EKG Sensor
Product Number: ENEKG189

Overview

An electrocardiogram – abbreviated as EKG or ECG – is a test that measures the electrical activity of the heartbeat. With each beat, an electrical impulse (or wave) travels through the heart. This wave causes the muscle to squeeze and pump blood through the body.

The EKG (Electrocardiogram) sensor measures cardiac waveforms which illustrate how electrical impulses travel through along the heart. This provides users with a map of the heart. It is an ideal tool for experiments in Human Physiology.

The EKG (Electrocardiogram) sensor can be connected to all einstein™ data loggers.

Typical experiments

Human Physiology

• Monitoring personal EKG
• Comparing EKG graphs at rest and after activity
• Investigating EKG with different body positions

How it works

The EKG (Electrocardiogram) is a procedure that measures the heart muscle's contractions by using electrodes located in different places on the body.

Ions and charged molecules such as potassium, calcium, chlorine, and charged protein molecules are involved in the depolarization and repolarization of the cardiac muscle. This process can be recorded by electrodes at the surface of the skin. A recording of the heart's electrical activity is called an electrocardiogram (EKG).

The cells of the heart's conducting system will depolarize spontaneously. This spontaneous depolarization is most apparent in a cluster of cardiac muscle cells embedded in the upper wall of the right atrium. This group of cells is called the pacemaker (also known as the sinoatrial or SA node). Depolarization of the pacemaker generates a current that leads to the depolarization of all other cardiac muscle cells. The depolarization of the cardiac muscles triggers the heart's contraction. The wave of depolarization travels from the right atrium to the left atrium quickly enough that both atria contract at essentially the same time.

The atria and the ventricles are isolated from each other electrically by connective tissue that acts like the insulation on an electric wire. The depolarization of the atria does not directly affect the ventricles. There is another group of cells in the right atria, called the atrioventricular or AV node that will conduct depolarization down to the ventricles via a special bundle of conducting fibers (called the Bundle of His) to the ventricles. The muscle wall of the ventricles contain the Purkinje Fibers, which are a special system of muscle fibers that cause depolarization in all parts of the ventricles almost simultaneously. This process causes a small time delay, so there is a short pause after the atria contract and before the ventricles contract. Because the cells of the heart muscle are interconnected, this wave of depolarization, contraction, and repolarization spreads across all of the connected muscle of the heart.

When a portion of the heart is polarized and the adjacent portion is depolarized, an electrical current is created that moves through the body. This current is greatest when one half of the connected portion of the heart is polarized and the adjacent half is not polarized. The current decreases when the ratio of polarized tissue to non-polarized tissue is less than one to one. The changes in these currents can be measured, amplified, and plotted over time. The EKG represents the summation of all the action potentials from the heart, as detected on the surface of the body. It does not measure the mechanical contractions of the heart directly.

Sensor specification

Range:	0 – 3 V
Resolution (12-bit):	732 µV
Recommended Sample Rate:	100 samples/sec
Gain	1mV body potential = 386 mV sensor output
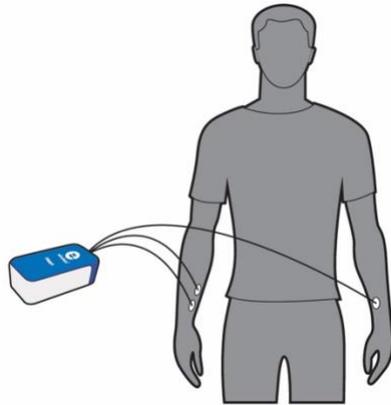
Sensor Cable sold separately

Note: This product is to be used for educational purposes only. It is not appropriate for medical or research applications. Specifically, it may not be used for patient diagnosis.

Technical Notes

- The electrodes should be kept refrigerated in a clean, dry, airtight container for storage. Even with airtight storage, opened electrode packages cannot be stored from one year to the next.
- The presence of metal or magnets on the body can disturb the EKG signal.
- The sensor's circuitry isolates the user from the possibility of electrical shock in two ways:
  - The sensor signal is transmitted through an opto-isolation circuit.
  - Power for the sensor is transferred through a transformer. The circuitry protects against accidental over-voltages.

Equipment List

- EKG sensor
- Package of one hundred silver/silver chloride electrode patches.

Connecting the EKG Sensor to a Person

Use three electrode patches per subject. The electrodes cannot be reused.
- Remove watches, jewelry, belts and rings.
- Because the electrical signal produced by the heart and detected at the body's surface is small, it is very important that the electrode patch makes good contact with the skin.
- Clean the areas of skin where the patches will be attached with a paper towel to remove dead skin and oil.

www.einsteinworld.com

- Peel three electrode patches from the backing paper. Firmly place the first electrode on the inside of the right wrist.
- Place a second electrode a few centimeters above the first one.
- Place a third electrode on the inside of the left wrist.
- Place each electrode so it is on the inside part of the arm (closer to the body) and the tab on the edge of the electrode patch is pointing down. This way, the wire of the sensor can hang freely without twisting the edge of the electrode patch.
- Connect the micro alligator clips of the three leads to the tabs on the edges of the electrode patches:
- Connect the two leads labeled R.A. (right arm) to the right arm electrode patches - the red lead should be above the green
- Connect the lead labeled L.A. (left arm) to the left arm electrode patch

Safety Instructions

- This product is to be used for educational purposes only. It is not appropriate for medical or research applications. Specifically, it may not be used for patient diagnosis.
- Always connect the ground lead (black) to the electrode before connecting the negative or positive lead.
- If the insulation on a lead is broken do not use the sensor.
- Never place an EKG sensor, patches, clips or leads near or in water or other liquids.
- Do not put the positive lead on the right forearm or the negative lead on the left forearm.

Data logging and analysis

MiLAB™

1. Take your einstein™ Tablet or pair your einstein LabMate with your Android or iOS tablet via Bluetooth
2. Insert the sensor cable into one of the sensor ports
3. Launch MiLAB™
4. MiLAB™ will automatically detect the sensor

5. Make sure the icon next to the sensor is checked (✓) to enable it for logging

MiLAB™ Desktop

1. Pair your einstein™ LabMate with your PC, MAC, or Linux machine via Bluetooth, or connect it via the USB cable (found in the einstein™ LabMate box).
2. Insert the sensor cable into one of the sensor ports via the DT to einstein™ sensor adaptor

3. Launch MiLAB
4. MiLAB will automatically detect the sensor and show it in the Current Setup Summary window
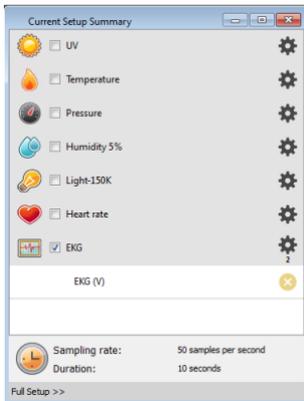
5. Click Full Setup, located at the bottom of the Current Setup Summary window to program the data logger's sample rate, number of samples, units of measurement, calibration and other options
6. Now you can program the data logger's sample rate, number of samples, units of measurement, and other options.
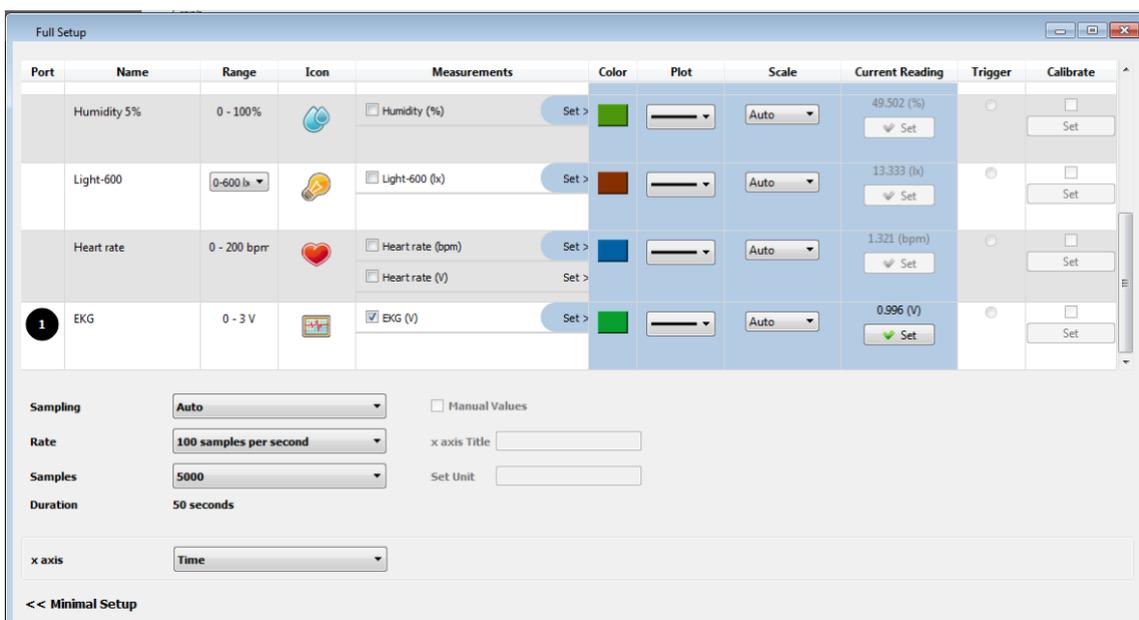

7. Click the Run button (   ) on the main toolbar of the Launcher View to start logging

Calibrating the Sensor

The EKG sensor requires no calibration.
It is designed to produce a signal between 0 and 3 V, with 1 V being the isoelectric line.

An Example of using the EKG Sensor

EKG Diagram

Below is a typical graph showing data obtained using an EKG sensor.
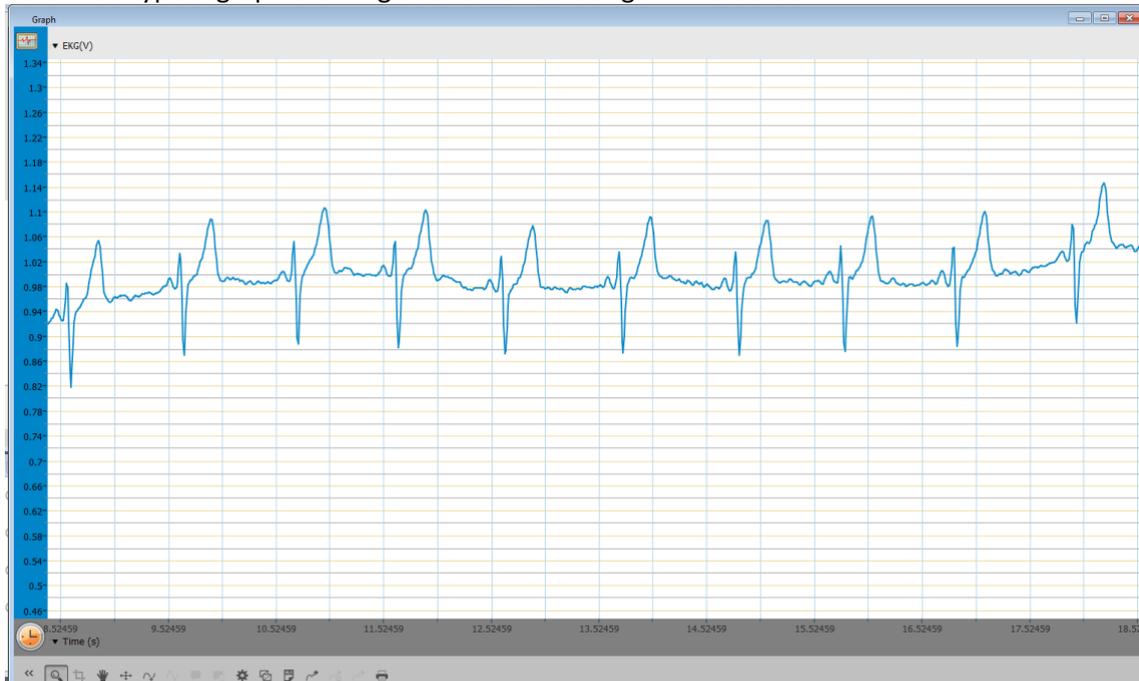
Figure 1: EKG data

Troubleshooting

1. If the EKG signal is unclear with no recognizable pattern, check for the following:
   - Electrode is off or defective
   - Dirt on the skin interfering with the signal
   - Metal object on the body interfering with the signal
   - Twisted leads
   - Loose electrode patches
2. If there is no signal display on the screen check for the following:
   - The EKG sensor is not connected to the data logger
   - Electrodes are loose
   - Leads are misplaced
3. If the baseline drifts up and down:
   - Make sure the subject's arms do not move and the leads are firmly in place.
4. If the R wave appears upside down:
   - Make sure the leads are placed properly

Technical support

For technical support, you can contact the Fourier Education's technical support team at:
Web: www.einsteinworld.com/support
Email: support@fourieredu.com

Copyright and Warranty

www.einsteinworld.com

All standard Fourier Systems sensors carry a one (1) year warranty, which states that for a period of twelve months after the date of delivery to you, it will be substantially free from significant defects in materials and workmanship.
This warranty does not cover breakage of the product caused by misuse or abuse.
This warranty does not cover Fourier Systems consumables such as electrodes, batteries, EKG stickers, cuvettes and storage solutions or buffers.

ALBERT EINSTEIN and EINSTEIN are either trademarks or registered trademarks of The Hebrew University of Jerusalem. Represented exclusively by Green Light. Official licensed merchandise. Website: einstein.biz