NEULOG MOTION LOGGER SENSOR GUIDE

NeuLog motion logger sensor
NUL-213

The NeuLog motion sensor can be used for any science experiment 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 this guide.

The motion sensor uses an ultrasonic transducer to both transmit an ultrasonic wave, and measure its echo return. Objects in the range of 0. 15to 2meters (short range) or 0.2 to 10 m (long range) can accurately be measured to give distance, velocity and acceleration readings using this method.

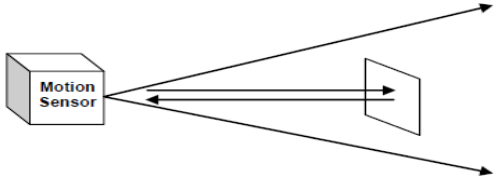
Among hundreds of possible experiments that can be performed with the NUL-213 sensor are: gravity, ball drops, momentum, impulse, conservation of energy, kinetic vs. potential energy, and many more.

The motion sensor's measurement units are:

- Meters (m): The SI distance unit
- Meters/second (m/s): The SI velocity unit which measures the distance traveled over time
- Meters/second^2 (m/s^2): 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. 15to 2 meters (short range) or 0.2 to 10 m (long range); results may be inconsistent outside of this range. Ultrasonic waves emitted from the sensor 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 within the cone may be reflecting the ultrasonic waves adding noise to the experiment.
- Use objects which are at least 10 cm x 10 cm 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.

NEULOG MOTION LOGGER SENSOR GUIDE

- When using the motion sensor to detect an individual's movements, try carrying the sensor instead of pointing it at oneself. For example, to measure a student's velocities have him/her walk or run with the sensor while pointing it to 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.

Included with the sensor:

- NeuLog General Guide
- Attached metal ultrasonic wave emitter

Sensor specifications:			
	Distance (long and short)	**Velocity (long and short)**	**Acceleration (long and short)**
Range and operation modes	0.2 to 10.0 m (long) 0.15 to 2.0 m (short)	±10 m/s	±100 m/s^2
ADC resolution	13 bit		
Resolution	1 mm	0.14 m/s (long) 0.48 m/s (short)	0.2 m/s^2 (long) 2.3 m/s^2 (short)
Max sample rate (S/sec)	100		

Experiment Duration: 1 second to 31 days.

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.

NEULOG MOTION LOGGER SENSOR GUIDE

Videos and experiment examples:

- Videos, literature and other probes can be found at www.NeuLog.com.
- In order to access the motion sensor's page, choose "Products" on the main menu and then "Motion logger sensor".
- In order to access the motion sensor's experiments, choose "Example Labs":
    - Falling Objects (P-1)
    - Walking Analysis (P-2)
    - Motion Parameters of a Moving Cart (P-3)
    - Newton's Second Law (P-4)

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 (^{o}C, ^{o}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 ultrasonic transducer is a device which converts a pulse train to transmitted ultrasonic pulses that can be sensed and converted back to an electronic pulse train by another similar ultrasonic transducer or by itself.

The ultrasonic transducer is based on ceramic crystal, which is cut in a certain way and is placed between two metal plates.

The crystal is characterized by the piezoelectric effect. Electrical field changes between the plates create mechanical vibrations in the crystal.

The crystal has a resonance frequency. The mechanical vibrations and electrical reactions depend on this resonance frequency.

Supplying pulses to the crystal of the ultrasonic transducer in a rate according to its frequency, causes it to vibrate and to transmit these pulses as an acoustic sound. This sound cannot be heard because it is above the hearing frequency range, usually at 40 KHz.

The acoustic sound can be converted back to electronic pulses by another ultrasonic transducer or by the the transmitter when it stops transmitting. The acoustic pulses vibrate this transducer and these vibrations are turned into voltage pulses.

The speed of the ultrasonic wave is 300 m/s because it is a sound wave. For distance measurements, a burst of the transducer frequency wave is sent and the system measures the time between sending and receiving.

$S = 300 * t$

Velocity is obtained by calculating the difference between two successive distances divided by the time between the samples (according to the sampling rate).

Acceleration is obtained by calculating the difference between two successive velocities divided by the time between the samples (according to the sampling rate).

NEULOG MOTION LOGGER SENSOR GUIDE

The motion sensor uses a very sophisticated method that enables it to measure a long distance range with a low power of pulses, which allows its use also battery operated.

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.

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!

NeuLog

Flexible, simple, fast, forward thinking.

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