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Design and Implementation of a Three Phase Transmission Line Fault Detection and Protection using Arduino

Gopal Dhoke[1], Atul Dhurve[2], Abhishek Pandagre[3], Shivshankar Farkade[4], Prof. Meena Sune[5]

[1, 2, 3, 4]Students, [5]Assistant Professor
Department of Electrical and Electronic Engineering, Shri Balaji Institute of Technology and Management, Betul, Madhya Pradesh, India

Abstract

This project addresses the need for Power grids to suffer frequent faults, highlighting the need for improved transmission line protection. This paper proposes an Arduino-based fault detection system for enhanced reliability and safety. The system utilizes current transformers to sense variations and potential impedance measurements for fault location. It also integrates and sound sensors for comprehensive fault detection. Upon fault detection, the Arduino triggers alarms, displays the status on an LCD screen, and can send SMS alerts. This system offers rapid fault identification and response, reducing downtime and Furthermore, Arduino's low cost makes this a feasible solution for improving power transmission line reliability and safety.

Keywords: An Arduino-based system for detecting faults in power transmission lines. The system uses various sensors and aims to improve the reliability and safety of power grids

1. INTRODUCTION

A fault in a power system can be called any abnormality in the electric current flowing in it. For example, if the current is interrupted by some failure in the circuit, the resulting fault is an open circuit fault. If the current in the circuit bypasses the normal load, it results in a short circuit fault. In a three-phase system, the fault may occur between one or more phases and ground or only between phases of the system. Generally, protective devices are used in transmission systems to detect fault conditions, which results in the operation of circuit breakers or isolators that help limit the damage due to the failure. In three-phase or polyphase systems, a fault may affect some phases (causing asymmetrical faults). If all the phases are affected equally, it results in a symmetrical fault. Symmetrical faults are easier to analyze than asymmetrical faults.

2. CLASSIFICATION OF FAULTS

Symmetric faults

In a three-phase system, if a fault affects all three phases equally, it is called a symmetric or a balanced fault. Generally, symmetric faults constitute about 5% of the total faults.

Asymmetric faults

An unbalanced or asymmetric fault results in an unequal effect of fault on each of the three phases Asymmetric faults are further classified as LL or Line to Line fault, LG or Line to Ground fault, and LLG or Double Line to Ground fault.

LL fault is a short circuit between two lines, caused by ionization of air, or when lines come into physical contact, for example, due to a broken insulator.

LG Fault is a short circuit between one line and the ground due to physical contact caused by lightning or storm.

LLG fault occurs when two lines come in contact with the ground and each other. This is mainly caused by storm damage.

3. LITRATURE SURVEY

NIRANJAN L, et al. (2020) recommend many power transmission companies primarily rely on circuit indicators to detect faulty parts of their transmission lines. Even if sensors, breakers, and other communication lines are used, the system looks very expensive and consumes the same amount of time in the wrong location and specification. However, there are still challenges in finding the exact location of these errors. Although fault indicator technology has provided reliable methods of detecting permanent errors, the current state of error detection is very worrying and time-consuming as the technical team and monitoring teams still have to physically monitor and inspect equipment for long hours to find faulty parts. Of their transmission lines, and then they have to clear the error, which requires a lot of human effort to identify the error location and remove the error. Wire-based monitoring of transmission lines provides a solution to many of these concerns such as real-time structural awareness, rapid error detection, accurate error detection and detection of electrical errors in mechanical errors, and reduced costs due to conditional rather than occasional correction. Care, etc. These applications define solid requirements such as faster delivery of large amounts of highly reliable data. The success of these applications depends on building an efficient and reliable network structure with fast response time.

Prof. Vikram Singh R. Parihar, et al. (2020) Electric Power System is divided into many different categories. One of them is the power transmission system, where power is transferred to productive stations and smaller stations via transmission lines to consumers. Both methods can meet various types of malfunctions often referred to as "Error". An error is simply defined as several unpleasant but inevitable incidents that can temporarily disrupt a stable power system situation that occurs when a system installation fails at any time. GSM-based error detection and location system was used to adequately and accurately diagnose and error detection. This will ensure a short response time for technical personnel to correct these errors and thus help save transformers from damage and disaster. The system uses a current transformer, voltage transformer, PIC 16F877 Microcontroller, RS-232 connector, and GSM modem. The system automatically detects errors, analyzes and separates these errors and then calculates the error distance from the control room using an impedance-based algorithm method. Finally, the error details are transferred to the control room. In conclusion, the time required to detect an error has been greatly reduced, as the system automatically and accurately provides the location information for the error. By using this project, we can detect three-phase transmission lines that one can monitor Temperature, Voltage, and Current using the GSM modem by sending a message

4. METHODOLOGY

The design of this system relies on the use of a potential transformer, microcontrollers, and the GSM module. The system can detect all the different types of asymmetrical faults at the occurrence of faults on the three-phase overhead lines. When the system detects a fault, it classifies it according to the characteristic condition of the voltage and current and the location of the fault. The signal received is transferred to the microcontroller for detection and classification. The GSM module sends a message in the form of a short message service (SMS) to an official on duty. The official on duty would act based on the location and severity of the fault.

4.1 BLOCK DIAGRAM

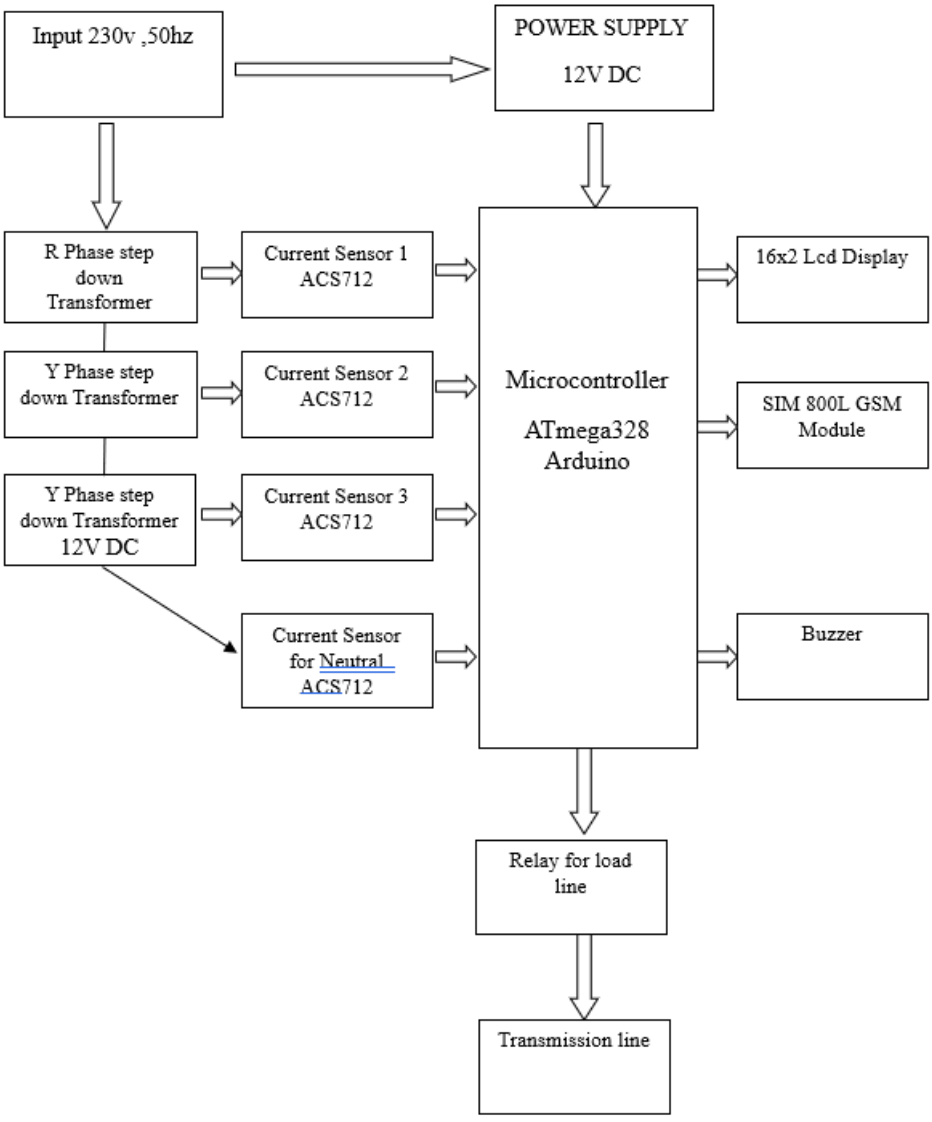


Fig 4.1 Block Diagram

The voltage, fire, short, and open circuit sensors are attached to both Arduino and transmission lines maintaining the connection between them, meanwhile, the Arduino is connected to RPS, and the LCD, buzzer, and GSM are connected to Arduino completing the circuit. When supply is given to the circuit, if there is any problem in the circuit like high voltage or low voltage the voltage sensor comes into work and indicates the Arduino which sends a signal to lcd to display that there is a short circuit at a specific area and also the buzzer will be alerted. The same process will be continued for all the sensors, if there is a fire at any of the transmission lines the fire sensor comes into work, and if there are any open and short circuits respective sensors come into work.

4.2 ATMEGA328 MICROCONTROLLER

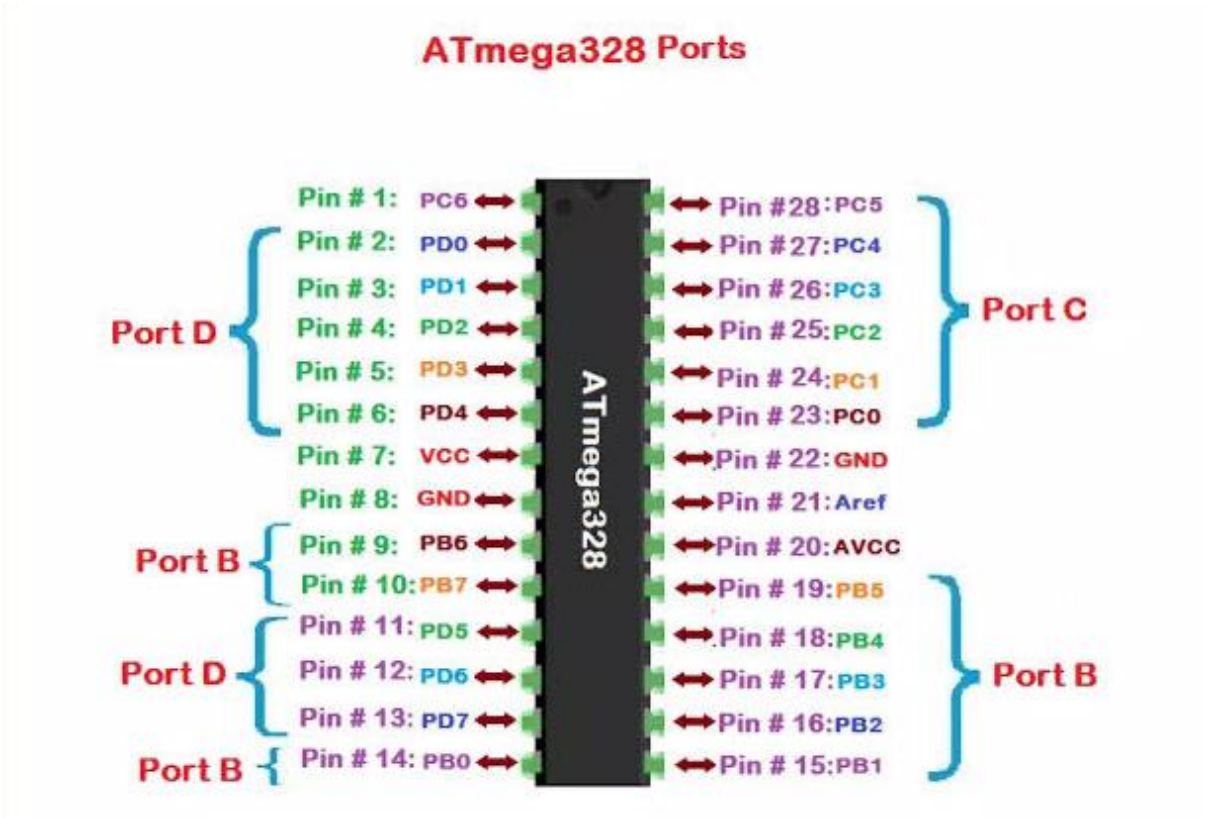
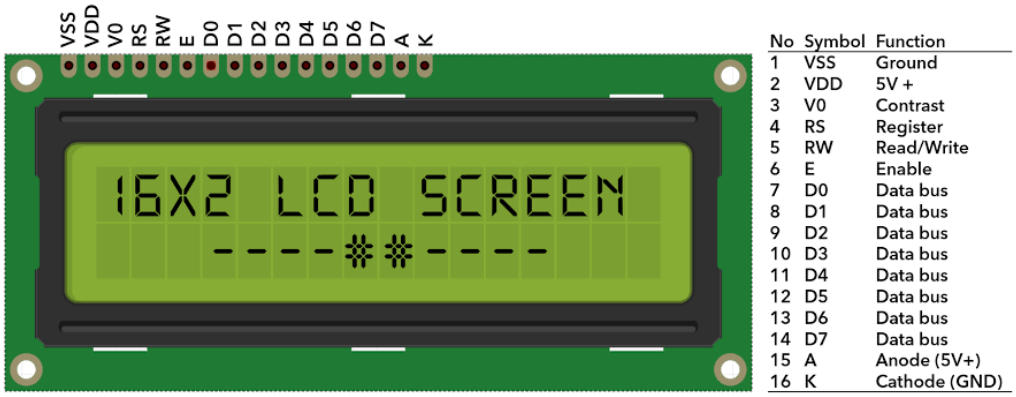


Fig 4.2 Atmega328 Microcontroller

ATmega-328 is an Advanced Virtual RISC (AVR) microcontroller. It supports the data up to eight (8) bits. ATmega-328 has 32KB internal built-in memory. This microcontroller has a lot of other characteristics. You should also have a look at the Introduction to PIC16F877a (it's a PIC Microcontroller) and then compare the functions of these two Microcontrollers. ATmega 328 has 1KB Electrically Erasable Programmable Read Only Memory (EEPROM). This property shows if the electric supply supplied to the microcontroller is removed, even then it can store the data and can provide results after providing it with the electric supply. Moreover, ATmega-328 has 2KB Static Random Access Memory (SRAM). Other characteristics will be explained later. ATmega 328 has several different features which make it the most popular device in today's market. These features consist of advanced RISC architecture, good performance, low power consumption, real timer counter having a separate oscillator, 6 PWM pins, programmable Serial USART, programming lock for software security,

throughput up to 20 MIPS, etc. ATmega-328 is mostly used in Arduino. Further details about ATmega 328 will be given later in this section**.**

4.3 16×2 CHARACTER LCD



No	Symbol	Function
1	VSS	Ground
2	VDD	5V +
3	V0	Contrast
4	RS	Register
5	RW	Read/Write
6	E	Enable
7	D0	Data bus
8	D1	Data bus
9	D2	Data bus
10	D3	Data bus
11	D4	Data bus
12	D5	Data bus
13	D6	Data bus
14	D7	Data bus
15	A	Anode (5V+)
16	K	Cathode (GND)

Fig 4.3 16×2 Character LCD

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simple programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc. An LCD is an electronic display module that uses liquid crystal to produce a visible image. The 16×2 LCD is a very basic module commonly used in DIYs and circuits. The 16×2 translates to a display of 16 characters per line in 2 such lines. In this LCD each character is displayed in a 5×7 pixel matrix.

4.4 CURRENT SENSOR

Fig.4.4 Current Sensor

Current sensors are vital components in electronic systems, serving to measure the flow of electric current within circuits. They play pivotal roles in various applications, providing essential data for monitoring, protection, and control purposes. The diverse types of current sensors include Hall effect sensors, current transformers (CTs), resistive shunt sensors, and Rogowski coils, each employing distinct principles for current measurement.

4.6 RELAY

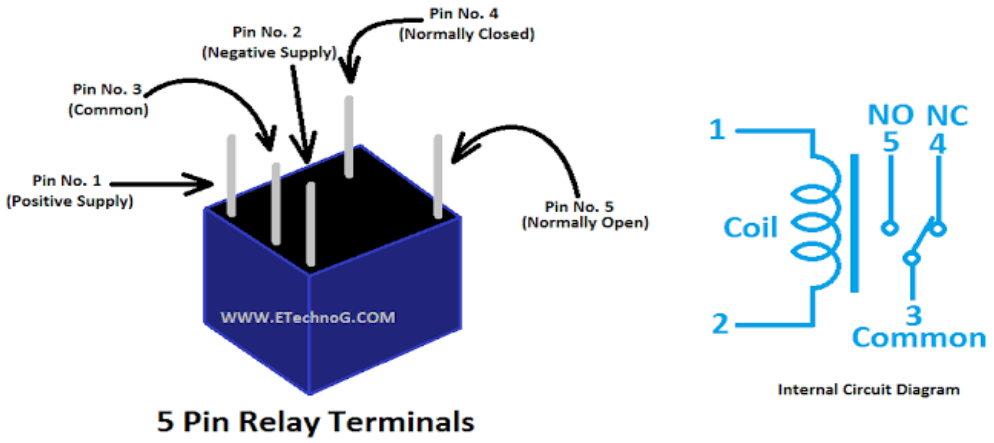


Fig. 4.6 Relay

A relay is an electrically operated electronic switch that is commonly used in circuits and systems to control higher po wer signals with lower power inputs. The term "relay" comes from the French word "relais" which means to pass on. In simple terms, a relay allows a small electrical circuit to switch to a separate high-powered circuit. The relay is a type of electronic switch that opens or closes the circuit contacts by using electronic components without any mechanical operation. In this relay, the current carrier pilot relaying scheme is used for the protection of the transmission line.

4.7 GSM SIM800L MODULE

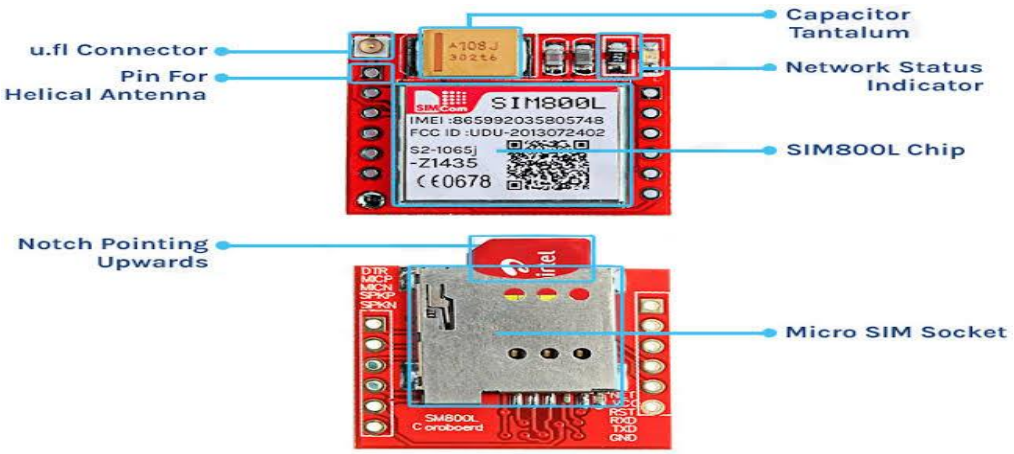


Fig. 4.7 GSM SIM800L MODULE

SIM800L is a miniature cellular module that allows for GPRS transmission, sending and receiving SMS. Low-cost small footprint and quad-band frequency support make this module the perfect solution for any project that requires long-range connectivity. After connecting power module boots up, searches for the cellular network, and logs in automatically. On board, LED displays connection state. There is a SIM card connector on the board. The module is powered from 3.8 V to 4.2 V. Additionally, the set includes an antenna.

5. Result

Fig. 5.1 Output of Project

If fault between L and G with phase B and neutral/ground than R and Y phase voltage will be R=0.24, Y=0.18 and so on.

If fault between L and L with phase Y and neutral/ground than Y and N phase voltage will be Y=0.21, N=0.20 and so on.

Calculation after fault condition

T 1	T 2	T 3
BG R = 0.24 Y = 0.18 B = 0.77 N = 0.76	BG R = 0.24 Y = 0.18 B = 0.77 N = 0.76	BG R = 0.24 Y = 0.18 B = 0.77 N = 0.76
RG R = 0.79 Y = 0.21 B = 0.20 N = 0.67	RG R = 0.62 Y = 0.22 B = 0.23 N = 0.52	RG R = 0.52 Y = 0.22 B = 0.23 N = 0.45
YG R = 0.18 Y = 0.78 B = 0.19 N = 0.77	YG R = 0.14 Y = 0.60 B = 0.14 N = 0.63	YG R = 0.28 Y = 0.57 B = 0.20 N = 0.44

RB R = 0.88 Y = 0.21 B = 0.88 N = 0.20	RB R = 0.78 Y = 0.20 B = 0.77 N = 0.19	RB R = 0.66 Y = 0.20 B = 0.70 N = 0.22
YR R = 0.83 Y = 0.86 B = 0.21 N = 0.22	YR R = 0.78 Y = 0.78 B = 0.21 N = 0.20	YR R = 0.67 Y = 0.64 B = 0.21 N = 0.20

6. CONCLUSION

This paper concludes that the Wifi technology used for the fault detection of three-phase lines through messages is provided to the In-charges of that location, using communication protection schemes. The Messages of fault location will be sent to the Charge by the internal programming of Arduino connected to the Wifi Module. To get the exact faulty phase under abnormal conditions has been occurred the RYB Indicators are also provided for faulty phase indication purposes. Also, this project helps to detect transformer temperature, when temperature rises to a certain level transformer is automatically isolated from the system. If this system is implemented, our system will become reliable and faultless, which is our main vision in the project.

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