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IoT Based Health Monitoring for Heart Rate and Body Temperature

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Abstract: In this era of modernization, most of companies competes among them to follow the standard and system that meet with the technology currently used. Data collection using papers having issue for current health monitoring situation where the increases of population and growth in rural and cities area. Communication between machine of system needed to be monitor using the Internet of Things (IoT) platform. Continuous power supply will be needed as the system will be updated every seconds. The method of this project will be the implementation on health monitoring based on IoT. DC-DC Buck Converter will be designed as continuous power supply for the system develop. The solution of internet connection will be the uses of microcontroller with WIFI (wireless fidelity) module that is NodeMcu. The parameter for this project will be the reading of the heart rate from AD8232 heart rate sensor and body temperature from DS18B20 temperature sensor that will display on the IoT platform. The Pulse Width Modulation (PWM) from the Arduino microcontroller will operate based on the duty cycle that programmed. This project can display the analog heartbeat and body temperature that almost same as the actual body temperature as user doing the cardiovascular exercise. This project also can have the heart rate reading in BPM (beat per minute) using formula. Therefore, the IoT based health monitoring for heart rate and body temperature can be developed with continuous power supply to have the real-time and continuous data stored on IoT platform.

Keywords: Internet of Things, DC-DC Buck Converter, Continuous power supply

1. Introduction

Day by day, people is aware of the importance of practicing a healthy lifestyle. Sports and exercises are the most approach taken for their body to keep fit. Some of them have a consistency on having a heathy life but several of them not have a good planning and take a wrong path by forcing themselves to do sports activities beyond their limits. Having exercise without limitation can effect their health condition. The method used for current health monitoring will have lot of sensors but the monitoring system is not in real-time. The health care scheme focusing more on measurement and monitoring various biological parameter that most used in monitoring that are heart rate, oxygen

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saturation level in blood, and body temperature using web server also android application [1]. To overcome this situation, IoT can be implemented to be easier and better result. The uses of battery as DC power supply will powered the electrical devices that operates using DC supply. The developement of the use of electronic device in sport science for monitoring system give a new way of data collection like heart rate and body temperature will give a fast response wheter the person is in good condition or bad condition [2].

One of the example for health monitoring case is cycling sport. Cycling sport increasingly attract more people to equally follow the trend to have a ride in a group to fullfill their leisure time especially on weekend. In the last few years, the number of death cases in cycling sport is increasing not even in this country but it also happen at the other country. Many of them facing of high intensity training, riding pattern and overlimit that effect their body condition that called Cardiovascular disease (CVD) [3]. The cardiovascular system of their body cannot commit with the movement during the training or ride session. Based on the CVD, heart failure is one of top situation currently facing by medical department. Thus, the implementation of electrical devives for sport science application will help the medical team to get precise and more faster result when perform the health monitoring [4].

2. Methodology

This chapter will describe the action taken to develop the project and the way to complete it. The chapter also will focus more on designing, simulation and process to do the prototype. This project consists of two part for the prototype that are electrical part also electronic with IoT part.

2.1 Project Block Diagram

This project will have communication between the prototype with the IoT platform that will send the data through the software that can access multiple users. Figure 1 will give a short brief how the project will be developed as the block diagram. The flow of the project will be start from the power converter circuit that give continuous supply to turn on the NodeMcu ESP8266 and give the voltage into the sensors that have selected to monitor and give the output at the IoT platform that are ECG (Electrocardiogram) and temperature sensors. The power converter use is DC to DC Buck Converter that will step down the input voltage as the NodeMcu ESP8266 just need maximum 5V to turn on. The sensors that use will give the result on the serial plotter at the coding software use that is Arduino IDE also IoT app that will be use. ECG AD8232 heart monitor sensor and DS18B20 temperature sensor will be used in this project.

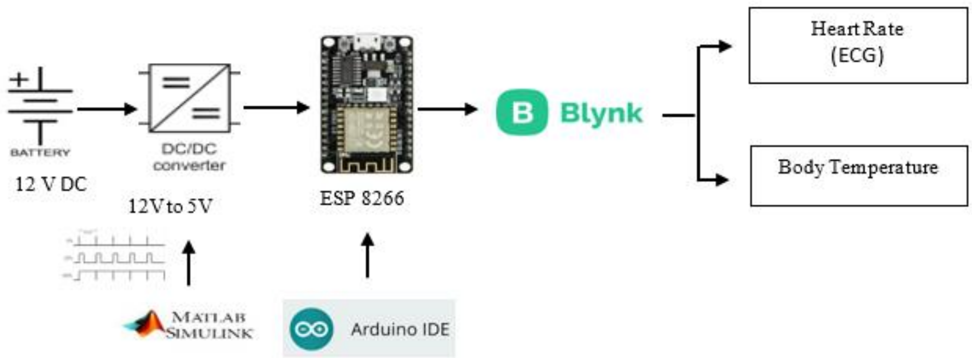

Figure 1: Block diagram of the project

2.2 Project Flowchart

To design this project, there will have two part of hardware to be construct. Figure 2 shows the overall project flowchart. In this stage, the information for selecting sensors and IoT platform that will be used to display the result. After collecting the information, Arduino IDE link with NodeMCU ESP 8266 are use as command window to generate the upload coding to give the signal to the sensors that used also to turn on the sensors. AD8232 ECG heart rate sensor and DS18B20 temperature sensor have been selected as to measure the heart rate and body temperature. The IoT platform will be communication from WIFI interface from the NodeMCU 8266 link with Blynk. The electrical part that is DC-DC circuit design for buck converter. Electrical part consists of designing the power converter circuit. DC to DC Buck Converter have been chosen for doing the conversion from the input voltage and produce the lower output voltage that is 5V. The switching configuration for the converter will be MOSFET (Metal Oxide Semiconductor Field Effect Transistor). The supply voltage is 12V battery and needed to step down into 5V output voltage. The switching circuit needed to design using the simulation software such as MATLAB. In the MATLAB features, there is a feature that can be used to deals with circuit analysis for electrical that is MATLAB Simulink. Therefore, after the first part and second part of the hardware are completed, both the part will be combined and produce the desired output.

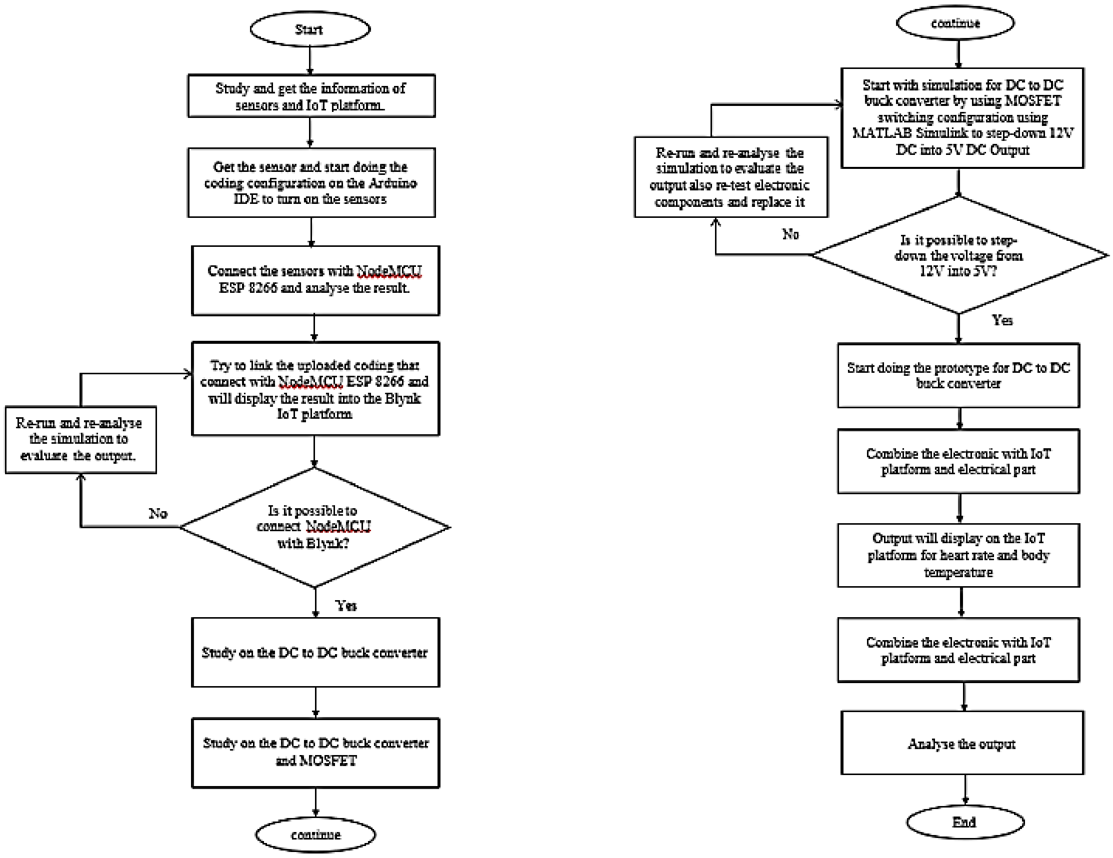

Figure 2: Overall project flowchart

2.3 Hardware setup

Figure 3 shows the completed prototype that combine the electrical and electronic with IoT part that place in a box. The prototype consists DC power supply, gate driver, DC-DC buck converter circuit, NodeMcu, AD8232 heart rate sensor, and DS18B20 temperature sensor. The DC-DC buck converter will act as power supply for NodeMcu to turn on. Supply voltage is 5V and the NodeMcu will turn on the sensors that are heart rate and temperature. The value of heart rate and body temperature will be display on the Blynk IoT application.

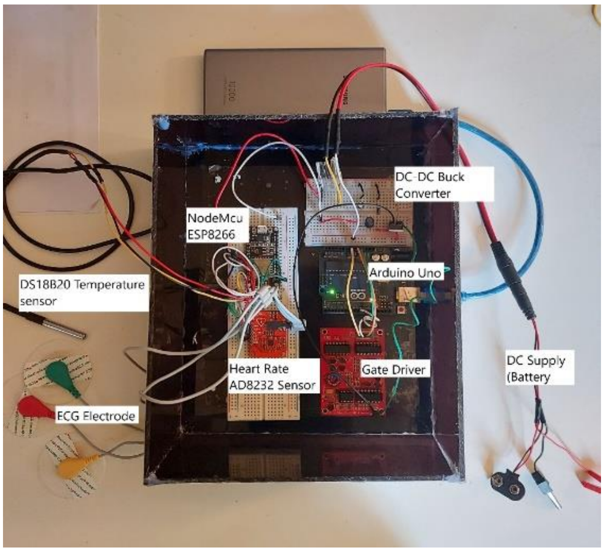

Figure 3: Overall prototype setup

3. Results and Discussion

3.1 Hardware output from IoT platform

The implementation of IoT for this project is connection with Blynk IoT platform. The result can be displayed at Blynk application. Blynk app are display the output from heart rate and temperature sensors. As the result, the sensors were tested when the user in three cases during normal condition, doing cardio exercises for 3 and 5 minutes are tabulated in Table 1, 2 and 3. The equation for calculating heart rate and heart rate (BPM) is followed as equation below:

$$Heart\ rate = Heart\ Beat\ \times \frac{220}{1024} \qquad Eq\ 1$$

$$BPM = Heart\ rate\ \times 0.68 \qquad Eq\ 2$$

Table 1: Output for Heartbeat, Body Temperature, Heart Rate, and Heart Rate (BPM) from Blynk Application during normal condition

Case 1	Heart Beat	Body Temperature °C	Heart Rate	Heart Rate (BPM)
Normal Condition	577	27	124	84
	575	27	124	84
	573	27	123	84
	571	27	122	83
	577	27	124	84
	580	27	125	85
	577	27	124	84
	573	27	123	84
	577	27	124	84
	573	27	123	84

Figure 4 shows the graph of heart beat and heart rate (BPM) that give the conversion of the analog data from heart rate sensor into the BPM standard unit for heart rate. The different of BPM reading for normal condition are not too far for each sample.

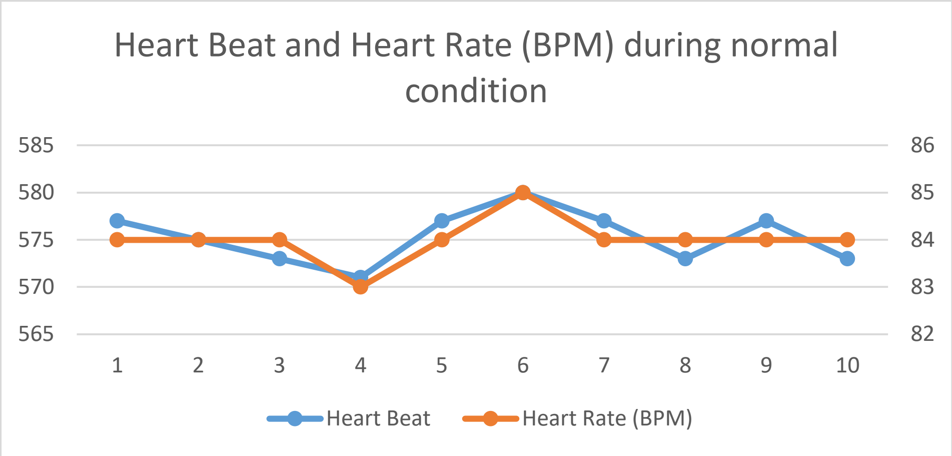

Figure 4: Heart beat and Heart rate (BPM) during normal condition

Table 2: Output for Heart Beat, Body Temperature, Heart Rate, and Heart Rate (BPM) from Blynk Application during cardio exercises for 3 minutes

Case 2	Heart Rate	Body Temperature °C	Heart Rate	Heart Rate (BPM)
Cardio exercises for 3 minutes	560	33	120	82
	480	33	103	70
	540	33	116	79
	560	33	120	82
	720	33	155	105
	560	33	120	82
	550	33	118	80
	800	33	172	117
	570	33	122	83
	720	33	155	105

Figure 5 shows the graph of heart beat and heart rate (BPM) that give the conversion of the analog data from heart rate sensor into the BPM standard unit for heart rate. The heart rate BPM reading start increasing as the cardio or heart rhythm is following the pace of exercise that has been done.

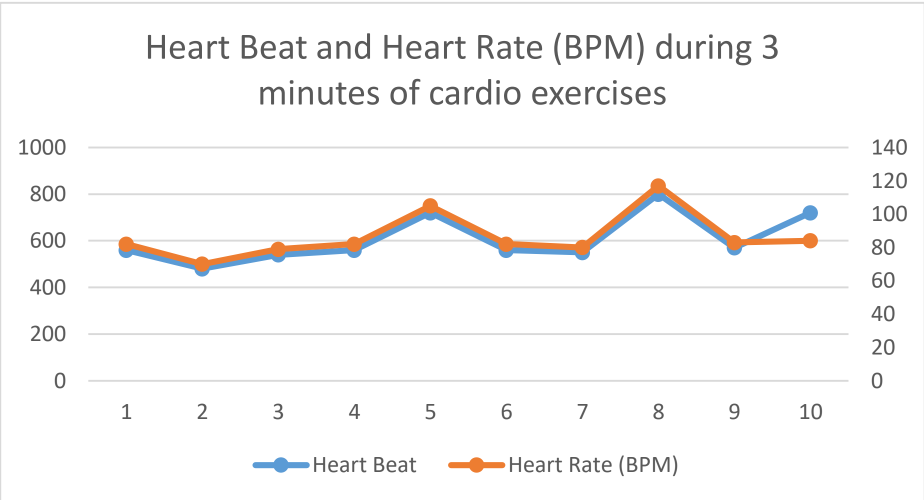

Figure 5: Heart beat and Heart rate (BPM) during 3 minutes of cardio exercises

Table 3: Output for Heart Beat, Body Temperature, Heart Rate, and Heart Rate (BPM) from Blynk Application during cardio exercises for 5 minutes

Case 3	Heart Rate	Body Temperature °C	Heart Rate	Heart Rate (BPM)
	537	34	115	78
	535	34	115	78
	1021	34	219	145
	490	34	103	70
Cardio exercises for 5 minutes	535	34	115	78
	1021	34	219	145
	500	34	107	73
	1021	34	219	145
	490	34	103	70
	535	34	115	78

Figure 6 shows the graph of heart beat and heart rate (BPM) that give the conversion of the analog data from heart rate sensor into the BPM standard unit for heart rate. The heart rate BPM reading start increasing as the cardio or heart rhythm is following the pace of exercise that has been done also the difference of each sample can be seen clearly. Therefore, from Table 1 until Table 3 results of heart rate and temperature display ECG signal and body temperature that measured to see the heart rhythm and body temperature. The signal for normal condition will be clearly seen while the distortion for heart rhythm after 3 minutes and 5 minutes cardio exercises due to the breathing pattern, movement from electrode also motion.

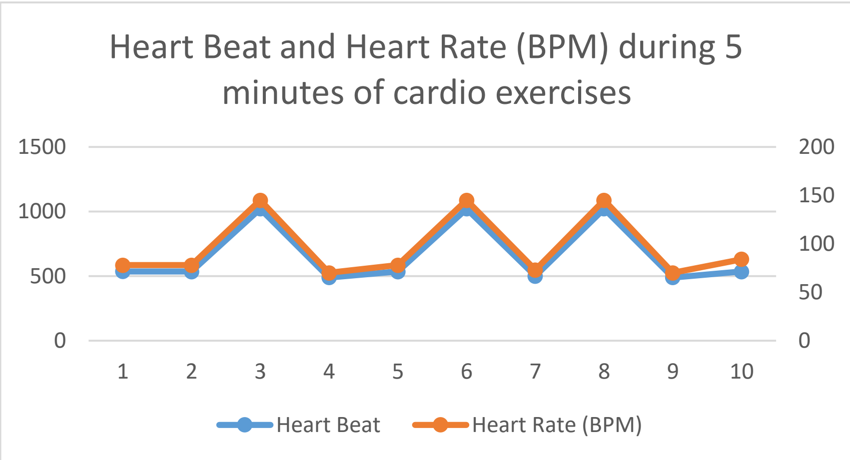

Figure 6: Heart beat and Heart rate (BPM) during 5 minutes of cardio exercises

3.2 Simulation Result DC-DC Buck Converter

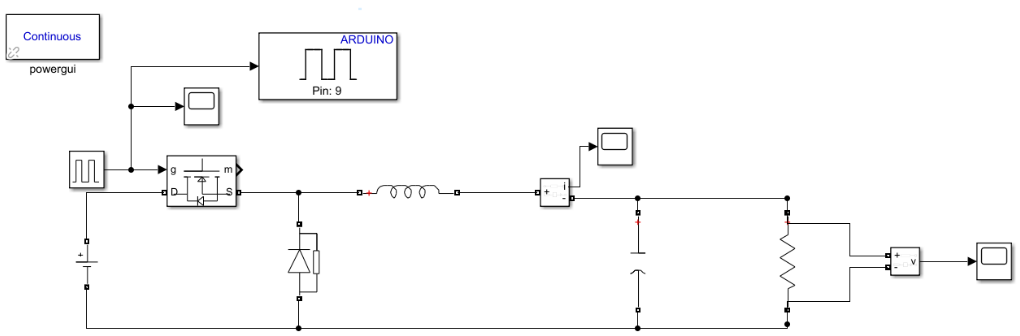

Figure 7: Buck Converter MATLAB schematic design

From Figure 7, the open loop schematic design for buck converter consists of MOSFET, diode, inductor, capacitor and resistor. In actual prototype, the connection of resistor will be replaced by the load that is NodeMcu and sensors. The pulse generator will connect with Digital Pin 9 at Arduino hardware to give the PWM.

Manual calculation for duty cycle, D, inductor, L and capacitor:

$Assume$:

$$Input\ voltage,\ v_{in} = 12V$$

$$Output\ voltage,\ v_{out} = 5V$$

$$Output\ voltage,\ v_{out} = 5V$$

$$frequency,\ f = 25kHz \quad \%V = 1\%$$

$$Estimated\ current = 50mA$$

$$I_{OCCM} = 12V$$

Calculated duty cycle:

$$Duty\ cycle, D = \frac{V_{out}}{V_{in}} = \frac{5V}{12V} \qquad (Eq\ 3)$$

$$= 0.4167$$

Calculated inductor:

$$L = \frac{(1-D)}{2f} \cdot \frac{V_o}{I_{OCCM}} \qquad (Eq\ 4)$$

$$= \frac{1-0.4167}{2(25k)} \cdot \frac{5}{50m}$$

$$= 1.167mH$$

Calculated capacitor:

$$C = \frac{(1-D)}{8(L)(f)^2} \cdot \frac{1}{\%V} \qquad (Eq\ 5)$$

$$= \frac{(1-0.4167)}{8(1.167m)(25k)^2} \cdot \frac{1}{1\%}$$

$$= 10\mu F$$

Figure 8 shows the use of capacitor is stored and transfer energy from input into the output. The energy transfer depends on the state of MOSFET switching that ON and OFF state. Therefore, the output voltage of the simulation circuit as display from scope will be 5.051 V

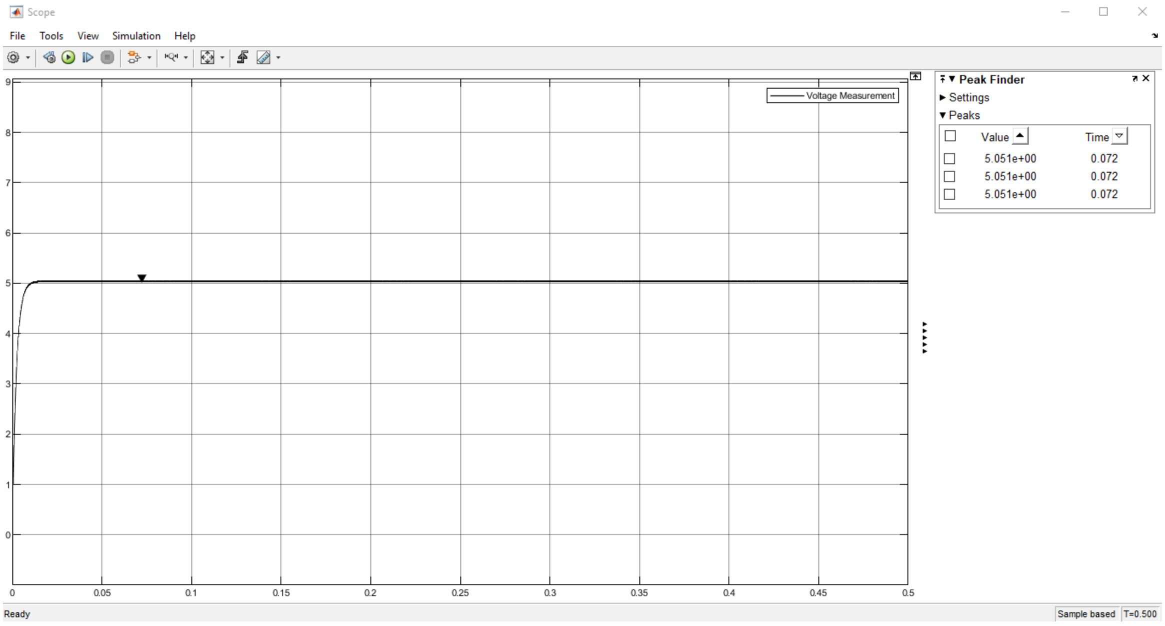

Figure 8: Voltage measurement from simulation circuit

3.3 Hardware result for DC-DC Buck Converter

The hardware circuit DC-DC Buck converter will be same as simulation circuit. The additional component that used and different from simulation circuit is Gate Driver circuit. Gate Driver is used to give the input voltage from Arduino step-up from 5V into 15V to operate the MOSFET to turn ON.

Figure 9 shows the hardware result for DC-DC Buck Converter final output when the circuit is complete with additional dc power supply from battery and pulse from Arduino. The output is 7.6V step-down from 12V DC. If the pulse from Arduino disconnected from gate MOSFET pin, the inductor is discharge and the voltage will slightly decrease as Figure 10. The buck converter circuit design not step-down as desired output that is 5V cause by the component selection, loop that not stable that comes from the open loop circuit, and switching frequency that not suitable for circuit design.

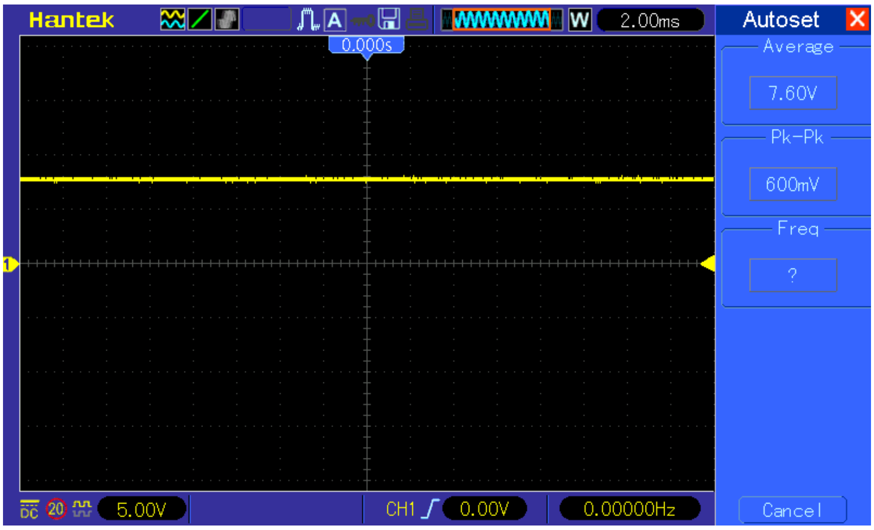

Figure 9: Output from hardware for buck converter

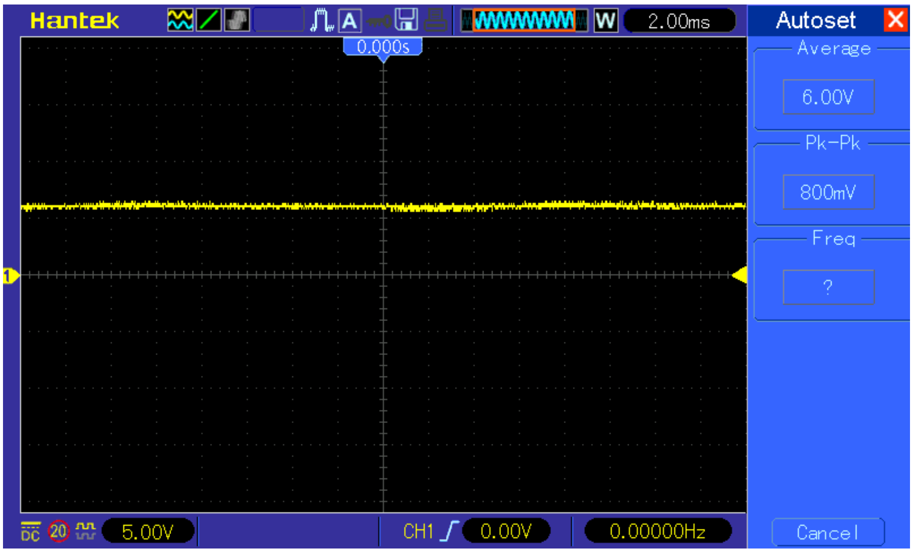

Figure 10: Output from buck converter when pulse disconnect

4. Conclusion

As conclusion, the project developed have completed that are designing DC-DC Buck Converter and IoT part with sensors. Objective one is achieved as project can be used for health monitoring also can give the concept to step-down the DC voltage supply by applying the power converter circuit. The implementation of IoT for this project can be said as successful work as the measured sensors parameter display on the Blynk IoT platform which the first objective is achieve. The designing of DC-DC Buck Converter not fully successful as the final output is not as desired output that is 5V DC as stated on the second objective. The final output from buck converter is 7.6V DC. NodeMcu can be turn ON and the sensor can be used also measured the parameters but it will cause an overvoltage supplied. The concept of buck converter is achieved as the voltage slowly decrease when the pulse disconnected. Next, the third objective is achieved and can be testing to perform on normal person during normal condition, 3 and 5 minutes doing cardio exercises. The project developed have gave a new lesson and experience when designing the converter and dealing with the IoT platform to display the real-time monitoring. Thus, this project can be said follow to the scope of project but the outcome will be achieved in certain part also not fully achieved for second objective and third objective for this project will be helpful for health monitoring and continuous power supply that can be tested on user.

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