

# Motion Sensor

PS-2103A

Included Equipment	Part Number
Motion Sensor	PS-2103A
Additional Equipment Required	
PASPORT Interface	See PASCO catalog or <a href="http://www.pasco.com">www.pasco.com</a>

## Quick Start

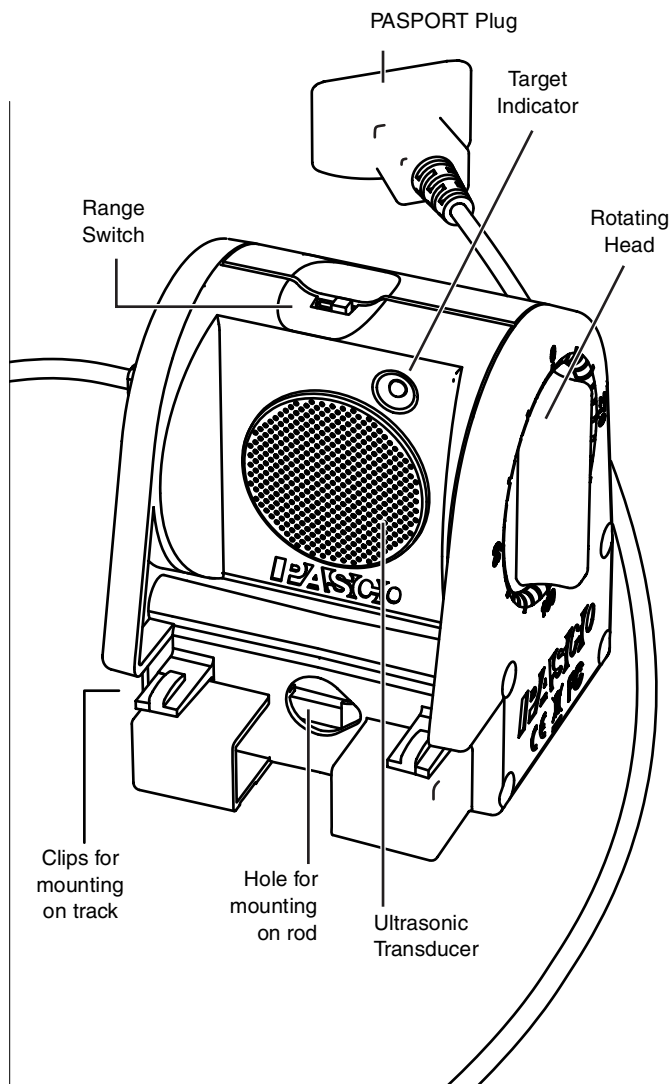
1. Connect the Motion Sensor to your PASPORT interface.
2. If you are using a computer, connect the PASPORT interface to it and start DataStudio.
3. Place an object in front of the sensor at least 15 cm away.
4. Press or click the start button to begin recording data.
5. Move the object in a straight line directly away from or toward the sensor.

## Introduction

The PS-2103A Motion Sensor works with your PASPORT interface to measure and record position, velocity, and acceleration. It produces a series of ultrasonic pulses and detects the sound reflecting back from an object in front of it. The interface measures the times between outgoing pulses and returning echoes. From these measurements, it determines the position, velocity, and acceleration of the object.

This instruction sheet includes procedures for:

- setting up the hardware and software (page 2),
- collecting data (page 2),
- changing the sample rate (page 2),
- calibrating the sensor (page 3),



- mounting the sensor on equipment (page 3), and
- troubleshooting (page 4).

Theory of operation is described on page 4, and specifications are listed on page 4.

*Note: Essential DataStudio and GLX tasks are described briefly in this instruction sheet. For more instructions press F1 to open DataStudio's on-line help or see the Xplorer GLX Users' Guide.*





## Set-up

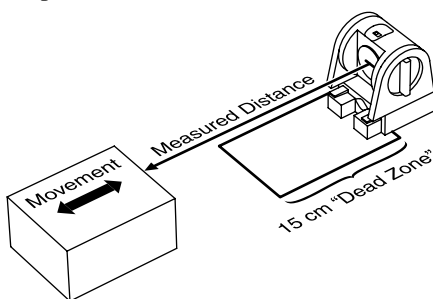
### To Connect to a PASPORT Interface

1. Connect the Motion Sensor's plug to any port of your PASPORT interface.
2. If you are using a computer, connect the PASPORT interface to it and start DataStudio.

DataStudio or your standalone PASPORT logging interface will automatically prepare itself for data collection and create a graph to display position data.

### To Aim the Motion Sensor at an Object

1. Set the range switch to the short range (  ) or long range (  ) setting.
  - Select  for measuring a cart on a track.
  - Select  for measuring most other objects.
2. Arrange the Motion Sensor and object so that the Motion Sensor's transducer faces the object.
  - The object should be at least 15 cm from the transducer.
  - If the object will move, it should move directly toward or away from the Motion Sensor.
  - Aim the motion sensor slightly up to avoid detecting the tabletop.



3. Remove objects that may interfere with the measurement. These include objects between the sensor and target object, either directly in front of the sensor or to the sides.

## Data Collection

### DataStudio

1. Click **Start**.



The Motion Sensor starts clicking. If a target is in range, the target indicator flashes with each click. DataStudio starts collecting and displaying data.

2. Click **Stop** to stop data collection.
3. Click **Start** again to start recording data in a new data run.

### Xplorer GLX (Standalone)

1. Press .


The Motion Sensor starts clicking. If a target is in range, the target indicator flashes with each click. The GLX starts collecting and displaying data.

2. Click  to stop data collection.
3. Click  again to start recording data in a new data run.





## Sensor Configuration

### To View Velocity and Acceleration

The Position measurement appears by default. You can also enable Velocity and Acceleration measurements.

- In DataStudio, click **Setup** to open the Experiment Setup window. Select the **Velocity** and **Acceleration** check boxes.
- On the GLX while viewing any display screen, press  twice to open a data source menu. Select **More** to expand the menu. Select **Velocity** or **Acceleration**.

### To Change the Sample Rate

- In DataStudio, click **Setup** to open the Experiment Setup window. Click the up or down button next to the **Sample Rate** setting.
- On the GLX, press  +  to open the Sensors screen. Highlight the **Sample Rate** setting and press  or .

The normal range of sampling rates is between 1 Hz and 50 Hz. At the default rate of 10 Hz, the Motion Sensor can measure distance up to 8 m. The maximum distance decreases with increasing sample rate. At very high sample rates (between 50 Hz and 250 Hz), the maximum distance is less than 2 m.

## To Calibrate the Motion Sensor

*Note: Calibration is usually not necessary. The following steps require DataStudio.*

1. In the Experiment Setup window, click the Motion Sensor tab.
2. Place a target object at a standard distance in front of the Motion Sensor (typically about 1 m).
3. Precisely measure the distance from the Motion Sensor's transducer to the nearest point of the target object.
4. Enter this distance (in meters) in the **Standard Distance** field.
5. Click the **Set Sensor Distance = Standard Distance** button.

DataStudio adjusts the speed-of-sound constant that it uses to calculate distance.

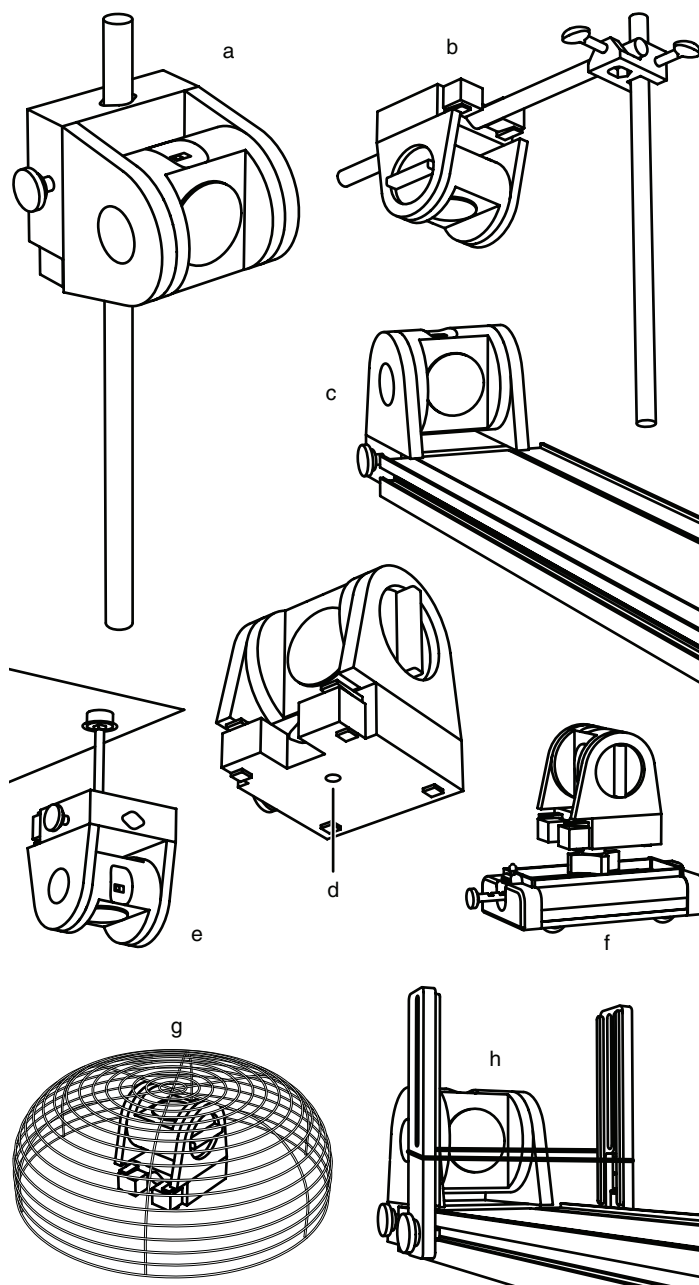
## Equipment Mounting

Mount the Motion Sensor as illustrated on a vertical rod (a) or a horizontal rod (b).

Integrated clips allow it to be attached to the end of a dynamics track (c).

A threaded hole in the bottom of the unit (d) is provided for attachment to the PS-2546 Magnetic Bracket (e), the ME-6743 Cart Adapter (f), and other 1/4-20 threaded mounting devices such as a camera tripod.

To protect the Motion Sensor from being hit by an object, use a device such as the SE-7256 Motion Sensor Guard (g) or ME-9806 bracket with a rubber band (h). The Motion Sensor can “see through” a wire screen or rubber band placed close to the transducer.



## Troubleshooting

If the Motion Sensor fails to perform satisfactorily, try these steps:

- Ensure that the target object is no closer than 15 cm.
- Switch the range switch to the other setting.
- Adjust the aim left, right, up, or down. In some cases the Motion Sensor works 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 large object if it has a harder surface.
- Remove 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 with a frequency of about 49 kHz. This burst of pulses can be heard as a single click. The ultrasonic pulses reflect off 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 uses this time and the speed of sound to calculate the distance to the object. To determine velocity, it uses consecutive position measurements to calculate the rate of change of position. Similarly, it determines acceleration using consecutive velocity measurements.

## Specifications

<b>Minimum Range</b>	15 cm
<b>Maximum Range</b>	8 m
<b>Transducer Rotation</b>	360°
<b>Range Settings</b>	<p><b>Short Range:</b> for distance measurement up to 2 m with improved rejection of false target signals and air-track noise</p> <p><b>Long Range:</b> for distance measurement up to 8 m</p>
<b>Mounting Options</b>	<ul style="list-style-type: none"> <li>• On rod up to 12.7 mm diameter</li> <li>• Directly to PASCO dynamics tracks</li> <li>• On table top</li> </ul>

## Technical Support

For assistance with any PASCO product, contact PASCO at:

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

Phone: 916-786-3800 (worldwide)  
800-772-8700 (U.S.)

Fax: (916) 786-7565

Web: [www.pasco.com](http://www.pasco.com)

Email: [support@pasco.com](mailto:support@pasco.com)

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

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