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I would like to thank my supervisor for helping me every step of the way and also my parents for supporting me financially and emotionally. They made this project come to life and helped me to put a clear picture of what my idea was all about.

DECLARATION

I Joseph Madaiza ,declare that this project tilted "3phase fault detection and appliance protection system " is my own work and that I have not plagiarized any part of it. l have not used any sources without proper citations. I have not also submitted this project for any course or degree.

I understand that plagiarism is a serious academic offense and that I could be penalized for it. I have read and understood the University policy on plagiarism and I agree to abide by it.

I have attended the list of all the sources I have used in this project.

Joseph Madaiza

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ABSTRACT

The objective of the 3 phase fault detection and appliance protection system is to detect no voltage, over voltage and under voltage on each of the three phases.If any of the above mentioned scenarios happen the system will automatically cutoff power going to the appliance using relays and the system alerts the user through an SMS message from the GSM clearly stating the nature of the scenario. A 16×2 LCD is used to display the voltages on each sensor. We use Atmega328p ic as our controller. We can reduce the risk of damaging 3 phase appliances by implementing this system as it automatically cutoff power to the appliances thus protecting them

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CHAPTER ONE: INTRODUCTION:

1.1 Introduction

The project is titled three phase protection and failure detection and enables one to detect if there is a phase failure whether under or no voltage. The scope of this project is to switch off automatically using a controller and relays/contactors.

1.2 Background of study

Electricity has become major part of our lives. There are some sectors that cannot work without electricity, like production lines in factories and in medical sectors. If there is a power outage a company could literally lose millions of dollars or a patient could die. all this should be avoided at all cost since its even though there are power outages almost twice a week in Zimbabwe. This project addresses this problem to some extent. It focuses on providing three phase appliance protection when there is an unnoticed power failure of the phases. [1] It will be used in main sectors to make sure that major industrial appliances are protected and also to measure the quality of electricity being provided. The project provides a way to seamlessly turn off power supply lines without having to manually turning off mains and without the help of a certified electrician. With the use of a few electronic components like ac voltage sensors and a microcontroller with a C program, the project successfully detect and turn off systems. The sensor helped to identify which line had electricity at a particular moment.[2]

1.3 Problem Statement

Destruction of valuable three phase appliances due to unnoticed failing of the phases from power supply and later detection of the failure.

1.4 Project Aim

To develop a system that successfully protect three phase appliances from power failure due to power supply.

1.5 Objectives

To design a system that detect failure in a three phase power supply output.
To design a system that can turn off three phase power when a fault is detected.
To design a system that can alert user of a power failure using gsm technology.
To design a system that can distinguish between no voltage and under voltage.

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1.6 Methods and Tools

Automatic power turning off method using relays/contactors will be employed. Software to program will be Arduino ide which used C++ programing language.

The system will have a printed circuit board which will be fabricated using cnc machine and the softwares proteus, candle and flatcam to design the pcb and schematic.

1.7 Project Motivation/Justification

The rate at which 3 phase industrial machineries coming to a halt due to power supply issues.

The need to protect machineries thus reducing costs and expenses of a company.

1.8 Summary of the remaining/coming chapters

The following chapter there will be a clear description of the development of the system from the simulations stage to the designing of the protototype. The fabrication of a printed circuit board will also be clearly shown. Results of the system will be stated in the last chapters of this project.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter describes the work done by other people in relation to this project. It also explains the costs analysis of each work and also the components used on different projects

2.2 Review of past related work

In august 2017 Ofaulagba G and E.E Udoha of Federal university of Petroleum Resources, Nigeria Designed an automatic phase selector and changeover Switch for 3 phase supply. [3]It provided means of switching from one phase AC mains to another in case of a failure in the existing phase. It also changed over to generator if there is failure in all three phases of the mains.

2.2.1 Technologies used

As their main controller they used the atmega 328pu ic. This was connected to three voltage sensors as inputs and lcd together with 4 relays as their outputs.

Strengths of the project

It is cheap

It also switches generators

2.2.2 Weaknesses

It does not have an web application to notify user of any changes

2.2.3 Cost benefit analysis

Using relay made the project cost effective since the cost $2 each rather than using contactors that cost $15 each. The cost of creating the whole project was $60 united states dollar.

In 2021 Waluyo and Kamal Salam Syah of Bucarest designed and implemented an Arduino based automatic transfer switch. It switched from primary source of power to a backup power source. The backup source was a generator 900VA, 220V ,4.09A which provided a frequency of 50Hz.[4] The transfer of power source was controlled by an android application c linked to the system via Bluetooth protocol.

2.2.3 Technologies used

HC05 bluetooth module

Arduino uno REV3

5v relay

Smart phone

Android app

2.2.4 Advantages of the system

Switching can be controlled wirelessly using Bluetooth technology

2.2.5 Disadvantage/limits

Bluetooth has a short range so one hase to be within range to control the system

2.2.6 Cost benefit analysis

The system was cheap to fabricate relays cost $2 each and Arduino uno costs $20, the hc05 bluetooth module costs $6. All together the system costs $40 and can be retailed at $50 each.

2.3 Proposed work

In this project, zmpt101b were used as voltage sensor to determine which phase has electricity and ones which has no electricity. The Atmega328p was used as the main controller with its analog pins connected to the voltage sensors. A 16x2 lcd display was used for notifications that which line is in use. Overally the system is designed to protect three phase equipment from under and no voltage in any of the three phase while they are in use.

2.4 Theory of Selected Components

The system uses the following components:

- Atmega 328p microcontroller
- GSM
- 5v relays
- 16*2 LCD
- PCB
- Voltage sensor
- Resistors
- Connectors

A brief description for each is outlined below.

2.4.1 Atmega 328p

8-bit ATmega328P microcontroller. Along with ATmega328P, other components connected to it are crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Atmega has 14 digital input/output pins (where 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.[5]

Figure 2. 1 : Shows the controller ATMEGA328P pin layout

Table 1:Shows atmega328p pin descreption

Pin category	Pin name	Details

Power	Vin, 3.3V, 5V, GND	Vin: input voltage using an external power source. 5V: regulated power supply for microcontroller and other components on board. 3.3V: 3.3V supply generated by on-board voltage regulator. GND: ground pins.
Reset	RESET	Resets the microcontroller.
Analog pins	A0-A5	Used to provide analog input in the range of 0-5V
Input/output pins	Digital pins 0-13	Can be used as input and output pins.
Serial	0(RX), 1(TX)	To receive and transmit TTL serial data.
External interrupts	2, 3	To trigger an interrupt.
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.
SPI	10(SS), 11(MOSI), 12(MISO) and 13 (SCK)	Used for SPI communication.
Inbuilt LED	13	To turn on the inbuilt LED.
TWI	A4(SDA), A5(SCA	Used for TWI communication.
AREF	AREF	Provides reference voltage for input voltage.

2.4.2 16×2 LCD Module

Figure 2.2 16x2 LCD shows an LCD used to display the results from different scenarios of the project

Features of a 16*2 LCD module

- Operating Voltage is 4.7V to 5.3V
- Current consumption is 1mA without backlight
- Alphanumeric LCD display module, meaning can display alphabets and numbers
- Consists of two rows and each row can print 16 characters.
- Each character is built by a 5×8 pixel box
- Can work on both 8-bit and 4-bit mode
- It can also display any custom generated characters
- Available in Green and Blue Backlight

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Figure 2. 2 LCD shows the pin layout on the LCD

Pin Number	Pin Name	Description
Pin 1	Vss(Ground)	Ground pin connected to system ground.
Pin 2	Vdd(+5V)	Powers LCD with 5V (4.7V-5.3V).
Pin 3	VE(Contrast V)	Describes the contrast level of display. Grounded for maximum contrast.
Pin 4	Register Select	Connected to microcontroller to shift between command/data register.
Pin 5	Read/Write	Used to read or write data. Normally grounded to write data on LCD.
Pin 6	Enable pin	Connected to microcontroller and toggled between 1 and 0 for data acknowledgement.
Pin 7-14	Data pins D0-D7	Data pins 0-7 form an 8-bit data line and can be connected to a microcontroller to send 8-bit data. LCD can also operate on 4-bit data mode where in such cases pin 4, 5, 6 and 9 will be left out
Pin 15	LED positive	Backlight LED pin positive terminal.
Pin 16	LED negative	Backlight LED pin negative terminal.

Table 2: shows the 16×2 lcd pin description

2.4.3 G.S.M (Global System for Mobile communications)

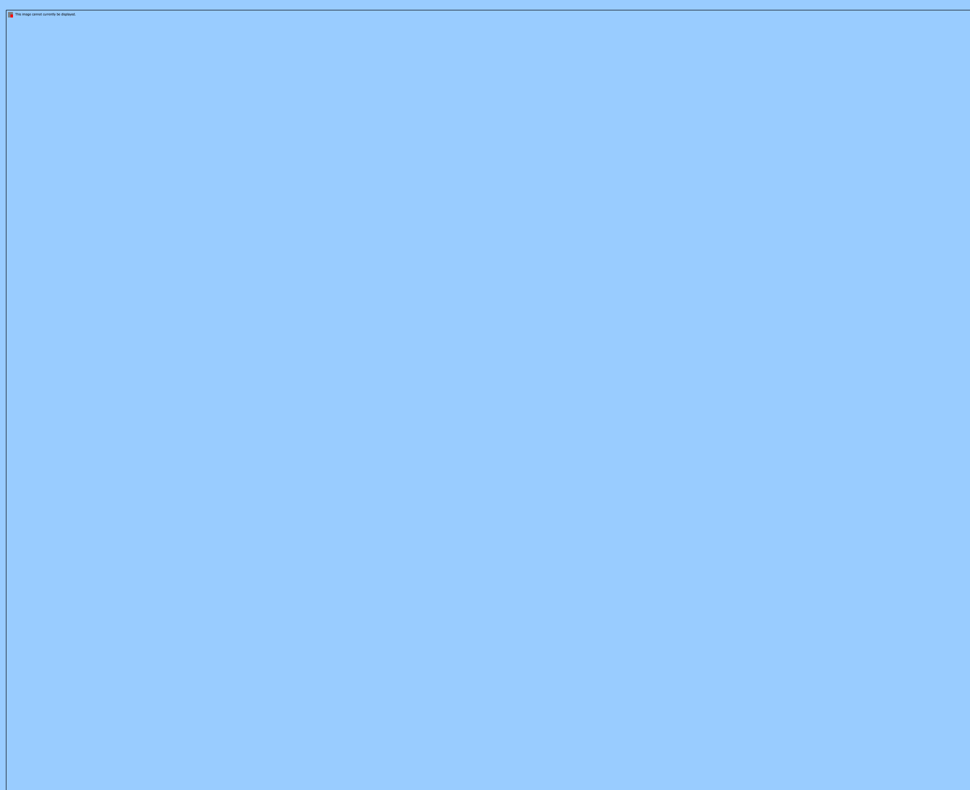


Figure 2. 3 Shows the front side of a GSM module clearly showing the SIM card slot and different positions for inserting different pins

Figure 2.4 Shows the back side of a GSM module clearly showing the SIM card chip

2.4.3 GSM Module

GSM stands for Global System for Mobile Communications. It is a standard for digital cellular networks that was developed by the European Telecommunications Standards Institute (ETSI) in the early 1990s. GSM is the most widely used cellular network in the world, with over 6 billion subscribers.

GSM uses a variation of time division multiple access (TDMA) to allow multiple users to share the same radio frequency. This is done by dividing the radio frequency into time slots, and each user is assigned a specific time slot to transmit .

GSM also uses a digital voice codec called Full dataRate (FR) to encode voice data. FR is a 13-bit codec that provides a good quality of voice.

GSM networks are typically divided into three areas: the mobile station (MS), the base station subsystem (BSS), and the network switching subsystem (NSS).

The MS is the device that the user carries, such as a mobile phone or a tablet. The BSS consists of the base transceiver stations (BTSs) and the base station controllers (BSCs). The BTSs are responsible for transmitting and receiving data between the MS and the NSS. The BSCs are responsible for managing the BTSs and for routing data between the BTSs and the NSS.

The NSS consists of the mobile switching center (MSC), the home location register (HLR), and the visitor location register (VLR). The MSC is responsible for routing calls between different MSs. The HLR is responsible for storing the subscriber information for all users in a particular network. The VLR is responsible for storing the subscriber information for users who are currently roaming in the network.

GSM networks are typically interconnected to form a global network. This allows users to roam from one network to another without losing their connection.

GSM is a mature technology that has been in use for over 20 years. It is a reliable and efficient technology that provides good quality of voice. GSM is also a cost-effective technology, which is why it is the most widely used cellular network in the world.

2.4.3.1 Advantages of GSM:

Widely available: GSM networks are available in most countries around the world.

Reliable: GSM is a mature technology that has been in use for over 20 years.

Efficient: GSM is a cost-effective technology.Good quality of voice: GSM uses a digital voice codec called Full Rate (FR) to encode voice data. FR is a 13-bit codec that provides a good quality of voice.

2.4.3.2 Disadvantages of GSM:

Data speeds are limited: GSM is a 2G technology, so data speeds are limited.

Security: GSM security is not as good as 3G or 4G.

Not as widely used in developing countries: GSM is not as widely used in developing countries as 3G or 4G.

Overall, GSM is a mature and reliable technology that provides good quality of voice. It is the most widely used cellular network in the world, and it is a cost-effective technology. However, data speeds are limited, and security is not as good as 3G or 4G.

2.4.4 5V Relay Module – How it Works and Application

5V relay module specifications

From home automation to industrial control, the 5V relay module is one of the most popular modules for switching power systems. So we decided to write an article about it, explaining how it works and some of its popular applications.

What is a 5V Relay Module?

Before we can understand how a 5V relay module works, we need to know what it is. The 5 volt relay module is a type of relay module that requires a 5V DC input to operate. But that's not all there's to it. Here's more, including the specifications

5V Relay Module Description

A 5V relay module is a single or multi-channel relay module that works with a low-level trigger voltage of 5V DC. The input voltage can be from any microcontroller or logic chip that outputs a digital signal.

Like most other relays, the 5V relay module is an electrically operated, electromagnetic switch that can be used to turn on or turn off a circuit. It consists of two parts: the relay itself and the control module.

The relay contains the coil that creates the magnetic field, the armature that move to complete or disconnect a circuit, and contacts that open and close to operate the load switch.The relay control module is the interface or part of the relay module that the user interacts with. It contains the input terminals for connecting to the microcontroller, as well as the output terminals for connecting to the load.The control module also contains LED indicators for power and status and other devices such as protection diode, transistor, resistor, and other semiconductor devices necessary for its operation.5V Relay Module Specifications

The 5V relay module specifications are normally written on the top side. These include the input voltage/current, load current/voltage, and operating or release times. The specifications vary depending on the manufacturer. In general, they would look something like this:

Normal voltage: 5V DCNormal current: 70mAMaximum load current: 10A/250V AC, 10A/30V DCMaximum switch voltage: 250V AC, 30V DCOperate time: ≤ 10msRelease time: ≤ 5ms

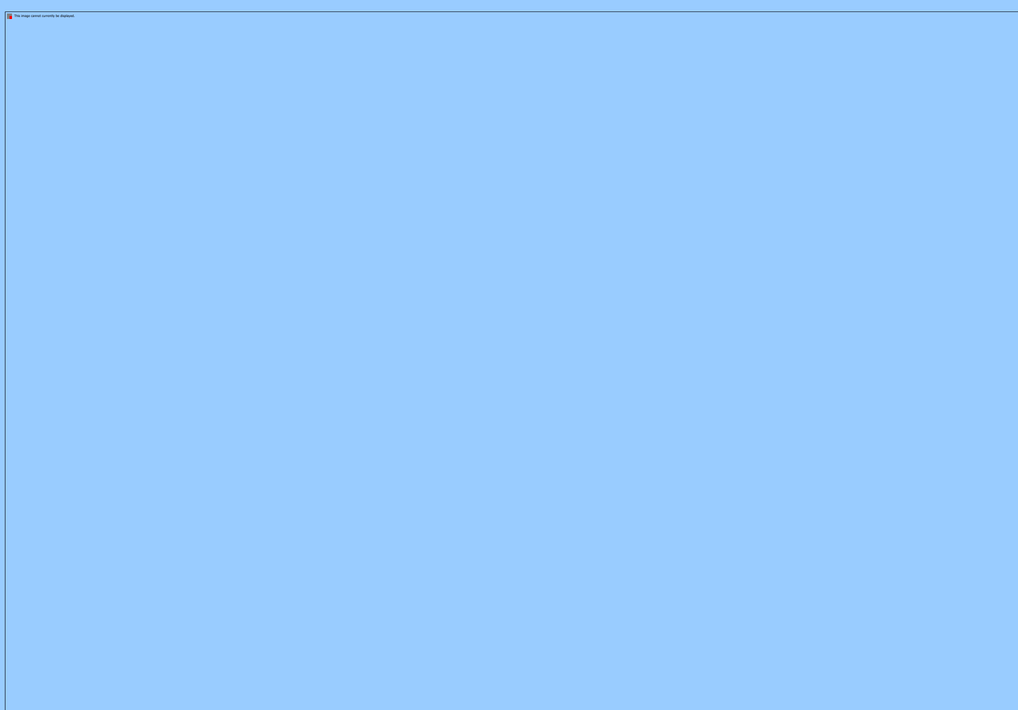


Figure 2.5 Relay module schematics

5V Relay Module Circuit

The 5V relay modules are made up of connection points or pins, and several major components, such as diodes, transistors, resistors, and the relay itself. These make up the circuit that controls the relay. The 5V relay module circuit is further explained below.

5V Relay Module Pinout

The 5V relay module pinout is composed of connections on the input side where it receives the trigger signal, and the output side where it controls the load.

The input side, as shown in the above relay module circuit diagram, has 3 or 4 connections: These are listed and explained below.

VCC – this is the power connection. It supplies 5V DC to the module and is normally connected to the positive terminal of the power supply.GND – this is the ground connection. It connects to the negative terminal of the power supply.IN1, IN2 – these are the inputs where the trigger signal is applied. IN1 is for a single-channel relay module, while IN2 is for a dual-channel relay module. The IN (Input) pin is connected to the output of the microcontroller, sensor, or logic device.

2.4.4.1 The relay module output side has three connections:

NO (Normally Open) – this is the load connection when the relay is ON. When the relay is off, the NO maintains an open connection with the COM.COM (Common) – The relay module connection labeled "COM" is the common connection for both the NO and NC (Normally Closed) pins.NC (Normally Closed) – this is the load connection. It connects to the COM terminal by default, or when the relay is OFF.5V Relay Module Parts

2.4.4.2 Now, let's take a look at the main components of a 5V relay module. They include:

The LED – this is an indicator or status LED that lights up when the relay is ON.

The transistor – the transistor amplifies the trigger signal so that it can activate the relay.

The diode – a flyback diode is used to protect the 5V relay module circuit from flyback voltage spikes when the relay coil de-energizes.

The resistor – the resistor limits the current flowing through the relay module circuit.

The relay – this is the main switching component of the module and usually either an NC (Normally Closed) or NO (Normally Open) type.

Figure 2.6 Examining a 5V relay module

5V Relay Module Working

The 5V relay module requires a 5V signal delivered from a microcontroller or sensor to trigger the switch. Its working is also very simple. When the input pin is HIGH, the relay turns on, and when the input is LOW it turns off. Below is the 5V relay module working principle.

The relay is activated by a low-level trigger signal applied to its IN1 or IN2 pin. When the trigger signal is applied, the transistor turns ON and amplifies the signal.This triggers the relay to turn ON and connect the load to either the NO or NC pin. The LED will light up to indicate that the relay is ON.When the trigger signal is removed, the transistor turns OFF and the relay turns OFF. The load is then disconnected from the NO or NC pin. The LED will turn OFF to indicate that the relay is OFF.

The 5V relay module can be used to control a load such as a lighting system, motor, or solenoid. It can also be used to switch AC or DC voltages. The maximum voltage and current that the 5V relay module can control is dependent on the specifications of the relay.

2.4.4.3 Using a 5V relay module with Arduino

Figure 2.7 Shows a 5V Relay Module for Arduino

The 5V relay module can be easily interfaced with an Arduino. The above diagram shows how to connect a single-channel relay module with Arduino microcontrollers, a popular project among hobbyists.

The 5V relay module Arduino wiring is very simple:

You only need to connect the VCC and GND pins of the relay module to the 5V and GND pins of the Arduino, connect the IN1 pin of the relay module to a digital output pin of the Arduino, and connect the load to the NO and COM pins of the relay module.

When the digital output pin is set to HIGH, the module turns ON and activates the relay. This will turn ON the load connected to the NO and COM pins of the relay module.When the digital output pin is set to LOW, the circuit OFF and deactivates the relay, turning OFF the load.

The 5V relay module can also be easily interfaced with a Raspberry Pi. When used with a Raspberry Pi, 5V relay module can be used to control a load such as an LED system, motor, or solenoid.

Figure 2.8 Below shows Zmpt101k voltage sensor

2.4.5 ZMPT101K Voltage Sensor

The ZMPT101K voltage sensor is a small, high-accuracy, and low-cost module that can be used to measure AC voltage. It is based on a precision voltage transformer that has a turns ratio of 1000:1000. This means that for every 1000 volts applied to the primary coil, the secondary coil will output 1 volt. The sensor has a linear range of 0 to 1000 volts and a linearity of less than 0.2%. The phase angle error is less than 20 degrees.

The ZMPT101K sensor has an isolated analog output that can be connected to a microcontroller or other device. The output voltage is proportional to the input voltage. The sensor can be used to measure AC voltages up to 250 volts.

The ZMPT101K sensor is a popular choice for DIY projects and applications where accurate AC voltage measurement is required. It is easy to use and can be interfaced with a variety of devices.

2.4.5.1 Here are some of the features of the ZMPT101K voltage sensor:

Small size

High accuracy

Low cost

Easy to use

Isolated analog output

Wide linear range

Low phase angle error

Can measure AC voltages up to 250 volts

2.4.5.2 Here are some of the applications of the ZMPT101K voltage sensor:

Home automation

Power monitoring

UPS systems

Solar power systems

LED lighting control

Scientific research

If you are looking for a small, high-accuracy, and low-cost voltage sensor, the ZMPT101K is a good option. It is easy to use and can be interfaced with a variety of devices

2.4.6 PCB (Printed Circuit Board)

2.4.6.1 Here are the steps involved in PCB soldering:

1. Prepare the soldering iron. This involves tinning the tip of the iron with solder.

2. Tinning the tip of the soldering iron
3. Prepare the PCB. Clean the PCB with isopropyl alcohol to remove any oxidation.
4. Cleaning the PCB with isopropyl alcohol
5. Position the components. Place the components on the PCB in the correct locations.
6. Placing the components on the PCB
7. Heat the joint. Heat the joint with the soldering iron until the solder melts.
8. Heating the joint with the soldering iron
9. Apply solder. Apply solder to the joint while it is still hot. The solder should flow evenly around the joint.
10. Applying solder to the joint
11. Clean the joint. Remove any excess solder with a solder sucker or wick.
12. Cleaning the joint with a solder sucker or wick

2.4.6.2 Here are some additional tips for PCB soldering:

Use a solder with a melting point that is appropriate for the type of PCB you are soldering.Use a flux that is compatible with the type of solder you are using.Hold the soldering iron at a 45-degree angle to the joint.Apply heat to the joint for a few seconds, but not too long or you will overheat the components.Apply solder to the joint in a small amount at a time.Be careful not to overheat the solder, or it will become brittle.Once the joint is complete, check it to make sure that it is properly soldered.

2.4.7 16MHz oscillator

Figure 2.9 Above shows a 16MHz oscillator

The 16MHz oscillator is a type of resonator that is used to create an oscillating signal at a frequency of 16 million hertz. It is a small, electronic component that is made up of a quartz crystal and a resonant tank circuit. The quartz crystal is what gives the oscillator its high frequency and stability. The resonant tank circuit helps to amplify the signal and ensure that it is stable.

2.4.7.1 16MHz oscillators are used in a wide variety of electronic devices, including:

Microcontrollers: Microcontrollers need a stable clock signal to keep time and execute instructions. A 16MHz oscillator is a common choice for microcontrollers because it provides a good balance of frequency and stability.

Radios: Radios need a stable clock signal to tune to specific frequencies. A 16MHz oscillator is often used in radios because it is a relatively inexpensive and easy-to-use option.

Computers: The central processing unit (CPU) in a computer needs a stable clock signal to execute instructions. A 16MHz oscillator is often used in computers because it is a common frequency that is supported by many different types of CPUs.

16MHz oscillators are available in a variety of packages, including DIP, SMD, and QFN. The package type that you choose will depend on the specific application that you are using the oscillator in.

2.4.7.2 Here are some of the benefits of using a 16MHz oscillator:

High frequency: 16MHz is a relatively high frequency, which means that it can be used in applications where a high degree of precision is required.

Stability: Quartz crystals are very stable, which means that the frequency of the oscillator will not drift over time.

Cost-effective: 16MHz oscillators are relatively inexpensive, which makes them a good choice for budget-minded applications.

If you are looking for a high-frequency, stable, and cost-effective oscillator, then a 16MHz oscillator is a good option to consider.

2.4.8 22pF capacitor

Figure 2.10 22pF capacitor

22pF capacitor is a ceramic capacitor with a capacitance of 22 picofarads. It is a passive electronic component that stores electric charge. Ceramic capacitors consist of two or more alternating layers of ceramic material as the dielectric and metal layers acting as the non-polarized electrodes**.**

2.4.8.1 22pF capacitors are commonly used in a variety of electronic applications, including:

Bypass capacitors: Bypass capacitors are used to filter out unwanted high-frequency signals from a circuit.

Decoupling capacitors: Decoupling capacitors are used to provide a low-impedance path for current flow between different parts of a circuit.

RF capacitors: RF capacitors are used to store and release energy at radio frequencies.

ESD protection capacitors: ESD protection capacitors are used to protect electronic circuits from electrostatic discharge.

22pF capacitors are typically available in a variety of sizes and voltage ratings. The most common size for 22pF capacitors is 0603, which is a metric designator that refers to a capacitor with a diameter of 0.6 mm and a height of 0.3 mm. 22pF capacitors are also available in larger sizes, such as 1206 and 1806.

The voltage rating of a 22pF capacitor indicates the maximum voltage that the capacitor can withstand without breaking down. The most common voltage rating for 22pF capacitors is 50 V. However, 22pF capacitors are also available in higher voltage ratings, such as 100 V, 250 V, and 500 V.

When choosing a 22pF capacitor for a particular application, it is important to consider the size, voltage rating, and capacitance tolerance of the capacitor. The size of the capacitor will determine how much space it takes up in the circuit. The voltage rating of the capacitor will determine the maximum voltage that the capacitor can withstand. The capacitance tolerance of the capacitor indicates how close the actual capacitance of the capacitor is to the specified capacitance.

2.4.8.2 Here are some examples of 22pF capacitors:

Ceramic disc capacitor: This type of capacitor is made of ceramic material and has a disc-shaped form factor. Ceramic disc capacitors are typically the most common type of 22pF capacitor.

Ceramic multilayer capacitor: This type of capacitor is made of ceramic material and has a multilayer form factor. Ceramic multilayer capacitors are typically more expensive than ceramic disc capacitors, but they offer better performance at high frequencies.

Metallized film capacitor: This type of capacitor is made of metalized film and has a flat, rectangular form factor. Metallized film capacitors are typically less expensive than ceramic disc capacitors, but they offer lower performance at high frequencies.

2.5 Cost Benefit analysis of the project

COMPONENTS	PRICE(USD)
Atmega 328p	15

3 channel relay	15
Pcb board	5
Zmpt101k voltage sensor	10
Oscillator	1
Ic holder	0.50
Capacitors and resistors	3
Casing	15
Lcd	13
Lamp holder	2
Dc power supply	7
Switches x 2	3
TOTAL	109

2.6 schedule analysis of the project

ACTIVITY	ESTIMATED COMPILATION TIME
LITERATURE REVIEW	1 week
DESIGN ANALYSIS	9 days
SIMULATION AND DESIGN	5 days
GATHERING COMPONENTS	4 days
CONSTRUCTION OF CIRCUIT	2 weeks
TESTING OF CIRCUIT	2 days
RESULTS ANALYSIS	3 days
FAULT RECTIFICATION	5 days
TESTING	1 day
DOCUMENTATION	1 week

2.7 Summary

This chapter showed clearly on the components that will be used and their respective prices. It also stated clearly how much time each stage of the project will take. Some similar work relating to this project was also shown. The following chapters will describe the creation of the project prototype form the simulation stages to the finishing of the actual product.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Main work

In theory the system is supposed to read the presence of electricity in an electric line/phase using a voltage sensor. Since this is a prototype the electricity will be taken from the mains and it will be around 240 r.m.s. there are many voltage sensors but the one that has been chosen in this project is the zmpt101k. it has a voltage tolerance of 1000v and can measure AC voltage.[6] This sensor was chosen because of its price, it is relatively cheap and does its job just fine.

The system is supposed to turn off all of the lines when the sensors detect that there is no longer a voltage signal in any of the three phase lines . The relay/contactor is the one to switch from off the lines .[7] The relay was chosen instead of a contactor because it is cheaper and the system is a prototype so there is no huge load or voltages that would require a contactor.

In theory the system is supposed to alert the user that there was a power loss or over voltage in any of the 3 phase. This is done by sounding a buzzer and displaying on an lcd.

The controller that will be used to read data from the sensors will be atmega 328p beacause it is easy to interface sensors to it and it is a recent chip, meaning easy to program and has support from many developing communities like git hub.

3.2 System Description

3.2.1 System Block diagram

The block diagram above clearly describes the system in terms of inputs processor and outputs. The project inputs will be the zmpt101k voltages sensor, which will be feeding to the controller atmega328p. The atmega328p is a microcontroller capable of handling analogue signal from the ac voltage sensors and it has a 10 bit analogue resolution.It has 7 analogue pins so it is more than enough for the three input voltage sensors. The outputs of the system are the 16x2 lcd, and relay switches to switch between respective lines. When there is a drop in voltage whether to zero or to a brown out, the voltage sensor detects the fluctuations and sends the signal to the controller,the controller determines the course of action. It switches off all adjacent lines using relays. The controller also makes the transition very visible by displaying it on the lcd

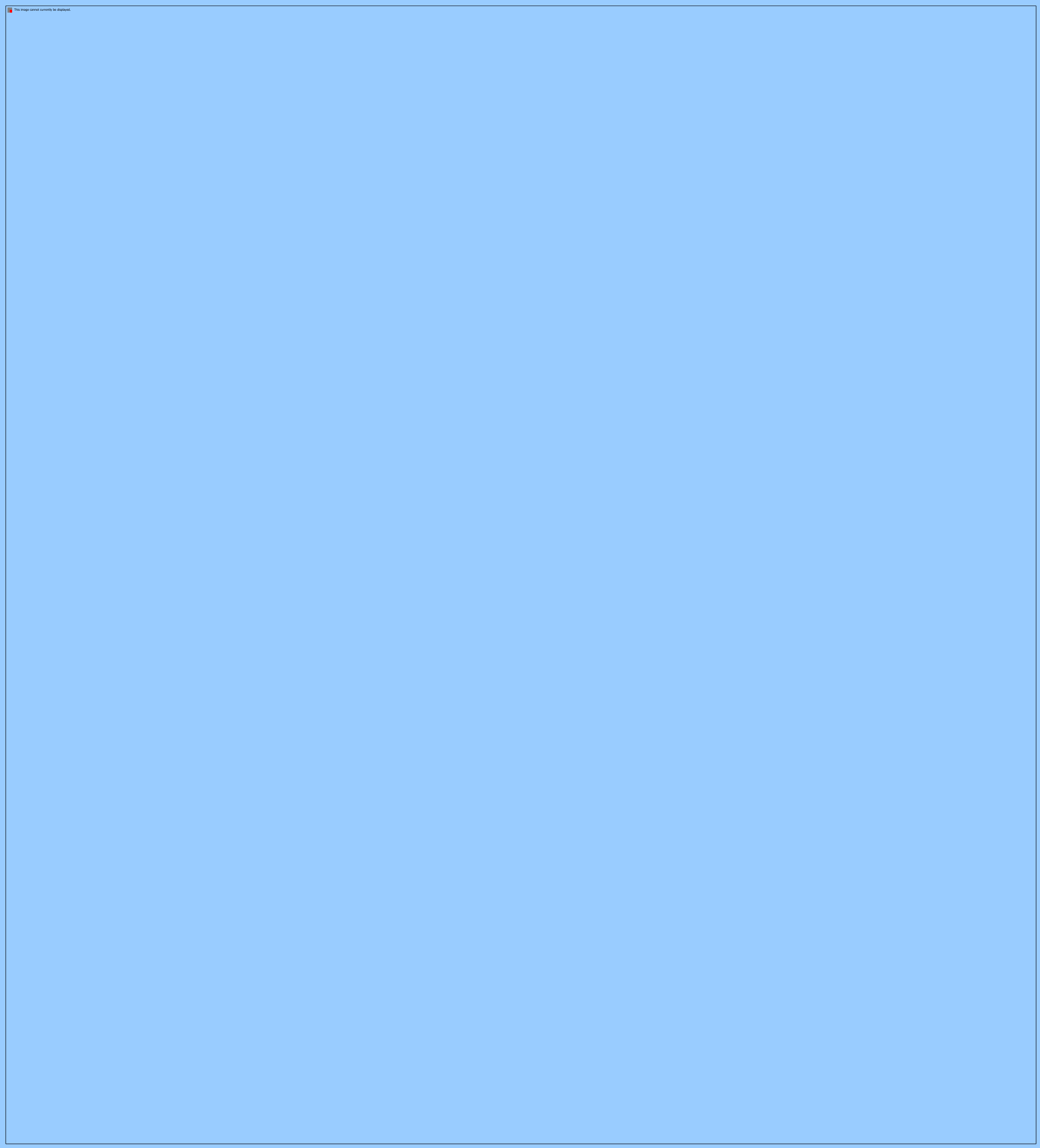
3.2.2 Softwares used

For simulation the software proteus was used. The software proteus was used to design the pcb and convert it into gerber file. The gerber file was edited by a software FLATCAM so that it could be read on a cnc machine. The flatcam converted the gerber file to a cnc extension readable by the cnc controlling software(candle). The cnc created the physical pcb and drilled holes for system's components.

3.2.3 Systems development

In the development of this project firstly there was designing of a system for simulation in proteus. There was careful choosing of components for the project. After simulation, designing of the pcb was in place. The after drilling and milling on the cnc machine, there was placement of components and soldering. The testing of the prototype soon followed. After testing supervisor was given feedback of the working system. The casing of the project was done after the analysis of the results and writing of document.

3.2.4 Shows the Flow chart on how the system is executed from one stage to another



3.2.5 Shows the Circuit diagram of project

Figure 3. 1 PCB layout

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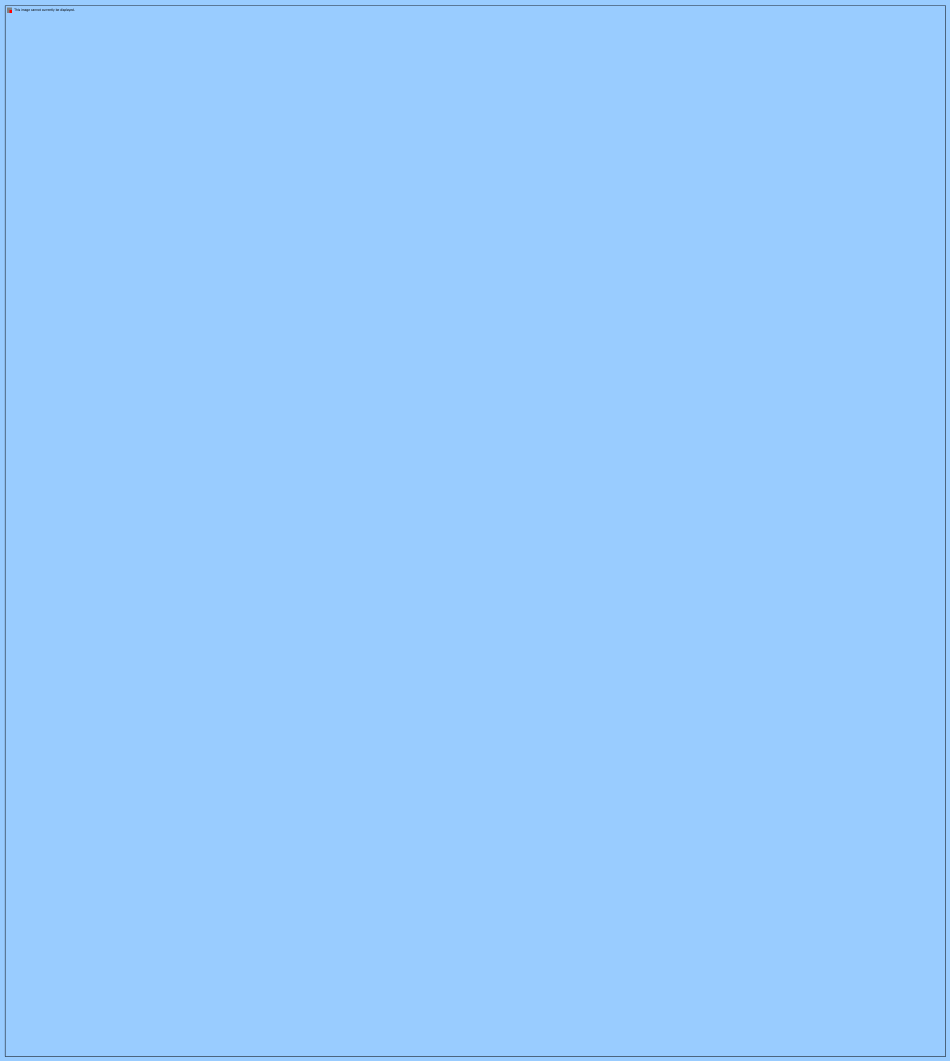
Figure 3. 2 schematic diagram



3.2.5 Codes

Code 1

3 phase fault detection and protection for turning off and on the system and sending a message using GSM alerting no voltage, under voltage at any phase using ATmega328P controller:

C++

```
// Define the pins for the three phases

 int phase_a = 2;
```

```
int phase_b = 3;
int phase_c = 4;
// Define the pin for the GSM modem
 int gsm_pin = 5;
 // Initialize the GSM modem
void setup_gsm() {
pinMode(gsm_pin, OUTPUT);
 digitalWrite(gsm_pin, HIGH);
 }
// Check the voltage levels on the three phases
 void check_voltage() {
 int voltage_a = analogRead(phase_a);
int voltage_b = analogRead(phase_b);
 int voltage_c = analogRead(phase_c);
// Check if there is no voltage on any of the phases
if (voltage_a == 0 && voltage_b == 0 && voltage_c == 0) {
 // Send a message to the GSM modem
 Serial.println("No voltage");
send_message("No voltage");
 }
// Check if the voltage is too low on any of the phases
if (voltage_a < 100 && voltage_b < 100 && voltage_c < 100) {
// Send a message to the GSM modem
 Serial.println("Under voltage");
send_message("Under voltage");
```

```
} }
// Send a message using the GSM modem
void send_message(String message) {
// Open a serial connection to the GSM modem
Serial.begin(9600);
// Send the message
Serial.println("AT+CMGS=\"+263784523501\"");
delay(1000);
Serial.println(message);
delay(1000);
Serial.println("");
delay(1000);
// Close the serial connection
Serial.end();
}
// Main loop
void loop() {
check_voltage();
delay(1000);
}
```

This code will check the voltage levels on the three phases every second. If there is no voltage on any of the phases, or if the voltage is too low on any of the phases, a message will be sent to the GSM modem. The message will be "No voltage" or "Under voltage", depending on the condition.

To run this code, you will need an ATmega328P controller, a GSM modem, and three analog sensors. You will also need to install the Arduino IDE and the GSM library. Once you have everything set up, you can upload the code to the controller and start monitoring the voltage levels on your three phases.

CHAPTER FOUR: RESULTS ANALYSIS

4.1 RESULTS ANALYSIS

Condition	theory	Actual results	
When E-line 1 had no power but E-line 2 and E-line 3 had power	The system is to send an alert that one of the phase has failed and turn off all the remaining phase to protect motors	Power to the motors were cut off to protect the system and an alert sms was send that line 1 has failed.	
When E-line 1 and E-line 3 had no power	The system is to send an alert that one of the phase has failed and	Power to the motors were cut off to protect the system and an	

but E-line 2 had power	turn off all the remaining phase to protect motors	alert sms was send that line 1 and 3 has failed.	
When E-line 1 and E-line 2 had no power but E-line 3 had power	The system is to send an alert that one of the phase has failed and turn off all the remaining phase to protect motors	Power to the motors were cut off to protect the system and an alert sms was send that line 1 and 2 has failed.	
When E-line 1 had power but E-line 2 and E-line 3 had no power	The system is to send an alert that one of the phase has failed and turn off all the remaining phase to protect motors	Power to the motors were cut off to protect the system and an alert sms was send that line 2 and 3 has failed.	

Table 3: Above shows an analysis of the project results

Figure 4. 1 shows the system when there is power on all lines

Figure 4. 2 shows the system when line 3 has under voltage

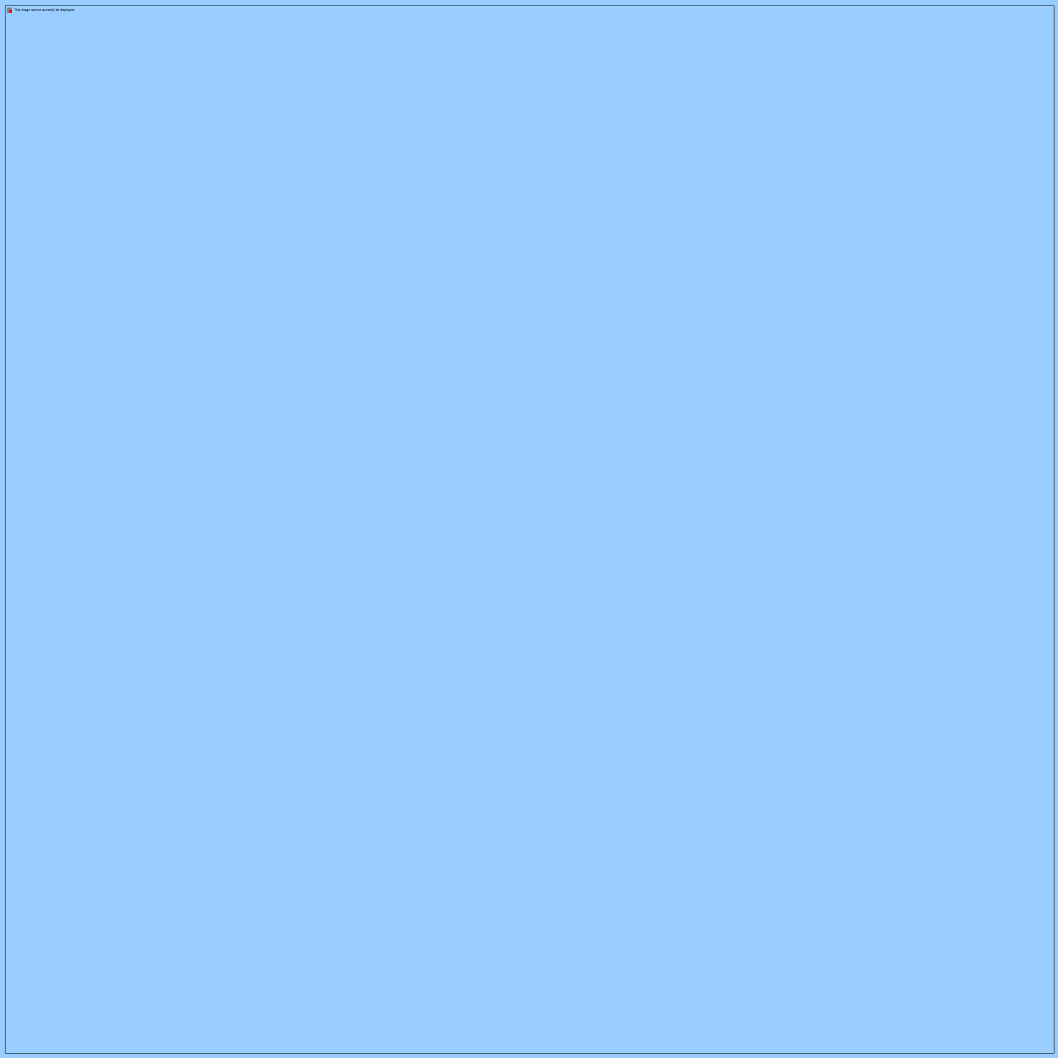


Figure 4. 3 show the system when there is no power on all lines

According to the results it can be clearly shown that the theoretical results was exactly what was acquired in this project. The system successful turned off when there was a fault be it under voltage , over voltage and no voltage. The system was able send an alert sms using the gsm module. The cutting off of power was made possible by relay modules.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The results above show that overally the project was a success. All the results corresponded with theoretical results. Most of the objectives were met except the last objective, there was no way of determining that the system really reduced damaging of appliances by 90%

5.2 Recommentations

5.2.1 Areas of further research

.The project can be improved by adding a webpage to monitor line switching online and using contactors in place of relays. Using a larger lcd which is 20x4 will be preferable in order to display all necessary information.

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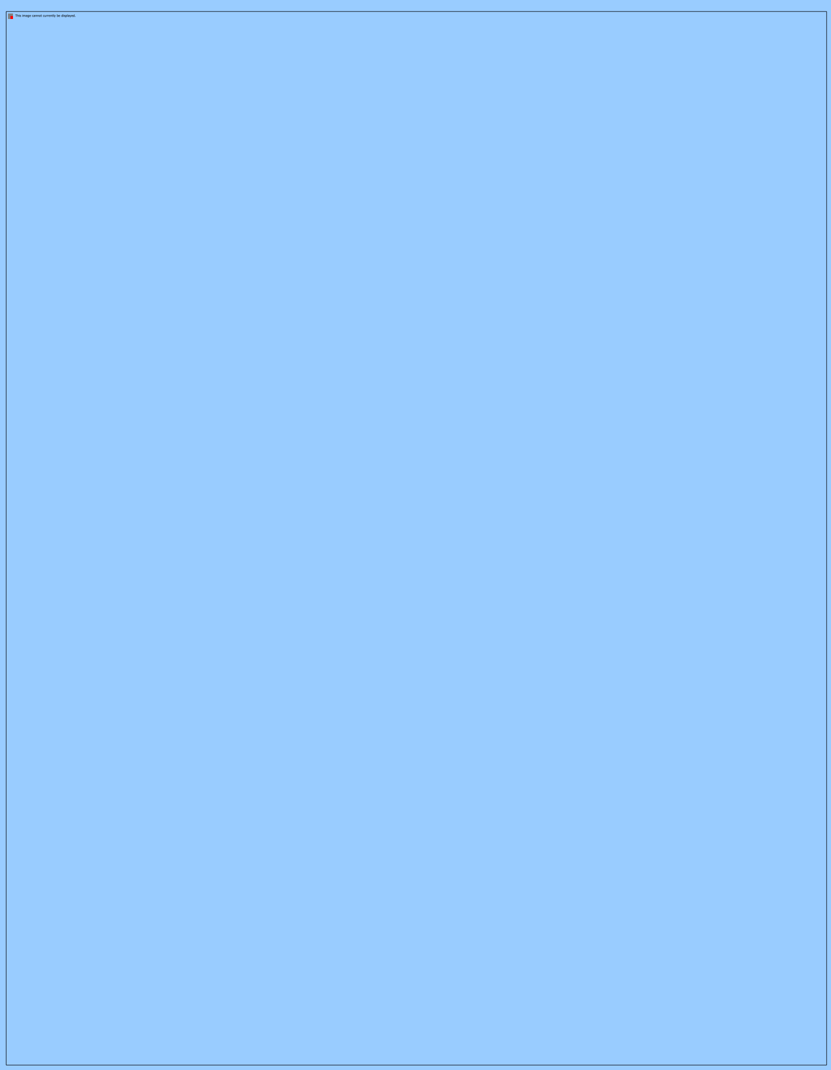
APPENDICES



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