

Photo Gate Sensor

(for EcoLog XL)

DT137



The Photo Gate sensor is a general-purpose photo gate that measures the time it takes for an object to pass between its arms.

The Photo Gate sensor is used for a wide variety of experiments in physics and physical science classes and is supplied with a mounting rod.

Typical Experiments

- Measuring the free fall acceleration
- Studying the swing of a pendulum
- Measuring the speed of a rolling object
- Measuring the speed of objects undergoing collisions

How it Works

The Photo Gate sensor has a narrow, infrared beam and fast response time, which provides very accurate signals for timing. When the infrared beam between the source and detector is blocked, the output of the photo gate is *high* (high voltage, 5 V, on the graph) and the light-emitting diode (LED) on the photo gate lights up. When the beam is not blocked; the output is *low* (low voltage, 0 V, on the graph) and the LED is off.

When working with EcoLog XL and EcoLab software, it is recognized as a **0-5 V** sensor.

Sensor Specification

Range:	0 V – 5 V
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 Photo Gate sensor is shipped fully calibrated.


Measuring Timing Events with the Photo Gate Sensor and EcoLog XL

In Timer mode EcoLog XL measures simple time events from Input A to Input B. digital switches, like photo gates, must be connected to both Input A and Input B. For example, if two photo gates are connected EcoLog XL will measure the elapsed time between blocking the beam of the photo gate connected to Input A and blocking the beam of the photo gate connected to Input B. EcoLog XL waits until gate B is unblocked, then displays the elapsed time.

At the same time EcoLog XL stores the full four events (blocking and unblocking at the two gates) in the memory. These events can be downloaded and displayed in EcoLab.

Up to 1000 timing events can be stored in one Timer session. The minimum event time is 0.01s and the maximum event time is 999.99s.

To perform a timing measurement with EcoLog XL:

1. Connect photo gates to both the external inputs
2. Move through the cycle of modes by pressing **Scroll**  button until the **Timing** mode is displayed:

Timing

Go to confirm

3. Press **Go**  to confirm.

If one or both the inputs are empty, you will be asked to connect both photo gates:

Please connect
Both switches


After connecting both photo gates EcoLog XL enters the timing mode and displays:

No. taken


Timing begins each time a body enters photo gate A and ends when leaving photo gate B. EcoLog XL then displays the elapsed time between entering the gates along with the measurement number, for example:

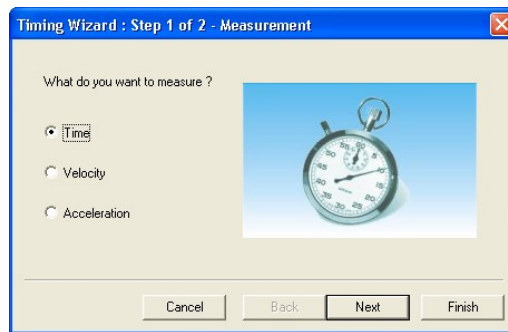
No. taken 03
0.79 sec

At the same time EcoLog XL stores the full four events (blocking and unblocking at the two gates) in the memory.

4. To cancel any pending timing event, to exit the Timing mode and return to the main menu. Press the **Stop**  button.
5. The stored data can now be downloaded to a computer for analysis.


Measuring Timing Events with the Photo Gate Sensor with EcoLog XL and EcoLab Software

1. Click **Timing Wizard**  on the main toolbar to switch to Timing mode and to open step 1 of the Timing Wizard dialog:



2. Click an option to select measurement: **Time**, **Velocity** or **Acceleration**
3. Click **Next** to move to step 2:



4. Click an option to select the measuring method (see next section).
5. If required enter the body's width, or the distance between the gates in cm in the appropriate edit box (in velocity and acceleration measurements only)
6. Click **Finish**.
7. Click **Run**  on the main toolbar to begin measuring.

To change the measurement or the method: Click **Analysis** on the menu bar, then click **Timing Wizard**.

To analyze the same data with another measurement or method: Select the desired options with the Timing Wizard, then download the data from EcoLog XL.

To exit Timing mode click **Timing Wizard**  a second time.

Measuring methods

The Timing Wizard 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:

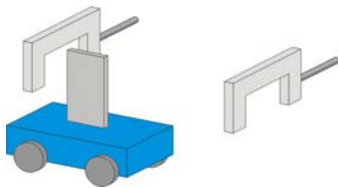
Time

At one gate



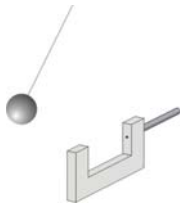
Measures the time it takes the body to cross the photogate (between blocking and unblocking the infrared beam)

Between gates



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

Pendulum



Measures the time period of an oscillating body (the time interval between the first and the third blockings of the beam)

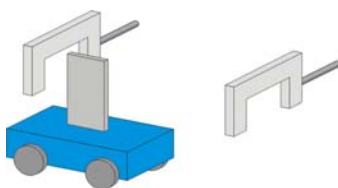
Velocity

At one gate



Measures the time it takes the body to cross the photogate (between blocking and unblocking the infrared beam) and returns the velocity. You should enter the body's width

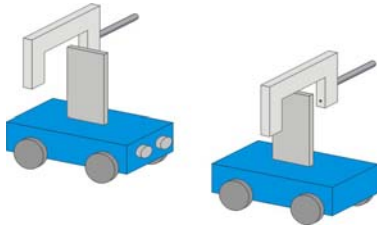
Between gates



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

You should enter the distance between gates

Collisions

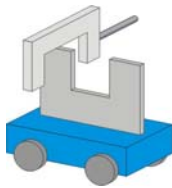


Measures the crossing time intervals at each gate and returns the corresponding velocities.

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

Acceleration

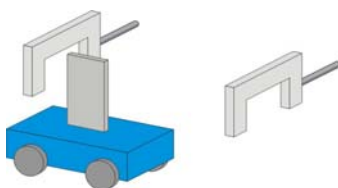
At one gate



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

You should enter the flags width

Between gates



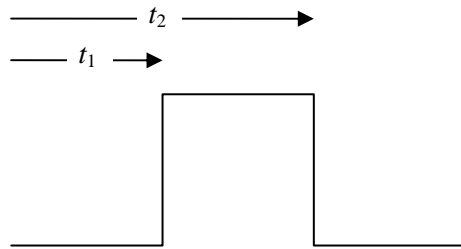
Measures the crossing time at the first gate, the time it takes the body to move from one gate to the second gate and the crossing time at the second gate and returns the average acceleration.

You should enter the body's width

Time schemes and calculations

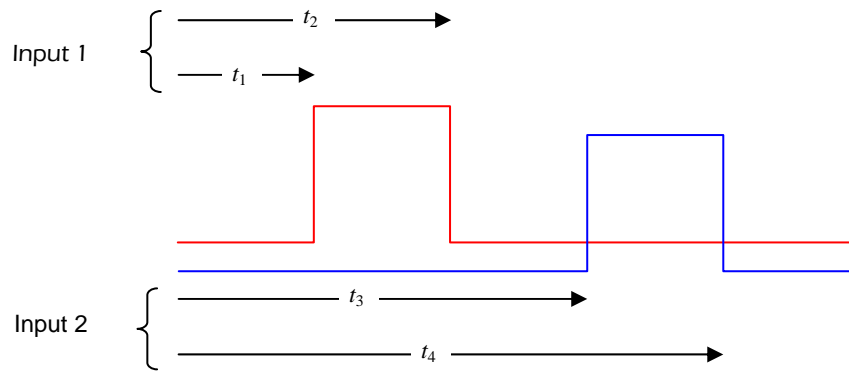
Time measurements

At one gate



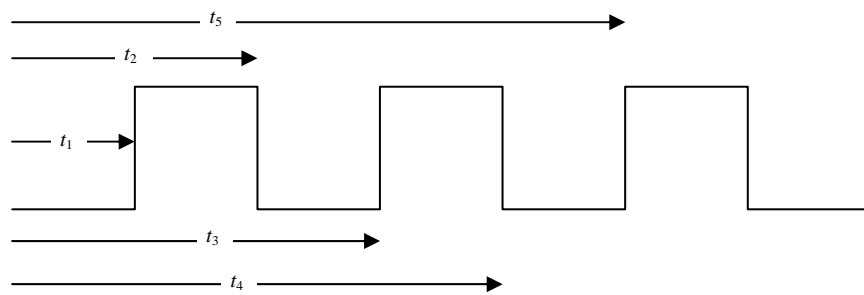
Result: $\Delta t = t_2 - t_1$

Between gates



Result: $\Delta t = t_3 - t_1$

Pendulum (one gate)

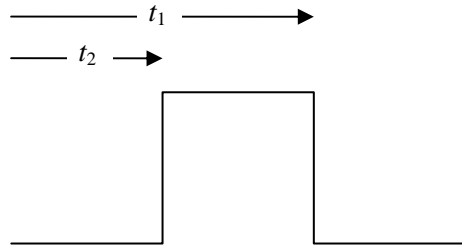


Result: $\Delta t = t_5 - t_1$

Velocity

At one gate

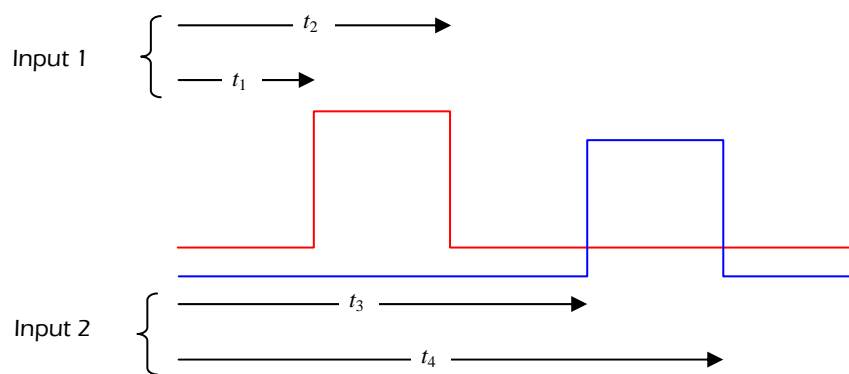
Required parameters: w – the body's width



Result: $v = \frac{w}{\Delta t}; \Delta t = t_2 - t_1$

Between gates

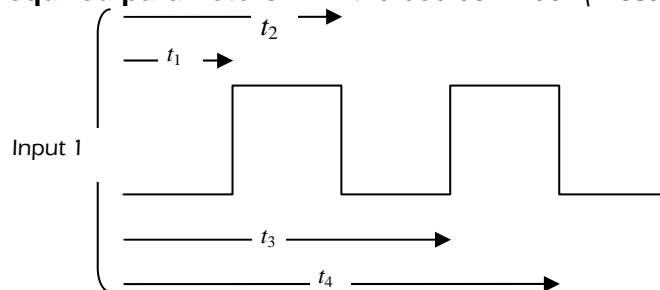
Required parameters: L – the distance between gates

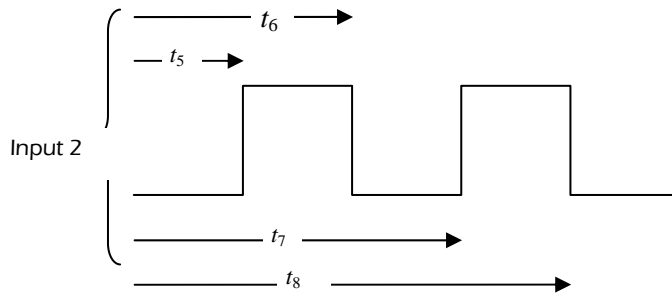


Result: $v = \frac{L}{\Delta t}; \Delta t = t_3 - t_1$

Collision (two gates)

Required parameters: w – the bodies' width (must be identical)





Result:

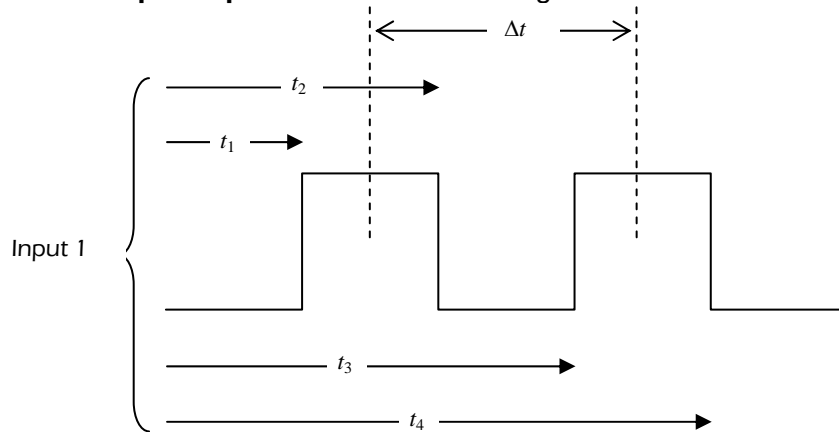
$$u_1 = \frac{w}{t_2 - t_1}; \quad v_1 = \frac{w}{t_4 - t_3}$$

$$u_2 = \frac{w}{t_6 - t_5}; \quad v_2 = \frac{w}{t_8 - t_7}$$

Acceleration

At one gate

Required parameters: w – the flags' width



Result:

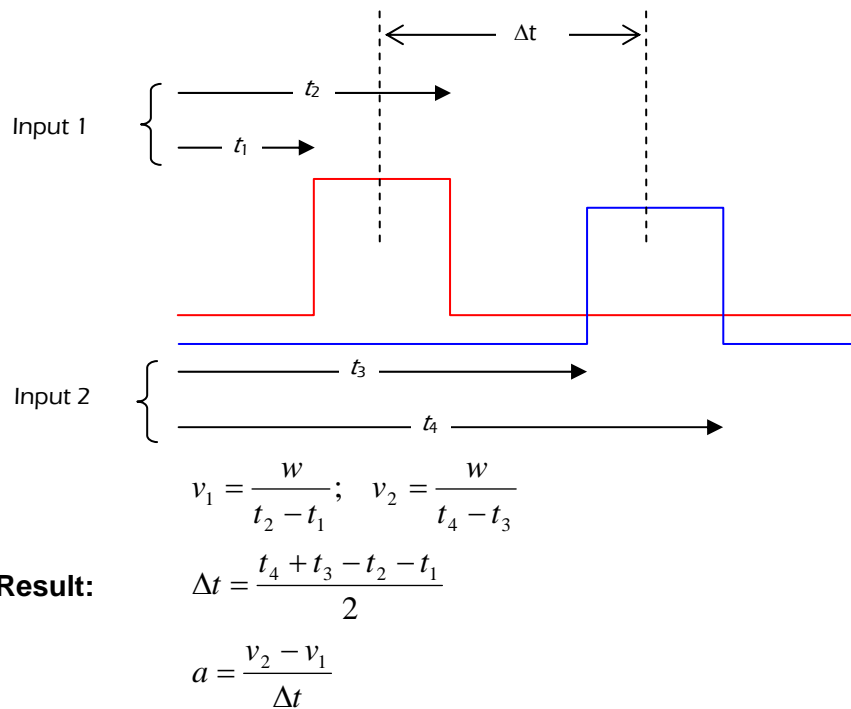
$$v_1 = \frac{w}{t_2 - t_1}; \quad v_2 = \frac{w}{t_4 - t_3}$$

$$\Delta t = \frac{t_4 + t_3 - t_2 - t_1}{2}$$

$$a = \frac{v_2 - v_1}{\Delta t}$$

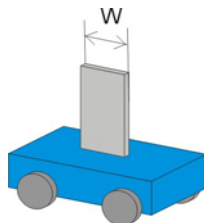
Between gates

Required parameters: w – the body's width

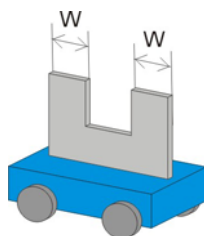


Tips on using flags with the Timing Wizard

When measuring the motion of a moving cart it is convenient to attach a vertical 'flag' to the cart (see picture below). You can mount a slotted wooden block on the cart and insert the flag onto the slot, or use masking tape to attach the flag to one side of the cart.



Use a double flag to measure acceleration at one gate. The width of the two flags must be the same.



An Example of using the Photo Gate Sensor

FREE FALL ACCELERATION

By using two photogates we can measure the velocity of a falling body at each gate and the time it takes the body to move from one gate to the other – thus enabling EcoLog XL to calculate the acceleration.

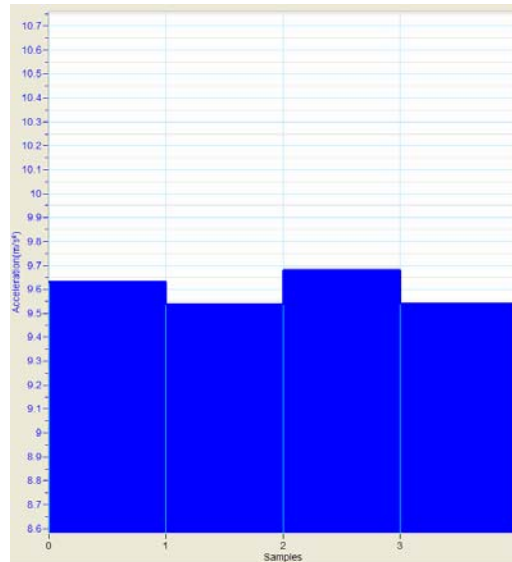


Figure 1: Using the photo gate to measure the free fall acceleration

Technical Support

Please contact Fourier technical support as follows:

Web: http://www.fourier-sys.com/support_support.html

Email: support@fourier-sys.com

Consult the FAQs before contacting technical support:

http://www.fourier-sys.com/support_faq.html

Copyright and Warranty

All standard Fourier Systems sensors carry a one-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.