

## NEULOG PHOTO GATE LOGGER SENSOR GUIDE



### NeuLog photo gate logger sensor NUL-209

The NeuLog photo gate sensor can be used for any science experiment which involves taking accurate velocity and/or acceleration measurements especially in the field of Physics.

The sensor comes pre-calibrated so you can start experimentation right out of the box using this guide.

Among hundreds of possible experimental subjects that can be studied with the NUL-209 sensor are: velocity/acceleration/distance relationships, impulse, collisions, conservation of energy, force, momentum, and many more.

The photo gate sensor uses an infrared beam which detects if an object is passing through it. Therefore, the sensor actively reads out as "open" or "blocked". While collecting data however, there are several parameters to truly customize your experiment:

- Velocity with a single gate
- Velocity with two gates
- Acceleration with a single gate
- Acceleration with two gates
- Change in time between two gates
- Velocities with timing card.

For the "two gates" options you will need two separate photo gate modules. Experiment customization is explained after the following quick start guide.

#### Notes:

The photo gate sensor cannot work together with any other NeuLog sensor. A special message appears when another sensor is connected together with the photo gate sensor.

The photo gate sensor cannot work in the off-line mode since it is mandatory for it to be connected to the computer for its operation options. The off-line mode is disabled when the application finds that the photo gate sensor is connected.

The photo gate sensor cannot work with the Graphic display module, VIEW-101.

#### Quick start procedure:

##### PC or Mac Computer

##### Materials needed:

- NUL-209 Photo Gate Sensor
- USB-200 USB Module
- A USB to mini USB cable (included with the USB-200 module)

Your photo gate sensor needs to be connected to a USB-200 module. The USB-200 module then connects to a computer via a USB to mini-USB cable. Please note that you cannot plug the photo gate sensor directly into the computer.

The browser based application can be downloaded for free at [www.NeuLog.com](http://www.NeuLog.com) as well as a full application user guide.

Choose "Downloads" on the main menu and then choose "Software and Application".

##### Procedure:

1. Install the NeuLog application.
2. Connect the USB-200 module to the PC or Mac
3. Connect the photo gate sensor (or sensors) to the USB-200 module (they directly plug together). Please note that no calibration is required for this sensor.
4. Open the NeuLog application by clicking on the shortcut on the screen.
5. Once a photo gate sensor module box appears on the left side of the screen the probe has been automatically identified and you can begin experimentation.
6. If the photo gate sensor is not automatically identified then click the "Search for sensors" icon to find the sensor.
7. Click on the "On-line experiment" icon; this will open an empty table.
8. Click on the "Experiment setup" icon to change the experiment options (velocity with single gate for example).
9. The photo gate sensor will give a live reading in its module box to the left side of the screen while plugged in (Open or Blocked).
10. To run an experiment and collect data click the "Run experiment" icon.
11. To end data collection, click the "Stop experiment" icon.

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### Tablet, smart phone device

#### Materials needed:

- NUL-209 Photo Gate Sensor
- WIFI-201 WiFi module
- BAT-200 Battery

Your photo gate sensor needs to be connected to a WIFI-201 module. The WIFI-201 module will create a closed NeuLog WiFi network which will stream the NeuLog data to a device of your choosing. Once your device is wirelessly connected to the NeuLog network, you can run experiments and collect data through a browser of your choosing.

#### Procedure:

1. Connect the photo gate sensor directly to the left side of a WIFI-201 module (no wires required).
2. Connect a BAT-200 module to the right side of the WIFI-201 module.
3. Although not required, we recommend plugging the BAT-200 to an outlet using a USB to mini USB charger (such as a typical cell phone charger). The WIFI-201 module will run for 60-90 minutes (depending on the sensor) without being plugged in.
4. The WIFI-201 can be powered directly using a mini to USB cord and plugging it into your computer or a wall charger. Please note this function is only available on WIFI-201 modules with the USB icon on the cover.
5. For further WIFI-201 instructions or the WIFI-201 quick start guide please visit: [www.NeuLog.com](http://www.NeuLog.com); Choose "Products" on the main menu, then choose "WiFi Communication module".
6. The WIFI-201 indicator lights will flash; take no action until the LED to the far left turns blue; this can take up to one minute.
7. Take your tablet or smart phone, go to the WiFi settings and select the NeuLog network (NeuLog0184 for example) which matches the ID found on the back of the WIFI-201 module (0184 for example).
8. Give your device about 20 seconds to connect to the WIFI-201 module.
9. Once the device is connected, go to your browser and type the website **wifi201.com** into the URL bar, then wait for 30-60 seconds.
10. You will see a "Control mode" icon in the application, click on this icon.
11. The application will then load a new screen and begin to auto detect the sensor(s); this can take a minute. (You can stop the search when the sensor is found.)
12. If the application does not auto detect the sensor(s), select "Search for sensors".
13. Once the sensor is found you will see a module box on the left side of the screen for the photo gate sensor. In this box, real time data will be displayed.
14. Click on the "On-line experiment" icon; this will open an empty table.
15. Click on the "Experiment set up" icon to change the experiment options (velocity with single gate for example).
16. The photo gate sensor will give a live reading in its module box to the left side of the screen while plugged in (Open or Blocked).
17. To run an experiment and collect data, click the "On-Line experiment" icon, then click the "Run experiment" icon.
18. If you have a newer generation WIFI-201 module (with the USB icon on the cover) this can be used as a USB-200, meaning you can tether the probes directly to the computer using the WIFI-201. To engage operation in this fashion, press 3 times on the panel button. Repeating this operation will return the module to WiFi mode.

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### Experiment customization:

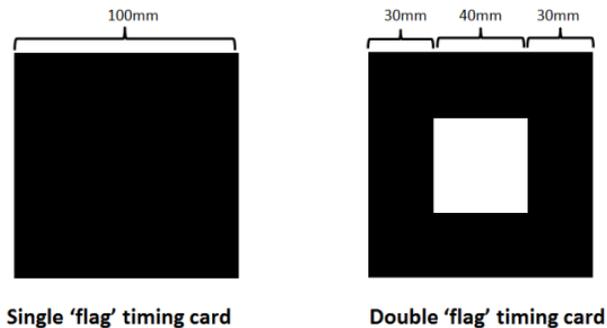
The NeuLog photo gate sensor offers several different experimental customization options. To access them, click on the "Experiment Setup" icon after your photo gate sensor has been detected.

### Timing cards:

Making timing cards is a unique option to further customize any experiment with the NeuLog photo gate sensor. To make timing cards we recommend cutting your desired shapes out of black plastic for the most accurate readings though even plain paper works just fine.

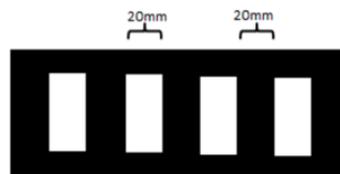
Timing cards examples:

#### For free fall experiments:



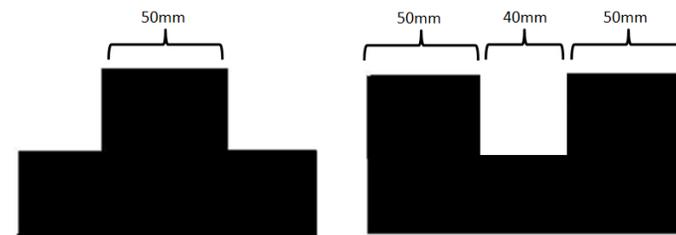
Single 'flag' timing card

Double 'flag' timing card



Multi 'flag' timing card

#### For moving cart experiments:



Single 'flag' timing card

Double 'flag' timing card

#### Velocity with a single gate:

Velocity with a single gate is the very basic velocity measurement using only one photo gate sensor and any object with a known width.

1. Click the "Experiment Setup" icon in the NeuLog application and select "Velocity with a single gate".
2. The figure shows the basic idea of what your experimental setup should look like.
3. Measure and input the object width (in millimeters) into the text field under the figure labeled "X[mm]".
4. Click "Save" and then you are ready to begin data collection.
5. Click on the "Run Experiment" icon.
6. For each time that the card passes through the photo gate, you will receive the time it took for it to pass and its velocity.



#### Acceleration with a single gate:

Acceleration with a single gate requires an object (or timing card) with two flags (example shown above) with known widths.

1. Click the "Experiment Setup" icon in the NeuLog application and select "Acceleration with single gate".
2. The figure shows the basic idea of what your experimental setup and timing card/object should look like.



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3. Measure and input the width for both flags.
4. Click "Save" and then you are ready to begin data collection.
5. Click on the "Run Experiment" icon.
6. For each time that the card passes through the photo gate, you will receive its acceleration.

### Acceleration with two gates:

Acceleration with two photo gates requires two NeuLog photo gate sensors and an object or timing card with a known width.

1. Click the "Experiment Setup" icon in the NeuLog application and select "Acceleration with two gates".
2. The figure shows the basic idea of what your experimental setup should look like.
3. Measure and input the width of your object (in millimeters) into the text field under the figure labeled "X[mm]".
4. Assign each of your photo gate sensors to both the "Sensor A" and "Sensor B" position.
5. Click "Save" and then you are ready to begin data collection.
6. Click on the "Run Experiment" icon.
7. For each time that the card passes through the two photo gates, you will receive its acceleration.



### Velocity with two gates:

The velocity with two gates option is ideal for experiments which examine collisions between two objects of known width and mass.

1. Click the "Experiment Setup" icon in the NeuLog application and select "Velocity with two gates".
2. The figure shows the basic idea of what your experimental setup should look like.
3. Measure and input the width and mass for both objects passing through the photo gates.
4. Assign each of your photo gate sensors to both the "Sensor A" and "Sensor B" position.
5. Be sure to space the photo gates far enough apart to allow for a collision between the two objects before they rebound back through the photo gates.
6. Click "Save" and then you are ready to begin data collection.
7. Click on the "Run Experiment" icon.



8. For each time the cards pass through the photo gates, you will receive the velocity and momentum of each one of them.

### Change in time between two gates:

Change in time between two photo gates requires two NeuLog photo gate sensors and an object or timing card with a known width.

1. Click the "Experiment Setup" icon in the NeuLog application and select "Delta t between two gates".
2. The figure shows the basic idea of what your experimental setup should look like.
3. Measure and input the width of your object (in millimeters) into the text field under the figure labeled "X[mm]".
4. Assign each of your photo gate sensors to both the "Sensor A" and "Sensor B" position.
5. Click "Save" and then you are ready to begin data collection.
6. Click on the "Run Experiment" icon.
7. For each time that the card passes through the two photo gates, you will receive the time difference between the first photo gate blocked and the second photo gate blocked.



### Velocities with timing card:

Velocities with timing card experiments require one NeuLog photo gate sensor and an object or timing card (a multi 'flag' is recommended). A known width is not required for the time measurements, it is however required for velocity calculations.

1. Click the "Experiment Setup" icon in the NeuLog application and select "Velocities with timing card".
2. The figure shows the basic idea of what your experimental setup should look like.
3. Choose the expected experiment. A longer duration will include fewer samples. Click "Save" and then you are ready to begin data collection (scroll the menu down to find the save button).
4. Click on the "Run Experiment" icon.
5. You will get the time difference in which every black flag passed through the photo gate. Velocities can be calculated by dividing the flag width by the time difference.



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### Included with the sensor:

- NeuLog NUL-209 Photo Gate Sensor Guide (this document)
- Infrared transmitter and receptor housed in the photo gate unit
- Threaded rod for easy connection to retort stands or other labware

### Sensor specifications

<b>ADC resolution</b>	Digital
<b>Accuracy</b>	100 $\mu$ s
<b>Resolution</b>	100 $\mu$ s
<b>Max sample rate (S/sec)</b>	10,000

### Sensor features:

- Fully digital data
- Rugged plastic ergonomic case
- Internally housed infrared transmitter and detector
- Photo gate handle with two threaded holes to customize your experimental setup
- Push button switch for Start/Stop experiments in off line mode
- LED indicator of experiment status (blinks while collecting data)
- Pre-calibrated sensing equipment

**Note:** NeuLog products are intended for educational use.

### Videos and experiment examples:

- Videos, literature and other probes can be found at [www.NeuLog.com](http://www.NeuLog.com).
- In order to access the photo gate sensor's page, choose "Products" on the main menu and then "Photo gate logger sensor".
- In order to find the science experiments, choose "Experiments" on the main menu of the NeuLog website, then choose "Physics", "Chemistry", "Biology" or "Environmental Science".

### Physics Experiments:

- Velocity of Free Falling Objects (P-35)
- Horizontal Launched Projectile Motion (P-49)

### Technical background:

The philosophy behind NeuLog's plug and play technology is based on each sensor's ability to store its own data due to an internal flash memory chip and micro-controller in each plastic NeuLog body. This technology allows the sensor to collect and then store the digital data in the correct scientific units ( $^{\circ}$ C,  $^{\circ}$ F, Lux, %, ppm, for example).

The sensor is pre-calibrated at the factory. The built-in software in the logger can be upgraded for free at any time using the provided firmware update.

The NeuLog photo gate sensor uses an infrared beam to determine when an object has passed through the photo gate. In every point where there is a break in the infrared beam, a 1 is registered in the program.

The NeuLog sensor firmware calculates velocities and accelerations based on the record of 1's and 0's as well as the experimental inputs. The computer program gets processed data from the sensor.

### Maintenance and storage:

- Never submerge the NeuLog plastic body in any liquid.
- Do not allow liquid into the photo gate sensor's body and probe.
- After use, gently wipe away any foreign material from the photo gate sensor.
- Store in a box at room temperature out of direct sunlight.

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### Warranty:

We promise to deliver our sensor free of defects in materials and workmanship. The warranty is for a period of 3 years from the date of purchase and does not cover damage of the product caused by improper use, abuse, or incorrect storage. Sensors with a shelf life such as ion selective probes have a warranty of 1 year. Should you need to act upon the warranty, please contact your distributor. Your sensor will be repaired or replaced.

Thank you for using NeuLog!



Flexible, simple, fast, forward thinking.

W: [www.neulog.com](http://www.neulog.com)

E: [info@neulog.com](mailto:info@neulog.com)

A: 850 St Paul Street, Suite 15, Rochester, NY 14605

P: 1.866.553.8536

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