Sound Level Sensor

Product No. 3175

Range: 40 to 110 dBA
Resolution: 0.1 dBA
Response time: 125 ms

Range: ±2000 mV
Resolution: 1 mV
Frequency response: 100 Hz - 7 kHz

DATA HARVEST

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DS 027 No 3

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Introduction

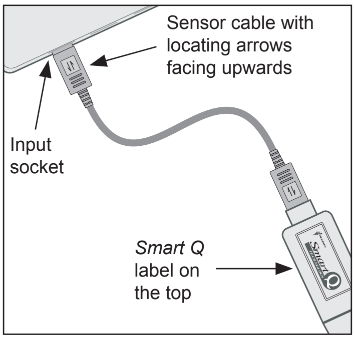
The *Smart Q* Sound Sensor can be used with two ranges to measure either sound pressure level in decibels (dBA) or frequency content in millivolts (mV). The Sensor is supplied preset to the decibel (dBA) range.

The electret microphone used in this Sensor has a broad frequency response of 100 Hz to 7 kHz.

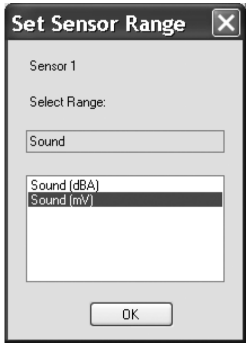
It has a sufficiently fast response to allow for the measurement of speed of sound and to capture waveforms. It is equally responsive to all sound frequencies within its range and can measure both transient and continuous noise.

Connecting

1. Hold the sensor housing with the *Smart Q* label showing on the **top**.
2. Push one end of the sensor cable (supplied with the **EASY**SENSE unit) into the socket on the sensor housing with the locating arrow on the cable facing upwards.
3. Connect the other end of the cable to the input socket on the **EASY**SENSE unit (with the locating arrow facing upwards).
4. The **EASY**SENSE unit will detect that the Sound Sensor is connected and display values using the currently selected range i.e. dBA or mV. If the range is not suitable for your investigation, set to the correct range (see page 2).



To set the range



- Connect the Sound Sensor to the **EASY**SENSE unit.
- Start the **EASY**SENSE program and select one of the logging modes from the Home page e.g. EasyLog. Select **Sensor Config** from the **Settings** menu.
- Select the Sound Sensor from the list (it will be listed using its current range) and click on the **Change Range** button.
- The current range will be highlighted. Select the required range and click on OK.
- Close Sensor Config. Click on New and then Finish for the change in range to be detected by the logging mode.

The range setting will be retained until changed by the user. With some **EASY**SENSE units it is possible to change the range from the unit. Please refer to the **EASY**SENSE unit's user manual.

Practical information

Ensure the level of the sound is within the Sound Sensors range. If the readings go off the scale, move the Sensor further away from the source, or turn down the volume of the sound.

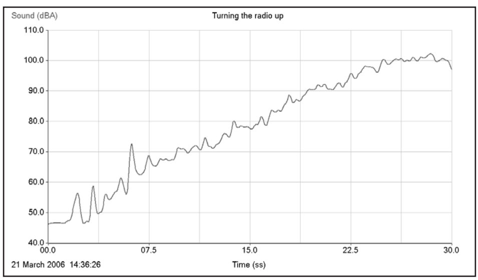
The Sound Sensor is not waterproof. If it is to be used in an environment where it could get wet, precautions must be taken to ensure liquid cannot enter the Sensor.
Note: *The microphone capsule is positioned in the end cap of the Sensor.*

Storage temperature: -10 to 60^{0}C max.

The dBA range

The unit of sound intensity level or loudness is the decibel (dB). The dBA output indicates sound pressure level with 'A' weighting to give a response similar to the human ear, so that a noise which sounds louder will produce a larger dBA reading.

The loudness of a sound depends on the amplitude of the sound waves. Increasing the 'volume' of a radio increases the amplitudes of the sound waves produced by the radios speaker, so the sound from the radio is louder.



Changing the loudness does not alter the frequency of a sound.

Comparing sound level with perceived loudness at a constant frequency of 1000 Hz:

Sound Level (dB)	Perceived Loudness
120	Threshold of pain
90	Extremely loud
80	Very loud
70	Loud
60	Moderately loud
50	Soft
40	Very soft
30	Extremely soft
0	Threshold of hearing

The efficiency of the human ear to different levels of loudness will vary with the frequency of the sound wave it is detecting. The ear is most sensitive and can detect the softest sounds at around 3,000 Hz; it cannot detect sounds over 18,000 Hz.

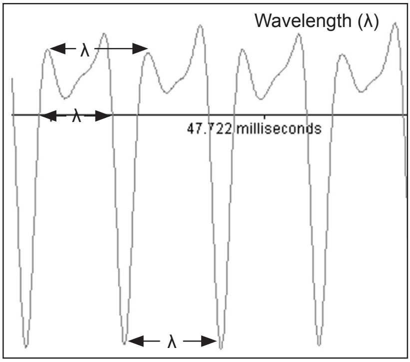
The ear has built in safety mechanisms to cut down the sensitivity of the ear as sound intensity increases. As airborne sound waves reach the eardrum, they are converted into mechanical vibrations that are then amplified via a lever system in the middle ear. The muscles in the middle ear modify the performance of this lever system and act as a safety device to protect the ear against excessively large vibrations from very loud sounds. One of these small bones passes the vibrations to a membrane covering the opening in the cochlea and they are transformed into hydraulic pressure. The cochlea to brain transmission system contains thousands of nerve fibres that are grouped by the frequency of the sound signal they carry; the number of fibres a sound requires gives the brain a gauge of intensity.

mV range

The mV signal has a frequency response of 100 Hz to 7 kHz and can be used for examining the frequency content of sound.

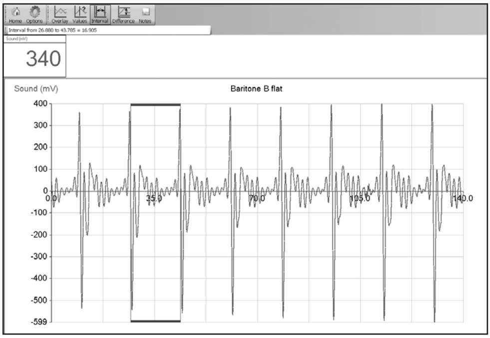
Sound waves are longitudinal. Particles oscillate about fixed points from left to right and the energy is also transferred from left to right. The amplitude of a wave is the maximum displacement of a particle from rest. The louder the sound, the larger the amplitude wave.

Wavelength is defined as the distance between two successive particles that are at exactly the same point in their paths and are moving in the same direction (same phase). It is given the symbol λ and is measured in metres.



The frequency of a wave is the number of complete cycles or oscillations of disturbance each second. The SI unit of frequency is Hertz (Hz).

Pitch depends on the frequency of the sound waves. Making the pitch higher increases the frequency.



Different musical instruments playing the same note can produce different waveforms. This graph is a recording of the wave pattern from a note on a ‘B flat’ Baritone instrument using an interval between samples of 25 μs (FAST). **Interval** is used to measure the period.

$$\text{Frequency} = \frac{1}{\text{Period}}$$

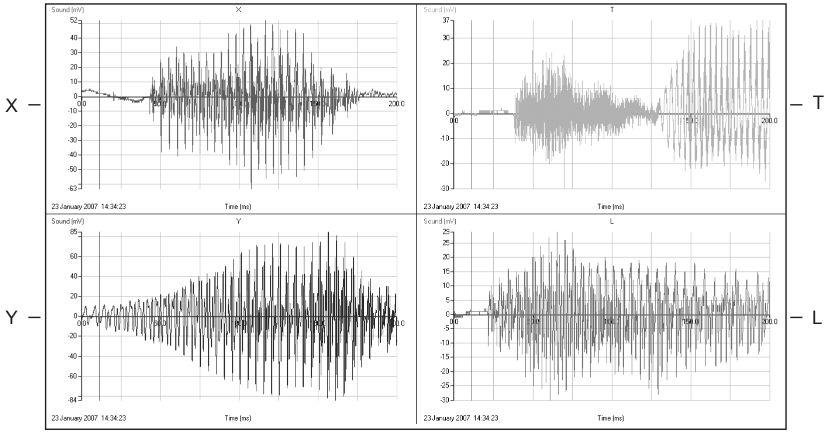
Period = 16.905 ms

$$\text{Frequency} = \frac{1}{16.9} \times 1000 = 59 \text{ Hz}$$

Investigations

- *Animal Activity Studies.*
- *Field Studies.*
- *Road Safety.*
- *Ear Design.*
- *Noise Pollution.*
- *Sound Insulation.*
- *Sound Decay.*
- *Sound Frequency.*
- *Speed of Sound.*
- *Air Resonance.*
- *Sound Waves: monitoring the effect of altering frequency and amplitude, wave forms of musical instruments, beat patterns.*

- *Voice recognition (Science at Work with* ***EASY****SENSE) – the sounding of a single letter using a logger capable of fast recording.*



Speed of Sound

Note: *This experiment requires very fast data capture and is therefore only suitable for* **EASY***SENSE units capable of fast logging.*

The speed that sound travels at will depend on:

- The material through which it is travelling. In solids and liquids there are more particles for the sound to travel through than in air, so it will travel faster.

Medium	Velocity of sound (m/s) at 20⁰C
Air	343
H_2O*	1,480
Quartz*	5,486
Steel*	6,096

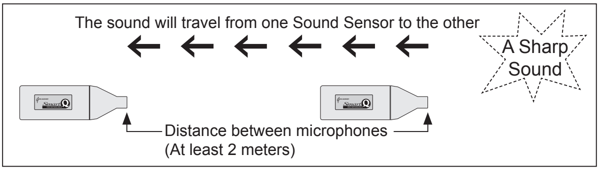
* **Note:** *These mediums are too fast for* ***EASY****SENSE to measure.*

- The temperature of the air - an increase in temperature will increase the velocity.

Temperature in ⁰C	Velocity of sound in air (m/s)
0	332.5
20	344.0
21	345.0
100	386.0

Speed of Sound in air

1. Connect the two Sound Sensors to the inputs on an **EASY**SENSE unit and place in a stand at least 2 metres apart. Align the Sensors so they are both facing in the direction of the sound source.



2. Data needs to be collected with a FAST recording time.

   In the example shown, Graph was set to record with a recording time of 100 ms and an interval between samples of 100 µs. The trigger was set for Sound, rises above 70 dBA or 600 mV with a 25% pre-trigger.

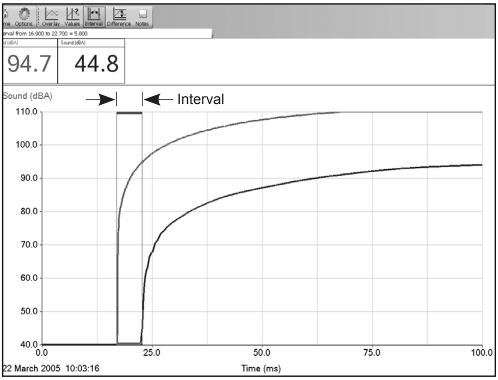


Fig.1: Result when using the dBA range

3. Keep the background noise to a minimum. Click on the **Start** icon.
4. Make a sound.
   Note: *The best results are obtained when the sound is short, sharp and loud e.g. hit a freestanding metallic object with a hammer, or glass with a metal rod. Perform several attempts before deciding the best option.*
5. Use **Interval** to measure the time between the sound reaching the first microphone and the second microphone.

Calculate the speed of sound: $v = \dfrac{l}{t_2 - t_1}$

Where l = distance between the two sensors and $t_2 - t_1$ = the time interval between the two points.

E.g. Fig 1. = $\dfrac{2\text{ m}}{5.80\text{ ms}} \times 1000 = 344.8$ m/s

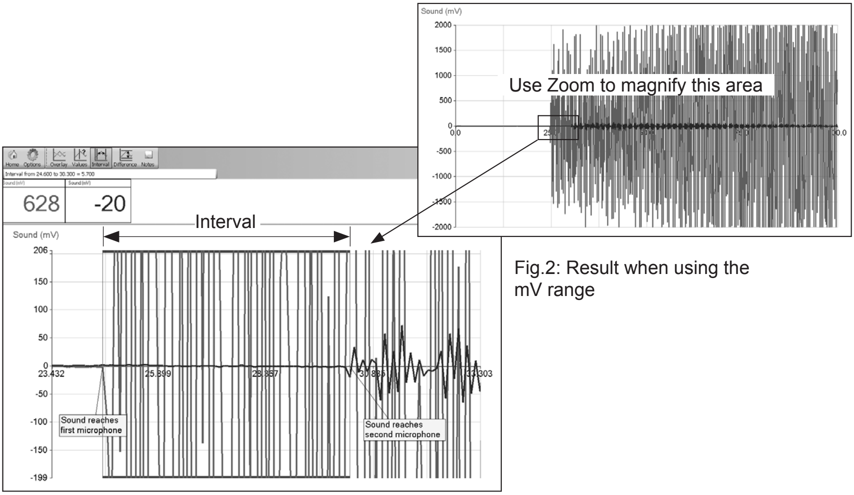


Fig.2: Result when using the mV range

Note: *To measure the speed of sound in a solid material e.g. wood, place the microphone on a long bar of the desired material facing down. The distance between the microphones should be as long as possible. The sound should be emitted from the material subject (e.g. hit the wooden bar with a hammer).*

Warranty

All Data Harvest Sensors are warranted to be free from defects in materials and workmanship for a period of 12 months from date of purchase provided they have been used in accordance with any instructions, under normal laboratory conditions. This warranty does not apply if the Sensor has been damaged by accident or misuse.

In the event of a fault developing within the 12-month period, the Sensor must be returned to Data Harvest for repair or replacement at no expense to the user other than postal charges.

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

Data Harvest Group Ltd are fully compliant with WEEE legislation and are 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.