IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-7, Issue-4, April 2019 E-ISSN: 2347-2693

Three Phase Fault Analysis with Automatic Trip and Reclosing

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DOI: https://doi.org/10.26438/ijcse/v7i4.711715 | Available online at: www.ijcseonline.org

Accepted: 20/Apr/2019, Published: 30/Apr/2019

Abstract-The main objective of this project is to identify abnormality in electrical power system and to develop a device for detecting and isolating the same. A fault in the electrical power system is any abnormal high electric current through it. Early detection of fault can help us avoid the damage caused by these abnormal conditions. Fault detection plays an important role in high-cost and safety crucial processes. The circuit is completely controlled by the microcontroller which consistently monitors the voltages of the three phases and if the voltage goes abnormal then the signal is sent to the connected LCD. With the help of transformer, the voltage is sensed; if the voltage level exceeds some particular set value, a signal is sent to microcontroller to disconnect the load. The current response is displayed on the LCD. This detection system here is realized by using microcontroller 89S52. Continuity of power supply in three phase devices is an important concern, as error in this leads to losses in the winding of the devices and may lead to damage of windings. So, there is a need to protect these devices from the abnormalities. In this scheme, we are providing a protection system for devices which not only provide protection from under load but also operate automatically after the supply has come back to normal. Henceforth it finds its application at various medical hospitals, industries, households and places where high protection is needed for saving the costly equipment connected to the main line.

Keywords—Microcontroller89S52,LCD, Relay, Relay Driver, 555 Timer, Fault Analyis

I. INTRODUCTION

The three phase power system is the most commonly used poly-phase system, employed by electrical grids worldwide for generation, transmission and distribution. This is due to the system being very cost effective as compared to other alternatives because it uses less conductor material. Three phase system is also utilized to power heavy loads, large motors and for many industrial applications.

A fault in electrical apparatus can be defined as the defect in its electrical circuit which directs the current from its intended path. Faults occurs either due to failure of insulation, breaking of conductors etc.

When a fault occurs on a system, the voltages of the three phases become unbalanced. The maximum possibility of fault occurrences is on transmission lines due to their greater lengths and exposure to atmospheric conditions. In three phase systems, a fault may occur between the phases and ground, or may occur only between phases. The short circuit current of a fault can be calculated for power systems. In power systems, protective devices detect fault conditions and operate circuit breakers and other devices to limit the loss of service due to a failure.

When a fault occurs in any part of the system, it must be cleared in a short duration of time in order to avoid heavy damage to electrical apparatus and personnel and also to avoid disturbance in the power supply to consumers. Relay and circuit breaker are some of the devices which are used for clearing the fault in system for the protection of electrical power system. Also various fuse wires, MCB (Miniature Circuit Breaker), ELCB (Earth Leakage Circuit Breaker), lightning arrestor, and different protective relays are used to isolate the electrical equipment [1].

The remaining portion of paper is organized as follows. In section II, we have given the brief idea about Related Works. Section III explains the detailed methodology of the project with block diagram. In section IV, the components used are described with their specifications. And finally the section V and section VI concludes the research work with future directions.

II. RELATED WORK

Pankaj B. Sondarva et al have discussed the big role of electrical power network is the continuity of service. The electrical substations which supply the power to the consumers can have failures due to some faults which can be temporary or permanent. This instigated an idea to investigate power system protection to improve reliability by focusing on fault detection [2].

M.S.Morey et al have discussed about the project that made them understand about the basic operation of the relay and the advanced techniques that are being used by the people to ensure the safe operation of the electrical appliance. This circuit isolates the load from the supply, if any power fluctuation occurs. The major advantage of the project is to save the appliances & show the type of the fault so that it will be easy for the operator to solve the same [3].

Sathish Bakanagari et al have discussed that the fundamental aim of their paper was to develop an automatic tripping mechanism for the three phase supply system. The project output resets automatically after a brief interruption in the event of temporary fault while it remains in tripped condition in the case of permanent fault [4].

III. METHODOLOGY

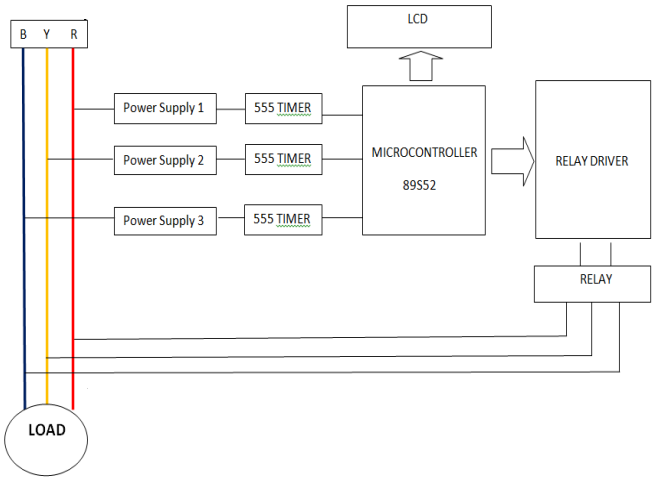

Figure 1. Block Diagram of the Proposed System

In this project, we have designed a three phase fault analysis system which not only detects the phase in which fault has occurred but also protects the three phase system by using relays. This model constantly checks the voltage and if the fault has been cleared, then the three phase device is automatically connected back to the supply.

The three phases R, Y & B are connected to three single phase transformers of rating 230V ac to 12V ac to step down the input voltages. Microcontroller cannot measure voltage greater than 5V; hence we have to reduce the voltage range within 5V. And for the same reason 12V ac is converted into pulsating dc voltage through bridge rectifier and after that capacitor smoothens out the dc signal, this signal is regulated through voltage regulator to 5V and connected to the micro controller through the 555 timer.

A separate power supply is provided to microcontroller for proper working. The input signals are continuously compared with the zero level to detect whether any phase is shut down.

The microcontroller is also interfaced with a LCD display which is programmed to show the active phase and the phases which are shut down.

Single Pole Double Throw (SPDT) type of relay is being used for ON & OFF condition of the three phase load.

Relays are connected to the microcontroller through relay driver. Relay driver is used for increasing the current handling capacity of incoming signals from the microcontroller unit.

This circuit is completely controlled by the microcontroller and it will consistently monitor the voltages of the three phases and if the voltage goes abnormal in any of the phase then the signal is sent to the LCD and also to the relays through relay driver.

So, if any of the phases has a fault, the microcontroller will send the signal to relay which will cut off all the faulty phases, tripping the whole three phase system connected to it. When the signal returns to normal condition; after a fixed delay from timer, the circuit will be reconnected. Hence our power system is protected.

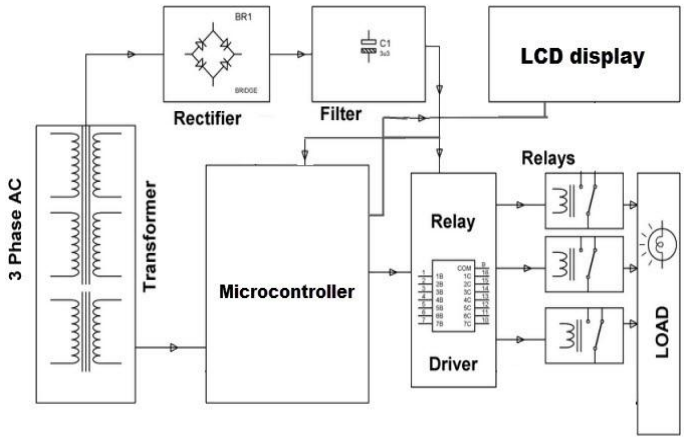

Figure 2.Proposed Simulated System

IV. COMPONENTS

Table 1.Components Used in the Experimental Setup

S.NO.	COMPONENT	QUANTITY
1.	Power supply	4
2.	Transformer	4
3.	Diode	-
4.	Voltage regulator	4
5.	Resistors	-
6.	Capacitor	-
7.	LED	3

8.	Relay	3
9.	Relay Driver	-
10.	555 Timer	3

A. MICROCONTROLLER

Here we are using the AT89S52 which is a low power, high performance CMOS 8 bit microcontroller. It has 4K bytes of in-system-programmable memory. It consists of 4 ports. Port 1 is connected to three power supply whereas port 0 and 1 is used in LCD interfacing.

It is a small, low-cost and self-contained computer-on-a-chip that can be used as an embedded system. It has low power requirement. By using this microcontroller, we get advantages of added features such as the ability to store measurements, to create and store user routines, and to display messages and waveforms.

B. RELAY

Relay is a type of switch that opens and closes the circuit electromechanically. It controls electrical circuit by opening and closing contacts in another circuit. Generally, these switches are used for smaller currents in a control circuit. A single pole double throw relay is used here for ON & OFF condition.

The relay consists of continuous power supply and whenever it gets driven or gets control signal then the relay gets activated and the load can be turned ON or OFF. It is used to provide isolation between microcontroller circuits and high voltage operating loads. Relays are connected to the microcontroller through relay driver.

C. RELAY DRIVER

Relay driver is a circuit used for driving a relay. Relay requires some driver circuitry to turn ON & OFF based on the requirement. Here relay driver circuit is realized using integrated circuit ULN2003. The IC ULN2003 is a Darlington transistor array which deals with high voltage and high current.

The IC ULN2003 comprises of 7-NPN Darlington pairs and is used to switch inductive loads. A Darlington pair is an arrangement of two bipolar transistors which is employed to provide high gain. It can be used for availing more relays. This circuit can also be paralleled for ever higher current output.

D. 555 TIMER

NE555 timer is the type of integrated circuit which is designed to be used as a timer, pulse generator, oscillator applications and by many more. These devices are capable of producing accurate time delays or oscillation in timing circuits.

It can be operated in a-stable or mono-stable mode with external (RC) timing control. In the a-stable mode of operation, the frequency and duty cycle can be controlled independently with the help of two external resistors along with a single external capacitor. It is widely used due to its low price, ease of use and stability. It operates in a wide range of power from +5 volts to +15 volts supply voltage and also its duty cycle is adjustable.

V. RESULTS AND DISCUSSION

This project is aimed for early detection as well as protection of the devices from faults in three phase system.

Here, the output will be shown in the form of a series of messages, for example, if a line is active and current is flowing through it normally then the LCD would display the result as OK. And if fault occurs across any of the phases, an error message or a cross sign will be displayed on the LCD corresponding to the line where fault has occurred. Then after a fixed delay the connected three phase circuit would be tripped until the fault is cleared.

This circuit will automatically reset to its initial condition in the case of a temporary fault whereas it will remain tripped if the fault which has occurred is permanent in nature.

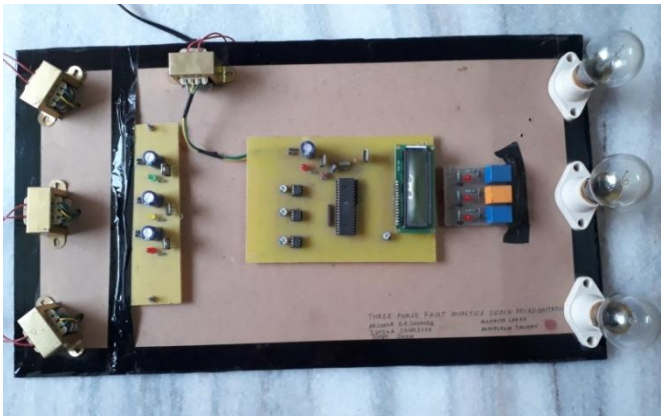

Figure3.Experimental Setup

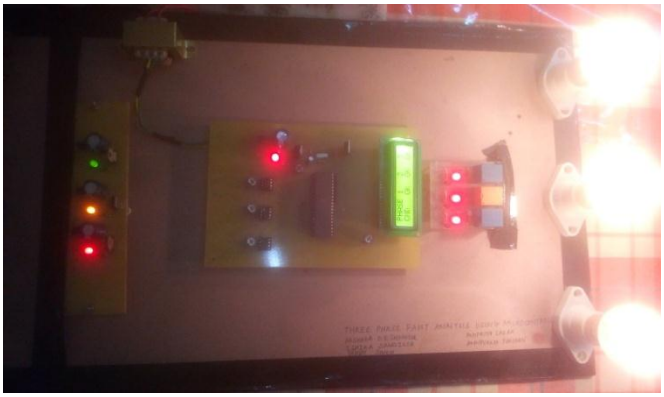

Figure 4. Experimental Setup with All Phases Active

Figure 5.All Phases Active and its LCD Output

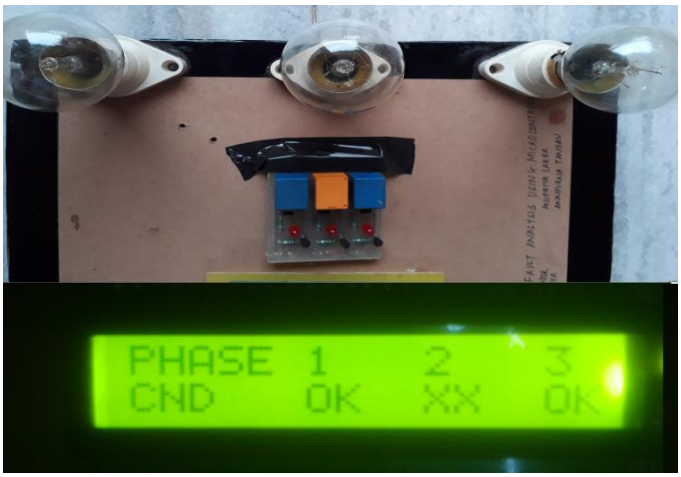

Figure 6.Fault in Second Phase and its LCD Output

VI. FUTURE SCOPE

In future, the following modifications can be implemented to the existing project:

1) By adding GSM service module in this system; we can inform the consumer in real time about the fault occurred; via a message, so that immediate action can be taken.
2) An IOT based system could be made to send notifications through web server and for adding other advance functionalities.
3) With the implementation of various sensors and other electronic devices, this circuit can then be used to find real time values of the system parameters such as current, voltages and power.
4) A software application for mobile phone can be developed, so that the real time monitoring and external control of the system can take place.

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