



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 4, April 2024

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

Advance Current Differential Relay using an Arduino UNO Microcontroller

Harikishan Jangid¹, Gaurav Namdev¹, Himanshu Kachhawa¹, Jayesh Chhawachharia¹, Dolly Malik¹,
Prateek K. Singhal²

U.G Student, Department of Electrical Engineering, Swami Keshvanand Institute of Technology, Management and Gramothan Jaipur, Rajasthan, India¹

Associate Professor, Department of Electrical Engineering, Swami Keshvanand Institute of Technology, Management and Gramothan Jaipur, Rajasthan, India²

ABSTRACT: In power system protection devices are essential and due to the switching losses and high response time we are advancing the conventional method of protection Device such as Relay using the Arduino. For the safety of the equipment this current differential relay in which Arduino is programmed like that it takes approximate 200 samples in a complete current cycle by which the reliability, accuracy and efficiency of this protection scheme increases with the Flexibility of reprogramming on the basis of different different Applications.

KEYWORDS: Arduino, differential Relay, power system

I. INTRODUCTION

In modern electrical power systems, ensuring the safety and reliability of transmission and distribution networks is of paramount importance. One critical aspect of maintaining system integrity is the timely detection and isolation of faults, which can lead to catastrophic failures if left unchecked. Current differential relays have long served as a cornerstone in protective relay systems, offering efficient fault detection capabilities by comparing currents at different points in the network. However, traditional current differential relays possess inherent limitations that hinder their performance in rapidly evolving power system environments.

The emergence of microcontroller technology, exemplified by platforms like Arduino, has revolutionized the landscape of embedded systems and automation. These versatile and cost-effective microcontrollers provide a flexible platform for the implementation of sophisticated control and monitoring systems. Leveraging the capabilities of microcontrollers presents a compelling opportunity to enhance the functionality and performance of current differential relays, thereby addressing longstanding challenges and expanding the horizons of protective relay technology.

This research paper aims to explore the advancement of current differential relays through the integration of microcontroller technology, with a focus on the Arduino platform. By harnessing the computational power and versatility of Arduino, novel approaches to current sensing, signal processing, and relay operation can be devised, offering improvements in accuracy, responsiveness, and adaptability. Through a systematic investigation of design principles, implementation methodologies, and experimental validation, this study seeks to demonstrate the feasibility and efficacy of employing Arduino-based solutions in enhancing the capabilities of current differential relays.

II. LITERATURE REVIEW

Current differential relays have been extensively studied and utilized in electrical power systems for their ability to detect faults by comparing the currents entering and leaving protected zones. This section provides an overview of existing literature on current differential relays and explores previous research on the integration of microcontrollers in relay systems.

Current Differential Relays:

Current differential relays have a long history in the field of protective relaying, dating back to the early days of electrical engineering. These relays operate based on the principle of Kirchhoff's current law, which states that the sum



of currents entering a node in a circuit must equal the sum of currents leaving the node. By comparing the currents at different points in the network, current differential relays can detect abnormal conditions such as short circuits and line faults. Previous studies have investigated various aspects of current differential relays, including their design, operation principles, and applications in power system protection.

Integration of Microcontroller:

The integration of microcontrollers in relay systems has garnered significant attention in recent years, driven by advancements in embedded systems and automation technology. Microcontrollers, such as those based on the Arduino platform, offer a cost-effective and flexible solution for implementing advanced control and monitoring functionalities in protective relays. Previous research has explored the use of microcontrollers for signal processing, data acquisition, and communication in relay systems. Studies have demonstrated the feasibility of employing microcontrollers to enhance the performance and intelligence of protective relays, enabling features such as adaptive protection schemes, fault location, and remote monitoring.

Gaps in Literature:

Though there exist an extensive literature on current differential relays and the integration of microcontrollers in relay systems, certain gaps need to be addressed yet. Foregoing studies have mostly focused on theoretical aspects and proof-of-concept implementations, with limited emphasis on practical aspects and real-world applications of current differential relay based on microcontroller technology. Moreover, there is a lack of comprehensive research that thoroughly investigates the design, implementation, and performance evaluation of current differential relay integrating microcontroller technology.

This paper focused on bridging these gaps by providing a detailed analysis of an advance current differential relay using microcontroller technology, with an emphasis on practical implementation and experimental validation.

III. METHODOLOGY

Hardware and Software Selection:

The selection of hardware components depends on the type of project such as this project is a prototype which can lead to industrial uses also. Arduino is the main key component of the system. Aproximately, every electronic equipment is working on below 5V voltage and the supply is provided from Arduino and Arduino is taking supply from a 12V DC voltage adapter. Here we are using components that are listed in Table 1.

Table 1: List of components

Hardware	Arduino- uno
	16*2 LCD Display
	I2C module for LCD
	Current Sensor -ACS712(30Amp)
	5V Active Low Relay module
	220V AC to 12V DC Adopter
	LOAD - Bulb(100W)
	Buzzer
	Switch
Software	Arduino-IDE

Circuit Design Concept:

The concept behind the circuit design of this project is based on the principle of current differential relay that is the comparison of difference between input current and output current with a preset value [5,6].

There are two cases as follows:

CASE 1: Normal condition

Difference of input and output should be less then the pre-set value, in this case supply will be continuous and relay doesn't operate

CASE 2: Fault

Difference of input and output current will be greater than the pre-set value, in this case supply will be cut-off and relay operates and the equipment will be isolated from the fault.

Programming

The Arduino microcontroller is programmed to perform various tasks, including reading current sensor outputs, implementing differential relay algorithms, and controlling relay operation [7]. Programming logic is developed to detect fault conditions, trigger relay tripping, and provide status indicators for system monitoring. Programming of Arduino is centered on the logic that is:

$$I_1 - I_2 \geq \text{Pre-set value}$$

where, I_1 and I_2 are input and output currents through the element in ampere respectively .

- When the condition (logic-above given) is become true then there is a trip signal sent to the connected mechanical relay which cut-offs the supply.
- When the condition is become false then there is no trip signal is sent to the relay and the supply will be continue and system will work normally.
-

IV. DESIGN AND IMPLEMENTATION

System Architecture

There is a simulated circuit of differential relay as shown in Figure 1.

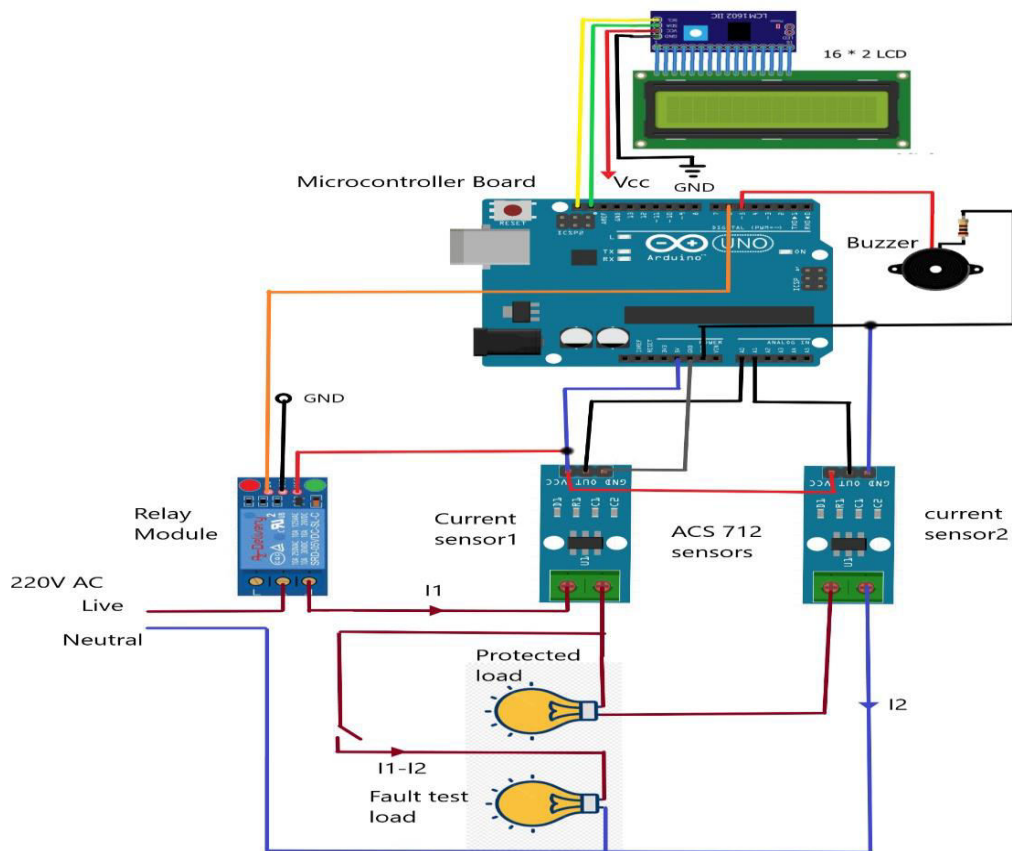


Fig 1 : Simulated Circuit of Differential Relay

Hardware Implementation

Initially a 230V, 50Hz supply is given to the load (100W bulb). Here two current sensors are utilized to collect the sample and measure the input current and the output current across the load and these samples are stored into the Arduino [8, 9]. For the occurrence of fault, a separate load (100W bulb) is utilized that can be turned ON and OFF using switch. Due to the fault there is a signal sent to the mechanical relay by which the supply will be cutoff and due to the Arduino programming the system will not be turned ON until the removal of fault and then reset the Arduino.

In this work, in order to identify the fault a current differential relay principle is utilized that is the comparison of difference of input and output current with a preset value of 0.1A. Thus, the logic for the operation of differential relay is

$$I_1 - I_2 \geq 0.1$$

During Normal Condition:

Input and output current measured by the current sensor 1 and 2 are respectively approximate 0.39A & 0.38A.

$$I_1 = 0.39A, I_2 = 0.38A$$

$$I_1 - I_2 = 0.01A, \text{ that is less than } 0.1$$

During Fault Condition:

Input current is 0.39A but for the fault second load is ON due to which output current is 0.01 Amp.

$$I_1 = 0.39A, I_2 = 0.01A$$

$$I_1 - I_2 = 0.38A \text{ that is greater than } 0.1$$

In this work, there are two ways to show the occurrence of fault:

- a) LCD displays "Fault Occurred".
- b) Buzzer starts beeping

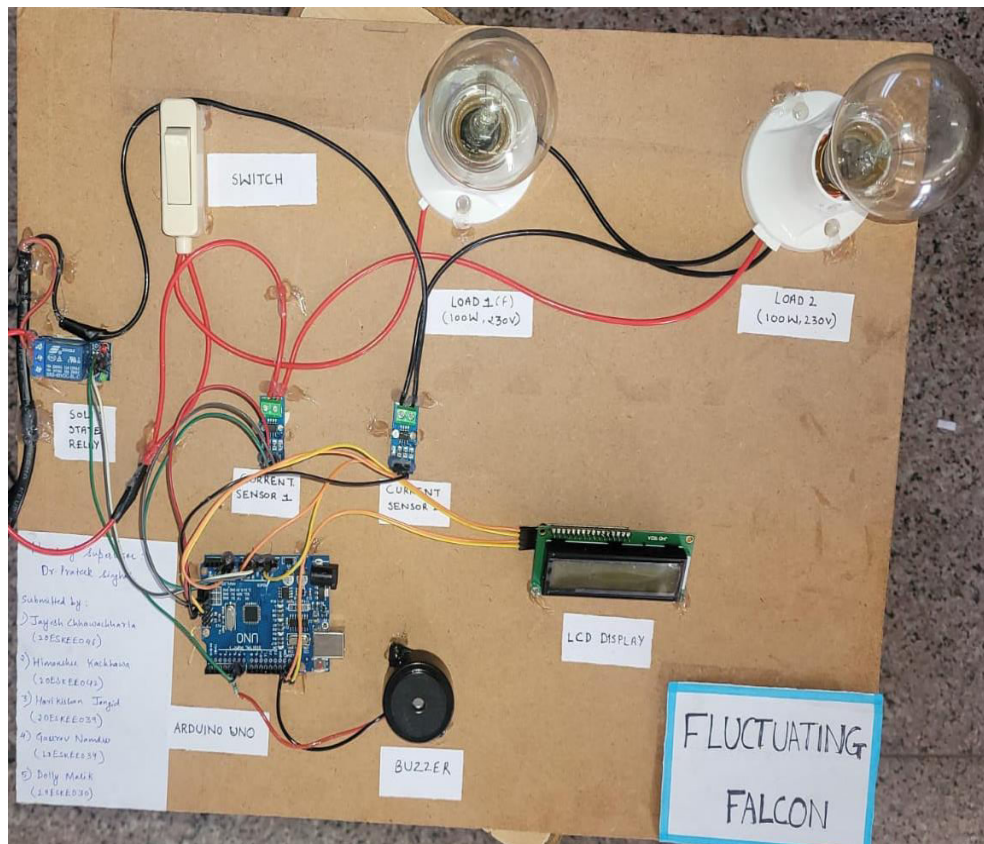


Fig 2 : Hardware Circuit of Differential Relay

Software Implementation

The programme is implemented through the Software Arduino IDE on Arduino UNO [10].

Procedural Steps:

- We are including Liquid crystal library.
- Output of current sensors are stored in Arduino at analog pins.
- Lcd pins are connected at digital pins of Arduino.
- Solid state relay (Mechanical switch) connected at digital pin of Arduino .
- Buzzer is connected at digital pin of Arduino for the alert during fault.

The programming logic developed for the Arduino microcontroller. Code snippets and algorithms are provided to elucidate the implementation of differential relay functions, fault detection algorithms, and relay control routines.

Effect of Integration during Testing

The integration of hardware and software components is performed, followed by rigorous testing to validate the functionality and performance of the relay system.

During the tests some key points comes into picture are as follows:

- This protection system is highly sensitive.
- Response time of relay during fault is decreased, and thereby, relay becomes faster so that faulty equipment is isolated Fastly
- Due to the fast isolation overall life of equipment increases.
- Cost of this protection scheme is less than convention scheme.
- Due to the reprogramming feature, device is flexible for the use in various applications.

V. CONCLUSION AND FUTURE WORK

The key findings of this work is that with the integration of microcontroller devices such as Arduino in the current differential protection system, the overall efficiency of the differential relay is increased, and thus making it more efficient, reliable, accurate and faster for various applications of power system protection system.

In near future, this advance protection relay could be utilized for more applications into the power system for higher ratings with some more inclusion in design and technology.

REFERENCES

1. Abbasi, S. A., & Abbasi, S. A. (2018). A review of the application of Arduino microcontroller systems in electrical engineering education. *IEEE Access*, 6, 54544-54552.
2. Al-Kandari, A. M., & Al-Awami, A. T. (2017). Design and implementation of microcontroller-based differential protection for power transformer using Arduino. *International Journal of Electrical Power & Energy Systems*, 92, 73-80.
3. Bhatt, A., & Sharma, R. (2020). Real-time implementation of differential protection for power transformers using Arduino. *Journal of Electrical Systems and Information Technology*, 7(1), 115.
4. Khan, F. A., Siddiqui, S. A., Alkahtani, M. H., & Abdel-Magid, Y. L. (2019). Implementation of differential relay for power transformer protection using Arduino Uno. *International Journal of Electrical Power & Energy Systems*, 106, 37-43.
5. Kumar, V., & Yadav, S. (2016). Design and implementation of differential protection for power transformers using Arduino Uno. *International Journal of Electrical Engineering and Computer Science*, 1(1), 14-19.
6. Prasanna, B. N., & Chauhan, S. (2018). Real-time implementation of differential protection for power transformers using Arduino Uno. In *2018 International Conference on Power, Instrumentation, Control and Computing (PICCC)* (pp. 1-6). IEEE.
7. Ramasamy, G., & Karthikeyan, P. (2017). Design and implementation of differential protection for power transformer using Arduino. *International Journal of Innovative Research in Science, Engineering and Technology*, 6(6), 11279-11285.
8. Sanjay, M., & Reddy, B. C. (2019). Implementation of differential protection for power transformer using Arduino. *International Journal of Engineering and Advanced Technology (IJEAT)*, 8(6), 748-753.
9. Singh, A., & Kumar, A. (2018). Real-time implementation of microcontroller-based differential protection for power transformer using Arduino. In *2018 International Conference on Sustainable Energy, Electronics, and coMputing System (SEEMS)* (pp. 1-5). IEEE.
10. Subramanian, S., & Srinivasan, S. (2016). Design and implementation of differential protection for power transformers using Arduino Uno. *International Journal of Research in Engineering and Technology*, 5(2), 132-136.



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details