Stethoscope Sensor

(Product No. 3176PK)

Stethoscope ±100 mV
Stethoscope F ±100 mV
Sound ±1000 mV
Sound F ±1000 mV

DATA HARVEST

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DS 093 No 3

Contents

Introduction

Pack contents (3176PK)

1 x Smart Q Stethoscope sensor (Product No. 3176)

1 x Traditional audio stethoscope (Product No. 3178)

1 x Piece of foam

A stethoscope is a listening bell designed to amplify the sounds created by the heart as it beats. In the hands of a trained diagnostician the sounds and the location of the sounds can reveal valuable information about the heart before invasive investigations are started.

The Smart Q Stethoscope sensor uses an electret microphone in a standard stethoscope chest piece to allow the heart sounds to be converted into an electrical signal. The signal can then be monitored with the **EASY**SENSE software and an appropriate logger.

The best results will come from a logger that can record at an intersample time of 2 ms or faster. If the logger will only record at a slower intersample rate detail in the heart sound will be reduced, but you should still see the double noise from the beat.

Heart sounds are traditionally described as Lub – dub and attempt to create an onomatopoeic representation of the sounds. The sounds can be used to describe the hearts activity, and if associated to other data from the heart beat can produce a physiological picture of the heartbeat.

Disclaimer

The Smart Q Stethoscope sensor is sold for the purpose of teaching and educational instruction. It is not, and has not been designed to be, a medical or diagnostic instrument. The results are illustrative only; any information gained from the use of this apparatus must not be used for any health and safety audit or diagnosis.

Read the instructions before use.

The Stethoscope sensor has a diaphragm held onto the sounding bell by a screw ring. The diaphragm increases the intensity of low frequency sound detection. If the diaphragm is removed the higher frequency sounds of the heart beat are detected.

To remove the diaphragm, unscrew the screw ring, it is designed to be easily removed. Information about the heart is gained by comparing the sounds at different location on the chest and by comparing the sounds with and without the diaphragm. The diaphragm should remain in the ring; keep both parts safe - it is not possible to purchase replacements.

Once the diaphragm is removed the microphone can be seen, it has been glued into place and it has a protective screen over the aperture but care should be taken not to damage the microphone.

Connecting

- Push one end of the sensor cable (supplied with the **EASY**SENSE unit) into the hooded socket on the adaptor.
- Connect the other end of the sensor cable to an input socket on the **EASY**SENSE unit.
- The **EASY**SENSE unit will detect that the Stethoscope sensor is connected and display values using the currently selected range. If the range is not suitable for your investigation, set to the correct range.

Ranges

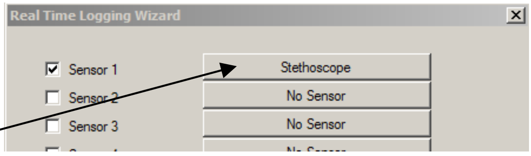
The Smart Q Stethoscope sensor has four ranges.

1. **Stethoscope ±100 mV** – This is the most sensitive of the ranges and is for making recordings of the heart beat sound wave using the Stethoscope both with and without the diaphragm attached.
2. **Stethoscope F ±100 mV** – This range has a low pass filter. It reduces the effect of the higher frequency sounds that can be created by speech, movement of the sensor over the skin, clothing across the sensor, etc. It is for making recordings of the heart beat sound wave using the Stethoscope both with and without the diaphragm attached. It could be used where noise is a problem.
3. **Sound ±1000 mV** – This is a reduced sensitivity range for detection of sound in solids. The transmission of sound through a solid reduces attenuation of the original signal and more will reach the sensor. If the stethoscope range is used the sensor can be swamped by the volume of the noise.
4. **Sound F ±1000 mV** – This range contains a low pass filter to help reduce the effect of high frequency sound. It can be of use when moving the sensor while recording, the effect of high frequency will be attenuated, detail will be lost in the produced waveform and the waveform may appear to be slower forming. Not recommended for speed of sound measurements in solids unless the signal is very confused..

Changing the range

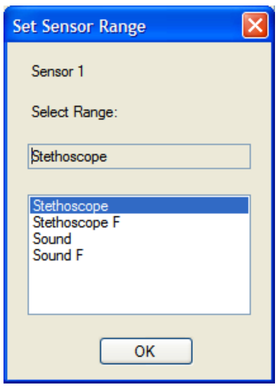
With some **EASY**SENSE units it is possible to set the range from the unit. Please refer to the **EASY**SENSE unit's user manual.

To alter the range in the EasySense software:



1. Select **EasyLog** from the Home screen.
2. Select the **New** recording wizard icon. 

3. Click on the sensor's name (it will be listed using its current range).
4. A set sensor range window will open. Select the required range, then OK.
5. Select Finish to exit the wizard.

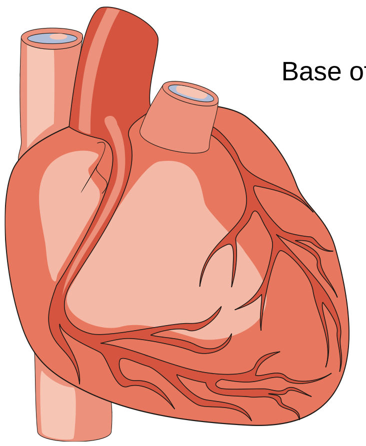


Or

1. From the Home screen select **Sensor Config** from the Settings menu.
2. Select the Stethoscope sensor from the list and click on the **Change Range** button.
3. The current range will be highlighted. Select the required range and click on OK. Close Sensor Config.

The range setting will be retained until changed by the user.

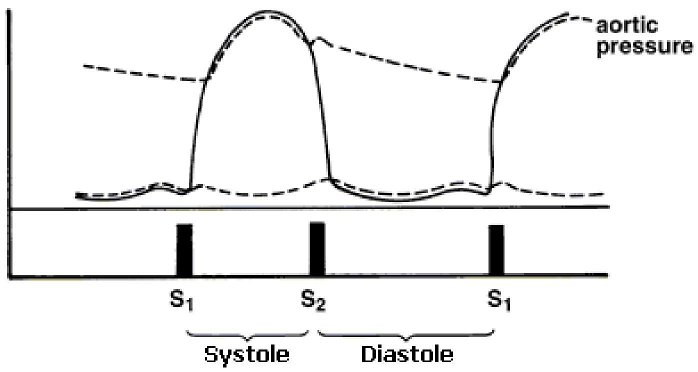
Information



The sounds of the heart are characterised as;

The 1st heart sound, **S1** (**lub**), marks the beginning of systole (end of diastole) and is related to the closure of the mitral and tricuspid valves.
It is loudest at the apex of the heart (point of heart, furthest away from the veins and arteries).

The 2nd heart sound, **S2** (**dub**), marks the end of systole (beginning of diastole) and is related to the closure of the aortic and pulmonic valves.
It is loudest at the base (top of the heart as it lies in the living body).



Systole = period of contraction (from the Greek to draw together, a description of the appearance of the heart in contraction)

Diastole = period of relaxation (from the Greek to expand, a description of the appearance of the heart after its period of contraction)

The practice of listening to the heart is called AUSCULTATION.

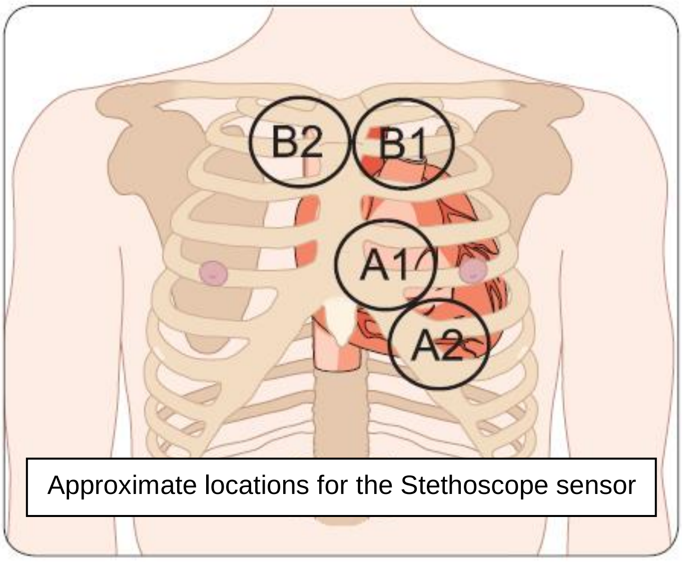
You can relate the auscultatory findings to the cardiac cycle:

S1	S2
Just precedes carotid pulse	Follows carotid pulse
Louder at apex	Louder at base
Lower pitch and longer than S_2	Higher pitch and shorter than S_1
Because systole is shorter than diastole:	
First of two grouped beats	Second of 2 grouped beats

Position of the sensor
More than any other sensor, the placement of this sensor is critical. Only a fraction of a cm of movement will create a large degradation of both signal strength and content.

Each location will produce a different pattern. A1 or B1 are the preferred locations for a ‘normal’ pattern.

Medical auscultation requires the patient to adopt different body positions to maximise the sound heard by the physician. We have found this is true for this sensor. When using A1 and A2 asking the subject to lean forward, from the hips, can give a dramatic increase in signal strength and quality. Typically about a 30 degree lean is optimum, if the lean becomes too large the signal degrades very rapidly.

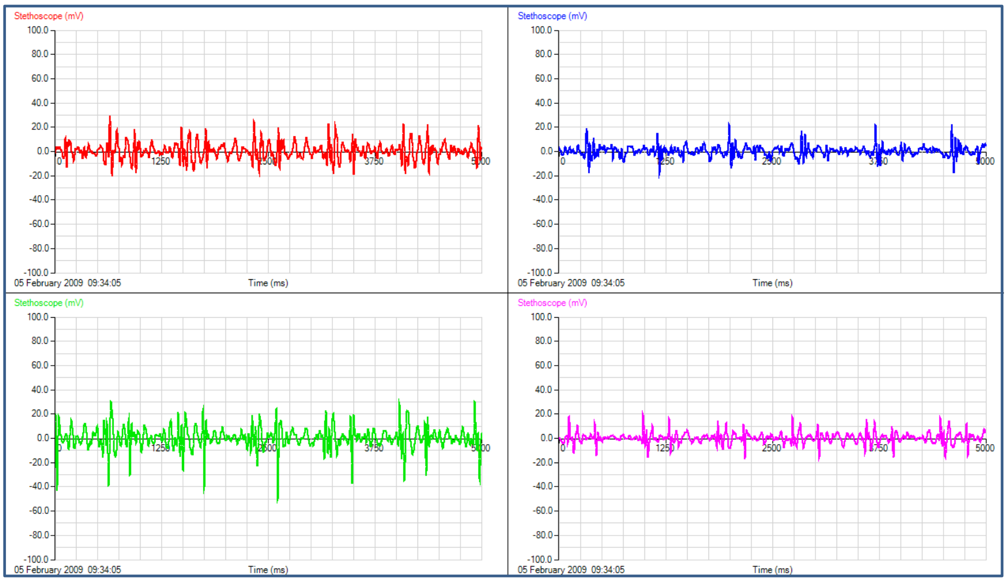


Approximate locations for the Stethoscope sensor

You can get an improvement in the quality of the recorded sound if the patient is supine (laying). You need to be prepared to try several positions.

It should be possible, for most of the work you will want to consider, to slip the sensor through a shirt opening and to place it in the correct position. The sensor does need to be in contact with the skin for the best response. If the sensor is touching material the signal will be muffled and the movement of the fibres over the diaphragm will introduce unwanted noise.

If a piece of medium soft plastic foam is used over the chest piece, the subject can push down on the foam to hold the sensor in position. If the foam is not used the subject can still hold the sensor but they may introduce noise from the tremor of their own fingers, hands, etc. The foam will also reduce the tendency to over press the sensor against the skin; some of the best results will be collected with a light touch. The stethoscope diaphragm on the sensor needs to be free to vibrate and transfer the sound waves reaching the skin to the microphone.



Sample heart beats at the 4 locations shown.

The intensity of the heart beat will be affected by the sensors precise location. A relocation of even a few millimetres can increase the intensity considerably. Try moving the sensor a fraction and over several data collections locate the optimal detection spot. Human variation will play a big role. The points indicated are starting points for the maximum response not absolutes, they never can be.

Investigations

The sensor is very good as a stimulus for discussion about the heart and how it works. Simply measuring the heart sound is a natural interest.

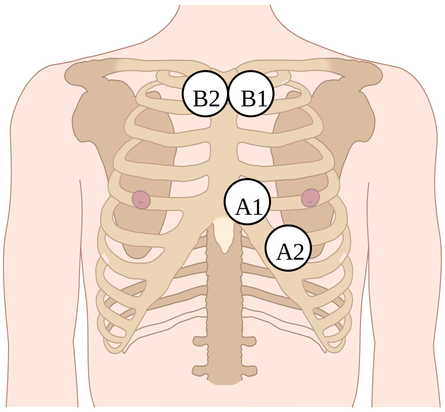
Reference to a visit to a doctor, and then asking the students to find the heart sounds will reveal how skilled the physician's job is and also help them understand the pattern of a stethoscope examination. Controlling breathing when monitoring the sounds can also reveal reasons why you are asked to breathe in, breathe out, etc. during an examination.

Recording heart sounds

Apparatus

- 1 x Stethoscope sensor set to the Stethoscope range with diaphragm fitted
- 1 x foam piece.
- An **EASY**SENSE unit capable of fast logging

Note: *You may want to use the conventional stethoscope to locate the best position for the heart sounds.*



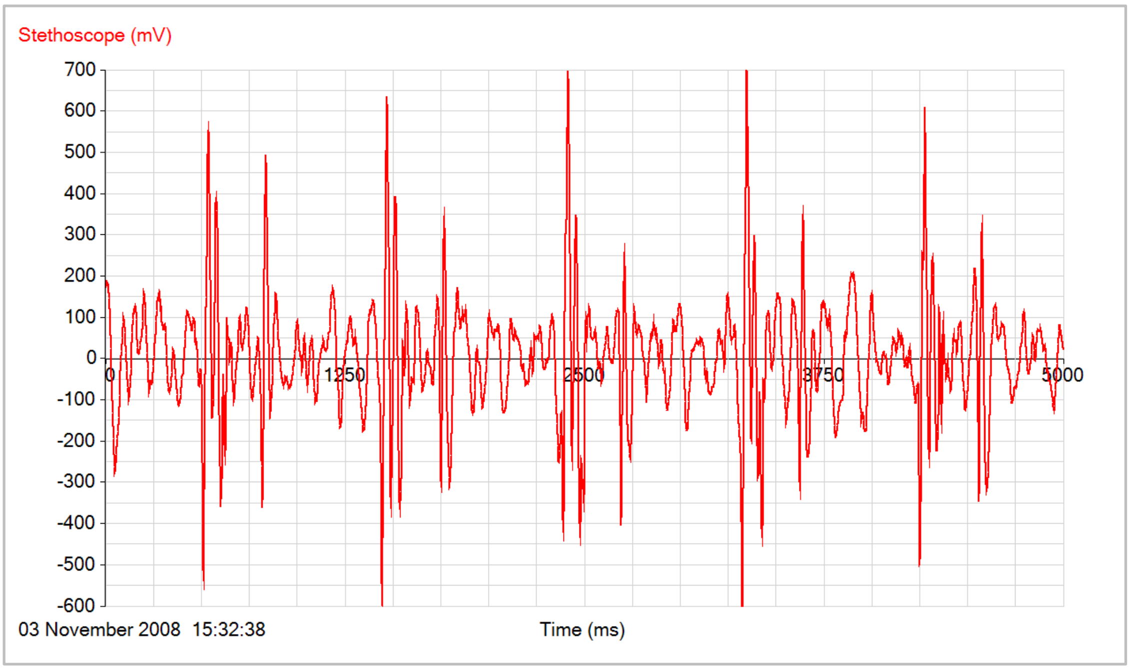
1. Start **EASY**SENSE software and select **Graph**. Use the set up table below to set the recording parameters. Do not select Start.
2. For most investigations use position A1 or B1 as indicated on the diagram.
3. Be prepared to make several recordings while finding the most responsive area for the recording. A little light exercise to stimulate the heart can make the task easier, you won't need vigorous exercise. Climbing a few steps will be sufficient.
4. Use the Stethoscope sensor with the diaphragm connected; once you have found the best recording spot you can of course compare the recording without the diaphragm.
5. It should be possible to slide the sensor through clothing to reach the sample point.
6. Place the foam pad on the sensor and push on the pad to press the diaphragm of the sensor to the skin. After a few attempts you will find the foam is not required, initially there is a tendency to press too firmly. The foam pad reduces the pressure on the sensor and helps to isolate the sensor from stray noises from clothing, finger pulse, etc.
7. When you are using the correct pressure you should feel the sensor on the skin, but not feel it pressing into the body mass.
8. When you feel the sensor is correctly in place click on Start and review the recording. Use the information collected to decide if the sensor needs moving, or you need to change your body position. Try a few variations to find the best result.
9. When the recording is as good as it can be, Save the data.
10. Try recording the heart noises at the different locations indicated and with and without the diaphragm. Use **Overlay** to collect the samples recorded onto one graph for comparison.

Set up table

You need to record with a short intersample time over a period of about 5 seconds.

Recording method	Length of recording	Intersample time
Graph	5 seconds	2 ms

This set up does not include a trigger. It should record a minimum of 4 sets of heart sounds (i.e. 4 heart beats). You will most likely collect 5 sets, but one set may be split over the beginning and end.



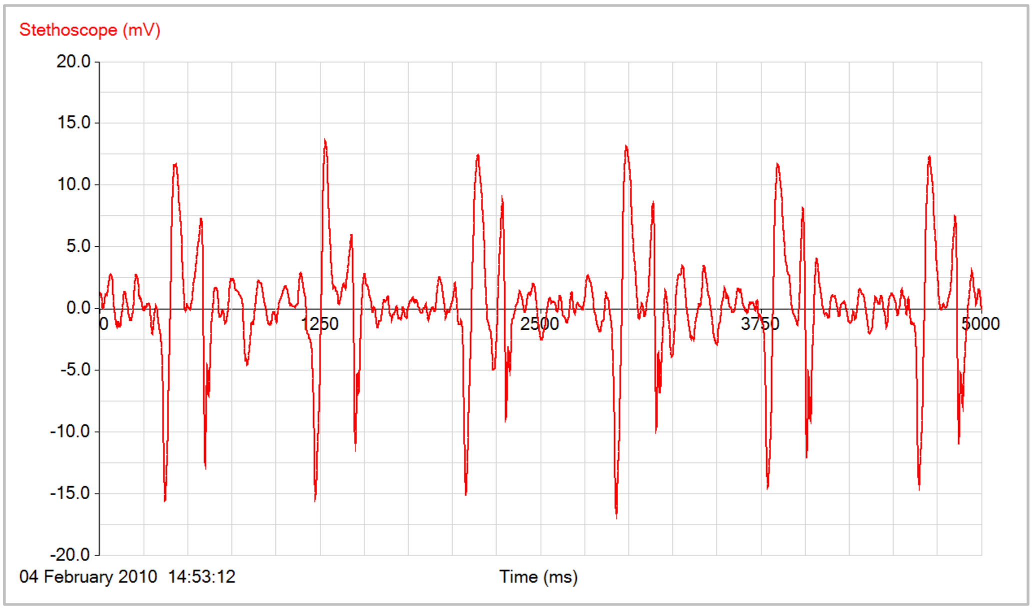
Sample heart sound trace (**Auto scale graph Min Max** used). Note how the heart sound appears as couplets, one is often louder and longer in duration, this is the S1 sound. Refer to the heart sound information earlier in this document for a description of the sounds. The heart sounds in the example were collected with the subject leaning forward slightly with the sensor at position A1.

Using Auto scale will often create a confusing graph. You should be looking to see a double beat pattern. The first beat will be stronger and of longer duration. The time interval from the beginning (S1) of one double beat to the next (S1) double beat is one cycle of the hearts beating rhythm.

Using the sensor to detect a pulse

A stethoscope is also used by a physician to listen to the circulatory sounds, most commonly when measuring blood pressure. The sampling period of the software and the dynamic range of the microphone will make it difficult to identify the subtle changes in noise a physician is trained to identify, however you should be able to demonstrate an audible pulse at the traditional pressure points

1. Use the same recording method as used to record heart sounds.
2. Place the sensor over the pressure point (at joints, where the musculature is reduced and the blood vessels are closest to the skin).



Recording of the pulse in the neck.

The sensor had been placed at the end of jaw on the lower edge of ear (left side). This location is useful as it shows a good pulse and is easily located by most students.

Recording the heart sounds with other heart monitoring sensors

This is a more complex investigation, but well worth the effort. It offers many teaching possibilities from a simple model of the role of medical electronics, to help with the understanding of the diagrams and explanations of the heart beat in physiology texts and lessons.

The Heart Rate sensor is indirectly recording blood pressure, it is uncalibrated. As the blood flows round the body it does so in a pulsatile form. Each pulse represents the output of the heart and is a pressure wave travelling around the system. The pressure wave peaks with the peak of blood expulsion from the ventricles (i.e. the point at which the valves open and blood moves from the ventricle into the aorta).

It should be possible to collect data that will compare favourably with diagrams seen in texts that combine heart sound, ECG, pressure and flow data (we cannot record flow). This will allow the student to see and experience the diagram.

Apparatus

- 1 x Stethoscope sensor set to the Stethoscope range with diaphragm fitted
- 1 x foam piece
- 1 x ECG sensor and electrode patches
- 1 x Heart rate / Pulse waveform sensor set to the waveform range.
- An EASYSENSE unit capable of fast logging

Note: *You may want to use the conventional stethoscope to locate the best position for the heart sounds.*

1. Connect the ECG as shown in the ECG sensor manual. Make sure the areas that will receive the electrode patches are thoroughly cleaned with alcohol to degrease the skin. It is worth positioning the patches early, they sometimes seem to need a “resting” period before maximum conduction is achieved.

2. Use a finger to record the Heart waveform. Test the result, you may need to swap the finger to get a pulse that is either big enough to see or is not so large that the waveform is lost.

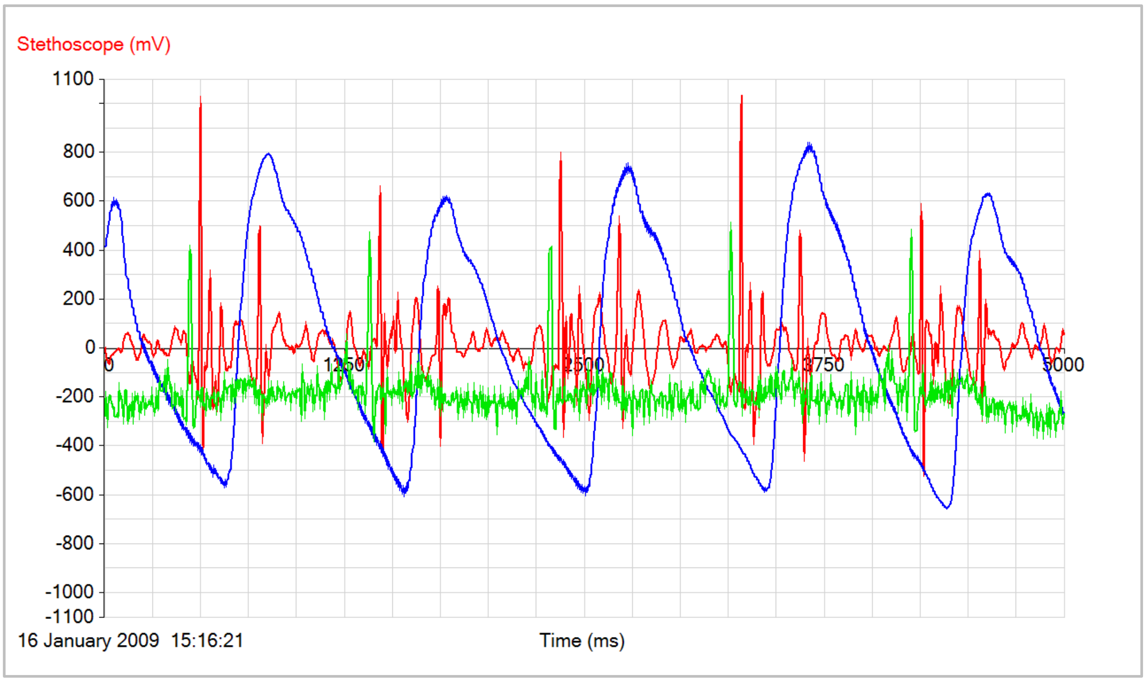
3. Finally find the best position for the Stethoscope sensor (using the conventional stethoscope). Use position A1. If the test subject is willing, use a biro to mark the position of the best response (do make sure the ink can be removed!).

Set up table

You need to record with a short intersample time over a period of about 5 seconds.

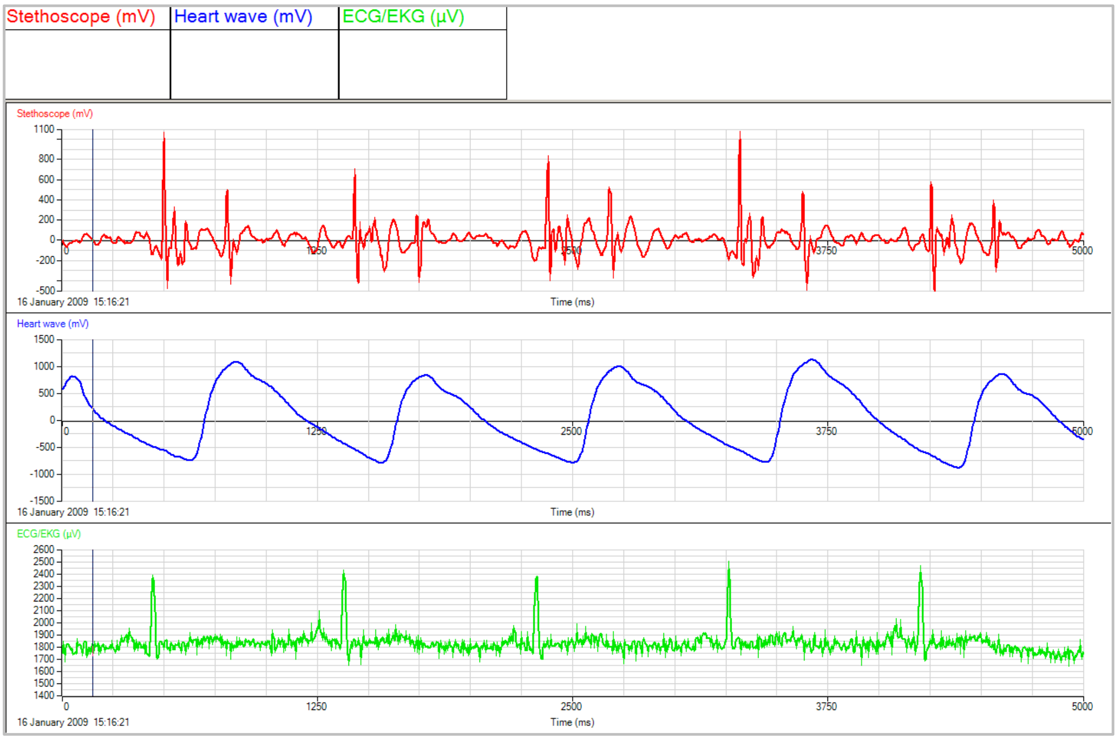
Recording method	Length of recording	Intersample time
Graph	5 seconds	2 ms

This set up does not include a trigger. It should record a minimum of 4 sets of heart sounds (i.e. 4 heart beats). You will most likely collect 5 sets, but one set may be split over the beginning and end.



Stethoscope, pulse waveform and ECG data, Sensor Settings, Y axis min & max adjusted

Use **Display**, **Number of graphs** to show the data over 3 graphs. Use **Show Hide** data to select one channel of data in each graph. Using the **Values** tool will now allow the relationship between sounds, pressure (the pulse wave) and EKG to be studied.



Stethoscope, pulse and ECG data separated out over three graphs

Table relating the events of the heart

	Cycle Component	Major Pump Event(s)	Electrical Event(s)
	Diastole	Ventricles and atria relaxed; passive filling	
SA-node "fires"- current flows throughout the atrial muscles and into the **AV (atrioventricular) node**			
	Atrial Depolarisation		**P-wave**
	Atrial Contraction	Atria force blood into the ventricles	P-wave ceases
AV node incorporates a **delay** (approx. 110 ms) into the conduction route from atrium to ventricles			
	Atrioventricular Delay		**Atrioventricular Delay**
	Ventricular Depolarization; Atrial repolarisation (masked by Ventricular behaviour)	"**LUB**" heart sound	**QRS complex**
	Ventricular Contraction	Ventricles force blood into pulmonary artery & aorta	(latter parts of QRS)
	Ventricular Repolarisation	Ventricles in late contraction followed by the initiation of ventricular relaxation ("**DUP**" heart sound)	**T-wave** (current flow between depolarizing and repolarizing parts of ventricles)

Limited warranty

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

Note: Data Harvest products are designed for **educational** use and are not intended for use in industrial, medical or commercial applications.

WEEE (**W**aste **E**lectrical and **E**lectronic **E**quipment) Legislation

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