

# Designing PQRSST Signal Generator as One of The Learning Media

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**Abstract**—In the world of education, a process of experience is obtained as a result of learning. To improve the quality and creativity in their learning, serious efforts are needed in creating tools as learning media. By making a signal generator PQRSST tool from the research this time, students are able to know the PQRSST signal form. The results of this study are the tools successfully created by producing signals with the form of PQRSST signals. From the results of the filter testing, HPF with cutoff frequency of 250 Hz will change the shape of the PQRSST signal. This is caused by HPF 400 Hz cutoff frequency value is greater than the PQRSST 296 Hz signal frequency. This also applies to LPF, LPF 500 Hz cutoff frequency value is smaller than the PQRSST 593 Hz signal frequency so that the PQRSST signal will be further away from the original form. In testing the BPF, the PQRSST frequency of 296 Hz will not change due to the range of cutoff frequency values is 100 Hz to 500 Hz. After that, this study got results of student responses with an average of 4.2 out of 5.

**Keywords**—learning; PQRSST signal; filter

## I. INTRODUCTION

The electrocardiogram is composed of waves and complexes [1]. Waves and complexes in the normal sinus rhythm are the P wave, PR Interval, PR Segment, QRS Complex, ST Segment, QT Interval and T wave the intervals. The PQRSST signal is a parameter signal produced by the work process of the heart [2]. The PQRSST signal is one of the signals most often studied in the world of education [3]. In the world of education, a process of experience and information is obtained as a result of learning, which includes the understanding and adaptation of the students to stimuli given to them towards growth and development [4]. In order to improve the quality and creativity in digital circuit courses, serious efforts are needed in creating tools as learning media. Quality and creativity improvement can be started by making a PQRSST signal generator. By making a signal generator PQRSST tool from this study, students are expected to be able to know what the PQRSST signal is and how the PQRSST signal is. Unlike the previous research conducted by Anna Dawatus S. in 2016 who still added the R/2R series to do DAC, in this study the PQRSST signal was able to be generated by utilizing a 12-bit DAC pin (Digital to Analog Conversion) contained in the Arduino DUE without add R / 2R circuits. After the PQRSST signal is successfully generated, students can do creativity by testing the

results of the PQRSST signal response to the filter circuit in the form of HPF (Highpass Filter), LPF (Lowpass Filter), and BPF (Bandpass Filter).

The P signal originates from the depolarization process. The Q signal is the final sign of the contraction on the P signal. The signal R is the final sign of contraction in the signal Q. The S signal is the final sign of contraction on the R signal and shows that the process of pumping blood throughout the body is complete. QRS complexes depolarize up to myocardial cells and there is a process of pumping blood throughout the body. Signal T is a condition during the repolarization process [5]. The form of the PQRSST signal can be seen in Figure 1.

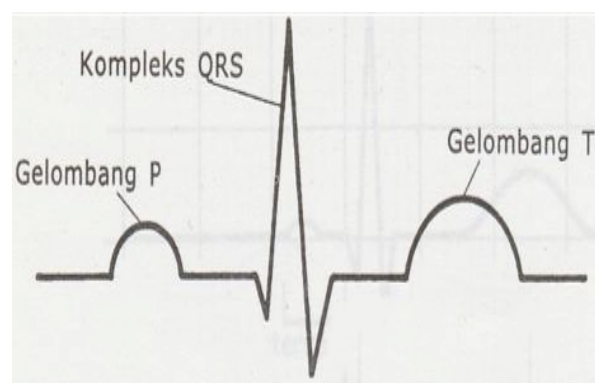


Fig 1. PQRSST Signal Form

Arduino DUE is the first Arduino board to use the arm core as a microcontroller. Equipped with 54 pins of digital input and output and 12 analog input pins. DUE has 2 pins with a 12 bit DAC system in it. The higher the bit value offered by the microcontroller indicates that the better waves can be produced.

LCD (Liquid Crystal Display) is a component that is used to display or provide certain indicators on an electronic device in order to facilitate users in operating it [6, 7]. Potentiometer is an electronic component that has resistance. Potentiometer consists of 3 feet with a lever that can be rotated to determine the value of resistance.

Capacitors are electronic components which are classified as passive components [8]. Capacitors can store electric

charges at a certain time and have farad units. Capacitors are commonly used as filter circuits. [9] A banana socket is a connecting terminal between one conductor and another conductor.

## II. METHOD

In this study, the method used is the experimental method. The first thing began with a literature study of the components needed. Then proceed with system design. In facilitating the explanation of the design of system devices, a block diagram design is made in Figure 2.

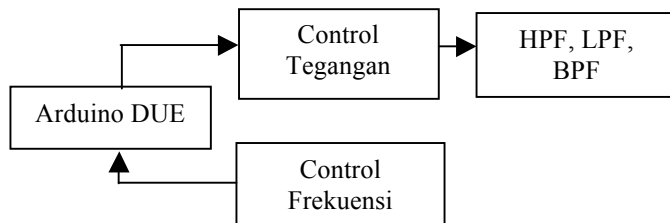


Fig 2. Diagram Block System

Figure 2 shows the frequency control block having an arrow heading to the Arduino DUE block. The control block is composed of a potentiometer circuit in ADC (Analog to Digital Converter). Digital values that have been obtained are then used to control the frequency of the signal signals. The Arduino DUE block stores code to form a PQRST signal. Then the next process is the code stored in DAC (Digital to Analog Converter) by Arduino so that it outputs the appropriate PQRST signal form. The output signal generated by Arduino then enters the voltage control circuit. The function of the voltage control circuit is to control the voltage of the PQRST signal to the desired level. After the signal has the desired voltage, then the signal enters the filter circuit. The filter circuit in this study consisted of HPF (Highpass Filter), LPF (Lowpass Filter), and BPF (Bandpass Filter). To make it easier for determine the shape of the tool, the initial design of the tool is in the form of a two-dimensional design. The physical form of the tool can be seen in Figure 3.

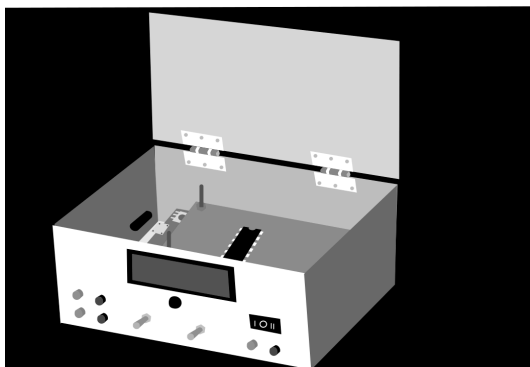


Fig 3. Physical Form of the Tool

In this study the data collected are the form of the PQRST signal, the response of the form of the PQRST signal to the HPF, LPF, and BPF filters, as well as the value of the response results to the tools that have been made.

## III. RESULTS AND DISCUSSION

The electrocardiogram is composed of waves and complexes. Waves and complexes in the normal sinus rhythm are the P wave, PR Interval, PR Segment, QRS Complex, ST Segment, QT Interval and T wave the interval. The first test conducted was to ensure that the code created and stored on Arduino succeeded in producing the form of the PQRST signal through the DAC pin. From previous research conducted by Anna Dawatus S. in 2016 also showed that DAC was able to produce a form of PQRST signal. Figure 4 shows the oscilloscope display when reading the signal produced by Arduino.

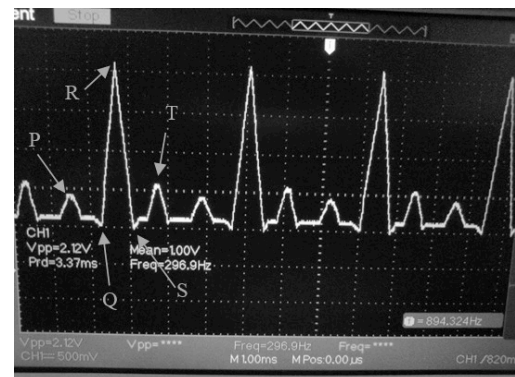


Fig 4. PQRST Signal

The next test is testing the shape of the signal against the HPF filter circuit. Figure 5 shows the shape of the PQRST signal with the HPF filter circuit set so that it has a cutoff frequency of 250 Hz. From Figure 8 it can be seen that the oscilloscope shows the frequency of the PQRST signal is 296 Hz, when the PQRST signal with a frequency of 296 Hz tries to pass the HPF circuit with a cutoff frequency of 250 Hz, what happens is the PQRST signal starts not showing its original shape.



Fig 5. HPF with Frekuensi Cutoff 250 Hz

Figure 6 shows the shape of the PQRST signal with a frequency of 296 Hz and passes the HPF circuit with a cutoff frequency of 400 Hz. The greater of cutoff value makes the signal away from the original shape.



Fig 6. HPF with Frekuensi *Cutoff* 400 Hz

After testing the HPF, the next step is to test the form of the PQRST signal in the LPF circuit. Figure 7 shows the shape of the PQRST signal with a frequency of 593 Hz and passes through the LPF circuit with a cutoff frequency of 500 Hz. The smaller the cutoff frequency in the LPF circuit, the more distant the signal from the original shape.

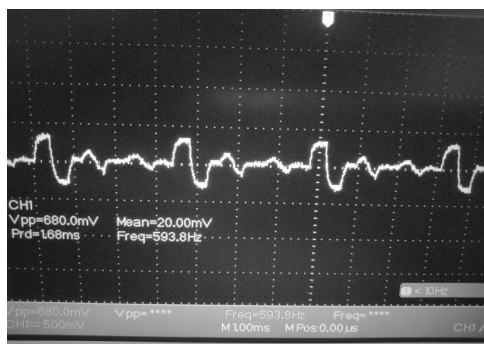


Fig 7. LPF with Frekuensi *Cutoff* 500 Hz

After testing the LPF, the next step is to test the PQRST signal against the BPF circuit. Figure 8 shows the shape of the PQRST signal with a frequency of 296 Hz and passes through a BPF circuit with a cutoff frequency of 100 Hz to 500 Hz. The frequency of the PQRST 296 Hz signal is at the susceptibility of the BPF frequency, this causes the form of the PQRST signal to remain original.

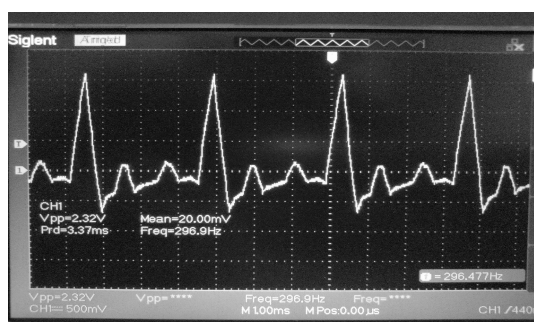


Fig 8. BPF with Frekuensi *Cutoff* 100 Hz until 500 Hz



Fig 9. Physical Form of the Tool

The physical form of the tool can be seen in Figure 9. In figure 9 it can be seen that there is a potentiometer with different numbers. Explanation of potentiometer functions as follows:

1. Potentiometer number 1 as the PQRST signal voltage regulation
2. Potentiometer number 3 as the PQRST signal frequency setting
3. Potentiometer number 4 as an HPF filter cutoff frequency setting
4. Potentiometer number 9 as the LPF filter cutoff frequency setting
5. Potentiometer number 14 as setting the BPF filter cutoff frequency setting

After the tool is ensured to work in accordance with the desired, then the next is to test the response of students to the design of the PQRST signal generator that has been made and get the response in table I.

TABLE I. RESPONDENT RESULT

No.	Aspect	Value (1-5)
1	The physical form of the PQRST signal generator is clearly displayed	4
2	There are an initial explanation and learning objectives	5
3	Use good and correct Indonesian language rules in accordance with the enhanced spelling	4
4	Can develop students' interest and creativity	4
5	The function of the tool follows the latest technological developments	4
Average		4.2

#### IV. CONCLUSION

From the research that has been done, it can be concluded that the design of the PQRST signal generator was successfully made by displaying the form of the PQRST signal and equipped with the results of testing the signal against HPF, LPF, and HPF circuits. In the HPF circuit, it is found that if the cutoff frequency is greater the PQRST signal frequency will negate the original PQRST signal. In the LPF circuit it is found that if the cutoff frequency is smaller than the PQRST signal frequency, it will negate the form of the

PQRST signal. And in the BPF circuit it was found that to obtain the original form of the PQRST signal, the frequency of the PQRST signal must be in the BPF cutoff frequency range. After the design of the signal generator, PQRST was successfully created, then the results of the students' responses were obtained from the research conducted and had an average value of 4.2 out of 5.

#### REFERENCES

- [1] A. D. Paul, K. R. Urzoshi, R. S. Datta, A. Arsalan. Design and Development of Microcontroller Based ECG Simulator. IFMBE Proceedings 35, pp. 292–295, 2011
- [2] A. D. Solichah, L. Anifah. “ Rancang bangun simulator sinyal elektrokardiograf (EKG),” vol. 05, no. 03, Universitas Negeri Surabaya, 2016.
- [3] M. Yamin. “ Upaya meningkatkan hasil belajar siswa melalui lesson study pada penjumlahan pecahan di SDN Lamseyun,” Jurnal pesona dasar, vol. 3, no. 4, Universitas Syiah Kuala, Oktober 2016.
- [4] A. P. Nurdiansyah. ” Rancang bangun elektrokardiograf (EKG) menggunakan *programmable gain amplifier* (PGA) sebagai pengubah nilai *amplifier* otomatis,” Jurnal teknik elektro ,vol. 8, no. 1, Universitas Negeri Surabaya, 2018.
- [5] Arduino. 2019. Arduino DUE. (<https://store.arduino.cc/usa/duo>, diakses 25 Februari 2019).
- [6] ElectronicWings. 2018. LCD 16x2 Interfacing With Arduino Uno. ([www.electronicwings.com/arduino/lcd-16x2-interfacing-with-arduino-uno](http://www.electronicwings.com/arduino/lcd-16x2-interfacing-with-arduino-uno), accessed 26 Feb 2019).
- [7] S. Abdurrahman. ” Modul elctronika dan mekatronika elektronika dasar,” Direktorat pembinaan sekolah menengah kejuruan, Jakarta, 2017
- [8] Radiall. The Next Connexion. Banana Plugs Series. (<https://www.mouser.com/ds/2/516/BananaPlugs%20D7MOOCE-257160.pdf>, accessed 28 Feb 2019)..
- [9] A. Rizal. “Simulator of ECG Berbasis PC Sebagai Alat Bantu Ajar Pengolahan Sinyal Biomedis” [online] tersedia di <http://achmadrizal.staff.telkomuniversity.ac.id/wpcontent/uploads/sites/1/2014/06/16651090simulator-ecg-snppte.pdf>