

NEULOG ELECTROCARDIOGRAM LOGGER SENSOR GUIDE



NeuLog electrocardiogram logger sensor NUL-218

The NeuLog electrocardiogram sensor can be used for any science experiment that utilizes heartbeat data such as in the fields of: Biology, Physiology, Human medicine, Psychology, etc.

An electrocardiogram is a very commonly used medical device which measures and graphs the heart's electrical activity. Every single heartbeat is a very complex event which involves many anatomical locations undergoing changes in their electrical charges. A depolarizing cascade event originates in the Sinoatrial (SA) Node, often referred to as the natural pacemaker, and travels throughout the rest of the heart.

The sensor comes pre-calibrated so you can start experimentation right out of the box using this guide.

Among hundreds of possible experimental subjects that can be studied with the NUL-218 sensor are: electrical impulses, heart rate monitoring, human physiology, muscle physiology, heart rate changes to stimuli, and many more.

The ECG sensor's measurement unit is:

- Arbitrary analog unit (Arb): An arbitrary unit to demonstrate waves, frequencies, and periods. What you see on the Y-axis is signal intensity, while the X-axis shows time.

Electrocardiograms:

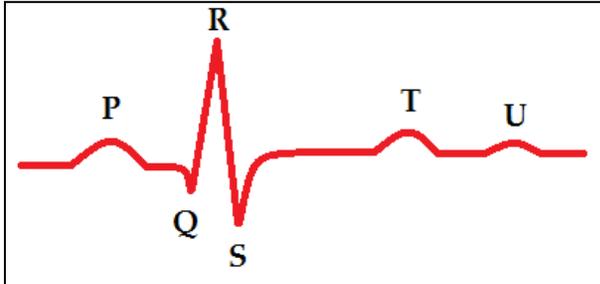
The heart undergoes a very complex process of electrical activity; this is the basis for how electrocardiograms work. As the heart's muscles contract, the cells are electrically depolarized causing a

cascade of depolarization to flow across the heart – contracting the heart's muscle fibers.

During a heartbeat a complex series of events happen which begin with the cells resting potential at roughly -90 mV (millivolts). The heart's Sinoatrial Node begins the cascade by depolarizing – creating an electrical voltage. The electrical signal travels to the right atrium and almost immediately to the left atrium. Because the atria and the ventricles are insulated from each other by a special type of cell which acts as an electrical insulator, the signal is picked up in another cluster of cells called the Atrioventricular (AV) Node located in the right atria. The signal is carried by a special type of fibers - the Bundle of His into the ventricles. Purkinje fibers rapidly spread the electrical depolarization cascade throughout the ventricles. The entire event takes some time to complete. The graph is a visual demonstration of the heart's relative charge at any given point during heartbeats.

The electrical voltage is measured on the skin using conducting leads and it is converted into a graph that is very standard and reproducible.

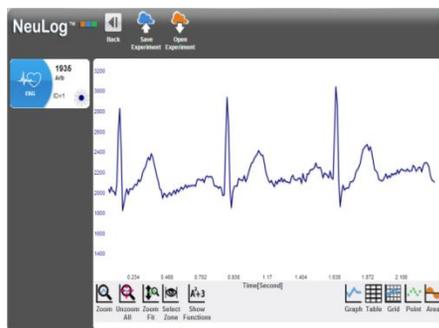
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- P:** Contraction of atria
- Q:** Initial depolarization of the interventricular septum
- R:** Early depolarization of the ventricles
- S:** Late depolarization of the ventricles
- T:** Repolarization of the ventricles
- U:** Often hidden by the T wave – this wave has an unknown origin

The graph in the previous page represents one complete heart beat from depolarization of the Sinoatrial Node to repolarization of the ventricles.

The following graph is from a NeuLog ECG experiment.



Connecting to the ECG sensor:

The NeuLog electrocardiogram sensor uses three reusable clip leads for easy connection to the arms and legs. The heart's electrical fluctuations can be measured as a voltage signal appears between the left and the right arms.

This is a noisy signal and very difficult to measure. Instead, it is much better to use a reference electrode (usually connected to the left leg) and to measure the voltages of the left arm and the right arm in reference to this electrode and to amplify the difference between them. This is how it is done in NUL-218.

Leads: Black: Reference, Red: Left, Yellow: Right

The NUL-218 is completely isolated from electrical power and signal in order to prevent the effect of these on the test subject.

How to connect:

1. Connect the NeuLog ECG sensor to a smart device using one of the following guides (PC or Mac/Tablet/Viewer).
2. Wet the red clip and place it on the subject's left wrist with the metal connector on the underside (palm side) of the arm.
3. Wet the yellow clip and place it on the subject's right wrist with the metal connector on the underside (palm side) of the arm.
4. Wet the black clip and place it on the subject's left leg or forearm or elbow.
5. Connect the three alligator clips (red, yellow, black) directly to their corresponding arm clip's (red, yellow, black) metal piece that forms a loop.
6. You are now connected.

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Note: There are other configurations possible, this is just one. If the R wave shows a downward slope instead of upward, your connection's polarization is reversed though the absolute results are still the same.

Included with the sensor:

- NeuLog General Guide
- NeuLog ECG probe with three alligator clips for easy connection to clamp leads
- Three ECG clamp leads (red, yellow, black)

Sensor's specifications	
Range and operation modes	0 to 4092 Arbitrary units
ADC resolution	12 bit
Resolution	1
Max sample rate (S/sec)	100

Experiment Duration: 1 seconds to 31 days.

Sensor's features:

- Fully digital data
 - Rugged plastic ergonomic case
 - Push button switch for Start/Stop experiments in off line mode
 - LED indicator of experiment status (blinks while collecting data)
 - ECG probe attached to the sensor's body by a durable rubber-coated wire with three alligator clip ends
 - Pre-calibrated sensing equipment
- Note:** NeuLog products are intended for educational use.

Videos and experiment examples:

- Videos, literature and other probes can be found at www.NeuLog.com.
- In order to access the electrocardiogram sensor's page, choose "Products" on the main menu and then "Electrocardiogram logger sensor".
- In order to access the ECG sensor's experiments, choose "Example Labs":
 - Electrocardiogram Measurement (B-40)

Technical background:

The philosophy behind NeuLog's plug and play technology is based on each sensor's ability to store its own data due to an internal flash memory chip and micro-controller in each plastic NeuLog body. This technology allows the sensor to collect and then store the digital data in the correct scientific units ($^{\circ}\text{C}$, $^{\circ}\text{F}$, Lux, %, ppm, for example).

The sensor is pre-calibrated at the factory. The built-in software in the logger can be upgraded for free at any time using the provided firmware update.

The ECG sensor detects minor changes in electrical voltage which originate in the heart and spread out across the body over a very short period of time. Cells have a resting potential of about 0.9 mV. A heart beat originates from an electrical impulse in the Sinoatrial Node, often called the natural pacemaker. The electrical potential cascade spreads across the heart. Using three leads (left, right and reference) the heart's electrical voltages (which originate in the heart) are measured.

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Although the NeuLog ECG sensor is not aimed for medical measurements, it is built as an ECG real device.

One important feature is complete electrical isolation from the USB and the computer to which it is connected.

The power supply is isolated and transferred by transformers.

The signals are converted and transmitted by optical couplers.

Maintenance and storage:

- Never submerge the NeuLog plastic body in any liquid.
- Do not allow liquid into the ECG sensor's body.
- After use, gently wipe away any foreign material from the ECG sensor.
- Store in a box at room temperature out of direct sunlight.

Warranty:

We promise to deliver our sensor free of defects in materials and workmanship. The warranty is for a period of 3 years from the date of purchase and does not cover damage of the product caused by improper use, abuse, or incorrect storage. Sensors with a shelf life such as ion selective probes have a warranty of 1 year. Should you need to act upon the warranty, please contact your distributor. Your sensor will be repaired or replaced.

Thank you for using NeuLog!



Flexible, simple, fast, forward thinking.

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V2015.5