ECG SENSOR 0628I
0 .. 5 mV

User's Guide

Figure 1. ECG sensor 0628i

CENTRE FOR MICROCOMPUTER APPLICATIONS

http://www.cma-science.nl

Description

The ECG (electrocardiogram) sensor measures voltages that are produced by the heart. These small voltages can be measured at the skin of the wrists and elbow through electrodes. The voltages are amplified by the sensor and filtered and transferred through an optical coupler to a measurement interface. By using the optical coupler, there is never any direct electrical contact between the person whose ECG is measured and the measurement interface or computer. This is for safety reasons. On the computer, a graphical representation of the signal, so called en electrocardiogram (ECG), is made by the Coach software.

The ECG sensor is delivered together with a package of 100 electrode patches.

The ECG sensor is equipped with a BT-plug and can be connected to the following CMA interfaces: €Lab**,** CoachLab II/II$^+$ and **U**LAB. Furthermore the sensor can be used with Texas Instruments CBL™, CBL2™ and Vernier LabPro.

Figure 2. The ECG electrode patches.

Sensor specifications

The ECG sensor has a memory chip (EEPROM) with information about the sensor. Through a simple protocol (I^2C) the sensor transfers its data: name, quantity, unit and calibration to the interface[1].

Suggested experiments

- Monitor ECG in rest
- Monitor ECG after mild exercise
- Investigate ECG changes with mild stimulants
- Study the P, Q, R, S, T waveforms
- Study the effect of different body positions on the ECG

Safety instructions

Inside, the ECG sensor consists of two electronic circuits that are isolated from each other. One of the circuits is connected to the measurement interface. It outputs the sensor signal. The other circuit is connected to the person whose ECG is measured. The signal between these two circuits is transmitted by an optical coupler. This is to protect the person from dangerous voltages in case of defects or errors.
However, for safe operation it is also necessary to always respect the following

[1] This is valid for the following interfaces: CMA €Lab**,** BT inputs of CoachLab II/II$^+$ and **U**LAB, TI CBL™and CBL2™, and Vernier LabPro.

instructions when using the ECG sensor:

1. The sensor, electrode patches and alligator clips of the sensor must never come into contact with water or any other liquid.
2. Never use the sensor if the insulation of any of the wires is damaged.
3. Never connect the alligator clips of the sensor to anything other than the electrodes.
4. Make sure the alligator clips of the sensor are not within reach of a wall outlet or any other power source.

The ECG sensor is to be used for educational purposes only. It is not appropriate for medical applications and not suitable for patient diagnosis.

Connection of the sensor to the body

Because the electrical signal that is produced by the heart and measured at the skin is very weak, a good contact between skin and electrode is essential for the correct working of the ECG sensor.

1. Read the safety instructions.
2. Clean the areas of the skin where the electrode patches will be applied (inside of left and right wrist and right elbow).
3. Peel an electrode patch from its backing paper and put it firmly on the inside of the right elbow. This is for reference.
4. Peel a second electrode patch from its backing paper and put it firmly on the inside of the right wrist.
5. Peel a second electrode patch from its backing paper and put it firmly on the inside of the left wrist.
6. Connect the white alligator clip from the sensor to the tab of the right elbow electrode (see figure 3).
7. Connect the red clip to the tab of the right wrist electrode.
8. Connect the blue clip to the tab of the left wrist electrode.

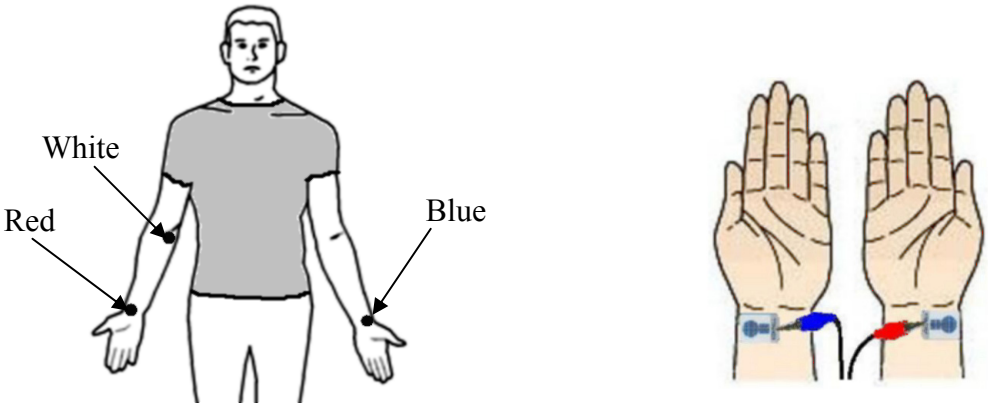

Figure 3. Connection of the ECG sensor to the body

Tips for use

- Muscles that are closer to the skin then the heart will produce electrical signals that are much stronger then the signal produced by the heart. To obtain a nice ECG signal, it is therefore necessary that the muscles of the arms (and also other muscles) are as relaxed as possible. It is easiest to put your arms on the arms of a chair or on a table. Also, breathe slowly.
- If the signal is not satisfactory, maybe the contact between the skin and the electrode patches is not good enough. Clean the skin with soap and water or alcohol, dry with a paper towel and reapply new patches. The electrode patches have a limited lifetime, especially after a package has been opened. Check if the patches are still good.
- An additional package of 100 electrode patches can be ordered at CMA.
- When a package of electrode patches is opened, their lifetime is limited. Open packages can be conserved best in an airtight box in a refrigerator.

Calibration

At the sensor output, 1 V corresponds to approximately 1 mV measured at the skin. To be able to measure both positive and negative waveforms, the sensor has an offset of about 2 V (± 0.5 V). To collect data you can:

1. Use the calibration supplied by the sensor EEPROM memory.
2. Use the calibration supplied in the standard sensor library of the Coach program. The name of the ECG sensor in the sensor library of Coach is: ECG sensor (0628i) (CMA) 0..5mV.
3. Use no calibration. For the ECG sensor, normally, you are only interested in the waveform or frequency of the ECG signal, so it is not necessary to use any calibration at all.

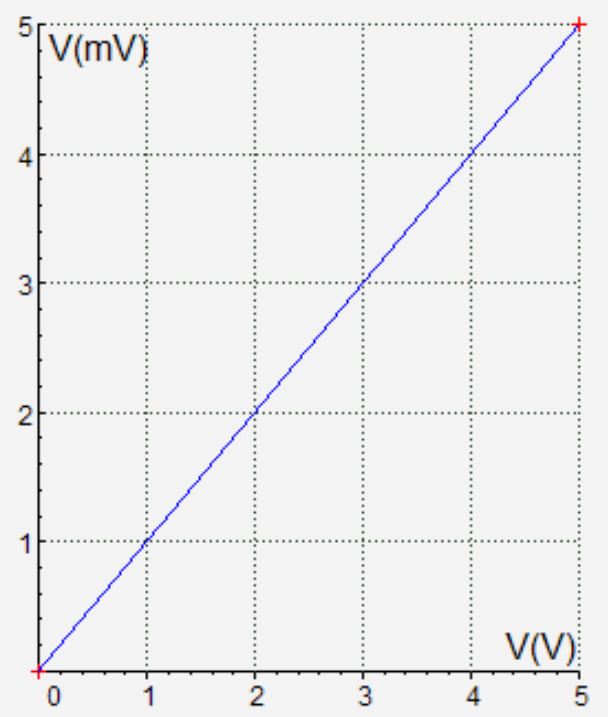

Figure 4. Default calibration graph of the ECG sensor (used in the Coach sensor library and in the sensor memory).

The electrocardiogram

A schematic ECG of one heartbeat is shown in figure 5. Every (normal) heartbeat is composed of a P wave, a QRS complex and a T wave.
The P wave is caused by depolarization of the atrial tissue prior to contraction.
The QRS waves are generated by currents when the ventricular tissue depolarizes, prior to contraction.

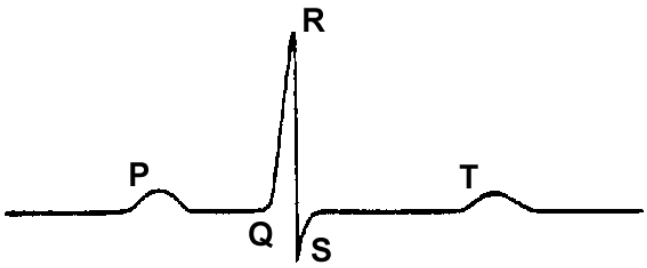

Figure 5. Schematic ECG

The T wave is caused by currents generated as the ventricle recovers from depolarization.
The P-R interval is between 0.12 and 0.20 seconds for most persons. The length of this interval is independent of the heartbeat rate (see figure 6).

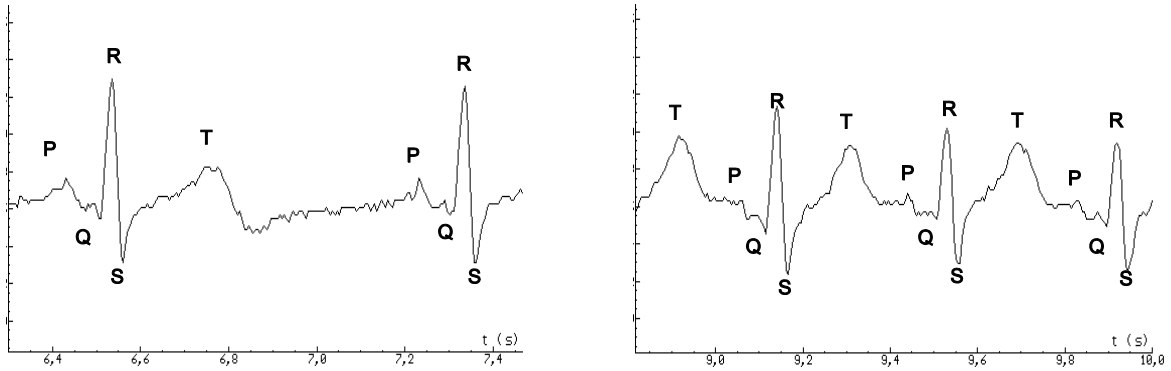

Figure 6. Two registrations of an ECG from the same person, on the left at a heartbeat of 80, on the right at a heartbeat of 162 beats per minute.

In general ECG's produced with the CMA ECG sensor will show this pattern. However no ECG, produced with this equipment is the same. Specifically, the height of the P wave and the length of the S wave may differ from the pattern shown in medical books (compare figure 5 and figure 5). Figure5 is taken from a medical book; figure 6 are ECG's made with the CMA sensor.
This might be due to the method of measuring (the electrodes are placed on the wrists instead of on the breast), but also to the fact that the CMA ECG sensor is an instrument that doesn't meet medical standards.

Technical specification

Input range	0 to 5 mV
Output range	0 to 5 V
Output offset	~ 2 V (± 0.5 V)
Calibration function	V_{in} (mV) = V_{out} (V)
Resolution using 12 bit A/D converter	1.2 µV
Current consumption	40 – 70 mA
Sensor information for Auto-ID and calibration	256 byte serial EEPROM
Connection	Right-hand BT (British Telecom) connector

Warranty:

The 0628i ECG sensor is warranted to be free from defects in materials and workmanship for a period of 12 months from the date of purchase provided that it has been used under normal laboratory conditions. This warranty does not apply if the sensor has been damaged by accident or misuse.

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

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