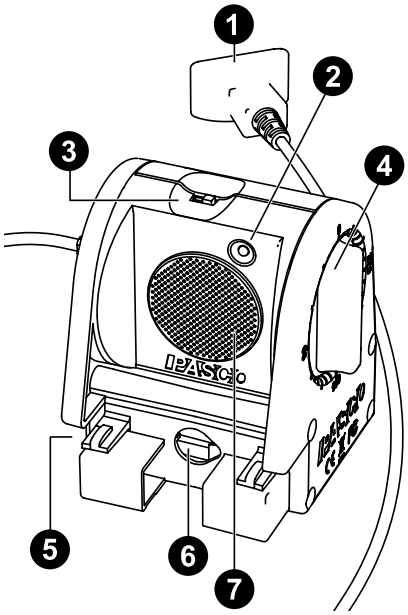
Motion Sensor (PS-2103A)

Introduction

The Motion Sensor works with a PASCO interface to measure and record the position, velocity, and acceleration of an object in front of the sensor. To do this, the sensor produces a series of ultrasonic pulses and detects the sound reflected back from the object. The interface then measures the times between outgoing pulses and returning echoes. From these measurements, the sensor determines the object's position, velocity, and acceleration.

Features



1 PASPORT plug
Use to connect the sensor to a PASPORT interface.

2 Target indicator
Flashes when the sensor detects the echo of an emitted pulse.

3 Range switch
Use to switch the sensor between long range and short range settings.

4 Rotating head
Use to adjust the angle of the transducer with respect to the ground.

5 Clips
Use to mount the sensor on a PASCO track.

6 Mounting rod hole
Insert a mounting rod into this hole and tighten the thumbscrew (not pictured) to secure the sensor in place.

7 Ultrasonic transducer
Emits the ultrasonic pulses used by the sensor to measure position, velocity and acceleration.

Additional equipment required:

- PASPORT-compatible interface
- PASCO Capstone or SPARKvue data collection software

Get the software

You can use the sensor with SPARKvue or PASCO Capstone software. If you're not sure which to use, visit pasco.com/products/guides/software-comparison.

SPARKvue is available as a free app for Chromebook, iOS, and Android devices. We offer a free trial of SPARKvue and Capstone for Windows and Mac. To get the software, go to pasco.com/downloads or search for **SPARKvue** in your device's app store.

If you have installed the software previously, check that you have the latest update:

SPARKvue: Main Menu > Check for Updates

PASCO Capstone: Help > Check for Updates

Set up the software

SPARKvue

Connect the sensor to SPARKvue:

1. Start SPARKvue, then click **Sensor Data**.
2. Turn on your PASPORT interface if required, then connect the interface to SPARKvue. For more detailed steps, see the manual for your chosen interface.
3. Plug the PASPORT plug of the Motion Sensor into one of the PASPORT ports of the interface. SPARKvue should automatically detect and identify the sensor.

Collect data with SPARKvue:

1. In the **Select Measurements for Templates** column, select the appropriate measurement or measurements for your experiment.
2. In the **Templates** column, select **Graph** to enter the Experiment Screen. The graph will automatically display your selected measurement on the y-axis and time on the x-axis.
3. Click **Start** to begin data collection.

PASCO Capstone

Connect the sensor to Capstone:

1. Start Capstone, then click **Hardware Setup** in the **Tools** palette.
2. Turn on your PASPORT interface if required, then connect the interface to Capstone. For more detailed steps, see the manual for your chosen interface.
3. Plug the PASPORT plug of the Motion Sensor into one of the PASPORT ports of the interface. Capstone should automatically detect and identify the sensor.

Collect data with Capstone:

1. Create a Graph display by double-clicking **Graph** in the **Templates** palette.
2. Assign the axes by clicking each **<Select Measurement>** box and selecting an appropriate measurement.
3. Click **Record** to begin data collection.

Set up the hardware

Aim the Motion Sensor at an object

1. Set the range switch to either **Short Range** ( ) or **Long Range** ( ). Short Range should be used when measuring a cart on a track, while Long Range should be used for any other object.
2. Arrange the Motion Sensor and object so that the Motion Sensor's transducer faces the object, as shown below. The object should always be at least 15 cm from the transducer. If the object will move, ensure that it will only move directly toward or away from the Motion Sensor.

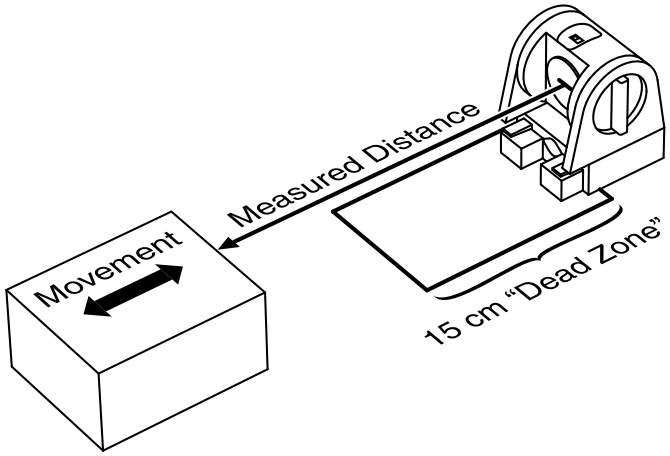


Figure 1. Proper positioning of the Motion Sensor and object.

TIP: Aim the motion sensor slightly up to prevent it from detecting the tabletop.

3. Remove any objects between the sensor and target object, either directly in front of the sensor or to the sides, to prevent these objects from interfering with the measurement.

If the target object is properly in range, the target indicator will flash with each click.

Sample rate

The default sample rate for the Motion Sensor is 20 Hz. The sample rate can be changed in PASCO Capstone or SPARKvue; for a detailed guide, see the PASCO Capstone or SPARKvue online help.

The typical range of sampling rates for normal operation is between 1 Hz and 50 Hz. The maximum distance decreases as the sample rate increases. At the default sample rate, the Motion Sensor can measure distances up to about 8 m, whereas at very high sample rates (between 50 Hz and 250 Hz), the maximum measurable distance is less than 2 m.

Equipment mounting

As shown in Figure 2, the Motion Sensor can be mounted on a vertical rod **(A)** or a horizontal rod **(B)**. Integrated clips also allow it to be attached to the end of a dynamics track **(C)**.

A threaded hole in the bottom of the unit **(D)** allows the sensor to be attached to a Magnetic Bracket (PS-2546) **(E)**, a Cart Adapter (ME-6743) **(F)**, or other 1/4-20 threaded mounting devices like a camera tripod.

To protect the Motion Sensor from being hit by an object, use a device like the Motion Sensor Guard (SE-7256) **(G)** or an IDS Photogate Bracket (ME-9806) with a rubber band **(H)**. The Motion Sensor can "see through" a wire screen or rubber band placed close to the transducer.

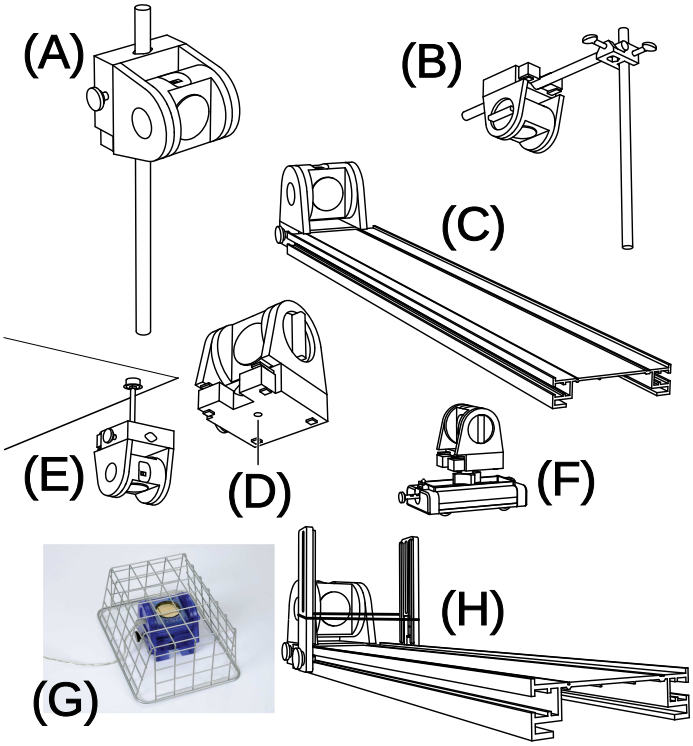


Figure 2. Mounting options for the Motion Sensor.

Troubleshooting

If the Motion Sensor fails to perform properly, try these steps to improve the performance:

- Ensure that the target object is at least 15 cm away from the transducer at all times.
- Switch the range switch to the other setting.
- Adjust the aim left, right, up, or down. In some cases the Motion Sensor will work best when it is aimed slightly to the side or above the target in order to exclude interfering objects.
- Improve the target by adding a larger or harder surface to reflect ultrasound. A small object can be a better reflector than a large object if the small object has a harder surface.
- Remove any interfering objects near the target object or sensor.
- Increase or decrease the sample rate.

Theory of operation

The Motion Sensor uses an electrostatic transducer as both a speaker and a microphone. For each sample, the transducer transmits a burst of 16 ultrasonic pulses at a frequency of about 49 kHz. This burst of pulses can be heard as a single click. The ultrasonic pulses reflect off of an object and return to the sensor. The target indicator on the sensor flashes when the transducer detects an echo.

Sound intensity decreases with distance. To compensate, the sensor increases the gain of the receiver amplifier as it waits for the echo. The increased gain allows the sensor to detect an object up to 8 m away. The lower gain at the beginning of the cycle reduces the circuit's sensitivity to echoes from false targets.

The sensor measures the time between the trigger rising edge and the echo rising edge. It then uses this time and the known speed of sound in air to calculate the distance to the object. To determine velocity, the sensor uses consecutive position measurements to calculate the rate of change of position. Similarly, it determines acceleration using consecutive velocity measurements.

Software help

The SPARKvue and PASCO Capstone Help provide additional information on how to use this product with the software. You can access the help within the software or online.

SPARKvue

Software: Main Menu > Help

Online: help.pasco.com/sparkvue

PASCO Capstone

Software: Help > PASCO Capstone Help

Online: help.pasco.com/capstone

Specifications and accessories

Visit the product page at pasco.com/product/PS-2103A to view the specifications and explore accessories. You can also download experiment files and support documents from the product page.

Experiment files

Download one of several student-ready activities from the PASCO Experiment Library. Experiments include editable student handouts and teacher notes. Visit pasco.com/freelabs/PS-2103A.

Technical support

Need more help? Our knowledgeable and friendly Technical Support staff is ready to answer your questions or walk you through any issues.

Chat	pasco.com
Phone	1-800-772-8700 x1004 (USA) +1 916 462 8384 (outside USA)
Email	support@pasco.com

Regulatory information

Limited warranty

For a description of the product warranty, see the Warranty and Returns page at www.pasco.com/legal.

Copyright

Trademarks

Product end-of-life disposal

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 or disposal service, or the place where you purchased the product. The European Union WEEE (Waste Electronic and Electrical Equipment) symbol on the product or its packaging indicates that this product must not be disposed of in a standard waste container.

CE statement

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

FCC statement

This 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.