

## NEULOG MOTION LOGGER SENSOR GUIDE



### NeuLog motion logger sensor NUL-213

The NeuLog motion sensor can be used for any science experiment or activity which requires accurate distance, velocity, or acceleration readings such as in the fields of Physics, Mechanics, Physiology, Biology, etc

The sensor comes pre-calibrated so you can start experimentation right out of the box using any of the following guides.

The motion sensor uses an ultrasonic transducer to both transmit an ultrasonic wave, and to measure its echo return. Objects in the range of 0.15 to 6 meters can accurately be measured to give distance, velocity, and acceleration readings using this method.

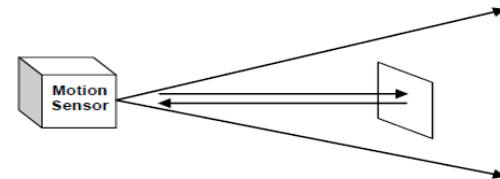
Just a few of the thousands of possible experiments that can be done with the NUL-213 sensors are: gravity experiments, ball drops, momentum, impulse, conservation of energy, kinetic vs. potential energy, and many more.

The motion sensor can collect data using the following units of measure:

- Meters (m): The SI distance unit
- Meters/second (m/s): The SI velocity unit which measures the distance traveled over time.
- Meters/second<sup>2</sup> (m/s<sup>2</sup>): The SI acceleration unit which measures the change in velocity over time.

### For best results:

The NUL-213 motion sensor has a working range between 0.15m and 6.0 meters, results may be inconsistent outside of this range. Ultrasonic waves that are emitted from the sensor and spread out in a cone pattern at about 15° around the point of reference.



- If possible, attach the sensor to something stable to avoid movements which can give skewed readings.
- If you get poor readings, another object in the foreground or background that is within the cone that may be reflecting the ultrasonic waves to add noise to the experiment.
- Use objects which are at least 10cm x 10cm when tracking specific targets.
- For smaller targets we recommend starting the object closer to the sensor, for larger objects we recommend starting farther away.
- When testing in areas with many hard surfaces; the waves may bounce around and create extra noise for the detector. This can cause irregular graphs. To reduce the noise level try covering some of the surrounding surfaces with a soft material to dampen sound such as cloth or foam.
- When using the motion sensor to detect an individual's movements; trying carrying the sensor instead of pointing the sensor at one self. For example to measure a student's velocities have them walk or run with the sensor while pointing it at the wall.
- Make sure your motion sensor is not mounted near a computer, monitor, or television.
- Sometimes other sources of sound (such as fans, motors, etc can affect results).
- Try various sample rates until the cleanest data is observed, slow rates may provide better results for certain experiments.

### Distance, velocity, and acceleration graphs:

During motion experiments it is often beneficial to show distance, velocity, and acceleration all on the same graph. Using the NeuLog software it is very easy to plot all three graphs at once:

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1. Use one of the following guides located in the “Quick start procedure” section of the instruction manual to connect the motion sensor to your chosen device.
2. Once your motion sensor has been detected; click the motion sensor icon and change the range to “Distance”
3. Ensure the “Speed & Acceleration” button is selected; it will have a pink color when selected.
4. Collect data.
5. Click the motion sensor icon again.
6. This time click on the pink “Speed & Acceleration” button, this will cause the data to change into table form on the right.
7. Underneath the graph select the “Graph” button to see the data in graphic form.

**Note:** The velocity and acceleration graphs are assigned colors; to view which is which you can click the motion sensor icon again and this time the words “Speed” and “Acceleration” will be colored according to the graph.

### Quick start procedure:

#### PC or Mac Computer

##### Materials needed:

- NUL-213 Motion Sensor
- USB-200 USB Module
- A USB to mini USB cable (which comes with the USB-200)

Your motion 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 motion sensor directly into the computer.

Resident PC software and browser based software can be downloaded for free at [www.NeuLog.com/download](http://www.NeuLog.com/download) as well as a full software user guide. **Note:** Make sure not to download and install both types of software they will conflict on the computer.

##### Procedure:

1. Install the NeuLog software
2. Connect the USB-200 module to the PC or Mac
3. Connect the motion sensor to the USB-200 module (they directly plug together). Please note there is no calibration required for this sensor.
4. Open the NeuLog software.

5. Once a motion sensor logo appears on the left side of the screen the probe has been automatically identified and you can begin experimentation.
6. If the motion sensor is not automatically identified then click the “Search for sensors” icon to find the sensor.
7. Select the “On-line experiment” button; this will open a graph below.
8. Click on the “Module setup” button located on the motion sensor icon in the module window to change the sensor settings if need be.
9. Click on the experiment set up button to change the experiment settings if need be (experiment duration for example).
10. The motion sensor will give a live reading in the box to the left of the screen while plugged in.
11. To run an experiment and collect data click “Run experiment”.
12. To end data collection early, click “Stop experiment”.

#### Tablet, smart phone device

##### Materials needed:

- NUL-213 Motion Sensor
- WIFI-201 WIFI module
- BAT-200 Battery

Your motion 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 motion 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 micro USB charger (such as a typical cell phone charger). The WIFI-201 module will run for 15-75 minutes (depending on the sensor) without being plugged in.
4. For further WIFI-201 instructions or the WIFI-201 quick start guide please visit [www.NeuLog.com/download](http://www.NeuLog.com/download).
5. The WIFI-201 indicator lights will flash; take no action until the LED to the far left turns blue.

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6. Take your tablet or smart phone and go to the Wi-Fi settings and select the NeuLog network which matches the WIFI module ID found on the back of the WIFI-201 device. (NeuLogXXXX for example)
7. Give your device 1-2 minutes to connect to the WIFI-201 network.
8. Once the device is connected go to your browser and type in the website wifi201.com into the URL bar, then wait for 30-60 seconds.
9. You will see a "Control mode" icon in the browser, click on this icon.
10. The browser will then load a new screen and begin to auto detect the sensors, this can take a few minutes.
11. If the browser does not auto detect, select "Search for sensors"
12. Once the sensor is found you will see an icon on the left side of the screen for the motion sensor. The icon will display data in real time.
13. To set the motion sensor's settings click on "Module setup" button located on the motion sensor icon on the left side of your screen.
14. To change the experimental settings click the "Experiment setup" button (experiment duration for example).
15. To run an experiment and collect data click "Run experiment".

### Operation with NeuLog viewer

#### Materials needed:

- NUL-213 Motion Sensor
- VIEW-101 Viewing Module
- BAT-200 Battery

#### Procedure:

1. Connect the motion sensor to the left side of the viewer.
2. Connect the BAT-200 module to the right side of the viewer.
3. The VIEW-101 will auto detect the sensor and you will see it appear on the left side of the screen.
4. Once the sensor appears it will be monitoring data in real time.
5. To run an experiment and collect data click the run button (little green person).

### Off-line experiments

(Off-line experiments are for when you do not have a sensor connected directly to a computer, tablet, smartphone, or NeuLog viewer).

#### Materials needed:

- NUL-213 Motion Sensor
- BAT-200 Battery

#### Materials needed to configure your offline experiment:

- USB-200 USB Module or WIFI-201 WIFI module or VIEW-101 Viewing Module
- A USB to mini USB cable (which comes with the USB-200)

#### Procedure:

1. Connect the motion sensor directly to the left side of a charged BAT-200 module.
2. When ready to collect data press the "Start/Stop" button on the motion sensor, a red light will turn on for the duration of the experiment.
3. To change the experiment settings first connect to your chosen device (PC, Mac, tablet, smart device) and select the "Module setup" button. (For more information on how to change the experiment settings view quick start procedure section for your chosen device in this document.)
4. After the experiment has concluded (when the "Start/Stop" button is pressed again or the data collection period ends) connect the sensor to your chosen device. (full instructions in each device's quick start procedure section)
5. Open NeuLog software.
6. Click the "Off-line experiment" button.
7. Click the "Load data from sensors" button.
8. Select which experimental data to upload. (5 experimental runs can be stored at one time on the NUL-213 motion sensor)

### Restoring sensor's factory default settings:

#### Procedure:

1. Connect the USB-200 to a PC, Mac, tablet, or smart device.

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2. Connect the motion sensor to a USB-200 module (they directly plug together). Please note there is no calibration required for this sensor.
3. Open the NeuLog software.
4. Click the “Tools” icon.
5. Click “Restore sensor’s factory defaults” icon.
6. If prompted to clear the graph, click either the “Off-line experiment” or “On-line experiment” (whichever you are using).
7. Click “Clear experiment results”.
8. Resume from step 4.

### Included with sensor:

- NeuLog NUL-213 motion sensor guide (this document).
- Attached metal ultrasonic wave emitter.

Sensor specifications:			
	Distance	Velocity	Acceleration
Range and operation modes	0.25–6.0 m	±10 m/s	±100m/s <sup>2</sup>
ADC resolution	10 bit		
Resolution	2mm	0.1 m/s	0.01 m/s <sup>2</sup>
Max sample rate (S/sec)	100		

### Sensor features:

- Fully digital data.
- Rugged plastic ergonomic case.
- Push button switch to Start/Stop experiments in off line mode.
- LED indicator of experiment status (blinks while collecting data).
- Pre-calibrated sensing equipment.
- Metal ultrasonic wave emitting/detecting cone with wire mesh covering.
- **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)

- <http://www.NeuLog.com/Products/motionloggerSensor.aspx>
- **Falling Objects** - <http://www.neulog.com/Portals/3/Users/Experiment P-1 Falling objects Ver 3.6.9.pdf>
- **Walking Analysis** - <http://www.neulog.com/Portals/3/Users/Experiment P-2 Walking Analysis Ver 3.10.4.pdf>
- **Motion Parameters of a Moving Cart** - <http://www.neulog.com/Portals/3/Users/Experiment P-3 Motion Parameters of a Moving Cart Ver 3.6.6.pdf>
- **Newton’s Second Law** - <http://www.neulog.com/Portals/3/Users/Experiment P-4 Newton's Second Law Ver 3.14.4.pdf>

### 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 (°C, °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.

For a deep theoretical discussion of how ultrasonic sonar motion detection systems work please reference the American Association of Physics Teachers (AAPT) or The Physics Teacher periodical.

The motion sensor emits an ultrasonic sound wave through the metal cone on top of the sensor’s body. Sound waves follow a cone pattern and spread out at about 15° around the point the metal cone is aiming at. Objects in the cone of detection reflect the ultrasonic waves which are then detected by the sensor. Distance measurements are measured rapidly and can easily be translated to velocity or acceleration also.

### Maintenance and storage:

- Never submerge the NeuLog plastic body in any liquid.
- Do not allow liquid into the motion sensor’s body.
- After use, gently wipe away any foreign material from the motion 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 for a period of 3 years from the date of purchase. Our warranty 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.

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