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Three Phase Ultra Fast Electronic Circuit Breaker

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Abstract: The demand for efficient and dependable electronic circuit protection devices has increased with the proliferation of high-velocity digital systems. This paper introduces a unique method to home circuit protection with the improvement of a 3-phase electronic circuit breaker. Traditional mechanical circuit breakers have limitations in terms of reaction time and accuracy. The proposed electronic circuit breaker integrates advanced sensing technologies and microcontroller-based control algorithms to provide unique and efficient safety against overloads, short circuits, and earth faults in three-phase electric systems generally determined in domestic and industrial equipments. The layout emphasizes compactness, cost-effectiveness, and compatibility with existing electrical infrastructure.Here an Ultrafast electronic circuit breaker is designed which depends on the current detecting across a series component typically a CT (current Transformer).The current sensed is compared with preset value of microcontroller. The microcontroller will consistently check the magnitude of this current against a preset current to guarantee that the current flowing through the circuit isn't over the given rated value. Assuming the current at any point rises over the rated magnitude, the microcontroller initialize the tripping mechanism which cutoff the circuit. The Experimental effects reveal the superior overall performance of the electronic circuit breaker in terms of response time, reliability, and flexibility in comparison to conventional counterparts. This innovation promises to decorate safety and reliability in home electrical installations even as paving the manner for clever grid integration and energy management applications.

***Keywords*- Ultrafast circuit breaker, Overload, Over-current, Microcontroller, Relay, CT (current Transformer)**

I. INTRODUCTION

In modern domestic and industrial electric structures, ensuring safety and reliability is paramount. Conventional circuit breakers, while effective, often exhibit obstacles in response time and accuracy,In particular detecting and isolating faults in three-phase configurations. As residential electrical equipment continues to evolve and becoming more complex , there is a growing demand for circuit protection gadgets which could offer more desirable overall performance and flexibility.This paper introduces a singular technique to cope with these demanding situations: the Three-Phase Ultra-Fast Electronic Circuit Breaker (UFECB). Unlike traditional mechanical circuit breakers, the UFECB leverages improvements in semiconductor technology and digital control algorithms to provide ultra-speedy and particular safety against overloads, short circuits, and earth faults in 3-phase electric systems typically discovered in residential settings.The primary goal of this research is to expand a circuit breaker that not only meets but exceeds the safety and reliability standards anticipated in present day sensitive loads. By integrating advanced sensing technology and microcontroller-based control techniques, the UFECB objectives to limit response times and maximize accuracy in fault detection and interruption, thereby lowering the risk of electrical fires, gadget damage, and personal damage.Furthermore, the UFECB is designed with compatibility and ease of installation in mind, ensuring seamless integration into existing domestic and industrial electrical infrastructure. Its compact layout and cost-efficient implementation make it a practical answer for owners, electrical contractors, and building developers alike.Through complete experimental validation, this paper demonstrates the superior overall performance of the UFECB in comparison to traditional circuit protection devices. By

presenting stronger protection, reliability, and flexibility, the UFECB represents a large development in domestic circuit protection generation, poised to meet the evolving wishes of modern residential electrical systems.

II. LITERATURE SURVEY

The history of power electronics is very a great deal linked to the improvement of switching devices and it emerged as a separate subject while high-Power and MOSFET devices were introduced inside the 1960s and 1970s.Since then, the creation of latest devices has been observed with the aid of dramatic development in power rating and switching overall performance. Because of their functional importance, drive complexity, fragility, and costs, the power electronic design engineer must be ready with a thorough knowledge of the tool operation, issue, drawbacks, and related reliability and efficiency problems. In the Nineteen Eighties, the improvement of power semiconductor devices took an critical flip whilst new system technology evolved that allowed integration of MOS and bipolar junction transistor (BJT) technology at the equal chip. Thus a long way, two devices using this new technology had been brought: insulated bipolar transition (IGBT) and MOS managed thyristor (MCT). Many integrated circuit (IC) processing strategies in addition to equipment were adapted for the development of power devices.Notwithstanding, in contrast to microelectronic ICs, which process data, power device ICs process powerthus their packing and handling procedures are quite different. Power semiconductor devices address the core of modern power electronics, with two significant positive attributes of power semiconductor devices directing their development; 1.Switching speed (turn-on and switch off times) 2.Power handling abilities (voltage blocking and current conveying abilities) Enhancements in both semiconductor handling innovation and assembling and bundling methods have permitted power semiconductor advancement for high-voltage and high current ratings and quick turn-on and switch off characteristics.Today switching devices are made with astonishing power handling capabilities and switching speeds as will be shown afterward. The accessibility of various devices with different switching speeds, power handling capabilities , size, cost etc, makes it conceivable to cover many power electronic applications. Thus,compromises are made with regards to choosing power devices.

III. METHODOLOGY

Numerous strategy or discoveries from this field mainly generated into journal for others to take benefits and work on as impending studies. The technique is use to accomplish the goal of the research that will achieve a perfect result. In order to evaluate this project, the methodology based on System Development Life Cycle (SDLC), this includes three major step, which is planning, implementing and analysis. The methods involved are summarized in the block diagram of figure 1

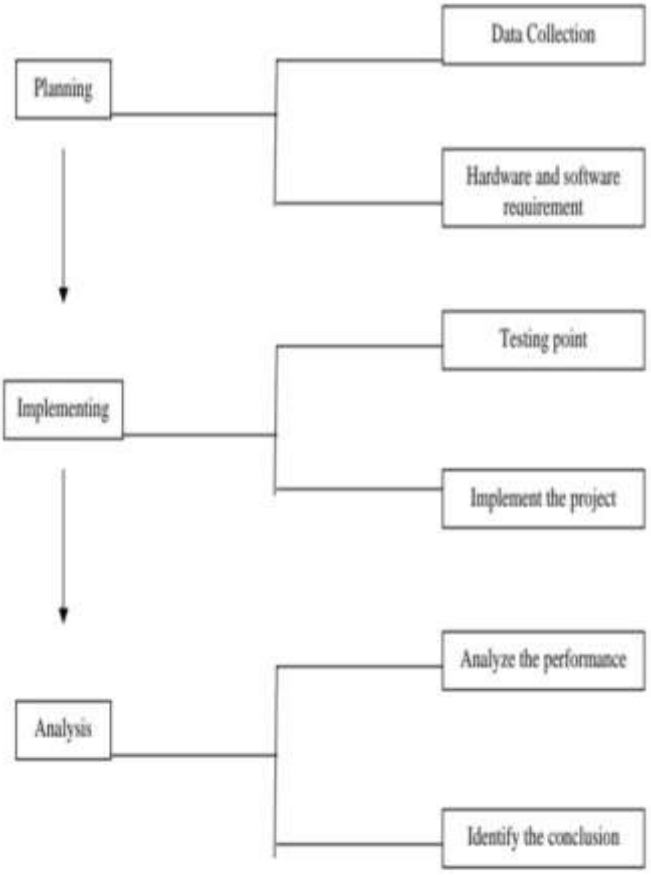

Fig.1 Steps of Methodology

IV. HARDWARE IMPLEMENTATION

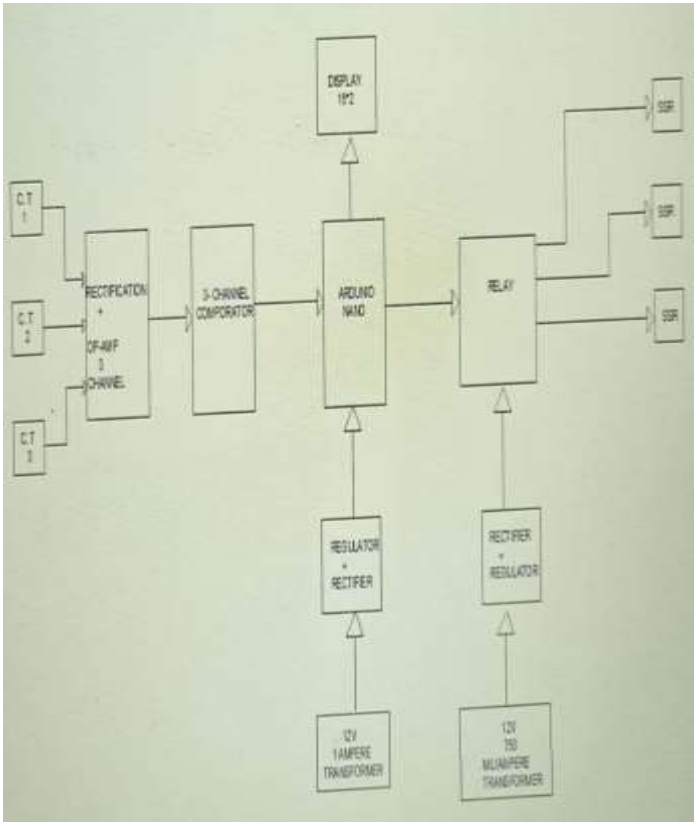

Fig.2. Block Diagram

The 220/12V, 1Amp transformers, Bridge rectifiers , 7805 voltage regulator are coupled to Arduino Nano and the opto-coupler, these are used for the checking and control of the circuit condition at no load, normal load and over-load. The Solid State Relay is connected with one terminal of the load and the opposite terminal is going to the comparator circuit along the supply wire. The circuit is energized with the 220/12V, 750mA transformer, then the bridge rectifier, the 7805 voltage regulator supply the required 5V to the arduino Nano and also optocoupler. Also the LCD is energized by the 5V and the light contrast are adjusted with a variable resistor. The LCD shows the status about the system module and show that the system is ready for load. On loading with a single 60 watt load i,e bulb, the LCD shows the condition of the UFECB as "normal condition". Here, the framework works fittingly until the second 60 Watt bulb is added. The optocoupler conveys a message on to the microcontroller i,e arduino. The microcontroller in approximately 1 microseconds passes electrical signal on to the SSR relay, which in turn incited the trigger from normally closed(NC) to normally open (NO) and the buzzer is operated instantly. The circuit breaker switch off the 2nd load and the LCD shows an overload status of system. The over-load i.e bulb, is then taken out and the reset button is pushed, then, at that point, the switch is pushed for the bulb to be on. This cycle is rehashed for the various times there is an over-load present in the model.

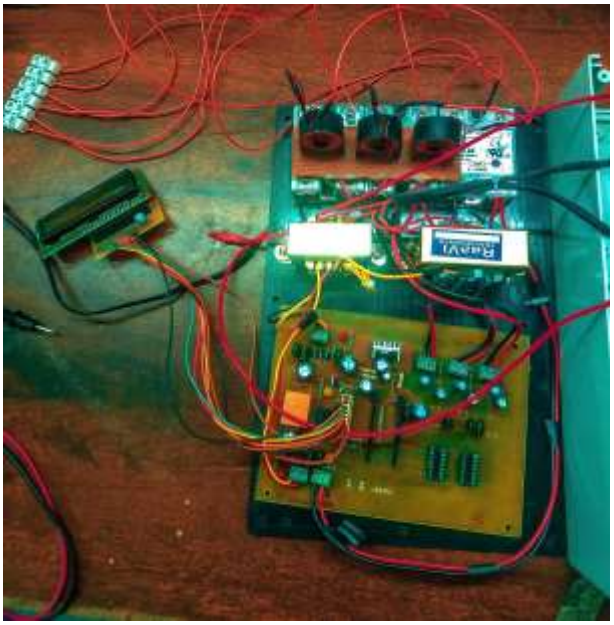

Fig 3. Hardware Implementation

V. RESULT

In Three phase ultrafast electronic circuit breaker, the tripping circuit was capable to turn ON and turn OFF the system loads when there is an over-current or over-load. The timed relay circuit with the arduino/microcontroller worked agreeably approximately 1.5 milliseconds. The buzzer alert to indicate when there is an over-load with the tripping process worked acceptably. When the circuit breaker module loads are off, the reset switch is off and afterward pushed on, to actuate the single load on, after the over-load is eliminated. The tripping circuit was able to switch ON and switch OFF. The tripping time and shutdown of the system when there is any form of over current or fault is approximately 1.5 milliseconds.

VI. CONCLUSION

A three phase ultrafast electronic circuit breaker offers various benefits in electrical systems, essentially guaranteeing fast and exact assurance against overcurrent faults. By utilizing advanced semiconductor technology, these circuit breakers can quickly detect and interrupt excessive current, protecting sensitive loads and safeguarding potential damage or hazards. Their capacity to response in microseconds minimizes downtime and enhances the reliability of electrical installations, making them essential in critical applications such as domestic and industrial systems. Overall, the implementation of ultrafast electronic circuit breakers represents a significant leap forward in electrical safety and system performance.

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