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Photogate Sensor
Product Number: ENFTG137

Overview

The Photogate Sensor measures the time it takes for an object to pass between its arms. It is especially designed for work with the Timing Wizard available in both the MiLAB™ and MultiLab™4 software - making experiments measuring speed, acceleration and velocity simple to conduct and understand. It used often used in conjunction with the Fourier Smart Pulley. The Photogate is used for a wide variety of experiments in physics and physical science.

The Photogate sensor can be connected to all types of einstein™ Tablets, einstein™LabMate™, and einstein™LabMate™+.

Typical experiments

Physics
- Measuring free fall acceleration
- Studying the swing of a pendulum
- Measuring the speed of a rolling object

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How it works

The Photogate sensor projects a narrow, infrared beam between its two legs. Normally the sensor's output is 0V, but when an object breaks the beam the output increases to 3V and the LED on the gate lights up. When an object breaks the beam, the sensor increases its output to 3V and the LED on the gate lights up.

Sensor specification

Range:	0-3V
Detector Rise Time:	180 ns
Detector Fall Time:	180 ns
Parallax Error	For an object passing within 1 cm of the detector, with a velocity less than 10 m/s, the difference between the true and effective length is less than 1 mm
Infrared Source:	Peak at 800 nm
Data Logger Port:	Digital

Calibration

The Photogate sensor is shipped fully calibrated.

Data logging and analysis

MiLAB™

1. Take your einstein™ Tablet OR pair your einstein™LabMate with your Android or iOS tablet via Bluetooth
2. Insert the sensor cable into one of the sensor ports
3. Launch MiLAB
4. MiLAB will automatically detect the sensor and show it in the Launcher View
5. Check the icon next to the sensor ( ) to enable it for logging

MultiLab4™

1. Pair your einstein™LabMate with your PC, MAC, or Linux machine via Bluetooth, or connect it via the USB cable (found in the einstein™LabMate™ box).
2. Insert the sensor cable into one of the sensor ports
3. Launch MultiLab4
4. MultiLab4 will automatically detect the sensor and show it in the Current Setup Summary window. It appears as both Photogate and Smart Pulley.
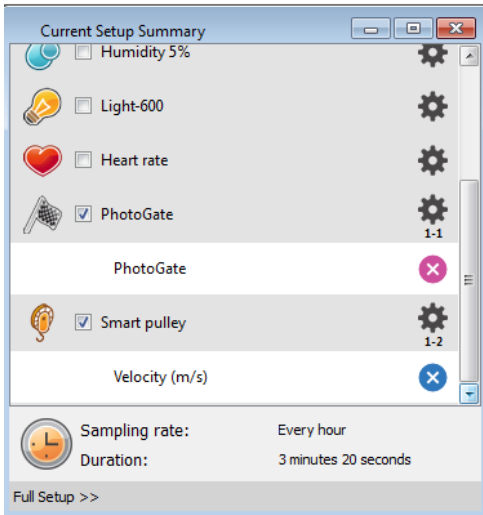
5. Click Full Setup, located at the bottom of the Current Setup Summary window to program the data logger's sample rate, number of samples, units of measurement, and other options
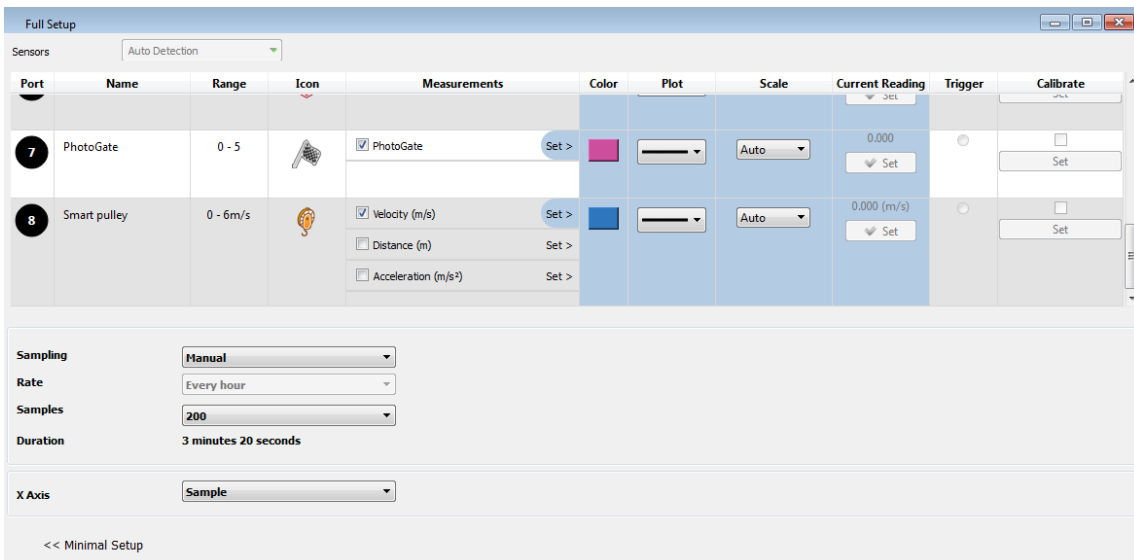
6. Click the Run button (　　)on the main toolbar of the Launcher View to start logging

Experiment set up

## Event-Based Time Measuring

The Photogate and Photogate plus Smart Pulley are most commonly used in Event-based Time Measurements - that is experiments that take measurements when certain things happen during an experiment. A good example of this would be measuring when a cart passes between the arms of a Photogate.

To use Event Based Time Measuring in MultiLab4:

1. Attach the Photogate(s) or Photogate and Smart Pulley sensor(s) to the data logger.

2. Select **Experiment Mode** 　 .

3. Select **Event Based Time Measuring** from the menu:
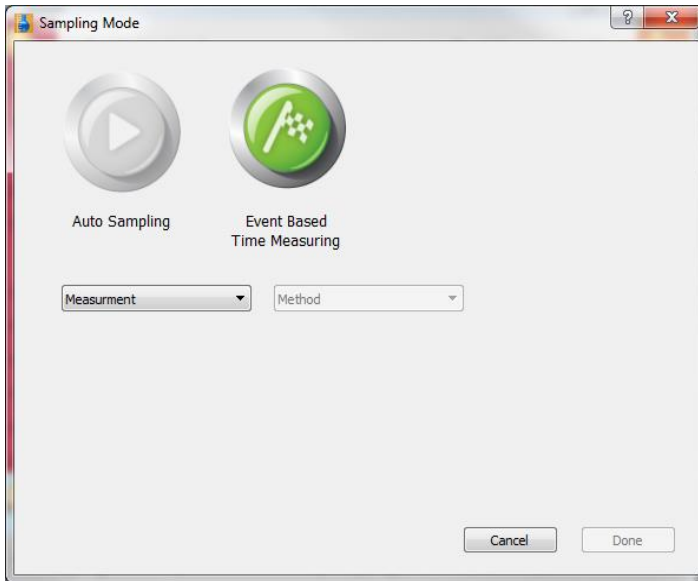
4. From the **Measurement** dropdown choose either **Time**, **Volume** or **Acceleration** (see details below).

5. Choose a **Method** from the dropdown menu (your choices are determined by the measurement method (see details below).

6. These sensors often use flags for more accurate measurements. After choosing a method, you will be able to enter the **Width** of the flag. By default MultiLab4 assumes you are working with 3 cm flags.

7. Click Done.

8. The **Run** button will be replaced by the Event Based Time Measuring button .

9. Click the **Event Based Time Measuring** button. For the duration of the experiment, the Photogate will record data according to the set parameters (for details see below).

Measuring Methods

There are various methods of analyzing the different measurements. In some measurements you will be asked to enter the dimension of the moving body, or the distance between the two Photogates to allow for the calculation of velocity and acceleration.

The methods depend on the selected **Measurement**.

Time

At one gate

Measures the time it takes the body to cross the Photogate (e.g. between blocking and unblocking the infrared beam).

Between gates

Measures the time it takes the body to move from one Photogate to the second Photogate (e.g. between blocking the first and blocking the second infrared beams).

Pendulum

Measures the time period of an oscillating body (e.g. the time interval between blocking the beam the first and third

times).

Velocity

At one gate

Measures the time it takes the body to cross the photogate (e.g. between blocking and unblocking the infrared beam) and returns the velocity.

You should enter the body's width.

Between gates

Measures the time it takes the body to move from one photogate to the second photogate (e.g. between blocking the first and blocking the second infrared beams) and returns the average velocity.

You should enter the distance between gates.

Acceleration

At one gate

A card with two flags must be attached to the moving body. The Timing Wizard measures the crossing time intervals of the two flags and returns the acceleration.

You should enter the flags width.

Between gates

Measures the crossing time at the first gate, the time it takes the body to move from one gate to the second gate and the crossing time at the second gate and returns the average acceleration.

You should enter the distance between the gates.

Auto Sampling

A second option, in MultiLab4, is to create a graph using a Photogate and then analyze the results using the Photogate feature.

1. Attach the Photogate(s) to the data logger.

2. Conduct the Experiment.

3. Use the Cursor function to select a range of the graph.

4. Click Photogate in the Analysis menu.

5. Choose to measure **Time**, **Velocity** or **Acceleration** and click **Next.**

6. If you choose to measure **Time** you must then choose **At one gate**, **Between gates** or **Pendulum (one gate).**

7. If you choose to measure **Velocity**, you must then choose **At one gate**, **Between gates**, or **Collision (two gates).**

8. If you choose to measure **Acceleration**, you must then choose **At One Gate** or **Between Gates**. In these types of experiments flags are often used to help collect the data. For an accurate measurement you must input the width of the body you are measuring in the Width box.

9. Click **Finish.**

Measuring Methods

Photogate offers you various methods of analyzing the different measurements. In some measurements you will be asked to enter the dimension of the moving body, or the distance between the two Photogates to allow for the calculation of velocity and acceleration.

The methods depend on the selected **Measurement**:

Time

At one gate

Measures the time it takes the body to cross the photogate (e.g. between blocking and unblocking the infrared beam).

Between gates

Measures the time it takes the body to move from one photogate to the second photogate (e.g. between blocking the first and blocking the second infrared beams).

Pendulum

Measures the time period of an oscillating body (e.g. the time interval between blocking the beam the first and third times).

Velocity

At one gate

Measures the time it takes the body to cross the photogate (e.g. between blocking and unblocking the infrared beam) and returns the velocity.

You should enter the body's width.

Between gates

Measures the time it takes the body to move from one photogate to the second photogate (e.g. between blocking the first and blocking the second infrared beams) and returns the average velocity.

You should enter the distance between gates.

Collisions

Measures the crossing time intervals at each gate and returns the corresponding velocities.

You should enter the bodies' width (the width of the two bodies must be identical).

Acceleration

At one gate

A card with two flags must be attached to the moving body. The Timing Wizard measures the crossing time intervals of the two flags and returns the acceleration.

You should enter the flags width.

Between gates

Measures the crossing time at the first gate, the time it takes the body to move from one gate to the second gate and the crossing time at the second gate and returns the average acceleration.

You should enter the distance between the gates.

Contents

The Photogate sensor comes equipped with:
- Photogate sensor
- Mounting Bar

The Photogate sensor is most commonly used along with the Timing Wizard found in both the MultiLab4 and MiLAB™ software. Please refer to the documentation in those programs for more details.

An example of using the Photogate Sensor

Exploring Velocity

In this experiment we will explore velocity using two photogates Fourier's Dynamic Track system. First we will measure the time (Δt) it takes for the cart to travel from one gate to the other. We will then use the distance (Δx) between the gates to determine the velocity of the cart using the equation: $v = \frac{\Delta x}{\Delta t}$.

Equipment:
- einstein™ Tablet or einstein™ LabMate™
- 2 Photogate sensors
- Dynamic Cart
- Dynamic Track
- Flag
- 2 stands
- 2 right angle clamps
- Measuring Tool

Equipment Setup
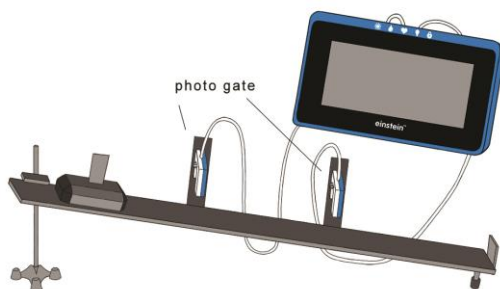1. Set up the Dynamic Track and Photogates as seen in Illustration 1:

Illustration 1

2. Assemble the equipment as shown in Figure 1.
3. Mount two photogates along the incline, 60cm apart, so that the cart's flag will block the photogates when passing through them.
4. Measure the distance between the photogates and write it down.
5. Mark a launching point on the track, just above the upper photogate.
6. **Note: It is important to launch the cart from the same point at every attempt.**
7. Launch either MultiLab4 or MiLAB.
8. Make sure only the Photogate sensors are selected.
9. Select the Event Based Time Measuring, then select Velocity, Between the Gates and enter the distance between the Photogates.

10. Select Run
11. Logging will begin as the cart passes through the first gate and end as it passes through the second.
12. Run again several times, each time moving the Photogates closer together.

Troubleshooting

If the sensor isn't automatically recognized by MultiLab4/ MiLAB, please contact Fourier Education's technical support.

Technical support

For technical support, you can contact the Fourier Education's technical support team at:
Web: www.einsteinworld.com/support
Email: support@fourieredu.com
Phone (in the US): (877) 266-4066

Copyright and Warranty

All standard Fourier Systems sensors carry a one (1) year warranty, which states that for a period of twelve months after the date of delivery to you, it will be substantially free from significant defects in materials and workmanship. This warranty does not cover breakage of the product caused by misuse or abuse.
This warranty does not cover Fourier Systems consumables such as electrodes, batteries, EKG stickers, cuvettes and storage solutions or buffers.

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