Item

- Coin-cell Battery Replacement Pack (10 pack) - PS-3504

Troubleshooting the Wireless Temperature Sensor

- If the sensor loses Bluetooth connection and will not reconnect, try cycling the ON button. Press and briefly **hold** the button until the status LEDs blink, and then release the button
- If the sensor stops communicating with the computer software or tablet application, try restarting the software or application. If the problem remains, press and hold the ON button for ten seconds and then release the button. Turn on the sensor in the usual way.
- Turn Bluetooth off and then turn it back on. Retry.

Temperature Probe Maintenance

Rinse and dry the temperature probe before putting the sensor away for storage. The probe is stainless steel and the diameter (5 mm or 0.197") is compatible with standard stoppers.

Suggested Experiments

Practically any experiment that uses a temperature measurement can be done with the PS-3201 Wireless Temperature Sensor. See the PASCO Web site at

www.pasco.com/products/lab-manuals

for more information about experiments

Sensor Specifications

Wireless Temperature Sensor	
Range	-40°C to +125°C (for the probe) -15°C to +50°C (for the housing)*
Accuracy	±0.5° C
Resolution	0.01°C
Sample Rate	Up to 10 Hz

*NOTE: Prolonged exposure of the sensor housing to temperatures at the extreme ends of the range will adversely affect battery life and performance.

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/support

Email: support@pasco.com

The Reference Guide will be updated periodically. For the latest revision of this Reference Guide, visit the PASCO Web site at

www.pasco.com/manuals

and enter the product number, PS-3201, in the text window.

Limited Warranty

For a description of the product warranty, see the PASCO catalog. For more information visit www.pasco.com/legal.

Copyright

This PASCO scientific document is copyrighted with all rights reserved. Permission is granted to non-profit educational institutions for reproduction of any part of this manual, providing the reproductions are used only in their laboratories and classrooms, and are not sold for profit. Reproduction under any other circumstances, without the written consent of PASCO scientific, is prohibited.

Trademarks

PASCO, PASCO scientific, PASCO Capstone, PASPORT, and SPARKvue are trademarks or registered trademarks of PASCO scientific, in the United States and/or in other countries. All other brands, products, or service names are or may be trademarks or service marks of, and are used to identify, products or services of their respective owners. For more information visit www.pasco.com/legal.

FCC Statement

This Class A digital device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

CE Statement

This device has been tested and found to comply with the essential requirements and other relevant provisions of the applicable EU Directives.

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.

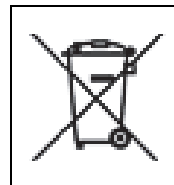
The European Union WEEE (Waste Electronic and Electrical Equipment) symbol (to the right) and on the product or its packaging indicates that this product **must not** be disposed of in a standard waste container.



Battery Disposal Instructions:

Batteries contain chemicals that, if released, may affect the environment and human health. Batteries should be collected separately for recycling, and recycled at a local hazardous material disposal location adhering to your country and local government regulations. To find out where you can drop off your waste battery for recycling, please contact your local waste disposal service, or the product representative.

The battery used in this product is marked with the International symbols to indicate the need for the separate collection and recycling of batteries.



Appendix A: **Bluetooth**SM **Compatibility**

Check the PASCO Web page at

www.pasco.com/compatibility

for the latest information on Bluetooth SMART compatibility.


Platform	Bluetooth SMART Compatibility
iOS	iPad 3 and later iPhone 4S and later iPod touch 5 and later
SPARK Element	All models
Android	Android 4.3 and later
Chromebook	Chrome OS (requires PS-3500 Adapter*)
Mac OS X ¹	Models introduced July 2011 or later
Windows	Windows 7 and later (requires PS-3500 Adapter*)

*The PS-3500 USB Bluetooth 4.0 Adapter, when connected to a USB port, allows up to three Bluetooth SMART devices, such as this PASCO wireless device, to connect to Windows computers, Chromebooks, and older Macintosh computers.



Note: The PS-3500 USB Bluetooth 4.0 Adapter is the only adapter we can currently recommend. Many other Bluetooth 4.0 adapters are available but this adapter has a specific design that enables in-app pairing of Bluetooth SMART sensors.

¹To check the Mac computer's Bluetooth compatibility, do the following:

- Click the  (Apple) Menu.
- Select *About This Mac*
- Click the *More Info...* button.
- Click the *System Report...* button.
- Select *Bluetooth* from the sidebar on the left, underneath *Hardware*.
- Scan down the list of information until you find "LMP Version".
- If your Mac is equipped with Bluetooth SMART, the LMP Version will show **0x6**. (Anything lower than **0x6** means an older version of Bluetooth. Your device will need the PS-3500 USB Bluetooth 4.0 Adapter.)

¹The Mac Mini and MacBook Air were updated with Bluetooth SMART support in 2011. The MacBook Pro was updated in 2012. The Mac Pro that debuted in December 2013 has Bluetooth SMART support.

Exception: Before *you upgrade to El Capitan* (Mac OS X 10.11.x), if you have a Macintosh with LMP version "0x4" that requires the PS-3500 USB Bluetooth 4.0 Adapter, please contact PASCO Technical Support for further instructions.

What is Bluetooth SMART[®]?

Bluetooth SMART (also known as Bluetooth Low Energy or Version 4.0 of the Bluetooth specification) is the latest protocol of the proprietary open wireless technology standard created by telecoms vendor Ericsson in 1994. It is the power- and application-friendly version of Bluetooth that was built for the Internet of Things (IoT).

Appendix B: Calibration


Calibration is not always necessary, especially if you are measuring a change in temperature rather than absolute temperature values. However, it is possible to calibrate the sensor.

Prepare for Calibration

Calibration will need an ice-water bath, a container of hot water, and a thermometer. The sensor will need to be “paired” with a tablet or computer, and the data collection software (for example, SPARKvue or Capstone) should be running.


Using SPARKvue Software for Calibration

NOTE: Check the Help System in SPARKvue for the most up-to-date information.

1. Place the thermometer in the container of hot water.
2. Click (or press) the Experiment Tools button .
 - The **Experiment Tools** screen opens.
3. Click **Calibrate Sensor**.
 - The **Calibrate Sensor: Select Measurement** screen opens.
4. Click the **Sensor** box and click the sensor to be calibrated.
5. Click the **Calibration Type** box and click a calibration type. (For this example, click “2-point”.)
6. Click **Next**.
 - The **Calibrate Sensor Enter Values** screen opens.
7. Place the temperature probe in the container of hot water.
8. Read the temperature on the thermometer. Under **Calibration Point 1**, click the **Standard Value** box and enter the known temperature value.
9. Under **Calibration Point 1**, click **Read From Sensor**.
 - The value measured by the sensor is transferred to the **Sensor Value** box.
10. Move the thermometer to the ice-water bath. Dry the temperature probe and then put the probe into the ice-water bath with the thermometer.
11. Wait until the reading on the thermometer stabilizes. Under **Calibration Point 2**, click the **Standard Value** box and enter the thermometer’s temperature value.
12. Under **Calibration Point 2**, click the **Read From Sensor** box.
 - The second value measured by the sensor is transferred to the **Sensor Value** box.
13. Click **OK**.

Using PASCO Capstone for Calibration

NOTE: Check the Help System in PASCO Capstone for the most up-to-date information.

1. Place the thermometer in the container of hot water.
2. Click **Calibration** () in the **Tools** Palette.
3. Choose the measurement you would like to calibrate now: **Temperature Measurement**.
4. Click **Next**.
5. Choose the type of calibration you would like to perform: **Two Standards (2 point)**.
6. Click **Next**.
7. Read the temperature on the thermometer and enter the value in the **Standard Value** text box.
8. Place the Temperature Probe in the container of hot water.
9. After the **Current Value** stabilizes, lick **Set Current Value to Standard Value**.
10. Click **Next**.
11. Move the thermometer to the ice-water bath. Dry the end of the temperature probe. Place the probe in the ice-water bath with the thermometer,
12. Wait until the reading on the thermometer stabilizes. Enter the second known temperature value in the **Standard Value** text box.
13. After the **Current Value** stabilizes, click **Set Current Value to Standard Value**.
14. Click **Next**.
15. Click **Finish**.

Theory of Calibration

One of the functions of the PASCO Data Collection Software is to take the stream of raw data from a sensor and transform it into the calibrated data that you see in the Graph, Table, and other displays. If you do not calibrate a sensor yourself, the software uses a default calibration that is loaded when the sensor is connected.

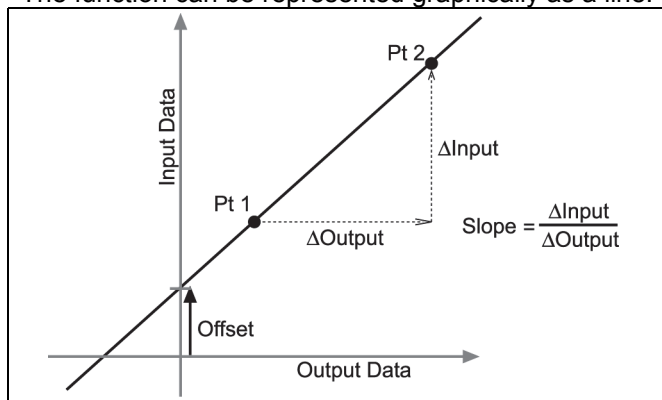
You can think of the software as taking in raw data and outputting calibrated data. When you perform a calibration, the software redefines the linear equation that transforms the raw input data into the calibrated output data. The linear function is of the form:

$$\text{Raw Input} = \text{Slope} \times \text{Calibrated Output} + \text{Offset}$$

Or:

$$\text{Calibrated Output} = (\text{Raw Input} - \text{Offset}) / \text{Slope}$$

The function can be represented graphically as a line.



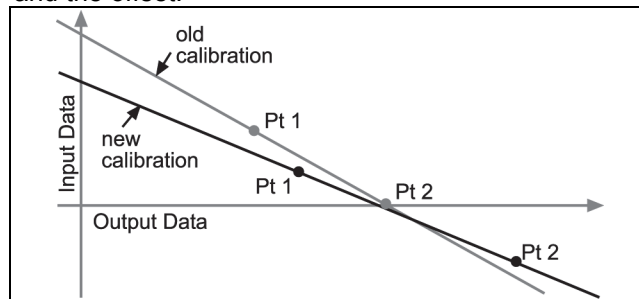
Two points, Pt 1 and Pt 2, define the line. In the two-point calibration procedure, each point is reset by associating a known standard value (for instance, the temperature of ice water) with a raw input measurement that the sensor sends out when it is in that standard. In a one-point calibration, only one of the points is reset by the user.

Types of Calibration

There are three types of calibration: two-point, one-point slope, and one-point offset. Any of these calibrations can be performed on a single sensor, or simultaneously on multiple similar sensors; however, for any given sensor, the software will automatically select the most typical calibration type as the default setting.

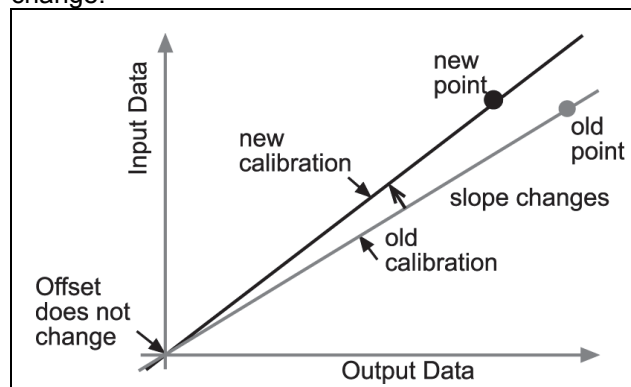
Two-Point

In a two-point calibration, you reset two points to define a new line. This type of calibration affects both the slope and the offset.



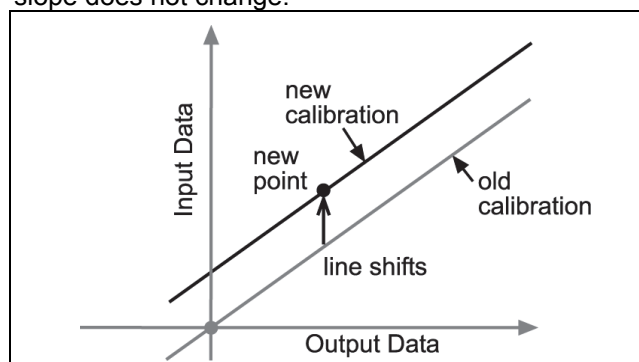
One-Point Slope

In a one-point slope calibration, you reset only one point. The slope of the line changes so that the line intersects the new point, while the offset (or Y-intercept) does not change.



One-Point Offset

In a one-point offset calibration, you reset only one point. The line shifts so that it intersects the new point, but its slope does not change.



Offset calibration is usually used to make one sensor agree with another sensor. Due to normal variation among probes, a second probe might read consistently higher than the first probe. Normally this difference would be insignificant; however, an offset calibration can be used to bring the sensors into closer alignment.

