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Design and Development of Arduino for Pulse 1 mV Sensitivity Settings on ECG Simulator

Andjar Pudji[1*], Muhammad Ridha Makruf[2]

[1,2]Department of Electromedic Engineering, Surabaya Health Ministry Polytechnic Pucang Jajar Timur 10 Surabaya, East Java, Indonesia

Abstract: ECG Simulator is a tool to simulate ECG signals. This device is useful for testing ECG devices during repairs, for research purposes on ECG signals or for educational purposes. The ECG simulator or often called the Phantom ECG is in principle a signal generator with the form of an "ECG like" signal or ECG signal that has been recorded. This design is based on Arduino which uses ATMEGA 328P IC and uses Digital to Analog Converter 12 bits to convert Digital data is the output of the Arduino into Analog data in the form of an ECG signal. In this study the researchers made a 1 mV Credit on ECG Simulator which is a tool to calibrate ECG equipment. The research design used is the study using the pre-experimental method with the type of after only design because the final results of tool measurement are compared with the control group. While this design through the following stages: circuit design and circuit testing. The error value is averaged 5 mm at a sensitivity of 0.5 mV and 9.5 mm at a sensitivity setting of 1 mV
Keywords: ECG Simulator, Sensitivity, Pulse 1 mV.

INTRODUCTION

An electrocardiogram (ECG) is a signal produced by the electrical activity of the heart muscle. This ECG is a recording of information on the condition of the heart taken by placing electrodes on the body. This ECG recording is used by expert doctors to determine the heart condition of the patient. The ECG signal is recorded using an electrocardiograph device. ECG signals are one of the most frequently used objects in studying bioelectric phenomena. This signal is studied in the field of medicine for health applications or in the field of biomedical engineering to study biomedical instrumentation techniques. This signal occurs because the spontaneous depolarization of heart cells begins with the Sinoatrial node (SA node). To learn ECG a tool is needed in the form of an ECG signal generator or ECG Simulator device to produce ECG signals.

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The author designed an ECG simulator tool equipped with sensitivity settings, but at this stage only a box wave formation process will be performed which will be used for calibration of 1 mV. This Phantom ECG produces a heart pulse with pulses that can be selected according to the test that is intended to be performed on an electrocardiograph plane so that it can be seen whether the aircraft can provide the same response as the one fed.

METHODS

The research design used was to use pre experimental method with the type of after-study design because the final result of measurement tool compared with the control group. In this study the researchers made a 1 mV Credit on ECG Simulator which is a tool to calibrate ECG equipment.
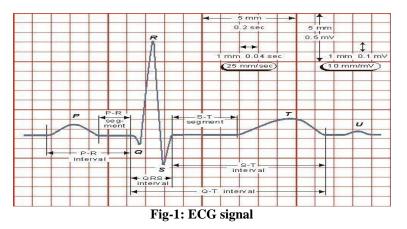
RESULTS AND DISCUSSION

Electrocardiogram (ECG)

The term ECG or electrocardiogram is a common diagnostic test used to evaluate heart function. The test records the electrical activity of the heart, and to a certain extent, identifies if there is abnormal circulation or blood flow. ECG gives a good picture of size and heart shape. The electrical activity of the heart
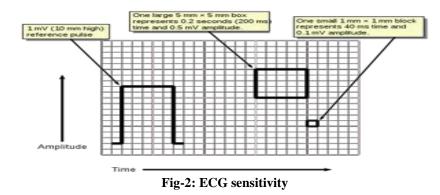
in the body can be recorded and recorded through electrodes installed on the surface of the body. ECG is just one of the laboratory tests which is a tool to help diagnose heart disease. The clinical picture of the patient remains an important handle in determining the diagnosis [1].

To obtain an ECG recording, electrodes are placed on the skin in certain places. The location of electrode placement is very important to note, because the wrong placement will produce different records. In this project use lead II.

Fig-1: ECG signal

A good ECG also displays a calibration consisting of 25 mm / s paper speed and 10 mm / mV sensitivity. Each ECG small box is 1 mm² in size. With a speed of 25 mm / s,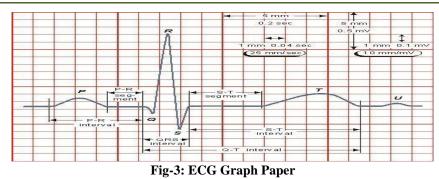 1 small box of ECG paper equals 0.04 s, each 5 small squares (1 large box) equals 0.2 s. The sensitivity is printed in the form of a calibration sign with a amplitude of 1 mV as high as 10 mm before printing ECG wave.

Fig-2: ECG sensitivity

Generally in calibrating the ECG using a 10 mm calibration at a speed of 25 mm / sec. But, it's a good idea to be careful when looking at ECG calibration, because ECG calibration can be enlarged up to 20 mm and can also be reduced to 5 mm. If the calibration is 20 mm, the vertical image (going upward or downward) in each small square is 2 milliVolt, and if the calibration is 5 mm, the vertical image in each small square is 0.5 miliVolt.

Calibration is an activity to determine the conventional truths of the value of measuring and measuring instruments by comparing traceable standards to national and international standards.

Definition of calibration According to ISO / IEC Guide 17025: 2005 and Vocabulary of International Metrology (VIM) is a series of activities that form a relationship between the value indicated by a measuring instrument or a measurement system, or a value represented by a measuring material, with known values relating to the quantity measured under certain conditions. Measurement results that are not consistent or beyond the threshold can affect health diagnostic results. ECG Calibrator is a device that can produce heart pulses and can be adjusted according to testing needs. The recorded heart pulses are then scanned and enlarged, and printed on millimeter paper [2].

Fig-3: ECG Graph Paper

The results of ECG waves are depicted on mm graph paper as shown, where small boxes have a size of 1mm × 1mm and a large box has a size of 5mm × 5mm. In the ECG there are two variables used, namely time and voltage. The time variable is expressed in a horizontal direction, and the variable voltage is in the upright direction. The scale for the time variable is 0.04s / mm or 25mm / s. The scale for voltage is 0.1mv / mm or 10mm / mV. The Heart Rate is a quantity that states the speed of the heart rate, expressed in the number of beats per minute (beat per minute - bpm). Heart rate can be obtained from the ECG by counting the number of R waves for one minute. Electrocardiograph calibration can be done internally and externally. Internal calibration usually uses the 1 mV signal feature on the electrocardiograph as a calibration signal. Whereas externally, calibration is carried out using an external calibrator that has many types of calibration signal features that can be sent to the electrocardiograph.

An ECG simulator is a device that can produce a heart pulse with pulses and amplitude that can be adjusted according to the tests performed on an Electrocardiograph device. This device is useful for testing ECG devices during repairs or calibration, for the purposes of research on ECG signals or for educational purposes. The ECG simulator or often called the Phantom ECG is in principle a signal generator in the form of an "ECG like" signal or recorded ECG signal.

The ECG is recorded on special standardized paper that rolls out of the machine at a certain speed and is controlled. Usually pink (but other colors can also be), with thick and thin lines running vertically and horizontally. Thin lines form small squares measuring 1 x 1 mm, while thick lines form large boxes measuring 5 x 5 mm.

Sensitivity 1 milli Volt

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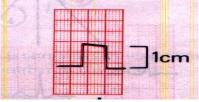

Fig-4: Sensitivity of 1 mV

A signal calibration can be entered with notes. The standard 1 mV signal must move the needle 1 cm vertically, that is, two large boxes on the ECG paper. In the calibration of 1 billion volts (1 mV) there are several settings that must be met:
• Sensitivity of 0.5 must produce a box signal as high as 1 Big Box
• Sensitivity 1 must produce a box signal as high as 2 Big Box
• Sensitivity 2 must produce a box signal as high as 4 Big Box

If this setting is appropriate, the ECG can already be used to the patient.

Arduino Uno

Arduino Uno is a microcontroller based board on ATmega328P. Arduino Uno is built from every component needed to support the function of a microcontroller. This board has 14 digital input / output pins (where 6 pins can be used as PWM output), 6 analog inputs, 16 MHz crystal oscillator, USB connection, power jack reset button. These pins contain everything needed to support the microcontroller, just connect to a computer with a USB cable or a voltage source can be obtained from an AC-DC adapter or battery to use it [3].

Fig-5: arduino board

Basically a microcontroller cannot stand by itself without being connected to other devices or devices. To make a minimum system can be used various types of microcontrollers, one of which is ATmega328P used on Arduino Uno. Arduino Uno board uses an ATmega328P microcontroller.

ATMega328P

ATMega328 is an 8 bit AVR family microcontroller. Some of the same types of microcontrollers with ATMega8 include ATMega8535, ATMega16, ATMega32, ATmega328, which distinguishes between microcontrollers, among others, memory size, number of GPIO (input / output pins), peripherial (USART, timer, counter, etc.). In terms of physical size, ATMega328P has a smaller physical size compared to some of the microcontrollers above. However, for other memory and periperial aspects ATMega328 is not inferior to the others because the memory and periperial size is relatively the same as ATMega8535, ATMega32, except that the number of GPIO is less than the microcontroller above.
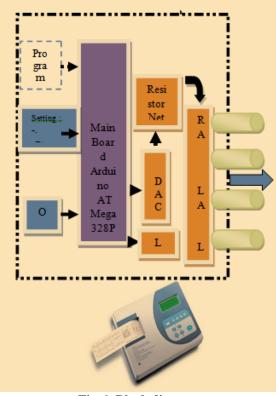

Fig-6: Block diagram

When the switch is pressed, all circuits then set the desired sensitivity, through the LCD display. Then the Sensitivity signal previously stored in the database will be converted into digital data using the Engauge digitizer program on Arduino. The output of the micro is still in the form of digital data, this is the use of the MCP4921 Microchip DAC IC to convert the digital data into analog data in the form of a 1 mV Pulse signal in order to form a normal human heart pulse, the output of the DAC enters the resistor network circuit to be divided into 4 connected outputs with electrode connector RA, LA, LL, RL. To set the BPM using a potentiometer using the Arduino ADC pin to change the Pulse 1 mV setting then displayed on the ECG machine.

CONCLUSIONS

Arduino board can use on ECG simulator for pulse 1 mv sensitivity settings to diagnostic test used to evaluate heart function. The arduino output on

Microchip DAC connected outputs with electrode connector RA, LA, LL, RL and used to change the Pulse 1 mV setting then displayed on the ECG machine.

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