

# Faculty of Electrical and Electronic Engineering Technology



# THE DEVELOPMENT OF DETECTION AND DATA LOGGING SYSTEM BASED ON 10T APPLICATION FOR VOLTAGE SAG AND VOLTAGE SWELL

ARIF HASYIMI BIN ALI

**Bachelor of Electrical Engineering Technology (Industrial Power) with Honours** 

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# THE DEVELOPMENT OF DETECTION AND DATA LOGGING SYSTEM BASED ON 10T APPLICATION FOR VOLTAGE SAG AND VOLTAGE SWELL

## ARIF HASYIMI BIN ALI

A project report submitted in partial fulfillment of the requirements for the degree of Bachelor of Electronics Engineering Technology with Honours



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2021

#### **DECLARATION**

I declare that this project report entitled "The Development of Detection and Data Logging System Based on IoT Application for Voltage Sag and Voltage Swell " is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.



## APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology (Industrial Power) with Honours.

Signature	MALAYSIA 3	
Supervisor Name	: DR. MOHD BADRIL BIN NOR SHAH	•••
Date	: 12/1/2022	
Signature	اونيۇىرسىتى تىكنىكل مليسىيا م	
Co-Supervisor	/ERSITI TEKNIKAL MALAYSIA MELAKA	•••
Name (if any)		
Date	:	•••

#### DEDICATION

Thank you to my loving parents for believing in me, supporting me through every situation that I have faced, inspiring me to be a better person, and assisting me with financial support for my education. You have given me strength when I had considered giving up, and you continue to provide their moral, spiritual, emotional, and financial support. I'd want to express my heartfelt gratitude to you. To my brothers and sisters, lecturers, friends, and classmates who have shared their words of encouragement and support with me, such as giving me moral support, believing in me, and encouraging me to complete this study, I am grateful.



#### ABSTRACT

Voltage sags and swells are the most prevalent kind of disruptions in the electric power grid. Most of the time, it is caused by a short circuit, a sudden shift in load, a loose connection, or the start of the heater or engine. Most electronic equipment is susceptible to voltage sags and swells, which can result in malfunctioning electrical components or an abrupt reboot of the system, which can then cause the equipment to cease functioning completely. When voltage sags or surges occur sporadically, it is extremely difficult to pinpoint the source of the sags or swells and determine their cause. A device that can detect voltage sags or swell for single phase 240V power distribution system is being created using an Arduino-based circuit that is connected to the internet in order to assist technicians or engineers in identifying the source of voltage sags or swell. A cloud platform will retain the data from the device, which will record when a sag or swell is observed, as well as the time and duration of the occurrence. In addition, a web-based interface will be built to display the data to the user.

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#### ABSTRAK

Kejatuhan dan kenaikan voltan adalah masalah yang paling biasa dalam sistem kuasa. Ia biasanya disebabkan oleh litar pintas, perubahan beban secara mendadak, sambungan yang longgar dan operasi permulaan pemanas/motor. Kebanyakan peralatan elektronik sensitif kepada kejatuhan dan kenaikan voltan, di mana ia boleh menyebabkan kegagakan pada komponen elektronik, atau menyebabkan but semula pada sistem, seterusnya mengganggu keseluruhan operasi pada perkakasan. Mengenalpasti punca kejatuhan dan kenaikan voltan adalah sukar sekiranya kejadian ini berlaku tidak menentu. Untuk membantu juruteknik atau jurutera mengenalpasti punca kejetuhan dan kenaikan voltan untuk fasa tunggal 240V sistem agihan kuasa telah dibangunkan menggunakan litar berasaskan Arduino yang disambung dengan internet. Peranti akan merekodkan waktu dan jangka masa ketika berlakumya kejatuhan atau kenaikan voltan dikesan, dan akan menyimpan data di platform awan. Pengantaramuka web juga akan dibangunkan untuk menunjukkan data kepada pengguna.

#### ACKNOWLEDGEMENTS

In the name of Allah, the Most Gracious, the Most Merciful, All praises and gratitude to Allah, All Mighty for his blessing and also for giving us the strength and patience to complete this bachelor degree project.

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## TABLE OF CONTENTS

		PAGI
DEC	CLARATION	
APP	ROVAL	
DED	DICATIONS	
ABS	TRACT	i
ABS	TRAK	ii
ACK	NOWLEDGEMENTS	iii
ТАВ	LE OF CONTENTS	i
LIST	T OF TABLES	iii
LIST	r of figures	iv
LIST	T OF SYMBOLS	v
LIST	T OF ABBREVIATIONS	vi
LIST	T OF APPENDICES	vii
CHA 1.1 1.2 1.3 1.4	PTER 1     INTRODUCTION       Background     Problem Statement       Project Objective     Scope of Project	<b>1</b> 1 2 2 3
CHA	APTER 2 LITERATURE REVIEW	4
2.1 2.2	Arduino Microcontroller	4
2.3	<ul> <li>2.2.1 PIC Microcontroller</li> <li>2.2.2 Real Time Clock</li> <li>Circuit of AC Voltage Measurement using Arduino Microcontroller</li> <li>2.3.1 Half Wave Rectifier</li> <li>2.3.2 Half-wave Rectifier with Smoothing Capacitor</li> <li>2.3.3 Zener Diode</li> </ul>	8 10 13 13 15 17
2.4	<ul> <li>2.3.3.1 Zener Diode Regulator</li> <li>IoT Module and Software</li> <li>2.4.1 ESP 8266 (WiFi Module)</li> <li>2.4.2 Blynk Software</li> </ul>	17 19 20 21
2.5	Related Previous Work	22
CHA 3.1	Overview METHODOLOGY	<b>24</b> 24

3.2	Circuit Design	26
	3.2.1 Voltage Interface Circuit	27
	3.2.2 Real Time Clock (DS 1307)	27
	3.2.3 Arduino Microcontroller Uno	28
	3.2.4 IoT Module (ESP 8266)	29
3.3	Programming Flowchart	29
СНА	PTER 4 RESULTS AND DISCUSSIONS	31
4.1	Introduction	31
4.2	Overall Project and Operation	31
4.3	Hardware Preparation	34
4.4	Experimental Result	36
СНА	PTER 5 CONCLUSION AND RECOMMENDATIONS	53
5.1	Conclusion	53
5.2	Future Works	54
5.3	Potential of Commercialization	54
REF	ERENCES	55
APP	ENDICES UTEN	57
	اونيومرسيتي تيكنيكل مليسيا ملاك	

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## LIST OF TABLES

TABLE	TITLE	PAGE
Table 2.1	Arduino UNO Specifications	7
Table 2.2	Specification and Factors of PIC16877A	9
Table 2.3	ESP 8266 (WiFi Module) Specifications	20



## LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 2.1	Voltage Sags and Swells	5
Figure 2.2	Timing Diagram	10
Figure 2.3	Real Time Clock Hardware Features	11
Figure 2.4	DS1307 Project Block Diagram	12
Figure 2.5	Half Wave Rectifier Waveform	14
Figure 2.6	Rectified Output Waveform	14
Figure 2.7	Resultant Output Waveform	15
Figure 2.8	Zener Diode Regulator	18
Figure 2.9	Circuit diagram for classification of power quality problems	23
Figure 3.1	Flowchart of methodology for this project	25
Figure 3.2	Field Diagram of Project	26
Figure 3.3	AC Voltage Interfacing Circuit	27
Figure 3.4	Real Time Clock DS1307	28
Figure 3.5	Arduino UNO Microcontroller	28
Figure 3.6	ESP 8266 (WiFi Module)	29
Figure 3.6	Programming Flowchart	30

## LIST OF SYMBOLS



## LIST OF ABBREVIATIONS

RTC	Real Time Clock			
AC	Alternating Current			
IDE	Integrated Development Environment			
V	Voltage			
Hz	Frequency Unit			
RMS	Root Mean Square			
VRMS	Voltage-Root-Mean-Square			
VP	Voltage Peak			
VZ	Voltage Resistance			
IEEE	The Institute of Electrical and Electronics Engineers			
I/O	Input / Output			
PWM	Pulse Width Modulation			
USB	Universal Serial Bus			
PIC	Peripheral Interface Controller			
LCD	Liquid-Crystal Display			
IC	Integrated Circuit			
DC	Direct Current			
Vout	Output Voltage			
VMAX	Maximum Voltage			
LED	Light-Emitting Diode			

## LIST OF APPENDICES

### APPENDIX

## TITLE

PAGE

60

Appendix A Arduino Coding

Appendix B Example of Appendix B

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#### **CHAPTER 1**

#### **INTRODUCTION**

#### 1.1 Background

Voltage sags, or voltage drops, which are the same, are rapid falls in voltage, usually from one minute to one second or a hundred milliseconds. The voltage sags are a brief transformation of voltage over the same time. In longer periods of low or high voltage the term 'undervoltage' is used.

Voltage drops are caused by sudden load changes such as short circuits or crashes, starting engines or electric heaters, or by sudden risings in the source impedance, generally due to a loose link. It is defined as the decrease 10% - 90% of nominal RMS voltage, at the power frequency for durations of 0.5 cycle to one minute. Voltage swells are almost always caused by a quick load drop in a circuit with a faulty or defective tension controller, even though a damaged or loose, neutral contact could also lead to them.

Voltage sags are the most frequent control disruptions. At a standard industrial site, it is not rare to see several sags per year at the service entrance and far more at the terminals. Voltage sags also can come from the utility side. However, most of the sags are created inside the house. For instance, the most common cause of voltage sags in residential wiring is the starting current induced by a refrigerator and an air conditioning compressor.

The occurrences of voltage sag and voltage swell can be detected by a logging device with internal data storage. However, with the growth of IR 4.0 in industry, IoT-based logger will offer more flexibility subsequently providing more efficient and real time analysis.

#### **1.2 Problem Statement**

Identifying the root of cause of voltage sags and swells is very difficult especially when the sags or swell is occurred intermittently. To know the time and duration of voltage sags or swell can help to identify the source of the problem. However, to log the events require a power quality meter or power analyzer which is expensive, hence may not economical for troubleshooting work. Therefore, a device that is able to log the voltage sags or swells can help engineer or technician to identify the root of the cause of the circumstances.

With the growth of I.R 4.0 that require large data and efficient work process, the logger should be equipped with IoT device. This will enable the logger to store large data at the cloud platform for flexibility and portability of real time analysis.

#### **1.3 Project Objective**

The aims of this project are:

a) To design algorithm that can detect, log and measure the duration of voltage sags and voltage swell.

- b) To design software that can collect, store and view the related data at web/apps platform.
- c) To design software that can collect, store and view the related data at web/apps platform.
- d) To develop IoT Arduino-based circuit that can measure 240V AC voltage.

#### 1.4 Scope of Project

The scopes of this project are listed below:

- a) Circuit Design
  - Using Arduino microcontroller, IoT circuit and interfacing circuit
- b) Program Develop
  - To program algorithm for Arduino microcontroller in Arduino IDE software
- c) Software Develop.
  - to use an appropriate software that can collect, store and view the related data at web/apps platform.
- d) Voltage Range for Measurement
  - 0V 240VAC, can detect the time of occurrence of voltage sags and

swell, also can measure the duration of event.

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#### **CHAPTER 2**

#### LITERATURE REVIEW

#### 2.1 Voltage Sags and Swells

Electric and electronic equipment in modern automated businesses is usually sensitive to power quality disturbances such as voltage sag, swell, flicker, and harmonics, among other things, [1]. Because of these interruptions, sensitive loads can fail, and in some cases the entire industrial process might be shut down, resulting in considerable output losses. Power quality difficulties such as voltage sag produced by big induction motors starting up and short circuit faults are among the most serious problems that can occur, [2]. Voltage sag is described as a transient fall in the RMS alternating current voltage from 0.9p.u. to 0.1p.u, [2]. of the nominal value during a power supply cycle. An rise in the RMS value of the alternating current supply voltage for a short period of time that varies from 1.1 to 1.8 percentage units over the nominal value is referred to as voltage swell. Voltage swells can be induced by a variety of factors, including the switching of large capacitors, the removal of heavy loads, and single phase to ground failures, [2].

Over the past 15 years, both the ideas of sags and swells, as well as the performance efficiency tools used to measure them, have advanced significantly. Each voltage lowers for a loop to 2.55 seconds below a user-defined low limit is referred to as sags in European cultures at the outset of the loop. They are first referred to be swells, although the voltage is higher than a user-defined maximum and they are quite similar to sags in appearance. In the IEEE 1159-95 recommended practice on electric power quality control, different meanings of amplitude and length are defined, [3]. These meanings are as follows:

- Sag (dip) a 0.5 to a minute voltage drop in rms or current at the power limit in 0.1 and 0.9 pu.
- Swell increases between 1.1 pu and 1.8 pu in rms voltages or current at a power frequency length of about 0.5 to 1 minute.

Voltage sags have the potential to cause device shutdowns or a reduction in the output and service life of electrical equipment, notably motors, among other things. Because of this, these disturbances are particularly problematic in the industrial sector, where a malfunctioning gadget can result in large financial losses, [4].



Figure 2.1 Voltage Sags and Swells

Generally speaking, the voltage swell is the polar opposite of the voltage sag or dip. Voltage swell is defined by IEEE 1159 as an increase of 110 percent to 180 percent of the nominal RMS voltage at the power frequency over a period of 1/2 to 1 minute for periods ranging from 1/2 to 1 minute. It is included in the second post of this site's list of specific power quality phenomena as one of the main types of power quality difficulties detailed in the first post of this site's list of specific power quality phenomena. The voltage swell is essentially the inverse of the voltage drop in terms of magnitude.

IEEE C62.41-1991 also describes the disturbance as "a momentary increase of the mains' power-frequency voltage outside of normal tolerances, over more than a cycle and less than a few seconds." This definition, on the other hand, is not preferred by the community of power quality experts. The swell outcomes are also more harmful than the sags results since the swell results are larger. However, the overvoltage condition may cause the equipment's power supply to decay in a slow and cumulative manner, rather than a rapid and immediate consequence. With a period of more than three cycles, incandescent bulbs can produce more light than they would otherwise produce.

#### 2.2 Arduino Microcontroller

Arduino is an open-source electronics platform that is easy to use, both in terms of the software and the hardware. An integrated programming system consisting of a programmable Arduino circuit board that runs on the user's computer is being developed. The integrated development environment (IDE) program is used for authoring and converting to circuit board machine code. The Arduino IDE makes use of a straightforward version of C++ and its straightforward, programmable environment, [5]. A microcontroller with an open package is also provided by Arduino, in addition to other features. Then, Arduino simplifies the process of working with microcontrollers and provides various advantages over other low-cost, open-source, and expandable hardware and software systems, as well as other open-source, and expandable software systems.

An excessive number of Arduino displays, which are extensively used in the business, are left unlocked. Programmer for Arduino, Arduino AT Mega 2560, Arduino UNO, Arduino NANO, and other Arduino-compatible boards, [5]. Take, for example, As a result of the fact that Arduino UNO is ready for use, this table is the most effective method to get started studying, and it is also the most popular of the Arduino microcontrollers. The

Arduino Uno serves as a microcontroller board for the AT Mega328. The Arduino UNO has 14 digital input/output ports, six of which may be used as PWM outputs, making it a versatile board. In addition to the six analog inputs, there is a USB interface, a ceramic resonator operating at 16MHz, an ICSP header and a power connector. It is not necessary for Arduino UNO to make use of a USB-to-serial interface chip. In place of this, the AT Mega is employed as a USB to serial converter.

Arduino UNO is a board that is widely used for educational purposes and is readily accessible for purchase. This is due to the fact that there is no soldering or specific connections required on the breadboard circuit design. It has also been used to create designs for innovations and automated control equipment. The Arduino UNO's fundamental needs are listed in Table 2.1

<u> </u>	
PARAMETER	VALUE
Microcontroller	ATmega328 ی شک
Operating Voltage	AL MALAYSIA MELAKA
Supply Voltage	7-12V
Maximum Supply Voltage (not recommended)	20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40mA
DC Current for 3.3V Pin	50mA

Table 2.1 Arduino UNO Specifications

#### 2.2.1 PIC Microcontroller

In computing, the PIC microcontroller is an abbreviation for a PIC and microcontroller manufactured by Microchip Technology, based in Arizona. PIC stands for "programmable integrated circuit." PIC microcontrollers were first created by General Instruments Microelectronics Division, and they are still in use today. Initially, it was read-only (ROM) and field programmable, but this was changed later on in the process.

EPROM was given for storing programs as well as various for-memory delete operations. The PIC microcontroller is referred to as the PIC micro in some circles. Aside from that, the device made use of an 8-bit data memory in the PIC microcontroller. The microcontroller's maximum data memory capacity of 16 bits is utilized. A variety of PIC10, PIC12, PIC16, and PIC24 versions are available for purchase. The instructions of the PIC10 and PIC12 microcontrollers are 12bit, and a 32-byte registry file is included as well. Because the ROM contains 512 words of address space, each of which has 12 bytes, the address space may be expanded to a maximum of 2048 addresses. These devices are responsible for the internal synchronization of clocks with a high frequency of 16MHz and low energy inputs with a frequency of 31 kHz.

The PIC16 has a resolution of 14 bits. EEPROM, LCD, and serial communication are all included in the PICs, which include 35 instructions, a 14 KB buffer, 46 bytes of RAM, a 9-bit registry, and a streamlined feature package that includes EEPROM, LCD, and serial communication. Because of this functionality, the controller will be able to use the control code more quickly and efficiently. Because of the usage of FLASH memory storage, the advantages of this PIC are also the primary advantages. The PIC16F877A is the most often used PIC for small projects and educational applications. In addition to 256 bytes of data storage, LCDs and self-programming features, 10-bit analog to digital converters with two channels and two PWM functionalities are included in the PIC16F877A data storage devices.

A / D applications are further developed as a result of the highlights' effect in the industrial, automotive, manufacturing, and consumer applications sectors, among others. For the PIC16F877A, the information and variables are displayed in Table 2.2.

PARAMETER NAME	VALUE	
Program Memory Type	Flash	
Program Memory (KB)	14	
CPU Speed (MIPS)	50	
RAM Bytes	368	
Data EEPROM (bytes)	256	
Digital Communication Peripherals	1-UART, 1-SPI, 1-I2C1MSSP(SPI/I2C)	
Capture/Compare/PWM Peripherals	2 Input Capture, 2 CCP	
Timers	2x8-bit, 1x16-bit	
ADC	8 channel, 10-bit	
Comparators	2	
Temperature Range (°C)	-40°C to 125°C	
Operating Voltage Range (V)	2V TO 5.5V	
Pin Count	40	

Table 2.2 Specification and Factors of PIC16877A

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#### 2.2.2 Real Time Clock

In computing, real-time clocks (RTCs) are watches with a time basis of one second. Furthermore, the Real-Time Clock (RTC) is frequently used in software or hardware to monitor clock time and calendar time, among other things. Many of the elements of an RTC are very specialized and are required in orders to maintain high precision and reliability levels. RTC devices that are not connected to a microcontroller communicate with it through the I2C or SPI bus.



Figure 2.2 Timing Diagram

A program function is also supplied that reads a second counter and schedules an event, B, to occur three seconds in the future. A delay is the term used to describe the action. It is important to note that the seconds counter runs constantly and does not stop and resume like some counters do. The accuracy of the RTC and its ability to operate continuously are the two most important criteria.



Figure 2.3 Real Time Clock Hardware Features

In addition to an external RTC frequency reference, an external crystal external oscillator is included. The clock has a frequency of 32,768 hertz. The use of an external clock source (TCXO, which is a crystal oscillator for temperature adjustment) results in a system that is extremely precise and reliable. It is necessary to utilize a multiplexer clock source and a pre-scaler clock input in order to generate a second clock and divide the original clock by 32,768. (215). A large RTC takes around 32 seconds or longer. Advanced counters are used to keep track of the date and time for particular RTC.

In this feature, a basic RTC without time or date counters is implemented using the software provided. One growing response is represented by a 1 Hz square wave produced by an output panel. An RTC must generate a large number of events in order to function as an interrupt processor. In an RTC, the pin that is responsible for controlling the rest of the microcontroller is commonly utilized. Normally, a single battery or power supply is connected to this control pin.

Dallas high-speed core microscopes are EPROM / ROM (RTC) compatible with the DS87C530 / DS83C530 EPROM / ROM (RTC) compatible with the Dallas semiconductor microscopes that are 8051-based. They employ four clocks each instruction cycle, rather

than the twelve clocks used by the normal 8051. In addition, they provide a unique combination of peripherals that other CPUs are unable to fully manage. It comes with a 1k x 8 SRAM battery backup, as well as an RTC and on-chip support. The improved mode allows the system to have a shorter power cycle while it is still in operation, which saves time.

It is excellent for instrumentation and small applications since it incorporates an integrated microcontroller core with a real-time clock (RTC), a battery-backed SRAM, and an energy storage mechanism. In addition, the devices sell a variety of peripherals for use with other Dallas high-speed microcontrollers. In addition to two serial ports, two data points, a chip control indication seen on the browser, and a watchdog timer, the board also has a watchdog timer and two data points. PMM option enables the software to choose a slower CPU clock than the default. The PMM operates at 64 or 1024 cycles per processor, with 4 cycles per machine cycle being employed as is customary. When the processor slows down, the power consumption reduces in tandem. It is necessary for the gadget to operate in a simpler mode in order to achieve EMI reduction. If the ALE signal is not required, this will turn it off. It is a variant of the DS87C530 for factory mask-ROMs that is geared for large-scale, cost-sensitive applications. It is a descendant of the DS87C530. All aspects of the DS87C530 are identical to the original, with the exception of the 16kB EPROM, which is replaced by the user's application software.



Figure 2.4 DS1307 Project Block Diagram

#### 2.3 Circuit of AC Voltage Measurement using Arduino Microcontroller

AC voltage measurements may be done utilizing the reversible and filter circuits by converting the alternating current voltage into the reciprocal direct current voltage. Because the knee voltage of the diode is just 0.7 Volt, the precision rectifier is employed with a weak alternating current voltage of 1000V. There is no difference between this voltage divider and the DC testing divisor with variable resistor R1 of 1k Ohms. A 5V Zener diode is utilized to remove the severe excess voltages generated by the Arduino. It is possible to change the voltage size of R1 (1k). According to its specs, the transformer's alternating current voltage ranges from 0V to 240V, [6]. For the voltage amplification circuit, the set DC value is specified.

#### 2.3.1 Half Wave Rectifier

A rectifier is a circuit that turns the alternating current (AC) into direct current (DC) at its output, [6]. Depending on which correction circuit is being used, the Half Wave Rectifier is either one or two steps away from the power supply source.

In the half-wave correction circuit, a power diode transforms just one half of a sinus wave from the alternating current to a direct current source. It is termed a half-wave since it only transmits half of the incoming CA power, as seen in the illustration below.



Figure 2.5 Half Wave Rectifier Waveform

$$Vdc = \frac{Vmax}{\pi} = 0.318Vmax = 0.45Vrms$$
$$Vmax = Vrms \times 1.414 \text{ or } Vrms = Vmax \times 0.7071$$

In this case, the diode is forward biased, meaning that it is positive for the cathode for the current that passes through the diode for each "positive" half-cycle of the sinusoidal alternating current.

In this case, the DC load is resistive (represented by the load resistance, R), and the voltage across the load resistor is the same as the Vs voltage, i.e., the voltage "DC" that is overloaded is sinusoidal only during the first half of the voltage cycle, VOUT = Vs, in this case. There is no current flowing through a diode or circuit as a result of this. As a result, resistance to voltage resistivities that are proportional to the voltage resistor are produced. In this way, no current flows through the charge resistor during the negative half cycle since there is no voltage applied to it during this period. As a result, VOUT equals zero. On the DC portion of the circuit, the current flows only in one direction to the Unidirectional Circuit. It was 0.45\*VRMS because the capacitor loaded would produce a waveform that was half as positive as the diode's waveform would be. The unique tension would be equal to 0.318\*Vmax of a waveform input to DC voltage, which is a significant amount of voltage. The equivalent DC voltage is then computed as follows: VDC over the charging resistor, where R is the charging resistor.



Figure 2.6 Rectified Output Waveform

Where  $V_{MAX}$  denotes the maximum or peak voltage of the alternating current sinusoidal supply, and RMS denotes the averaged value of the supply voltage (Root Mean Squared).

#### 2.3.2 Half-wave Rectifier with Smoothing Capacitor

When energy from an alternate (AC) source is adjusted for direct voltage (DC) supply, the volume of ripple voltage can be minimized by using a higher value capacitor; however, the price and size of the smoothing capacitor utilized are restricted.

By increasing the current, the pressure on the capacitor is raised and the capacitor is decreased more quickly (RC Time Constant) (smaller resistance to loading). When utilizing a single phase, half-Wave Rectifier, it is not essential to attempt to smooth the ripple voltage by utilizing a power diode or smoothing a condenser on its own. In this circumstance, "full-wave rectification" should be applied more efficiently. Due to the significant drawbacks of the half-wave rectifier, it is often employed in low-power applications. The range of the output is smaller than the range of the input range. This negative half cycle produces no output, resulting in a loss of half of the available power.



Figure 2.7 Resultant Output Waveform

It is the ratio between the RMS value of the alternating current voltage (on the input side) and the DC voltage (on the output side) of the rectifier that is known as the ripple factor.

The formula for ripple factor is:

$$\gamma = \sqrt{\left(\frac{V_{rms}}{V_{DC}}\right)^2} - 1$$

Which can also be rearranged to equal:

Ripple factor (r) = 
$$\frac{({I_{rms}}^2 - {1_{DC}}^2)}{I_{DC}} = 1.21$$

The ripple factor of half wave rectifier is equal to 1.21 (i.e.,  $\gamma = 1.21$ ).

We want to keep the ripple factor as low as possible for us to build a good rectifier. Therefore, capacitors and inductors are used as filters to reduce the circuit rips.

We must compute the current over the load for the half-wave rectifier's RMS value in order to determine its RMS value. If the instant loading current (IL) is equal to IL = IM sin timeframe, then the average loading current (IDC) is equal to:

$$I_{DC} = \frac{1}{2\pi} \int_0^{\pi} I_m \sin \omega t = \frac{I_m}{\pi}$$

Where  $I_M$  refers to the instantaneous load rate (Imax). The output DC current obtained throughout the load is therefore:

$$I_{DC}=rac{I_m}{\pi}$$
, where  $I_m=$  maximum amplitude of dc current

The RMS load current (IRMS) is equal to the average current (IDC) by  $\beta/2$  for a half-wave rectifier. Therefore, the RMS value for a half wave rectifier in load current (IRMS) is:

$$I_{rms} = \frac{I_m}{\pi} where,$$
  
$$I_m = I_{max,} which is equal to the peak instantaneous current across the load$$

The output voltage (VDC) across the load resistor is denoted by:

$$V_{DC} = \frac{V_{SMAX}}{\pi}$$

where,  $V_{SMAX}$  = maximum amplitude of secondary voltage

#### 2.3.3 Zener Diode

The Zener diode, which is a general-purpose standard diode composed of a silicone PN junction, operates similarly to a typical signal diode in that it travels through the power limit when biased in the forward direction of the signal. In the Zener diode, it functions in the same way as a typical signal diode.

The cathode, on the other hand, is more positive than the anode; hence, unlike a typical diode, which would flow through any stream if the inverse is biased, the diode of Zener will begin to move in the opposite way as soon as the value crosses the threshold. The reverse voltage is larger than the device in the energy diode, and the Avalanche Breakdown mechanism occurs on the degradation layer of the semiconductor, causing a current to oscillate across the diode in order to reduce the increase in voltage as much as possible.

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#### 2.3.3.1 Zener Diode Regulator

Zener Diodes may be used to provide a voltage output that is steady and has minimal ripple under a variety of various loading current situations, [6].



#### Figure 2.8 Zener Diode Regulator

Rs is connected in series with the Zener diode to limit the current flow from the diode to the voltage source. This helps to reduce the voltage spikes caused by the current flow. The stabilized voltage VOUT is obtained by using the whole Zener diode.

As a result, the Zener diode is linked to the cathode terminal linked to the positive DC rail, causing it to be reversed and to function in the disintegration state. The resistor Rs is used to limit the maximum current that may flow through the circuit.

The Zener diode must pass through the load current (IL=0), which has no load relationship to the circuit and hence must flow through it. This diode appears to have vanished totally from sight. In addition, if a modest RS series resistor value is used in conjunction with a big load resistor RL, the resultant diode current will be significantly higher. Because of this, the power dissipation requirement of the diode is increased in order to avoid exceeding the maximum power rate in non-load or high impedance circumstances. The right value for series resistors is assured as a result of this increase. The voltage of the RL is always the same as the voltage of the Zener (VR = VZ) voltage. Additionally, the load is connected to the Zener's diodes. When using an efficient voltage stabilizer, there is a minimum Zener current, and the Zener current in its breakdown field must always be greater than the charge value of the voltage stabilizer.

The greatest current limit is a function of the unit's power consumption and is inherent in the device. The voltage Vs must be greater than the voltage VZ. A minor difficulty with the Zener diode is that, in the process of attempting to regulate the voltage, the diode frequently generates electrical noise in the vicinity of the DC. This is normally not an issue in most applications, but a large Zener output decoupling capacitor may necessitate further smoothing. A Zener diode is still functional while it is in its reverse condition. In the event that the input voltage or load current varies, the Zener diode may be utilized to establish a base voltage control circuit that will maintain a constant DC voltage under load conditions.

During this reverse biased situation, the Zener voltage adjuster is comprised of a current resistor limit RS linked in series with the input voltage VZ and a Zener diode linked in parallel with the load RL to provide the desired voltage adjustment. The voltage of the stabilized output is always the same as the voltage of the diode's down voltage, which is VZ in this case.

#### 2.4 IoT Module and Software

When it comes to the internet of things, or IoT, it refers to a network of interconnected computing devices such as mechanical and digital machines, objects, animals, and people that have unique identifiers (UIDs) and the ability to transfer data over a network without the need for direct interaction between people or between people and computers, [7]. Embedded systems such as CPUs, sensors, and communication hardware are used to gather, send, and act on data from their surroundings in an Internet of Things (IoT) ecosystem, which is composed of web-enabled smart gadgets.

Sensor data from IoT devices is exchanged via connecting to an IoT gateway or other edge device, where it is either transferred to the cloud for analysis or processed locally on the device. On rare occasions, these devices will communicate with one another and act on the information they get from one another. Despite the fact that individuals may interact with the devices to set them up, give them instructions, or retrieve the data, the gadgets do the majority of the work themselves, [7].

#### 2.4.1 ESP 8266 (WiFi Module)

The ESP8266 is a system on chip (SoC) module that is Wi-Fi enabled, [8]. This framework is primarily used for the development of embedded applications for the Internet of Things (IoT). The Espressif Systems ESP8266 is a low-cost Wi-Fi microchip with a full TCP/IP stack and microcontroller capability that was developed by a Chinese manufacturing company based in Shanghai, Espressif Systems.

This device is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor to the ESP8266. Each ESP8266 Wi-Fi module comes pre-programmed with an AT command set firmware; simply connect this to your Arduino device to gain the same Wi-Fi capability as a Wi-Fi Shield. The ESP8266 module is a low-cost board with a large, and rapidly expanding, community, [9].

Pin	Pin	Alternate	Normally used for	Alternate Purpose
Number	Name	Name	سىت تىكىنكا	1 sign
1	Ground	10 <u>-</u> 10	Connected to the ground	2
	UNI	/ERSITI TE	of the circuit	LAKA
2	ТХ	GPIO – 1	Connected to Rx pin of	Can act as a General
			programmer/uC to	purpose
			upload program	Input/output pin
				when not used as TX
3	GPIO-2	-	General purpose	-
			Input/output pin	
4	CH_EN	-	Chip Enable – Active high	-
5	GPIO -	Flash	General purpose	Takes module into
	0		Input/output pin	serial programming

Table 2.3 ESP 8266 (WiFi Module) Specifications

				when held low
				during start up
6	Reset	-	Resets the module	-
7	RX	GPIO - 3	General purpose	Can act as a General
			Input/output pin	purpose
				Input/output pin
				when not used as RX
8	Vcc	-	Connect to +3.3V only	

#### 2.4.2 Blynk Software

The Internet of Things was in mind when Blynk was designed. In addition to all of the benefits associated, it can control hardware remotely, visualize sensor data, store data, as well as do many other impressive things. Blynk allows you to build hardware for your projects using microcontroller boards like Arduino, Raspberry Pi, and others, [8].

There are three major components in the platform:

- **Blynk app builder:** It enables you to create apps for your projects by incorporating various widgets. It is available for both the Android and iOS operating systems.
- **Blynk server:** In charge of all communications between your mobile device running the Blynk app and the hardware. You have the option of using the Blynk Cloud or running your own private Blynk server on your own computer. Open source, it is capable of supporting thousands of devices with ease, and it can even be launched on a Raspberry Pi computer.
- **Blynk libraries:** Enables server communication and processes all incoming and outgoing commands from your Blynk app and hardware. They are available for all of the major hardware platforms.
All of the aforementioned components interact with one another to form a fully functional IoT application that can be controlled from anywhere using a preconfigured connectivity type. The Blynk app on your mobile device can control your hardware via the Blynk Cloud or Blynk's personal server, [8]. It works the same way in reverse, sending rows of processed data from hardware to your Blynk app.

# 2.5 Related Previous Work

There have also been previous experiments done in conjunction with voltage dip and the swell problem for the use of a PIC microcontroller, which is done by, [10] a hardware device based on the microcontroller, was created to accomplish this.

The machine was self-contained, light, and inexpensive, and the hardware was simple in comparison to other devices. This system uses a PIC18F452 microcontroller, which is high-speed, low-power, and simple to use. The main feature of the PIC microcontroller is that it provides a constant 5 V DC of 230 V AC, which is powered by an energy source. The voltage sensing device provides three feedback signals to the UNIVERSITI TEKNIKAL MALAYSIA MELAKA microcontroller, which are equivalent in three measures. The microcontroller's software adjusts the voltage signals and sends them to the output devices, such as the LCD. The relay is activated, and charging is only possible under normal circumstances. Deficient voltage conditions are indicated by the respective LEDs, buzzer sound, and LCD display messages such as swelling, interruption, and imbalance. The type of power quality problem, as well as the p.u. voltage values, are clearly displayed on the LCD. To detect power efficiency issues, the equipment is designed and tested in a three-phase device. The hardware device correctly recognized normal state, voltage shrinking, swelling, interruptions, and imbalances, according to the test results. LCD is indicated as the condition and three-phase p.u. is indicated if the system is subject to state conditions. The strength of the current. The voltage level shown by the LCD over drops, swells, and interruptions, as well as the type of power quality problem. In the event of voltage imbalances. The LCD displays a condition, a proportion of variance, and three-phase p.u. During all of the power efficiency issues, the Relay caused an OFF buzzer to alert people of a fault that existed on the device. To demonstrate how the device interferes, specific colored LEDs were turned on. Hardware solutions that are both free and low cost, as well as simple and safe. The new solution is faster, simpler, and less expensive than previous data collection methods. Anyone with a basic understanding of the system can easily operate it. The differentiation aids in reducing the impact of power consumption issues.



Figure 2.9 Circuit diagram for classification of power quality problems

## **CHAPTER 3**

#### METHODOLOGY

## 3.1 Overview

The progress of software development is detailed in this chapter, which includes the design of software circuits, installation components, component testing, and a demonstration of the entire tensile and swell voltage for a single AC phase. The flow diagram method, as shown in Figure 3.1, is implemented separately and in accordance with the draft plan.

# a) Circuit Design

The Arduino Uno, a real-time clock, and the voltage circuit interfacing circuit are built first. The voltage circuit is connected to the Arduino Microcontroller via a serial monitor interface.

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# b) Programming

 Proteus 8 software is used to simulate the designed circuit in order to determine its efficacy.

## c) Sofware Design

- A reporting apps will be designed by using Blynk platform. The apps will display the information of occurrences in term of date, time, duration and magnitude. The apps also capable to store the occurrences data within a certain period also can display the history when requested.

# d) Performance Verification

- To ensure its efficiency, an analysis and test of the accuracy of the system used for logging the time and duration of voltage sags and swells will be performed.

The methodology flow chart for this project is shown in Figure 3.1. The following section will go over each step of the methodology in detail.



Figure 3.1 Flowchart of methodology for this project

# 3.2 Circuit Design

The circuit is constructed with the use of a microcontroller as main component to create an AC power supply. The circuit in question is divided into various parts:

- i. Voltage interface circuit
- ii. Real time clock (DS 1307)
- iii. Arduino microcontoller Uno
- iv. IoT module (ESP 8266)



Figure 3.2 Field Diagram of Project

Figure 3.2 illustrates the field diagram of the Arduino-based 240V input voltage Arduino power supply design. The real time clock is used when the sags and swell are detected to log the time and time of event.

#### 3.2.1 Voltage Interface Circuit

The analog input of Arduino microcontroller only can measure voltage ranging from 0V to 5V only. To enable the microcontroller to receive AC voltage of 240 V, an AC voltage interfacing circuit is required, as shown in Figure 3.3. Based on the circuit of the figure, 240 VAC supply is step down to 6VAC by using a transformer. Zener diode is used for voltage regulation, as reference elements, surge suppressors, and clippers circuits. Diode D3 is used to remove negative cycle of AC voltage and capacitor C1 is used to smooth the ripple thus stable DC voltage can be obtained.



Figure 3.3 AC Voltage Interfacing Circuit

## 3.2.2 Real Time Clock (DS 1307)

The Real Time Clock or RTC is an actual time monitoring system which can be used on any device that needs to retain the right time. RTCs also provide an additional energy source to keep momentum if the main energy source is down or inaccessible. RTCs use crystal oscillators of 32,768 kHz. The voltage sag and swell duration is logged and detected with RTC DS1307 as shown in Figure 3.5.



Figure 3.4 Real Time Clock DS1307

# 3.2.3 Arduino Microcontroller Uno

The main element in this project is Arduino UNO, which uses AT Mega 328 controller and able to utilize internal or external power supplies to detect and log voltage sags and swell. The optimized programming environment (IDE) for Arduino Uno is part of what makes Arduino Uno so easy to achieve.

The system Arduino Uno provides 20 I / O pins, which are required for six physical exits to operate as PWM outputs and seven variable pins. Arduino UNO also displays the magnitude and the waveform of voltage and swells on the serial panel.



Figure 3.5 Arduino UNO Microcontroller

### **3.2.4** IoT Module (ESP 8266)

ESP8266 is a tool which integrates into the Arduino IDE. It adds a menu item to tools menu for uploading the contents of sketch data directory into ESP8266 flash file system. The ESP8266 is capable of either hosting an application or offloading all WiFi networking functions from another application processor. This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime.



Figure 3.6 ESP 8266 (WiFi Module)

# **3.3 Programming Flowchart**

Figure 3.6 shows the flow chart of program code implementation in detecting logging in measuring the direction of voltage sags and voltage swell.



Figure 3.6 Programming Flowchart

## **CHAPTER 4**

#### **RESULTS AND DISCUSSIONS**

## 4.1 Introduction

In this chapter, the nodemcu ESP8266 microcontroller was chosen for this project. Several previous research have been compared. The language for this microcontroller is C language. The program has been done in Arduino IDE software. This software is easy to modify and compile. Therefore, the Arduino IDE is the most suitable microcontroller for this project.

## 4.2 **Overall Project and Operation**

To operate this project, we have made the program and compile on the Arduino software. As there is no error during execution, the project run successfully. The program had uploaded on the nodemcu ESP8266 and it can start to simulate to the circuit. The simulation process of this project is conducted by using Proteus 8 Professional software, and the simulation circuit is shown in Figure 4.1. The program code of the circuit is shown in APPENDIX B. The circuit is connected to AC source of 240 V. If the device detecting voltage sags or swell, the data will be displayed at the virtual terminal VT1 in term of voltage per unit value, sags/swell duration, and date/time of occurrences.



. Figure 4.1 Circuit simulation in Proteus 8 software

Figure 4.2 to Figure 4.3 shows the display of virtual terminal when the voltage sag. The data of sags occurrences is promptly displayed when it is detected by the device.



Figure 4.2 The displayed data when the device is start detecting the voltage sag

Virtual Terminal - SERIAL MONITOR	×
Upu: 0.38 , Sag started Upu: 0.38 , Sag started Upu: 0.38 , Sag started Upu: 0.38 , Sag started Upu: 0.55 , Sag started Upu: 0.89 , Sag started	^
Upu: 0.93 , Sag started DATE: 1/1/2022 TIME: 23:4:59 Sag End   Duration: 466 Upu: 0.98 , Normal	
Vpu: 0.98 , Normal Vpu: 0.98 , Normal Vpu: 0.98 , Normal Vpu: 0.98 , Normal Vpu: 0.98 , Normal	
Upu: 0.98 , Normal Upu: 0.98 , Normal Upu: 0.98 , Normal	~

Figure 4.3 The displayed data when the devices stop detect thus showing the duration of the sag.

Because this device is connected to an alternating current source from a socket outlet with a voltage of 240 V, the result of the voltage swell cannot be demonstrated. This device is capable of detecting when the voltage surpasses 240 V, at which point the voltage swell will be displayed on the serial monitor, indicating the result. In the residential area, the estimated voltage coming from the outlet socket is 220-230 V, which is an effect of the daily use factor. As a result, it is unaffordable to obtain voltages more than 240 V.

## 4.3 Hardware Preparation

This is necessary to build a hardware circuit in order to test the effectiveness of the designed circuit. Connected to the device are two 240 VAC switch socket outlets. For the status display, the device is then connected to a PC, which displays the data in the Serial Monitor interface within the Arduino IDE software, as well as by the blynk apps will displays the data, which may monitor from a distance. The block diagram of the experiment setup is shown in Figure 4.4.



Inside the interfacing circuit, there are half wave rectifier and 5 Vdc must be maintained at all times, we have used a capacitor to stabilize the voltage. A Zener diode as a voltage regulator to ensure that 5V is maintained at the terminals at all times to emulate the occurrences of voltage sag and swell in AC voltage, and the developed device should detect that event and displayed the related data at the Serial Monitor of Arduino IDE at PC and at the blynk apps. Figure 4.5 and Figure 4.6 shows the hardware prototype that is develop in this project. The interface of blynk apps at the phone to displayed the related data.



Figure 4.5 The Developed Voltage Sag and Swell Logger Device



Figure 4.6 The blynk apps home interface from the phone

# 4.4 Experimental Result

To verify the efficacy of the developed device, the device is connected to our home electrical system and it has successfully recorded a few sag occurences. Figure 4.7 to Figure 4.37 show the results that are displayed by the Serial Monitor of Arduino IDE software and blynk apps displays the results when the device detecting voltage sags, swells or remains normal, depending on the situation. It is found that when the device detected the voltage sag, the device will generate a date, time, and duration of the sag. Table 4.1 summarized the occurrences of voltage sag and swell including time, date, and duration for all 5 sag occurrences. There are no voltage swell detected so far in the home electrical system

ALAYSI.		
COM3	—	
		Send
[27859] Connecting to blynk-cloud.com:80 [28129] Ready (ping: 69ms). [33130] Connecting to blynk-cloud.com:80 [33276] Ready (ping: 60ms). DATE: 24/12/2021 TIME: 10:33:4 DATE: 24/12/2021 TIME: 10:33:4 Sag End   Duration: 24760 DATE: 24/12/2021 TIME: 10:33:4		^
File created successfully. DATE: 24/12/2021 TIME: 10:33:4 Sag End   Duration: 1060		~
		>
Autoscroll Show timestamp S7600 bau	4 ~	Clear output

Figure 4.7 The Device Output Detect Voltage Sag for the 1<sup>st</sup> Attempt

© COM3 —		×
		Send
DATE: 24/12/2021		^
TIME: 10:33:4		
DATE: 24/12/2021		
TIME: 10:33:4		
Sag End   Duration: 48011		
DATE: 24/12/2021		
TIME: 10:33:4		
DATE: 24/12/2021		
TIME: 10:33:4		
Sag End   Duration: 877		
DATE: 24/12/2021		
TIME: 10:33:4		
DATE: 24/12/2021		
TIME: 10:33:4		
Sag End   Duration: 844		~
<		>
Autoscroll Show timestamp 57600 baud V	Clear o	utput

Figure 4.8 The Device Output Detect Voltage Sag for the 1<sup>st</sup> Attempt

💿 сомз		
		Send
DATE: 24/12/2021 TIME: 10:33:4 DATE: 24/12/2021 TIME: 10:33:4 Sag End   Duration: DATE: 24/12/2021 TIME: 10:33:4 DATE: 24/12/2021 TIME: 10:33:4 Sag End   Duration: DATE: 24/12/2021 TIME: 10:33:4 DATE: 24/12/2021 TIME: 10:33:4 Sag End   Duration:	اونيونرسيتي تيكنيكل مليسيا ملاك UNIVERSITI TEKNIKAL MALAYSIA MELAKA 812	^
<		>
Autoscroll Show tim	estamp Newline V 57600 baud V	Clear output

Figure 4.9 The Device Output Detect Voltage Sag for the 1<sup>st</sup> Attempt

💿 СОМЗ	_		×
		Ser	nd
DATE: 24/12/2021			^
TIME: 10:33:4			
DATE: 24/12/2021			
TIME: 10:33:4			
Sag End   Duration: 880			
DATE: 24/12/2021			
TIME: 10:33:4			
DATE: 24/12/2021			1.0
TIME: 10:33:4			
Sag End   Duration: 878			
DATE: 24/12/2021			
TIME: 10:33:4			
DATE: 24/12/2021			
TIME: 10:33:4			
Sag End   Duration: 812			~
<			>
Autoscroll Show timestamp 57600 baud	~	Clear outp	ut

Figure 4.10 The Device Output Detect Voltage Sag for the 1<sup>st</sup> Attempt

	HALAYSIA MELLAK		
💿 СОМЗ		- 🗆 ×	
	NINN	Send	
TIME: 10:33:4 DATE: 24/12/2021 TIME: 10:33:4 Sag End   Duration: DATE: 24/12/2021 TIME: 10:33:4 DATE: 24/12/2021 TIME: 10:33:4 Sag End   Duration:	اونيونرسيتي تيڪنيڪل مليسيا ملاك <sup>905</sup> UNIVERSITI TEKNIKAL MALAYSIA MELAKA	~	
DATE: 24/12/2021 TIME: 10:33:4 DATE: 24/12/2021 TIME: 10:33:4			
Sag End   Duration: File closed	811	~	,
Autoscroll Show tin	nestamp Newline ~ 57600 baud	> Clear output	

Figure 4.11 The Device Output Detect Voltage Sag for the 1<sup>st</sup> Attempt



Figure 4.13 The Device Output Detect Voltage Sag for the 2<sup>nd</sup> Attempt

💿 СОМЗ	_		$\times$
			Send
DATE: 24/12/2021			^
TIME: 15:34:47			
DATE: 24/12/2021			
TIME: 15:34:48			
Sag End   Duration: 947			
DATE: 24/12/2021			
TIME: 15:34:51			
DATE: 24/12/2021			
TIME: 15:34:52			
Sag End   Duration: 1010			
DATE: 24/12/2021			
TIME: 15:34:53			
DATE: 24/12/2021			
TIME: 15:34:54			
Sag End   Duration: 945			
DATE: 24/12/2021			× .
Autoscroll Show timestamp S7600 baud	~	Clear	output

Figure 4.14 The Device Output Detect Voltage Sag for the 2<sup>nd</sup> Attempt

	MALAYSIA			
	STY ME			
💿 СОМЗ		_		×
<u> </u>				Send
TIME: 15:34:56				^
DATE: 24/12/2021	Name -			
TIME: 15:34:57	200			
Sag End   Duration:	947			
DATE: 24/12/2021	اويوم سيخ يتكسك مليسيا ملاك			
TIME: 15:34:59				
DATE: 24/12/2021				
TIME: 15:35:0	UNIVERSITI TEKNIKAL MALAYSIA MELAKA			
Sag End   Duration:	1077			
DATE: 24/12/2021				
TIME: 15:35:2				
DATE: 24/12/2021				
TIME: 15:35:3				
Sag End   Duration:	947			
DATE: 24/12/2021				
TIME: 15:35:5				$\checkmark$
Autoscroll Show time	estamp Newline V 57600 baud	~	Clear ou	utput

Figure 4.15 The Device Output Detect Voltage Sag for the 2<sup>nd</sup> Attempt

💿 СОМЗ		_		$\times$
1				Send
TIME: 15:35:5				^
DATE: 24/12/2021				
TIME: 15:35:6				
Sag End   Duration: 943				
DATE: 24/12/2021				
TIME: 15:35:7				
DATE: 24/12/2021				
TIME: 15:35:8				
Sag End   Duration: 878				
DATE: 24/12/2021				
TIME: 15:35:10				
DATE: 24/12/2021				
TIME: 15:35:11				
Sag End   Duration: 1010				
DATE: 24/12/2021				
TIME: 15:35:13				~
Autoscroll Show timestamp 57	600 baud	~	Clear o	output

Figure 4.16 The Device Output Detect Voltage Sag for the 2<sup>nd</sup> Attempt

	WALAYSIA 44			
💿 СОМЗ		_		×
				Send
DATE: 24/12/2021 TIME: 15:35:56				^
Sag End   Duration: DATE: 24/12/2021	43278 3 100			
TIME: 15:35:59 DATE: 24/12/2021	اونيۈم سىتى تىكنىكل ملىسىا ملاك			
Sag End   Duration:				
TIME: 15:36:1	ONIVERSITI LENNINGE MALATOIA MELANA			
TIME: 15:36:2 Sag End   Duration:	943			
DATE: 24/12/2021 TIME: 15:36:5				
DATE: 24/12/2021				~
Autoscroll Show tim	Newline V 57600 bau	d ~	Clear o	utput

Figure 4.17 The Device Output Detect Voltage Sag for the 2<sup>nd</sup> Attempt

СОМЗ	-	_		×
				Send
TIME: 15:36:5				^
DATE: 24/12/2021				
TIME: 15:36:6				
Sag End   Duration: 1009				
File closed				
DATE: 24/12/2021				
TIME: 15:36:7				
DATE: 24/12/2021				
TIME: 15:36:8				
Sag End   Duration: 273				
DATE: 24/12/2021				
TIME: 15:36:9				
DATE: 24/12/2021				
TIME: 15:36:9				
Sag End   Duration: 207				
?d??DUDd??d??DUDd??d?				$\sim$
Autoscroll Show timestamp 576	00 baud	~	Clear o	utput

Figure 4.18 The Device Output Detect Voltage Sag for the 2<sup>nd</sup> Attempt



Figure 4.19 The Blynk Apps Displayed the Related Data for 2<sup>nd</sup> Attempt

💿 СОМЗ	—		$\times$
			Send
File created successfully.			^
DATE: 3/1/2022			
TIME: 12:2:30			
Sag End   Duration: 1029			
DATE: 3/1/2022			
TIME: 12:2:31			
DATE: 3/1/2022			
TIME: 12:2:32			
Sag End   Duration: 1007			
DATE: 3/1/2022			
TIME: 12:2:34			
DATE: 3/1/2022			
TIME: 12:2:35			
Sag End   Duration: 948			
DATE: 3/1/2022			$\sim$
<			>
Autoscroll Show timestamp 57600 baud	$\sim$	Clear o	output

Figure 4.20 The Device Output Detect Voltage Sag for the 3<sup>rd</sup> Attempt



Figure 4.21 The Device Output Detect Voltage Sag for the 3<sup>rd</sup> Attempt

💿 СОМЗ	_		×
			Send
TIME: 12:2:58			^
TIME: 12:2:59			
Sag End   Duration: 916			
DATE: 3/1/2022			
TIME: 12:3:0			
DATE: 3/1/2022			
TIME: 12:3:1			
Sag End   Duration: 1010			
DATE: 3/1/2022			
TIME: 12:3:3			
DATE: 3/1/2022			
TIME: 12:3:4			
Sag End   Duration: 949			
DATE: 3/1/2022			~
<			>
Autoscroll Show timestamp 57600 baud	$\sim$	Clear o	utput

Figure 4.22 The Device Output Detect Voltage Sag for the 3<sup>rd</sup> Attempt

MALAYS/4	
COMS 2	
	Send
DATE: 3/1/2022	^
TIME: 12:3:0	
DATE: 3/1/2022	
TIME: 12:3:1	
Sag End   Duration: 1010	
DATE: 3/1/2022 UNIVERSITI TEKNIKAL MALAYSIA MELAKA	
TIME: 12:3:3	
DATE: 3/1/2022	
TIME: 12:3:4	
Sag End   Duration: 949	
DATE: 3/1/2022	
TIME: 12:3:6	
DATE: 3/1/2022	
TIME: 12:3:7	
Sag End   Duration: 1138	~
<	>
Autoscroll Show timestamp 57600 baud	✓ Clear output

Figure 4.23 The Device Output Detect Voltage Sag for the 3<sup>rd</sup> Attempt



Figure 4.25 The Device Output Detect Voltage Sag for the 4<sup>th</sup> Attempt

COM3	—		×
			Send
TIME: 13:16:53			^
DATE: 5/1/2022 TIME: 13:16:54			
Sag End   Duration: 878			
DATE: 5/1/2022			
TIME: 13:16:56			_
DATE: 5/1/2022			
TIME: 13:16:57			
Sag End   Duration: 878			
DATE: 5/1/2022			
TIME: 13:16:59			
DATE: 5/1/2022			
TIME: 13:17:0			
Sag End   Duration: 879			
DATE: 5/1/2022			
TIME: 13:17:2			~
Autoscroll Show timestamp 57600 baud	~	Clear o	output

Figure 4.26 The Device Output Detect Voltage Sag for the 4<sup>th</sup> Attempt



Figure 4.27 The Device Output Detect Voltage Sag for the 4<sup>th</sup> Attempt

💿 СОМЗ —		×
		Send
TIME: 13:17:12		^
Sag End   Duration: 879		
DATE: 5/1/2022		
TIME: 13:17:14		
DATE: 5/1/2022		
TIME: 13:17:15		
Sag End   Duration: 878		
DATE: 5/1/2022		
TIME: 13:17:17		_
DATE: 5/1/2022		
TIME: 13:17:18		
Sag End   Duration: 877		
DATE: 5/1/2022		
TIME: 13:17:20		
DATE: 5/1/2022		
TIME: 13:17:21		~
Autoscroll 🗋 Show timestamp Newline 🗸 57600 baud 🗸	Clear	output

Figure 4.28 The Device Output Detect Voltage Sag for the 4<sup>th</sup> Attempt

	MALAYSIA			
💿 сомз		_		×
				Send
Sag End   Duration:	877			^
DATE: 5/1/2022	*AINO			
TIME: 13:17:23				
DATE: 5/1/2022	shall a G. G			
TIME: 13:17:24	اويوم سيى بىكى س			
Sag End   Duration:	943			
DATE: 5/1/2022	UNIVED SITI TERMIKAL MALAVSIA MELAKA			
TIME: 13:17:26	UNIVERSITI TERNIKAL MALATSIA MELAKA			
DATE: 5/1/2022				
TIME: 13:17:27				
Sag End   Duration:	812			
DATE: 5/1/2022				
TIME: 13:17:28				
DATE: 5/1/2022				
TIME: 13:17:29	1011			
Sag End   Duration:	1011			×
Autoscroll Show tim	Newline 🗸 57600 baud	$\sim$	Clear	output

Figure 4.29 The Device Output Detect Voltage Sag for the 4<sup>th</sup> Attempt

© COM3 —		×
		Send
DATE: 5/1/2022		^
TIME: 13:17:31		
DATE: 5/1/2022		
TIME: 13:17:32		
Sag End   Duration: 944		
DATE: 5/1/2022		
TIME: 13:17:34		
DATE: 5/1/2022		
TIME: 13:17:35		
Sag End   Duration: 879		
DATE: 5/1/2022		
TIME: 13:17:37		
DATE: 5/1/2022		
TIME: 13:17:38		
Sag End   Duration: 909		
File closed		~
Autoscroll Show timestamp 57600 baud V	Clear	output

Figure 4.30 The Device Output Detect Voltage Sag for the 4<sup>th</sup> Attempt



Figure 4.31 The Blynk Apps Displayed the Related Data for 4<sup>th</sup> Attempt

💿 СОМЗ	_		$\times$
		Se	nd
File created successfully.			^
DATE: 5/1/2022			
TIME: 13:35:21			
DATE: 5/1/2022			
TIME: 13:35:22			
Sag End   Duration: 948			
DATE: 5/1/2022			
TIME: 13:35:26			
DATE: 5/1/2022			
TIME: 13:35:27			
Sag End   Duration: 868			
DATE: 5/1/2022			
TIME: 13:35:33			
DATE: 5/1/2022			
TIME: 13:35:34			
Sag End   Duration: 879			~
Autoscroll Show timestamp S7600 baud	~	Clear outp	ut

Figure 4.32 The Device Output Detect Voltage Sag for the 5<sup>th</sup> Attempt



Figure 4.33 The Device Output Detect Voltage Sag for the 5<sup>th</sup> Attempt

💿 СОМЗ	—		$\times$
			Send
TIME: 13:35:58			^
Sag End   Duration: 878			
DATE: 5/1/2022			
TIME: 13:36:1			
DATE: 5/1/2022			
TIME: 13:36:2			
Sag End   Duration: 879			
DATE: 5/1/2022			
TIME: 13:36:12			
DATE: 5/1/2022			
TIME: 13:36:12			
Sag End   Duration: 880			
DATE: 5/1/2022			
TIME: 13:36:19			
DATE: 5/1/2022			
TIME: 13:36:20			~
Autoscroll Show timestamp S7600 baud	~	Clear ou	utput

Figure 4.34 The Device Output Detect Voltage Sag for the 5<sup>th</sup> Attempt



Figure 4.35 The Device Output Detect Voltage Sag for the 5<sup>th</sup> Attempt

💿 СОМЗ			—		×
					Send
DATE: 5/1/2022					^
TIME: 13:36:46					
DATE: 5/1/2022					
TIME: 13:36:47					
Sag End   Duration: 944					
DATE: 5/1/2022					
TIME: 13:36:49					
DATE: 5/1/2022					
TIME: 13:36:50					
Sag End   Duration: 811					
DATE: 5/1/2022					
TIME: 13:36:51					
DATE: 5/1/2022					
TIME: 13:36:52					
Sag End   Duration: 944					
File closed					~
Autoscroll Show timestamp Newline	~	57600 baud	$\sim$	Clear o	utput

Figure 4.36 The Device Output Detect Voltage Sag for the 5<sup>th</sup> Attempt



Figure 4.37 The Blynk Apps Displayed the Related Data for 5<sup>th</sup> Attempt

Attempts	Timestamp	Duration (ms)	Count	Types
1	Fri Dec 24 2021 10:33:04	83392	13	Sag
	GMT+0800			
2	Fri Dec 24 2021 15:36:09	70321	16	Sag
	GMT+0800			_
3	Mon Jan 3 2022 12:03:07	22261	16	Sag
	GMT+0800			_
4	Wed Jan 5 2022 13:17:38	17041	19	Sag
	GMT+0800			_
5	Wed Jan 5 2022 13:36:52	14508	16	Sag
	GMT+0800			_





## **CHAPTER 5**

## CONCLUSION AND RECOMMENDATIONS

### 5.1 Conclusion

In conclusion, the objectives set through in Chapter 1 have been met and exceeded. The IoT-based voltage sags and swells logger is capable of detecting, logging, and measuring voltage sags and voltage swells with great accuracy. The device is also user-friendly, tiny, portable, and affordable when compared to a power analyzer meters with the same functionality. The integration of both the hardware and software project scopes is meeting all of the objective requirements in a responsible way. As part of the hardware part, the voltmeter interfacing circuit is constructed using electrical components and a breadboard, and the work of developing a specific electronic circuit is completed successfully and in accordance with the required operations. When it comes to the computer-software component, the algorithm that was developed has been successfully converted into C++ language coding for the ATmega328p microcontroller, which will allow for the recording of the duration of voltage sags and measurements of their duration. Finally, the experimental results demonstrate that the proposed device is capable of detecting, logging, and measuring voltage sags and voltage swells that are caused by a single AC phase.

## 5.2 Future Works

As a future work in terms of enhancing the performance of this project, there are various recommendations that will be quickly presented in order to obtain better performance from the IoT-based Voltage Sags and Swells Logger in the near future.

First and importantly, the bridge rectifier may be used to replace the half wave rectifier because it produces a full wave form of voltage sagging and swelling, making the appearance of the disturbance clearer and more apparent than the half wave rectifier.

Following that, the device may be designed to include a memory card module, which will allow for the storing of data as a result of voltage sag and swell situations. All of the data may be seen on the Serial Monitor and exported to the appropriate programme for further research and analysis.

Finally, the duration of voltage sag and swell is measured with a resolution of milliseconds for the duration of the test. It is recommended that the resolution be increased to microseconds in order to obtain more exact measurements. Increasing the structure of the programming code that is applied to the Iot-based is one method of accomplishing this goal.

#### 5.3 **Potential of Commercialization**

By performing the improvement to the developed device based on the recommendation explained in Section 5.2, the device will have a commercial value that can be used as a useful instrument for power system industry. The device can be used by technical or engineer to identify the source of voltage sag or swell based on the data collected by the device.

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## APPENDICES

## **Appendix A : Coding Arduino for Simulation**

#include "RTClib.h"
#define voltPin A0
#include <SoftwareSerial.h>
SoftwareSerial mySerial(2, 3); // RX, TX
RTC\_DS1307 rtc;

// Var for Duration //
int hour1,minute1,second1,durationsecond1,duration;
int hour2,minute2,second2,durationsecond2;
int minsecond = 60, hoursecond = 3600;

#### 

// Volt Reading Var//
double Vrms;
int Vadc;
double V = 240;
double Vpu;

```
void setup() {
   Serial.begin(115200);
   if (! rtc.begin()) {
      Serial.print("Couldn't find RTC");
      while (1);
   }
   if (! rtc.isrunning()) {
      Serial.print("RTC is NOT running!");
   }
   pinMode(voltPin,INPUT);
}
```
```
void loop() {
getvoltage();
displaystat();
if (Vpu > 0.9 && Vpu < 1.1) {
  sagswell = "Normal";
  if (flagSwell == 1) {
   flagSwell = 0; // swell end
   gettime1();
   durationSwell = millis() - durationSwell; // calculate duration swell
   // proceed to send data to logger
   Serial.println("Swell End | Duration: " + String(durationSwell));
   // Serial.print("Swell:" + String(durationSwell) + "|");
   delay(3000);
  }
  if (flagSag == 1) {
   flagSag = 0; // sag end
   gettime1();
   durationSag = millis() - durationSag; // calculate duration sag
   // proceed to send data to logger
   Serial.println("Sag End | Duration: " + String(durationSag));
   // Serial.print("Sag:" + String(durationSag) + "|");
   delay(3000);
 else if (Vpu >= 1.1 \&\& flagSwell == 0)
  sagswell = "Swell";
  flagSwell = 1; // start Swell
  durationSwell = millis(); // start count in millisecond
  gettime1();
  // Serial.println("Swell start!");
 }else if (Vpu <= 0.9 && flagSag == 0){
  sagswell = "Sag";
  flagSag = 1; // start Sag
  durationSag = millis(); // start count in millisecond
  gettime1();
  // Serial.println("Sag start!");
 }
}
void getvoltage(){
 Vadc= analogRead(voltPin);
// mySerial.println(Vadc);
 Vrms=(Vadc * 0.42007)/sqrt(2);
// mySerial.println(Vrms);
 Vpu = Vrms/V;
// mySerial.println(Vpu);
// Vadc = analogRead(voltPin);
//
```

```
// // 5000 is 5 seconds
 // if (millis() - reset > 5000) {
 // reset = millis():
 // minValue = 1025;
 // \max Value = 0;
 // }
 //
 // // find max and min from Vadc
 // if (minValue >= Vadc) {
 // minValue = Vadc;
 // }
 // if (maxValue <= Vadc){</pre>
 // maxValue = Vadc;
 // }
 //
 // int Vpeak = maxValue - minValue;
 // Serial.println(maxValue);
 // Vrms=(Vpeak * 0.19)/sqrt(2);
 // Vpu = Vrms/V;
}
void displaystat(){
 String state = "";
 if (sagswell == "Swell" || sagswell == "Sag") {
  state = "started";
 }
 Serial.println("Vpu: " + String(Vpu) + ", " + String(sagswell) + " " + String(state));
}
//-----RSITI TEKNIKAL MALAYSIA MELAKA
// RTC function START
// -----
void gettime1(){
 DateTime now = rtc.now();
 hour1 = now.hour();
 minute1 = now.minute();
 second1 = now.second();
 Serial.println("DATE: " + String(now.day()) + "/" + String(now.month()) + "/" +
String(now.year()) + " ");
 Serial.println("TIME: " + String(hour1) + ":" + String(minute1) + ":" + String(second1) +
"");
}
void gettime2(){
 DateTime now = rtc.now();
 hour2 = now.hour();
 minute2 = now.minute();
 second2 = now.second();
```

```
Serial.println("DATE: " + String(now.day()) + "/" + String(now.month()) + "/" +
String(now.year()) + " ");
Serial.println("TIME: " + String(hour2) + ":" + String(minute2) + ":" + String(second2) +
" ");
}
void getduration(){
durationsecond1 = (hour1*hoursecond) + (minute1*minsecond) + (second1);
durationsecond2 = (hour2*hoursecond) + (minute2*minsecond) + (second2);
duration = durationsecond2 - durationsecond1;
}
// ------
// RTC function END
// -------
```



