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# ECG SENSOR BT36i USER'S GUIDE



CENTRE FOR MICROCOMPUTER APPLICATIONS

<http://www.cma-science.nl>

## Short description

The ECG sensor measures electrical potentials, in the range between 0 to 5 mV, produced by the heart (Electro-cardiogram). These small voltages are measured at the skin of the wrists and elbow through electrodes.

The ECG sensor can also be used to measure the electrical potentials generated by muscle cells when these cells contract and relax (Electromyogram).

For safety reasons the sensor uses an optical coupler to avoid any direct electrical contact between the person whose ECG is measured and the measurement interface or computer.

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



The ECG electrode patches.

The ECG sensor can be directly connected to the analog BT inputs of the CMA interfaces. The sensor cable BT - IEEE1394 needed to connect the sensor to an interface is not supplied with the sensor and has to be purchased separately (CMA Article BTsc\_1).

## Sensor recognition

The ECG sensor BT36i has a memory chip (EEPROM) with information about the sensor: its name, measured quantity, unit and calibration. Through a simple protocol this information is read by the CMA interfaces and the sensor is automatically recognized when it is connected to these interfaces. If your ECG sensor is not automatically detected by an interface you have to manually set up your sensor by selecting it from the Coach Sensor Library.

## Calibration

The CMA ECG sensor BT36i is supplied calibrated. The output of the sensor is linear with respect to the measured voltage:

$$V_{\text{in}} \text{ (mV)} = V_{\text{out}} \text{ (V)}.$$

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 ( $\pm 0.5$  V).

The Coach software allows selecting the calibration supplied by the sensor memory (EEPROM) or the calibration stored in the Coach Sensor Library.

## **Safety instructions**

The ECG sensor consists of two electronic circuits that are isolated from each other. One of the circuits is connected to the person whose ECG is measured. The other circuit is connected to the measurement interface. The measured in the first circuit voltages are amplified, filtered and transferred through an optical coupler to a second electrical circuit. 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 instructions when using the ECG sensor:

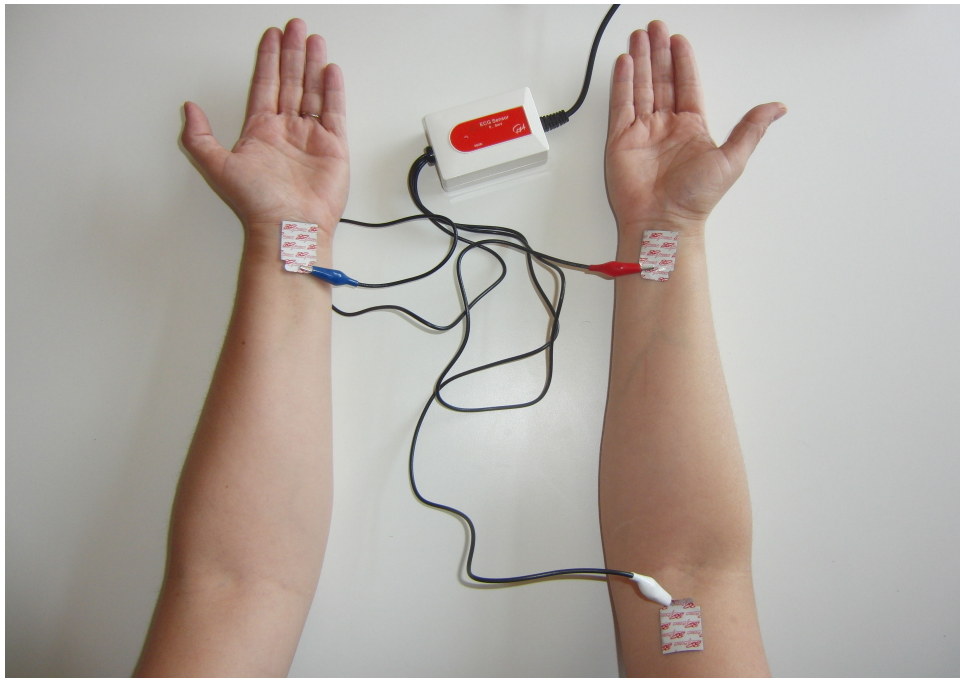
1. The sensor, electrode patches and alligator clips of the sensor must never come into contact with water or any other liquid.
2. Never use the sensor if the insulation of any of the wires is damaged.
3. Never connect the alligator clips of the sensor to anything other than the electrodes.
4. Make sure 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.
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.



Connection of the ECG sensor to the body.

### Tips for use

- Contracted muscles will produce electrical signals that are much stronger than 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. Open packages can be conserved best in an airtight box in a refrigerator.
- Additional packages of electrode patches (100 per package) can be ordered at CMA.

### Suggested experiments

The ECG sensor can be used for various experiments such as:

- Monitoring ECG in rest and after mild exercise
- Investigating ECG changes with mild stimulants
- Studying the P, Q, R, S, T waveforms
- Studying the effect of different body positions on the ECG

- Recording the electrical activity of a muscle (EMG)
- Associate amount of electrical activity with strength of muscle contraction.
- Investigate the relation between the EMG and the force exerted by the arm.

## The electrocardiogram

A schematic ECG of one heartbeat is shown in figure at right.

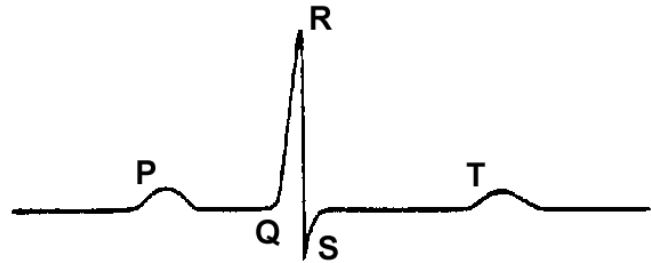
Every (normal) heartbeat is composed of a P wave, a QRS complex and a T wave.

The P wave is caused by depolarization of the atrial tissue prior to contraction.

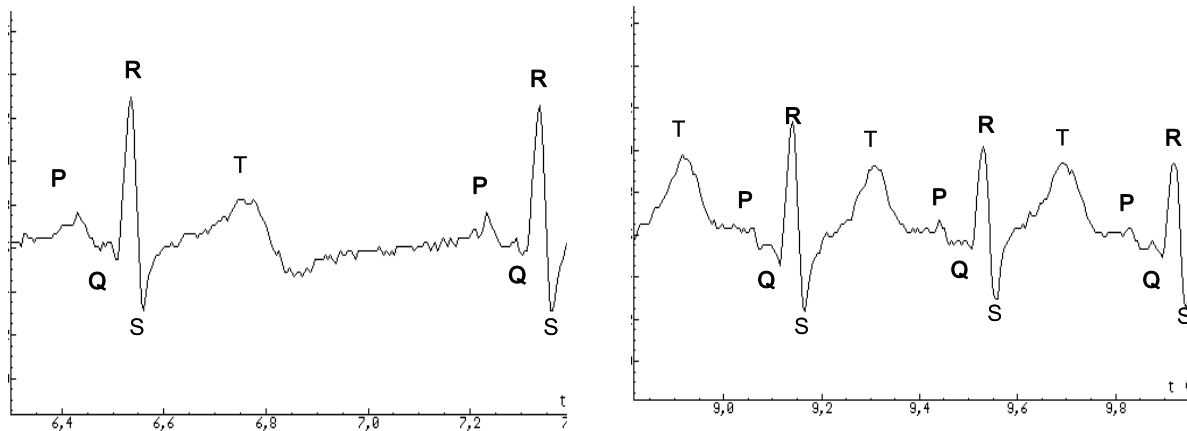
The QRS waves are generated by currents when the ventricular tissue depolarizes, prior to contraction.

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.



Schematic ECG



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.

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

<i>Sensor kind</i>	Analog, generates an output voltage between 0 .. 5 V
<i>Measurement range</i>	0 to 5 mV
<i>Resolution using 12 bit AD converter</i>	1.2 $\mu$ V
<i>Output offset</i>	$\sim 2$ V ( $\pm 0.5$ V)
<i>Calibration function</i>	$V_{in} \text{ (mV)} = V_{out} \text{ (V)}$
<i>Current consumption</i>	40 – 70 mA
<i>Connection</i>	IEEE1394 connector for BT-IEEE1394 sensor cable. Sensor cable not delivered with the sensor.

### Warranty:

The ECG sensor BT36i 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.

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**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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