## Faculty of Electrical and Electronic Engineering Technology

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



**ARIF HASYIMI BIN ALI**

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

**2021**

# THE DEVELOPMENT OF DETECTION AND DATA LOGGING SYSTEM BASED ON IoT 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**

**Faculty of Electrical and Electronic Engineering Technology**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2021**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

**BORANG PENGESAHAN STATUS LAPORAN**
**PROJEK SARJANA MUDA II**

Tajuk Projek: The Development of Detection and Data Logging System Based on IoT Application for Voltage Sag and Voltage Swell

Sesi Pengajian: 2021

Saya **Arif Hasyimi Bin Ali** mengaku membenarkan laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (✓):

| | | |
|---|---|---|
| ☐ | **SULIT*** | (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972) |
| ☐ | **TERHAD*** | (Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan) |
| ✓ | **TIDAK TERHAD*** | |

Disahkan oleh:

(TANDATANGAN PENULIS)

(COP DAN TANDATANGAN PENYELIA)

Alamat Tetap: PT 255 TAMAN SRI TANJUNG, BUNUT SUSU, 17020 PASIR MAS, KELANTAN

DR. MOHD BADRIL BIN NOR SHAH
Pensyarah Kanan
Jabatan Teknologi Kejuruteraan Elektrik
Fakulti Teknologi Kejuruteraan
Universiti Teknikal Malaysia Melaka

Tarikh: 12/1/2022

Tarikh: 12/1/2022

*CATATAN: Jika laporan ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali tempoh laporan ini perlu dikelaskan sebagai SULIT atau TERHAD.

**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.

Signature :

Student Name : ARIF HASYIMI BIN ALI

Date : 12/1/2022

**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 :

Supervisor Name : DR. MOHD BADRIL BIN NOR SHAH

Date : 12/1/2022

Signature :

Co-Supervisor :

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.

# *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, sebuah peranti yang boleh mengesan kejatuhan 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.

I am taking this opportunity to convey my deepest gratitude and appreciation to my beloved supervisor, Dr. Mohd Badril bin Nor Shah, for the assistance. He always has the right dose of advice when I needed them most and always give inspirational motivation when I am poignant during my diploma project.

I also greatly indebted to my family for listening to my complaints for their unconditional support and encouragement to me in pursuing this task. Without their constant support and encouragement, this diploma project would not be possible.





Finally, I would like to thank all the fellow colleagues and classmates, the Faculty members, as well as other individuals who are not listed here for being co-operative and helpful.

## TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

# LIST OF SYMBOLS

| | | |
|---|---|---|
| **VIN** | - | VIN |
| **VOUT** | - | VOUT |
| **Hz** | - | Frequency |
| **T** | - | Period |
| **s** | - | Second |
| **Z** | - | Impedance |
| **R** | - | Resistor |
| **C** | - | Capacitor |
| **V** | - | Voltage |
| **p.u** | - | per unit |
| **I** | - | Current |
| **min** | - | minute |
| $\gamma$ | - | Ripple Factor |

# 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

# 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.

# 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].

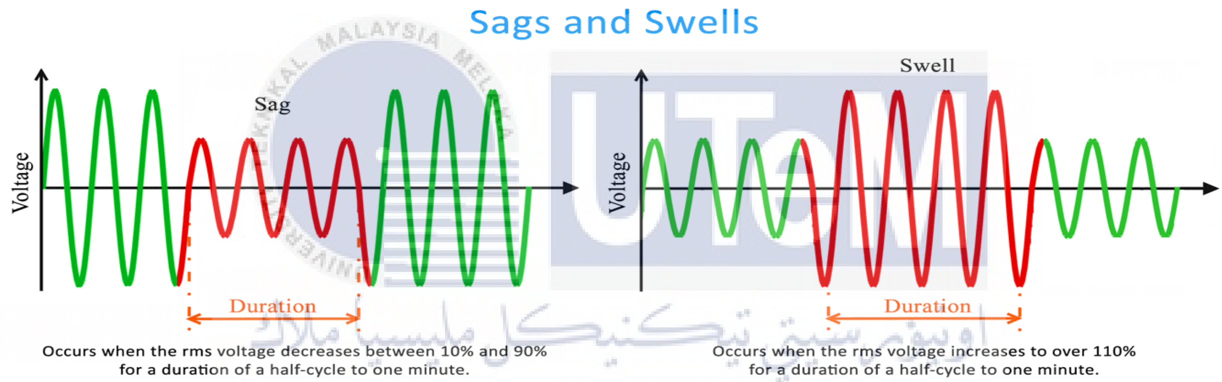




Figure 2.1 Voltage Sags and Swells

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

Table 2.1 Arduino UNO Specifications

| PARAMETER | VALUE |
| --- | --- |
| Microcontroller | ATmega328 |
| Operating Voltage | 5V |
| 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 |

### 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.