

ScienceCube



Wireless Motion (WL106M) User Guide



Rev. WL106M-03-2024

This product is to be used for educational purposes only. It is not appropriate for industrial, medical, research, or commercial applications.

 **KOREADIGITAL**

The Science Cube wireless motion sensors use ultrasonic waves to measure distances between objects.

Wireless motion sensors use ultrasonic waves to measure the distance between the sensor and an object. By continuously measuring moving objects, you can determine their location and speed in real time.

By using a large diameter transducer, it is resistant to ambient noise and noise and has achieved a minimum detection distance of 15cm. Since distance is measured non-contactly using ultrasonic waves, more accurate measurement is possible compared to contact sensors.

When designing scientific experiments, you can easily move and modify complex experiments by eliminating the need to connect signal cables.

Additionally, the sensor has a display window so you can immediately check the measured values, and measurements can be made by remotely connecting to a smart device or PC wirelessly or wired without an interface.

Suggested experiments

- Momentum and impulse experiments
- Constant velocity and constant acceleration exercise experiments
- Identification of gravitational acceleration of free-falling objects
- Understanding position-specific acceleration and energy conservation law in simple pendulum motion
- Find the impulse and momentum and learn about the law of conservation of momentum

Composition

The ScienceCube wireless motion sensor consists of the following.

- Wireless motion sensor(WL106M)
- USB-A/C cable
- Steel rod for laboratory stand
- Booklet

Feature

- Up to four Science Cube wireless sensors can be connected to a PC or smart device at the same time.
- It supports dual-mode Bluetooth, allowing you to connect not only smart devices but also desktop and laptop PCs to conduct experiments using the **Science#** application.
- It can be connected to a PC through a USB port and experiments can be performed using the **Science#** program.

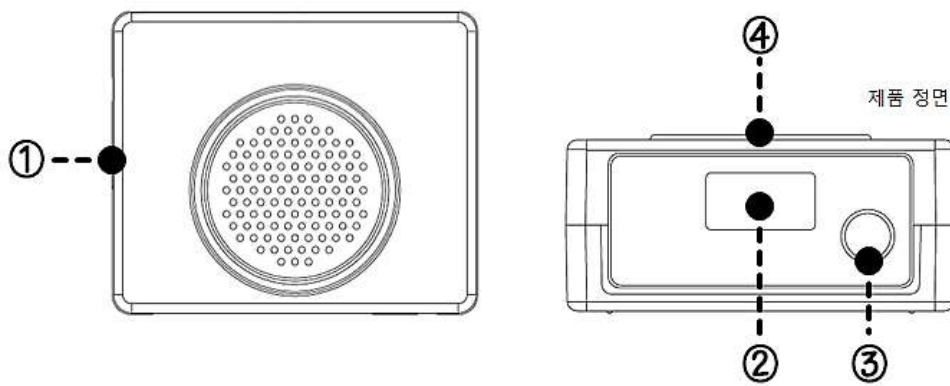


Function of wireless sensor

Structure

- ① USB port : Connect the sensor to a PC and use it for experiments or charging.

- ② OLED Display : Displays measured sensor values, sensor type, sensor ID, and remaining battery level.
- ③ Power/Function Button : It has functions such as power ON/OFF, measurement sensor change and calibration, etc.
- ④ Sensing part : It has a very thin membrane that transmits and receives ultrasonic waves that can measure the distance to an object, and is protected by a wire mesh.

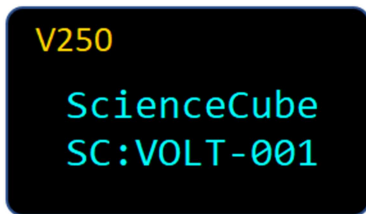


Caution : Do not subject the sensor to direct physical shock. Doing so may cause the sensor to malfunction or cause permanent damage. If an object approaches the sensor, use a safety net, etc. to protect the sensor from impact from the object.

Power/Function Button

Status	Turn	Action	Description
When the power is off	Click once	■	A short press turns the sensor on.
	Long click	■■■■■	A long press changes the mode and turns on the sensor.
When it's on	Long click	■■■■■	Turns off.

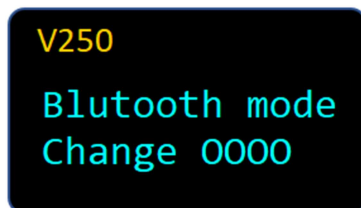
Start screen



V250 : Displays the sensor's firmware version.

SC:OOOO-001 : When you search for a Bluetooth device, the device name will be displayed. (Sensor name and 3-digit serial number)

Mode change



When you press and hold the power button and turn it on, the Bluetooth connection mode changes to **Mobile** or **PC** with the following message.

Measurement screen



① Connection mode	Mobile : Connecting Android or iOS. PC : Connecting to Windows PC 🔌 : Linked via a USB cable. ※ A long press changes the mode and turns on the sensor.
② Sensor-ID	This is the sensor's unique number and is displayed along with the sensor name in the device name when connected via Bluetooth.
③ Battery	Check the battery status, and when charging via USB, the display will change to charging.
④ Value	Displays sensor measurement values and units in real time.

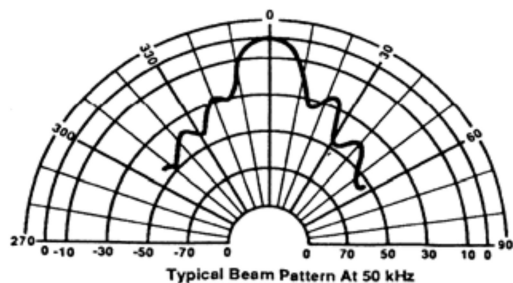
How it Works

The ScienceCube wireless motion sensor is a sensor that measures the distance to an object using ultrasonic waves.

The sensor generates ultrasonic waves using a device called a transducer, and the generated ultrasonic waves hit an object and are reflected and returned to the sensor. The sensor detects returning ultrasonic waves and measures the time from generation to detection. This time can be converted to distance by multiplying the speed of sound by the measurement time.

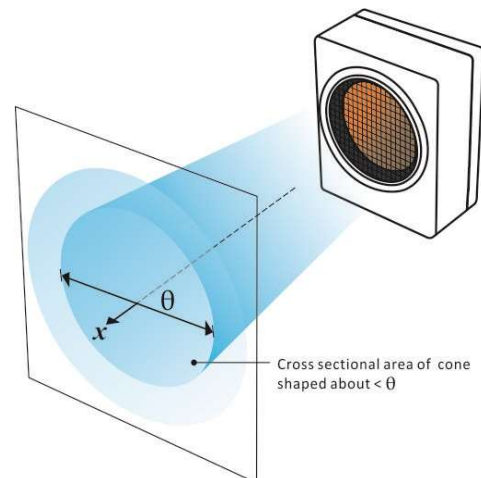
Ultrasonic and detection angle

Ultrasonic refers to periodic 'sound pressure' with a frequency exceeding the maximum limit of human hearing. Wireless motion sensors transmit and receive ultrasonic waves using a frequency of approximately 49.4 kHz.



Note: dB normalized to on-axis response.

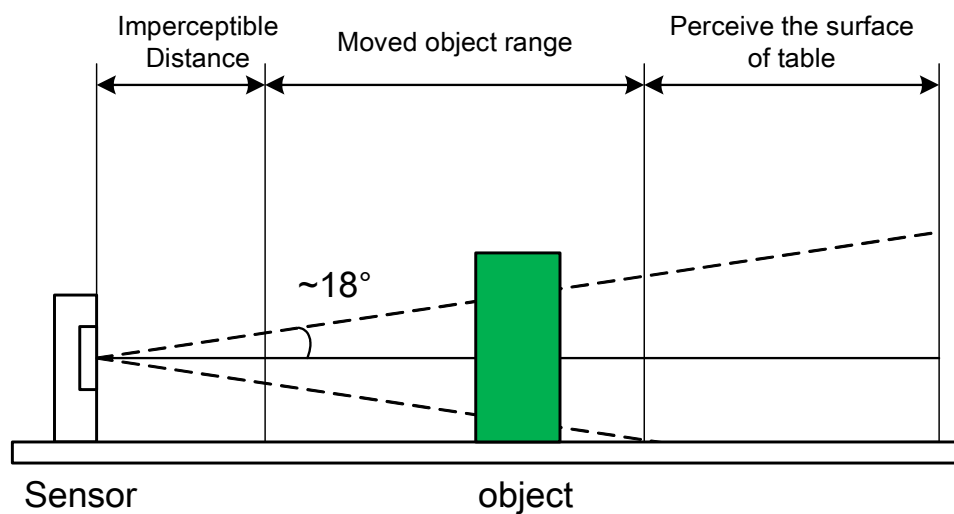
Note: Curves are representative only. Individual responses may differ.



Ultrasonic waves are emitted from the sensor transducer at an angle of approximately 15° and can respond at angles of up to 40° . When measuring the distance to an object, an experimental environment must be created so that other objects within the detection angle are not caught.

Constructing distance measurement

- ① The supersonic wave beam of Motion Sensor has a spread off angle. Construct the experiment so that the object moves within the range of the beam angle.
- ② There will be surrounding objects, floor, ceiling, walls within the beam angle. Keep in mind the actual perception distance(range) will diminish that much.
- ③ It will be impossible to obtain the correct data if there is a wave-reflecting object surrounding the sensor, such as a wall. The wall will reflect the supersonic wave, creating an echo affect.



- ④ The supersonic waves used in Motion Sensor measures the distance based on the velocity of an airborne wave (340m/s) in normal temperature (20°C). Different temperatures, density, concentration, media will transform the velocity significantly. Thus, the distance measured will need to be converted to a value based on the wave velocity in normal temperature.

The speed of sound according to the conditions of various media is as follows.

Medium	Temperature(°C)	Density(g/cm ³)	Velocity(m/s)
Air	20	0.0012	340
Vapor	100	-	471.5
Distilled water	20	1.0	1470
Physiological saline solution	37	1.01	1535

[Data collection interval] depending on the measurement distance of the object

The time in which the Motion Sensor supersonic waves reflected on an object returns (trip time) is influenced by the distance. The distance can be calculated with the wave's non-sensing distance (0.15m) as shown in the following.

In normal temperature atmosphere,

$$D + d = v \cdot \frac{t}{2}$$

D : the distance to an object

v : wave velocity in the medium

t : trip time of wave

d : value of wave non-sensing distance

The time gap(Δt) in which the wave pulse sent is calculated as $\Delta t = 2t$, taking wave interruptions and experiment errors into consideration. Then the following equation,

$$D = v \cdot \frac{\Delta t}{4} - d$$

is true.

Remember when setting measurement gap for practical experiment, that the distance between the sensor and object must be shorter than D while Δt is set as the measurement gap.

(Example) If the measurement gap is 0.02 sec (collect data 50 times per second), the maximum distance measurable is

$$\begin{aligned} D &= 340 (0.02/4) - 0.15 \\ &= 1.55 \text{ m} \end{aligned}$$

You need to construct the experiment so that the distance to be measured is shorter than 1.55m, as in practical experiment environment, the characteristics of the medium and spread error must be taken into consideration.

Note : Ultrasonic waves from wireless motion sensors can be used on objects that reflect sound, such as solids. Measurement may not be possible for objects that have uneven surfaces or do not reflect sound, such as the human body or clothing.

Using the Sensor

The ScienceCube wireless motion sensor can be measured in the following ways:

1. Run 'Science#' and connect the sensor wirelessly or wired.
2. If you want to check the speed and acceleration in the sensor value display area, select the box on the right.
3. If measurement is required starting from '0', execute [Zero Setting].
4. Set the [Data Collection Interval] and [Experiment Time] in [Experiment Settings].
5. Click [Start] to start the experiment.



For more information on how to use the Science#  application, see the help.

Calibration

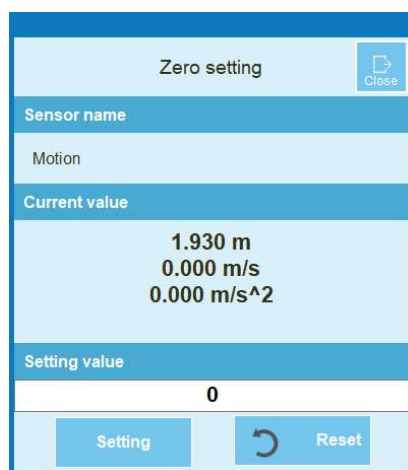
All wireless motion sensors are precisely calibrated using standard equipment during the manufacturing process before being delivered and are ready for immediate use. No separate calibration process is required.


However, if you want to display "0" in the current value for a smooth experiment, you can proceed with [Zero Point Setting]. [Zero point setting] can be done in the Science# program.

[Zero point setting] in science#

Science#'s zero setting does not affect the sensor's zero setting and is only reflected in the values displayed in the program.

Note : [Zero point setting] is reflected temporarily and returns to the default value when the sensor is turned on again.




If you press the  icon in the space where the sensor value is displayed in Science #, the [Zero point setting] menu will appear.

Here, if you press [Setting], it will change to 0.00 m, and if you press [Reset], it will return to the initial value.

Guide for scientific experiments

<Speed of a free-falling object>

① Place the wireless motion sensor on the floor and stack books next to it to prevent balls from falling directly on the sensor.

② Run Science #  and connect the wireless motion sensor via Bluetooth.

③ Set the experiment settings to [Automatic collection]-[Line chart]-[Data collection interval: 20HZ] [Experiment time: 3 seconds].

④ After pressing [Start Experiment], hold the ball with both hands and drop it. At this time, check that your hand is not detected by the sensor.

⑤ After [Experiment complete], look at the graph and analyze it.



Specifications

Item	Description
Range	0.15m ~6.5m
Resolution	± 0.001m
Sampling Time	Max. 100Hz (0.01 sec.)
Condition	0 ~ 60°C, Max. 85%RH
Wireless Connection	Bluetooth 5.0 or Classic 2.1
Wired Connection	USB-C
Battery	2,000mAh Li-Polymer rechargeable
Charging Time	within 5 hours
Operating Time	Approximately 22 hours after full charge (depending on usage conditions)
EMC	CE : EN 61326-1, EN 55011, EN 55032, EN 301

CAUTION: Do not use the instrument beyond the measurement range or in conditions that exceed the short-term exposure limits. Prolonged exposure beyond the maximum permissible range can cause serious damage to the sensor.

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- The contents of this manual are provided for informational purposes only, and product specifications and functions may be changed without prior notice to improve performance.
- This product is designed for science education. No warranty is provided and no liability is assumed for errors in industrial testing or manufacturing process controls, medical analysis or controls, or commercial design applications.

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