ECG Sensor
(Electrocardiogram)

(Product No. 3279)

Range: 200 to 4,000 µV

DATA HARVEST

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Contents

Introduction

The *Smart Q* E.C.G. (Electro-Cardio-Gram) Sensor monitors the electrical energy produced during a heartbeat. The change in electrical energy is detected by two leads and referenced to a ground signal. The changes in energy are displayed as a waveform.

The ECG Sensor is supplied with a pack of 100 ECG electrode patches for making attachment to the test subject's skin. Additional packs of these electrodes are available from your supplier - Product No. 3286.

Notes

- *This product is designed for demonstration of the ECG waveform. It is **not** designed or intended for medical diagnosis. Any information derived from the signal produced should be regarded as having no medical significance.*
- *Before recording check that:*
  1. *The test subject is not able to touch the PC or any source of power connected to the equipment.*
  2. *The PC is electrically safe e.g. conforms to the IEC standard 60950.*
- *As the average heart cycle is typically 0.7 to 0.8 seconds this Sensor is best used with an **EASY**SENSE unit capable of fast logging e.g. EasySense VISION, V-Log, V-Hub, QAdvanced, 3Link, 1Link.*
- *An **EASY**SENSE unit capable of only 10-bit resolution (e.g. Q3, Q3+, Q5, Q5+ or Flash Logger) may not capture a trace's fine detail.*
- *The best results are obtained from an ECG sensor if the **EASY**SENSE unit is USB or battery powered i.e. not used with a DC power supply.*

Connecting

- Push one end of the sensor cable (supplied with the **EASY**SENSE unit) into the hooded socket on the adaptor with the locating arrow on the cable facing upwards.
- 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 ECG Sensor is connected.

The electrode patches

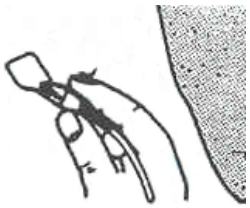
The electrode patches are a silver/silver chloride gel on a foil backing. The gel is hypoallergenic and has adhesive properties that enable the electrode to stick to the skin surface. The foil backing provides a constant area of contact and the gel gives a constant skin electrode resistance.

The electrode patches are disposable. A minimum of three electrode patches is required for each test subject (four to try out each attachment combination).

- To ensure good adhesion rub the area of skin to be used with a paper towel – preferably dampened with an alcohol rub e.g. industrial methylated spirits (IMS).
- Decide on the lead type arrangement to be used (see 'positioning the electrode patches' on page 4).
- Remove an electrode patch from the liner and place gel side down onto the skin, with the tab on the electrode pointing downwards on the arm or upwards on the ankle.

- Press the electrode firmly in place to ensure full contact.

- Clip the appropriate crocodile clip connector onto the tab part of the patch.



- After the investigation is complete remove the electrode patch slowly with a peel back action.

Notes:

- *Once a pack of electrodes has been opened they should be stored in a cool place, in a clean dry airtight container.*
- *The electrodes may dry out, so do not open the pouch until they are about to be used. See the pouch for the 'use by date'. Once opened fold the open end of the pouch over at least once and secure with a paper clip or similar.*

Positioning the electrode patches

Note: *The test subject can attach both the electrode patch and leads; there is no need for the intervention of a second person. If necessary the electrodes and leads can be connected discreetly under the test subjects clothing.*

There are four suggested positions for the electrode patches – the inside of the upper left arm, the inside of the upper right arm, the area behind the ankle on the left leg and the area behind the ankle on the right leg.

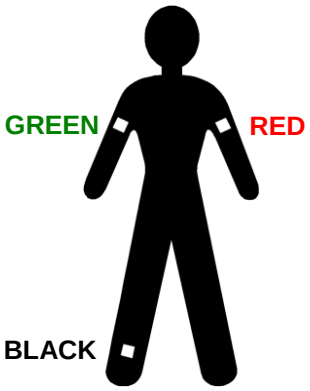
There are three electrode leads from the ECG Sensor each with a different colour crocodile clip connector. The crocodile clip for the positive lead is red, for the negative lead is green and for the reference point (isoelectric line) is black.

There are three different ways described that the electrode leads can be connected to the electrode patches. Each arrangement of lead and electrode will record a different shape and intensity of waveform and is described as a 'lead type'. For the majority of individuals either the Lead I or II layout will produce the 'typical' ECG trace.

Lead type	Red (Positive) lead	Green (Negative) lead	Black (Reference) lead
Lead I	Left arm	Right arm	Right ankle
Lead II	Left leg	Right arm	Right ankle
Lead II	Left leg	Left arm	Left ankle

Lead I

1. Rub the area of skin that will be used with the paper towel.
2. Place an electrode patch on the inner part of your right upper arm (RA), your left upper arm (LA) and on the area behind your right ankle (RL).
3. Connect the **Green** crocodile clip to the electrode tab on your **right arm** (RA).
4. Connect the **Red** crocodile clip to the electrode tab on your **left upper arm** (LA).
5. Connect the **Black** crocodile clip to electrode tab on your **right ankle** (RL).

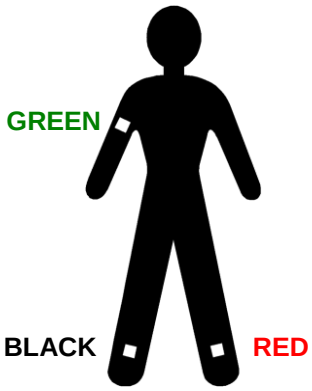


If attaching the lead to the ankle causes a problem, e.g. the test subject is wearing tights, use this alternative **Lead I** arrangement:

1. Place an electrode patch on the inside of your right elbow, right wrist and left elbow.
2. Connect the **Green** Crocodile clip to the electrode tab on your **right elbow**.
3. Connect the **Black** Crocodile clip to the **right wrist**.
4. Connect the **Red** crocodile clip to the **left elbow**.

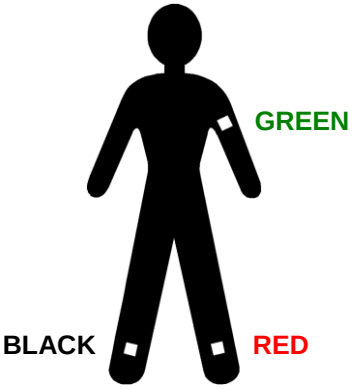
Lead II

1. Rub the area of skin that will be used with the paper towel. Place an electrode patch on the inner part of your right upper arm (RA), on the inner area behind your left ankle (LL) and on the inner area behind your right ankle (RL).
2. Connect the **Green** crocodile clip to the electrode tab on your **right arm** (RA).
3. Connect the **Red** crocodile clip to the electrode tab on your **left ankle** (LL).
4. Connect the **Black** crocodile clip to the electrode tab on your **right ankle** (RL).



Lead III

1. Rub the area of skin that will be used with the paper towel. Place an electrode patch on the inner part of your left upper arm (LA), on the inner area behind your left ankle (LL) and on the inner area behind your right ankle (RL).
2. Connect the **Green** crocodile clip to the electrode tab on your **left arm** (LA).
3. Connect the **Red** crocodile clip to the electrode tab on your **left ankle** (LL).
4. Connect the **Black** crocodile clip to the electrode tab on your **right ankle** (RL).



Measurement procedure

When the electrodes and leads have all been connected leave a time delay of at least **15 seconds** before starting to collect data. This gives time for the reference electrode to stabilise the waveform. The time delay required will depend upon the individual and the electrode layout.

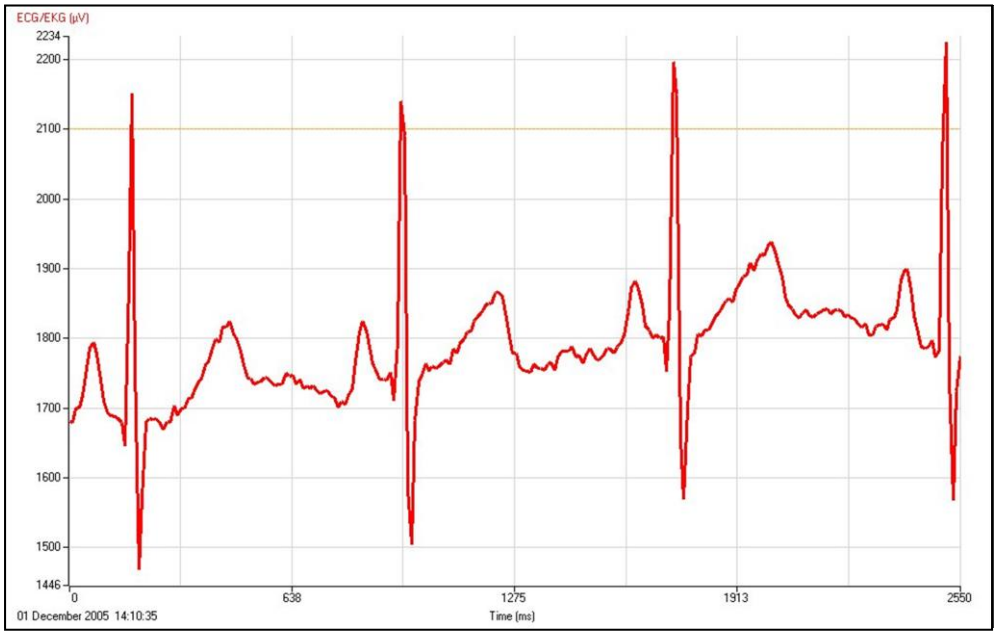
1. Open the **EASY**SENSE program and select either **Scope** or **Graph** from the Home screen. Select a suitable recording time – this will depend on the number of heart cycles required for analysis (the average heart cycle is typically 0.7 - 8 seconds, so with a recording time of 2.56 seconds = minimum of 3 cycles).

   Suggested recording setups

Graph				
Recording time	2 s (FAST)	5 s (FAST)	10 s (FAST)	10 s (REAL TIME)
Interval	500 µs, 1 ms, 2 ms	2 ms, 5 ms, 10 ms	5 ms, 10 ms	20 ms
Approx. no. of heart cycles	2	6	13	13

Scope			
Interval	5 ms	10 ms	20 ms
Duration	1.28 s	2.56 s	REAL TIME
Mode	Trigger mode	Trigger mode	Roll mode
Approx. no. of heart cycles	2	3	10

2. With the test subject sitting still, click on the **Start** icon.



Note: *Zoom (right click in graph area) has been used to adjust to the minimum and maximum limits of the data.*

Practical information

- Good contact between the electrode patches and the skin is the key to getting good results. To ensure good adhesion the area of skin being used should have any moisture, surface oil or dead skin removed by rubbing the area with a paper towel – preferably dampened with alcohol e.g. industrial methylated spirits (IMS).
- It may be useful to demonstrate the method of electrode attachment to new users.
- When the electrodes and leads have all been connected leave a time delay of at least 15 seconds before starting to collect data. This gives time for the reference electrode to stabilise the waveform. The exact time delay required will depend upon the individual and the electrode layout. Recordings taken before this time may show either a flat line or erratic values.
- Coughing, sneezing, laughing, moving and talking will affect the reading. The test subject should be relaxed and motionless.
- When investigating the effect of exercise unclip the crocodile clips from the electrode patches but leave the patches in place. After exercise reconnect the crocodile clips. In Graph select Overlay to record a new set of data without the previous set being erased.
- The electrode patches are a silver/silver chloride gel on a foil backing. The gel has adhesive properties that enable the electrode to stick to the skin surface. The gel is hypoallergenic and is unlikely to cause any skin reaction.
- The electrode patches are disposable. For hygiene reasons they should not be transferred from one user to another.
- Once a pack of electrodes has been opened they should be stored in a cool place (less than 25˚C) in a clean dry airtight container. The electrodes may dry out, so do not open the pouch until they are about to be used. See the pouch for the 'use by date'. Once the pouch has been opened fold the open end over at least once and secure with a paper clip or similar.
- The ECG Sensor has been tested to give the subject 3000 VAC of electric shock protection.
- Before recordings are made check that:
    1. The test subject is not able to touch the PC or any source of power connected to the equipment.
    2. The PC is electrically safe e.g. conforms to the IEC standard 60950.
- As the average heart cycle is typically 0.7 to 0.8 seconds this Sensor is best used with an **EASY**SENSE unit capable of fast logging e.g. EasySense VISION, V-Log, V-Hub, QAdvanced, 3Link, 1Link. An **EASY**SENSE unit capable of only 10-bit resolution (e.g. Q3, Q3+, Q5, Q5+ or Flash Logger) may not capture a trace's fine detail.
- The best results are obtained from an ECG sensor if the **EASY**SENSE unit is USB or battery powered i.e. not used with a DC power supply.

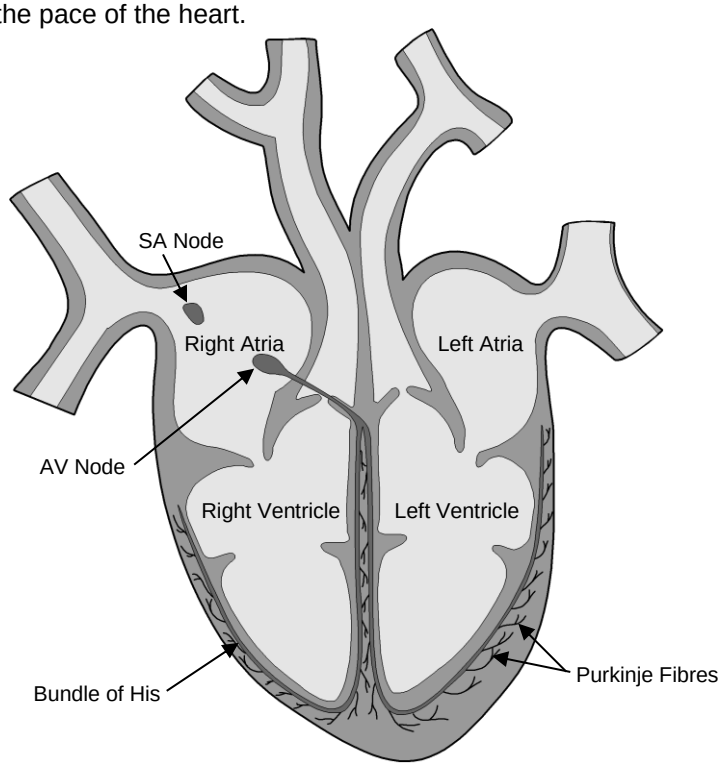
Background

All cells of an animal maintain an electrical gradient across their cell membranes. The gradient is created by the movement of ions across the membrane using ionic pumps and the expenditure of energy. The potentials are usually in the region of 100 mV and the interior of the cell is negative to the outside of the cell.

Cardiac cells have a potential of about 90 mV when fully polarised. The 90 mV potential is called the 'resting' potential and for most cells is constant. In some cells the opening of ion specific pores in the cell membrane will allow a sudden depolarisation to take place. The most dramatic of these depolarisations is seen in the creation and conduction of an impulse along a neurone. Cardiac cells have a built in tendency to depolarise and repolarise with a steady

rhythm. As each cardiac cell depolarises it also contracts, the mass of the cells in the heart following this rhythm form a large beating mass. A discrete area of the heart called the sinoatrial node or SA node (pacemaker) controls the pattern of polarity changes and creates a co-ordinated beat. An ECG is the recorded pattern of electrical changes that take place in the heart over the time of one or more heartbeats. The electrical changes being detected are very small and prone to disturbance from other events that cause the generation of electrical energy e.g. movement of limbs.

The heartbeat is generated from a wave of electrical energy that is generated in the SA node and then moves across and through the body of the heart. The pattern of movement is controlled by the structure of the heart and the varying electrical properties of the tissues that make up the heart mass. Effectively the atria are electrically isolated from the ventricles by a poorly conductive “skeleton” that contains the valves of the heart. A conductive pathway between the atria and the bottom of the ventricles carries the electrical energy from its point of origin (the atrioventricular node or AV node) to the correct area of the heart for a coordinated beat. The cells in the sinoatrial node beat with a slightly faster rhythm than the rest of the heart and they set the pace of the heart.



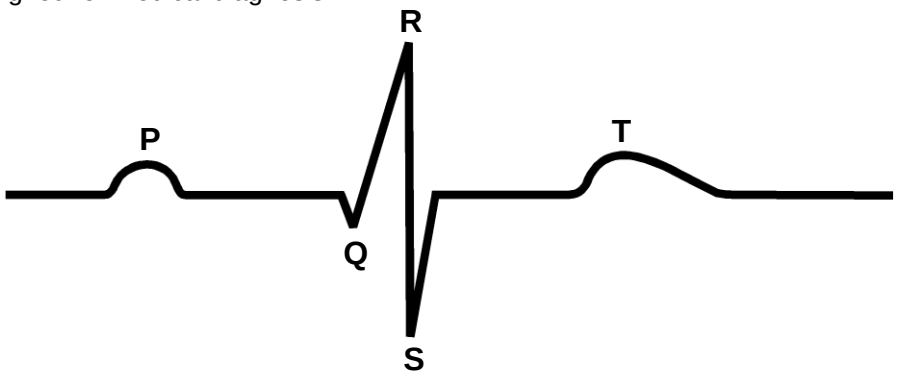
Events in the electrical activity of the heart:

1. The cells in the SA node depolarise and send a wave of depolarisation across the atria.
2. The wave of depolarisation reaches the beginning of the Bundle of His.
3. The depolarisation travels down the Bundle of His and is dispersed into the ventricle muscle mass by the Purkinje fibres.
4. The cells in the atria contract and then start to repolarise.
5. The wave of depolarisation travels through the ventricles from the apex of the heart back towards the atria.
6. The muscle mass of the ventricles contracts.
7. The ventricle cells repolarise.
8. The polarity of the SA cells is slowly decreasing back up to the trigger value for the next cycle. Unless other events, (such as neural stimulation from the vagus nerve or hormonal stimulation) override the SA node, this time back to trigger controls the pace of the heart.

With an ECG monitor connected the electrical events produce a trace called the Electrocardiagram (ECG). The trace has a well-defined pattern of events or waves. The ECG represents the summary of the electrical activity of the heart during one cycle or beat, it does not measure the mechanical contraction of the heart but it does relate to the activity of the heart in a cycle.

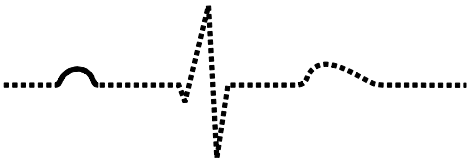
The following information refers to the typical or average ECG pattern. If results and times are different on the recorded trace this is not cause for concern. There is considerable variation of the ECG depending on the pattern of lead connection, age, gender, underlying heart abnormalities and medication.

Diagnosis from an Electrocardiagram is a skill that requires considerable training. This Sensor is not designed for medical diagnosis.



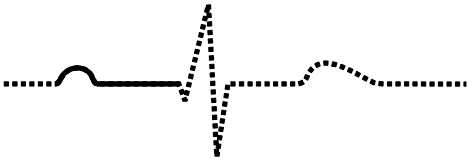
The P wave

The P wave represents atrial depolarisation – the time taken for an electrical impulse from the SA node to spread through the atrial muscle. It has duration of 0.06 to 0.11 seconds. The amplitude is a maximum of 0.25 mV.



The P-R interval

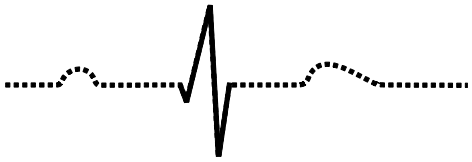
The P-R interval represents the time taken for the impulse to travel from the atria through the AV node, Bundle of His to the Purkinje's fibres. Duration of 0.12 to 0.20 seconds.



The QRS complex

The QRS complex represents ventricular depolarisation. The complex consists of 3 waves:

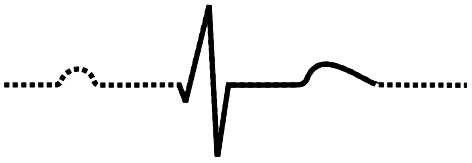
1. The Q wave which marks the beginning of the QRS complex. It may or may not be present.
2. The R wave is the first positive deflection.
3. The S wave is the negative deflection that follows the R wave.



Duration of the QRS complex is no longer than 0.10 seconds.
The amplitude of the complex varies with both gender and age.

The Q-T interval

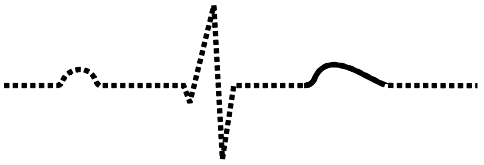
This represents the time necessary for the depolarisation and repolarisation of the ventricle. It extends from the beginning of the QRS complex to



the end of the T wave. The duration is age and gender dependant.

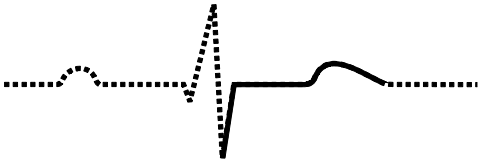
The T wave

The T wave represents the repolarisation of the ventricular muscle cells. It is normally 2 to 4 times the amplitude of the P wave. The duration is not measured.



The S-T interval

The S-T interval represents the end of ventricular depolarisation and the beginning of ventricular repolarisation.



Investigations

- Comparing the ECG to the waveform from the Heart Rate Sensor (Product No. 3147).
- Comparing the ECG of rested and exercised heart.
- What happens to the ECG trace if the sensor lead location is changed?
- Understand the meaning and relationship of the P, Q, R, S and T waveforms.
- Investigate the ECG after the use of mild stimulants (caffeine).

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

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.