1156 - Wireless Heart Rate Sensor

Revision: 0 | DS033

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Introduction

Thank you for purchasing the Smart Wireless Heart Rate Sensor. We pride ourselves on producing high quality products that meet with the demands of the busy classroom environment. If you have any problems using this sensor, please read this documentation in full before contacting the Data Harvest support team.

Overview

The Smart Wireless Heart Rate Sensor monitors the light level transmitted through the vascular tissue of the fingertip or the ear lobe and the corresponding variations in light intensities that occurs as the blood volume changes in the tissue.

Pack Contents

This product is supplied with the following items:

- 1 x Wireless Heart Rate Sensor
- 1 x USB Connecting Lead

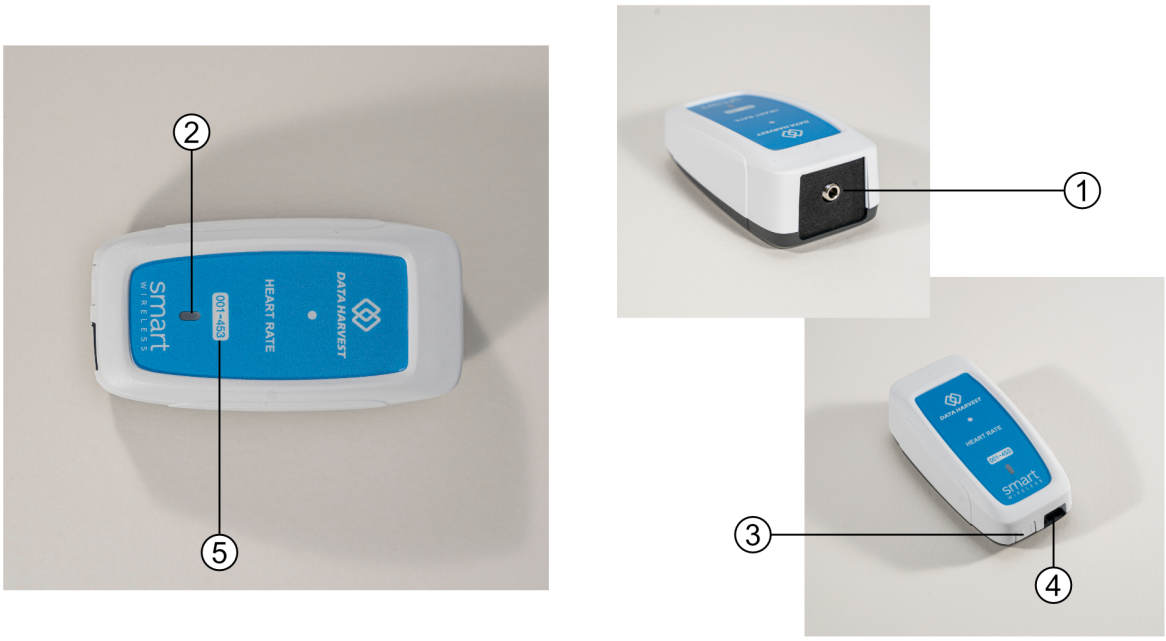
Additional Accessories

To get the most from your Smart Wireless Heart Rate Sensor, the following items should be considered:

- Wireless Temperature Sensor

Operational Overview

The diagram below shows the specific parts of the sensor. Read further to explore the functionality of each part of the sensor.



1. Sensor End Cap
2. Status Indicator
3. On/Off Switch
4. USB Port
5. Unique ID Number

Sensor End Cap (1)

Most Smart Wireless Sensors feature an end cap that is specific to the requirements of the device's internal sensor. The sensor's end cap is the direct interface between the device's internal sensor and your experiment.

The Status Indicators (2)

The sensor features a single status indicator that changes colour and flashes. See the table below for further information.

Status Light		Indicates
No light		Sensor is Off. Short press the On/Off switch
Blue flashing		Sensor On and Bluetooth advertising
White flashing		Charging via USB mains charger or USB port
Green flashing		Communication with the EasySense2 app (via USB or Bluetooth) has been established
Orange flashing		Recording data

Red flashing		Battery is low

On/Off Switch (3)

The sensor's on/off switch allows you to turn the sensor on, off or perform a hard reset.

To switch the sensor off

- Press and hold down the On/Off switch until the white light shows, then release.
- If not communicating with the EasySense2 app, the sensor will turn off after a period of one hour of inactivity.

Hard resetting the sensor

- If necessary, attach the sensor to power.
- Press and hold down the On/Off button for at least 8 seconds until the status LED gives a flash of blue light, then release.
- If the sensor fails to respond, contact Product Support at Data Harvest. Please provide details of:
  - The computer platform it is being used with and the EasySense2 app's version number.
  - A description of the problem being encountered.

USB Port (4)

Use to connect to a computer or a charging unit.

For specific USB or Bluetooth connectivity instructions, please see the 'Connectivity' section of this documentation.

For instructions on charging your device, see the section on 'Charging the Sensor'.

Unique ID Number (5)

All Smart Wireless Sensors are labelled with a unique ID number. This number is used in the EasySense2 app, so that you can identify each sensor when making a connection wirelessly.

Connectivity

The sensor is both USB and Bluetooth compatible. Install the EasySense2 app, if it is not already on your device. For details of how to operate the EasySense2 app, please refer to the EasySense2 documentation.

USB Connectivity

Quick Steps

1. Connect the sensor to the computer's USB port using the USB cable supplied.
2. The computer will automatically detect a new device and depending on your operating system, will install any applicable device drivers.
3. Start EasySense 2 app.
4. Within the EasySense2 app, the Devices icon will change to green to show that the sensor is connected, and the status light on the sensor will also turn green.
5. Begin your practical investigations.

Bluetooth Connectivity

Using Bluetooth, the sensor can wirelessly connect to mobile devices such tablets and mobile phones, as well as desktop or laptop computers, giving students the ability to run experiments independently without being tethered to a device.

See the EasySense2 app user manual system requirements for further details.

Quick Notes on Bluetooth Connectivity

Only use with the EasySense2 app, you do not need to pair the device. If paired, the sensor will not be available to the EasySense2 app.

Computers or devices will need to support Bluetooth Low Energy (BLE). For further information refer to the instructions provided for the EasySense2 app.

Quick Steps

1. Short press the on/off switch to turn the sensor on, blue LED will flash.
2. Open the EasySense2 app.
3. Select the Devices icon.
4. Select your sensor from the list of available sensors to connect to the device. Your sensor is identified by its unique ID in the list.
5. Click on connect at the side of your sensor in the list.
6. The Devices icon will change to green and the status light on the sensor will flash green to indicate a connection has been established.
7. Begin your practical investigations.

Connecting The Heart Rate Ear Lobe Sensor

- Insert the jack plug from the finger/ear lobe clip into the jack socket at the end of the Sensor housing.
- Attach the finger/ear lobe clip (Pleth) to either the fingertip or to the ear lobe.
- **Note:** Avoid applying pressure to the clip as this could affect the signal.

Charging the Sensor

The Smart Wireless sensors are fitted with a rechargeable lithium-ion battery and can be charged via the USB port. Use the supplied USB lead to connect the sensor either directly to a USB port on your computer, a powered USB hub or a USB mains charger that outputs 5 V at 500 mA or more.

A full charge can take up to 4 hours.

Additional Information

Whenever the sensor is connected to the USB port on the computer or to a USB mains charger (output 5 V at 500 mA or more), it will automatically recharge the battery (LED status flashing white).

When connected to a computer, the computer should be turned on and not in sleep or standby mode, as the battery may drain instead of charge.

The sensor will stay awake for 60 mins when Bluetooth advertising (LED status flashing blue).

Lithium-ion batteries are ‘memory-free’ and prefer a partial rather than a full discharge. Constant partial discharges with frequent recharges will not cause any harm. Frequent full discharges should be avoided whenever possible. Ideally the sensor should be stored at about 40% or more charge.

The speed at which a lithium-ion battery will age is governed by both its storage temperature (preferably less than 40℃) and state-of-charge.

Firmware Updates

Occasionally Data Harvest may release updated firmware which will contain improvements or new features.

Updates will take place when you connect your sensor to the EasySense2 app. You will be given the option to decline an update.

Updates can be performed over USB or Bluetooth and will typically take less than one minute. Updating firmware over USB will be quicker than Bluetooth.

Do not disconnect the sensor, or power off during the update.

If you have a wireless connection to the EasySense2 app, the sensor will have to be reconnected after performing the update.

Usage Information

The Smart Wireless Heart Rate Sensor is used to measure the cardiovascular pulse wave that is found throughout the human body. This pulse wave will result in a change in the volume of arterial blood with each pulse beat. This change in blood volume can be detected in peripheral parts of the body such as the fingertip or ear lobe using a technique called Photoplethysmography.

The device that detects the signal is called a plethysmograph (or 'Pleth' for short).

The Pleth consists of:

- An infrared LED which illuminates the tissue and
- An infrared LED which illuminates the tissue, and a light sensitive detector (LSD), which has been tuned to the same colour frequency as the LED, and detects the amount of light transmitted from the tissue.

The Pleth supplied with this sensor is a transmission mode plethysmographic signal (PPG) device, which uses transmitted light to estimate absorption. The infrared LED and the light sensitive detector (LSD) are mounted in a spring-loaded device that can be clipped onto the fingertip or ear lobe.

The infrared light emitted by the LED is diffusely scattered through the fingertip or ear lobe tissue. A light sensitive detector, positioned on the surface of the skin on the opposite side, can measure light transmitted through at a range of depths. Infrared light is absorbed well in blood, and weakly absorbed in tissue. Any changes in blood volume will be registered, since increasing (or decreasing) volume will cause more, or less absorption. Assuming the subject does not move, the level of absorption of the tissue and non-pulsating fluids will remain the same.

The amount of light that can be detected by the light sensitive detector (LSD) will vary with each test subject, and as to whether the clip is attached to a fingertip or ear lobe.

When attached to a finger:

- Position the finger lobe clip so that the light sensitive detector is on the fleshy side of the finger.
- Fingers should be clean.
- Nail varnish may cause falsely low readings.
- Values should not be affected by skin colouring.
- Some subjects may have poor peripheral circulation (the extent to which the blood vessels
- in the fingertip are filled with blood), in which case another subject should be selected.
- If the heart rate does not seem to settle, try warming the hands by rubbing together to increase the blood flow.
- If readings are lower than expected, try repositioning the clip to make sure firm contact is obtained.

When attached to an ear lobe:

- Remove any earrings before attaching the finger/ear lobe clip to the ear lobe.
- The clip can be made more secure by hooking the wire round the back of the ear, or by using the slide on the lead to attach it to the subject's clothing.
- If the heart rate does not settle or if readings are lower than expected, try repositioning the clip to make sure a firm contact is obtained.

Each time the finger/ear lobe clip is attached to a fingertip or ear lobe, wait until the signal stabilises before starting to record data - the initial unstable signal will be due to compression from the clip being attached.

Stay reasonably still while recording data. Movement e.g. raising and lowering a hand, will alter the pressure that the finger exerts on the clip, whilst simultaneously causing a change in venous blood that will affect light transmission through the tissue.

It is possible to alter heart rate by simply decreasing respiratory rate. Encourage the test subject to breath normally.

This sensor is not intended for medical diagnosis. Do not be alarmed if results do not correspond to quoted numbers. These numbers represent typical averages, and many healthy hearts have data that falls outside these parameters. It is quite normal for the heart to occasionally miss a beat.

The number of beats per minute is calculated, by the Heart Rate Sensor, by timing the width of a pulse and 'scaling up' to a rate of beats per minute. For example, a recorded wave form of a 0.7 second duration would become (1 ÷ 0.7) x 60 = 85.7 beats per minute. Sporadic short or longer beats will produce artificially high or low readings. This should not present a problem as trends in heart rate are studied, not absolute values or rapid changes.

The heart rate is averaged over every five beats to achieve a smoother reading.

If the finger/ear lobe clip 'loses contact' with the pulse, the sensor will attempt to re-establish communication. This may result in the reading momentarily dropping to zero. .

The light sensitive detector (LSD) in the clip can be sensitive to high-levels of ambient infrared light e.g. strong sunlight. If this is the case, try excluding the light, by covering the clip with some dark fabric e.g. by placing your hand inside a cloth bag.

With the beats per minute range (bpm) of the Heart Rate Sensor selected, the fastest speed that can be used to capture data is 50 Hz (20 ms). If an intersample time of less than 20 milliseconds is selected, then the values obtained will either default to the lowest reading, or the set-up will be rejected by the software. This fastest speed for the Waveform range (mV) is 1ms.

It is possible for the dicrotic notch to be recorded as a separate pulse, and so will give higher readings than expected. The effects are more noticeable if the clip is attached to the finger; try using it with the clip attached to the ear lobe.

Heart Rate (Notes)
Blood passes through the heart in two phases that alternate continuously.

The blood forced into the aorta during systole, moves the blood in the vessels forwards and sets up a pressure wave that travels along the arteries. This pressure wave expands the arterial walls as it travels, and is felt as the pulse.

The pulse may be felt at points where arteries pass over bones, known as pressure points e.g. in the wrist and neck. Pulse rate is a direct measure of the number of heart cycles in a minute (heart rate).

In normal healthy individuals the heart rate, and thus the pulse rate, varies with the phases of respiration. Irregular changes in heart rate occur in all people. Heart rate may be increased by exercise, nervous excitement, stress due to mental effort, by adrenaline entering the bloodstream, or with increase in temperature caused by fever. The heart rate decreases when asleep and some medical conditions may also cause a drop.

Following exercise, it takes a while for the heart rate to return to resting level. This is the recovery time and gives an indication of the fitness of the individual. Recovery time may vary from less than five minutes in very fit individuals, to around 15 minutes.

Safe Pulse Rates
During experiments, the safe heart rate should not be exceeded. The safe level is given as the maximum heart rate for age, minus 20 beats per minute
Maximum heart rate = 210 – (0.65 x age)

Waveform (Notes)
The heartbeat recorded by the Smart Wireless Heart Rate sensor is smoothed by the passage of blood through the capillaries, and the pressure signal does not resemble the pulse seen in an

electrocardiogram (which is used to record the hearts electrical activity). However, the periodicity of the signal is unchanged and the Heart Rate sensor can be effectively used to detect changes in heart rate.

The upstroke, called the anacrotic limb, is abrupt and is due to contraction of the ventricle (systole). The downstroke is more gradual and corresponds to the elastic recoil of the arterial walls. The downstroke regularly shows a fluctuation known as the dicrotic notch. This is due to vibrations set up when the aortic valve snaps shut – it has no major significance as an indicator of health.

For a healthy person at rest, the heart beats on average at about 60 beats per minute or one a second i.e. around 1 Hz. This frequency is not constant (even in a healthy individual at rest).

It takes approximately one second to record a complete wave, so it is usually best to select a short recording time.

This Sensor is not waterproof. Clean the clip by wiping with a cloth that has been rinsed in disinfectant.

Practical Investigations

The Smart Wireless Heart Rate Sensor can be used to investigate a number of scientific experiments such as:

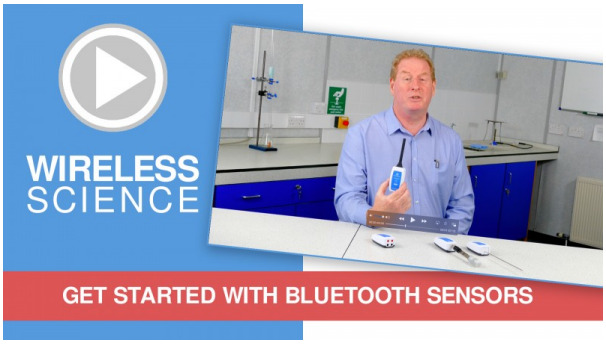
- Monitoring fitness - after exercise, pulse is timed until it gets back to the normal standing heart rate (this can be achieved by remaining in a sitting position and moving the legs).
- Monitoring resting
- Changes with mild stimulants (cups of coffee or cola – might show less effect on people
- who are accustomed to large amounts of caffeine).
- Variation in blood flow i.e. people who suffer with cold fingers will show a very low blood flow in their veins – try warming their hands
- Investigating pulse rate with different body positions (sitting, crouching, standing, laying down).
- The effect of music on pulse rate.
- The effect of the strictest teacher entering the room!

Online Videos

Learn how to use data logging in the classroom with our Secondary Science Academy demonstration videos, which will walk you through using the new EasySense2 app and show you how to get hands-on with the latest Bluetooth wireless sensors. The video experiments will show you how to get the best out of your science lessons.

New online content is being continuously uploaded onto our YouTube channel, including practical worksheets as well as videos.

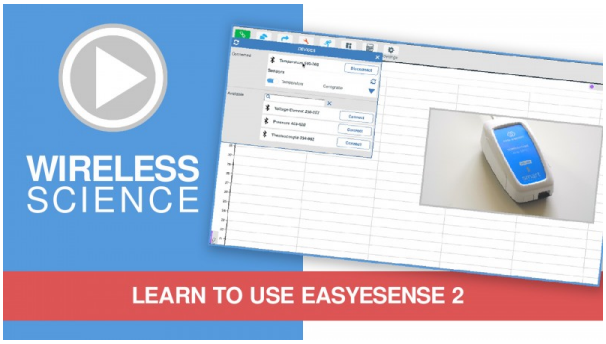
See our website for further information and links.



Explore Bluetooth Sensors

Are you looking to make the jump to our smart wireless sensors? Or have you recently purchased them and want to know more about how they work?

View video playlist



Explore EasySense2

The core of our science platform is our EasySense2 software. In these videos you will learn everything from the basics of our software to the most in-depth features.

View video playlist

Explore Science Practicals

See our Smart Wireless Sensors in action with a range of practical experiments. This is the best way to get started with the new Bluetooth sensors!

View video playlist

Sensor Specifications

Please read the following table for sensor specifications.

Feature	Detail
Measurement Ranges	0-200 Beats per minute and ±2000mV
Resolution	1BPM and 1mV
Fastest logging speed	1ms
Connectivity	Wired via USB Wireless via Bluetooth
Bluetooth Specifications	Bluetooth 4.2 low energy radio, single mode compliant Transmit (TX) power: 0 dBm Receiver (RX) sensitivity: - 90 dBm Usable transmission range: up to 10 m in open air Frequency Range: 2.402 to 2.480 GHz operation
Internal Battery	Rechargeable internal lithium-ion 3.7 V Power specification: 5 V at 500 mA
Storage/Operating Temperature	0 - 40℃
Humidity	0 to 95% RH (non-condensing)
Physical Specifications	Weight: approx. XX g External dimensions: approx. height XX mm x width XX mm x length XX mm

Limited Warranty

For information about the terms of the product warranty, see the Data Harvest website at: https://data-harvest.co.uk/warranty

Product Repairs

When returning goods to Data Harvest, please download and complete the repair return form to ensure you have sent us all the information we require, and send it to us alongside the item to be repaired. The second page of this form includes a return address label.

If you have purchased a Data Harvest manufactured product via a different company, please also supply proof of purchase.

Postage Charges

- In the event of a fault developing, the product must be returned in suitable packaging to Data Harvest for repair or replacement at no expense to the user other than postal charges.
- There will be no postal charge for the return of repaired goods to any mainland UK address (for other areas, additional shipping charges may apply).

Out of Warranty Repairs

Please visit https://data-harvest.co.uk/repairs for the most up to date charges for out of warranty repairs.

Warranty on Repaired Items

Once an item has been serviced and repaired, the product will have 1 year warranty against further failure of the component repaired.

International Returns

Please contact the authorised Data Harvest representative in your country for assistance in returning equipment for repair.

Compliance

This product complies to the following standards

Waste Electrical and Electronic Equipment Legislation

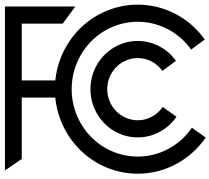
Data Harvest Group Ltd is fully compliant with WEEE legislation and is pleased to provide a disposal service for any of our products when their life expires. Simply return them to us clearly identified as 'life expired' and we will dispose of them for you.

FCC Details

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

CE

This product conforms to the CE specification. It has been assessed and deemed to meet EU safety, health and environmental protection requirements as required for products manufactured anywhere in the world that are then marketed within the EU.



Troubleshooting

If you experience any problems with your product, please try the following troubleshooting tips before contacting the Data Harvest support team.

Feature	Detail
Loss of Bluetooth Connectivity	**If the sensor loses Bluetooth connection and will not reconnect try:** Closing and reopening the EasySense 2 app. Switching the sensor Off and then On again. If you are using a Bluetooth Smart USB Adaptor on your computer, unplug the adaptor, plug back in again and try to reconnect. Hard reset the sensor and then try to reconnect.

Notices

Please read the following notices with regards to using your sensor

1. The sensor is much smarter than traditional Bluetooth sensors and you are not required to pair the device. If paired, the sensor will not be available to the EasySense 2 app.
2. When the sensor is connected to a computer, the computer should be turned on and not in sleep or standby mode or the battery may drain instead of charge.
3. Data Harvest products are designed for educational use and are not intended for use in industrial, medical or commercial applications.
4. The sensor is not waterproof.
5. Plastic parts may fade or discolour over time if exposed to UV light. This is normal and will not affect the operation of the sensor.
6. This Sensor is not waterproof. Clean the clip by wiping with a cloth that has been rinsed in disinfectant.

Contact Information

To contact Data Harvest directly, please use any of the following channels

Traditional Communications

Data Harvest Group Ltd.
1 Eden Court, Eden Way,
Leighton Buzzard,
Bedfordshire,
LU7 4FY
United Kingdom

Tel: +44 (0) 1525 373666
Fax: +44 (0) 1525 851638
Sales email: sales@data-harvest.co.uk
Support email: support@data-harvest.co.uk

Online Communications

We have active social media support channels using the following platforms

- Facebook
- Twitter
- YouTube

Office Opening Hours

Monday to Thursday - 08:30 to 16:45
Friday - 08:30 to 13:30
Saturday & Sunday & UK Bank Holidays - Closed

PDF Translations

The PDF formatted download of this manual is by default provided in the English (United Kingdom) language. If an alternative translation is available, it will be listed here.

We have for your convenience included a webpage translation feature to the online documentation which will allow you to translate and print individual pages of this documentation.
