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System To Check Healthiness Of Earthing System And Generate Alert Messages

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Abstract - The project focuses on creating a smart fault detection system for earthing pits in electrical setups. Earthing systems are vital for safely directing fault currents into the ground, protecting equipment and people. Our system uses sensors like Hall Effect sensors to monitor current flow in real time. When a fault is detected, it automatically isolates the faulty part using relays or breakers to prevent damage. It also identifies the fault source using diagnostic algorithms and machine learning. This helps improve safety, reduce downtime, and make electrical systems more reliable and efficient.

Key Words: ACS 712 Current Sensor , Earthing ,Grounding

1. INTRODUCTION

This is a safety-focused project designed to continuously monitor the flow of electric current in multiple electrical devices and the grounding line. It makes use of ACS712 current sensors to detect the amount of current flowing through different parts of a circuit. These readings are displayed in real-time on an I2C LCD display.

The primary objective of this system is to detect current leakage or faults that may occur in any connected equipment or the grounding system. In the event of an abnormal current detected in the ground line, the system identifies the faulty equipment and automatically disconnects the power supply using a relay, preventing potential damage, fire hazards, or electric shocks. A clear fault message is displayed on the screen to alert the user.

This system is simple, cost-effective, and ideal for applications in homes, laboratories, workshops, and small industries, where electrical safety and early fault detection are crucial.

2. EARTHING

In a country like India, where both rural and urban populations depend heavily on electricity for everything from agriculture to industry to home appliances, electrical safety is not a luxury, it's a necessity. One of the most critical but often overlooked aspects of electrical safety is earthing, also known as grounding. Simply put, earthing is the process of safely directing any stray or fault current into the Earth to protect people and equipment from electric shocks and damage.

While "grounding" is more commonly used in Western countries, especially in the United States, "earthing" is the term widely used in India. Though the terminology may differ, the principle remains the same: ensuring that excess electrical energy doesn't endanger lives or infrastructure.

India faces unique challenges that make earthing particularly important:

Unstable power supply in many regions, leading to frequent voltage fluctuations.

Lightning-prone areas, especially during monsoon season.

Widespread use of diesel generators and inverters, which increases the risk of improper grounding.

Rural electrification projects that often lack rigorous safety compliance.

3. FAULT DETECTION IN EARTHING SYSTEMS

In any electrical system, especially within the Indian environment of mixed infrastructure quality and diverse power sources, fault detection plays a crucial role in ensuring safety and continuity. Even the best earthing setup can fail over time due to corrosion, soil degradation, or physical damage. Without an effective mechanism for detecting such faults, the consequences can be severe—ranging from fatal electric shocks to fires and equipment failure.

Importance Of Fault Detection In India

Aging infrastructure: Many buildings, especially in urban centers like Delhi, Mumbai, and Kolkata, still operate with outdated wiring and no regular earthing inspection.

Rural installations: Low-cost setups in villages may not follow earthing standards, and faults often go unnoticed until an accident happens.

Environmental conditions: Monsoon rains, floods, and extreme heat can alter soil conditions and affect the integrity of grounding electrodes.

4. DATA

Hazard Type	Data/Statistics	Source/Remarks
Electrocution Fatalities	~12,500 deaths/year (34/day)	NCRB data (via WION News)
	236 deaths in Kerala (2021–22), 133 on consumer premises	Kerala Electrical Inspectorate (The Hindu)
	2,539 deaths in Karnataka over 5 years	The Hindu
Fire Accidents	85% of electrical fires in Goa linked to faulty wiring and earthing	Times of India
	~25,000 fire-related deaths annually in India, many due to electrical faults	Times of India
Equipment Damage	Voltage surges from poor earthing damage sensitive electronics	Electrical India Journal
Industrial Accidents	56% of industrial disasters from electrical faults; 8% of industrial	The Hindu

5. THEORITICAL ANALYSIS

This project focuses on detecting electrical leakage and ensuring safety through current sensing. It uses ACS712 Hall-effect-based current sensors to monitor the current in two equipment lines and the ground line. Normally, the current flowing through the live and neutral wires should be balanced, but a leakage to the ground due to insulation failure or a short-circuit increases the current in the ground path. The Arduino processes the analog data from the sensors, converting it into real-time current values. If the ground current exceeds a predefined threshold (e.g., 0.5A), the system checks the equipment lines to identify the faulty one. Upon detecting a fault, the system triggers a relay to cut off power, protecting against risks like electric shock, fire, or equipment damage. A 20x4 LCD display provides immediate feedback, showing current readings for all three lines and fault messages. The system filters out small currents below 0.09A to minimize noise. Essentially, this project acts as a miniature Earth Leakage Circuit Breaker (ELCB), enhancing safety in electrical installations by quickly detecting and addressing leakage issues.

6. COMPONENTS

1.Relay Module: A relay module is a key component used to control high-voltage devices with low-voltage signals. It acts as a switch that connects a low-power control system (like a microcontroller) to high-power devices such as motors or lights. By using either an electromagnetic mechanism or a solid-state design, relays ensure safe operation by isolating sensitive electronics from high current. They are commonly found in home automation, industrial machines, and robotics due to their versatility and reliability.

2. ACS712 Current Sensor: The ACS712 is a popular current sensor that measures both AC and DC currents with high precision. It uses Hall Effect technology to detect the magnetic field generated by current flow and converts it into a proportional voltage. This module is low power, highly accurate, and can easily interface with microcontrollers. Its built-in isolation ensures safety, making it ideal for measuring electrical currents in various applications, from battery-powered devices to larger systems.

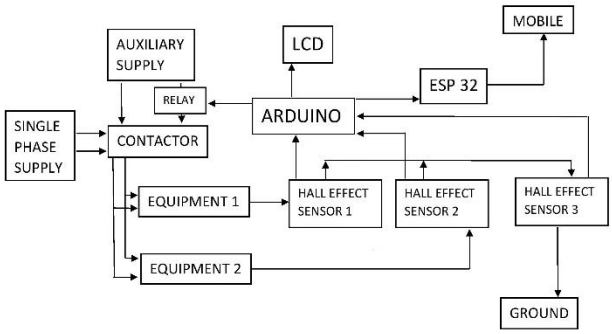
3. Arduino UNO R3: The Arduino UNO R3 is a versatile and beginner-friendly microcontroller board, widely used for prototyping and educational purposes. It features a microcontroller (ATmega328P) that processes inputs and controls outputs, with 14 digital pins and 6 analog input pins. Powered via USB or an external source, it can be programmed through a simple interface, making it ideal for projects ranging from robotics to IoT applications. Its open-source nature allows for easy customization and modification.

4.Single-Phase Contactor: A single-phase contactor is an electromagnetic switch used to control high-power electrical devices like motors, pumps, and lights. When energized, it creates a magnetic field that closes the circuit, allowing electricity to flow. Unlike smaller relays, contactors can handle higher loads and are typically used in circuits requiring more power. They are essential for safety and reliability in various industrial and household applications, such as heating and ventilation systems.

5.LCD 20x4: A 20x4 LCD is an electronic display module capable of showing 80 characters (20 characters across 4 rows). Commonly used in projects to display information, it features a clear 5x8 dot matrix character format. Many models come with a backlight for visibility in low-light conditions, and they often use parallel interfaces (4-bit or 8-bit), though I2C and SPI options are also available. These displays are widely used in electronics for providing user feedback in projects, such as showing sensor data or system status

6. The ESP32: Developed by Espressif Systems, is a cost-effective and energy-efficient microcontroller widely used as a Wi-Fi module in embedded systems and IoT applications. Featuring integrated Wi-Fi and Bluetooth capabilities, it enables wireless connectivity in compact and low-power designs. Its dual-core Tensilica LX6 processor, operating up to 240 MHz, along with built-in peripherals such as ADCs, DACs, and communication interfaces, allows it to handle both control and communication tasks efficiently. What sets the ESP32 apart is its ease of integration with platforms like the Arduino IDE, strong community support, and adaptability, making it a popular choice for wireless data transmission in smart devices and automation projects.

7. BLOCK DIAGRAM AND EXPLANATION



The system operates on a single-phase power supply that powers the entire setup. This main supply is routed through a contactor, which distributes power to two separate equipment units — Equipment 1 and Equipment 2 — connected in parallel. Alongside this, there is a separate auxiliary power supply dedicated to powering a relay. This relay is under the control of an Arduino and plays a crucial role in system protection. It energizes or de-energizes the contactor depending on whether a fault is detected.

Each piece of equipment is monitored individually for safety using Hall Effect current sensors. Sensor 1 is connected to Equipment 1, and Sensor 2 to Equipment 2, both placed on their respective ground lines. Additionally, Sensor 3 is installed at the common grounding point to keep an eye on the overall ground current.

The Arduino continuously reads the current values from all three sensors. If any of them detect a ground current that exceeds a predefined safety threshold, the Arduino interprets it as a ground fault. When a fault is detected, the LCD display shows which equipment is experiencing the issue. Simultaneously, an ESP32 module connected to the Arduino sends a real-time Telegram alert to the user's mobile phone.

To protect the system, the Arduino promptly deactivates the relay in case of a fault, which in turn cuts power via the contactor, ensuring that the faulty equipment is safely shut down. This setup ensures continuous monitoring and fast response to any potential earthing issues, enhancing safety and reliability.

8. SIMULATION

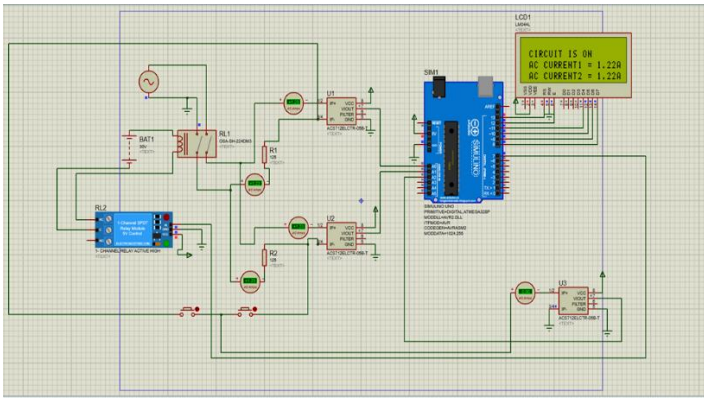


Figure 1 : Turning ON Circuit

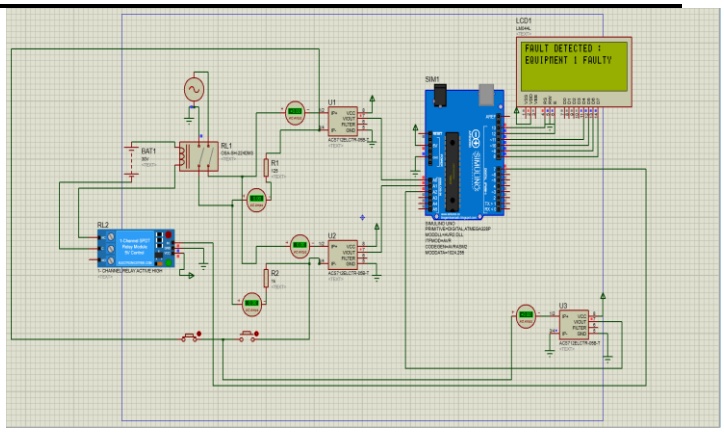


Figure 2 : Fault Occurred at Equipment 1

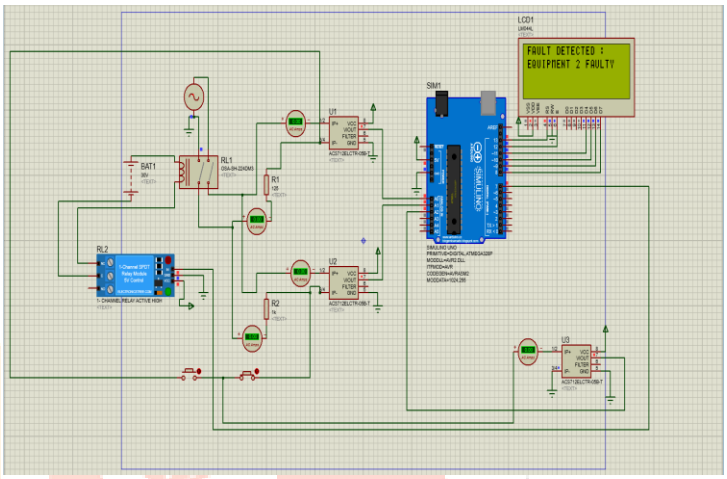


Figure 3 : Fault Occurred at Equipment 2

9. RESULTS

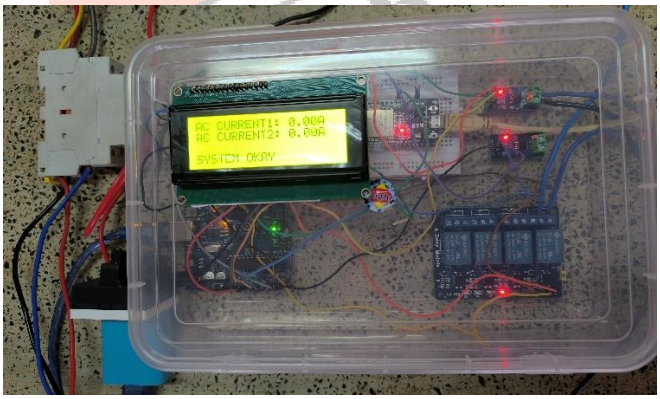


Figure 4 : Circuit Turned On

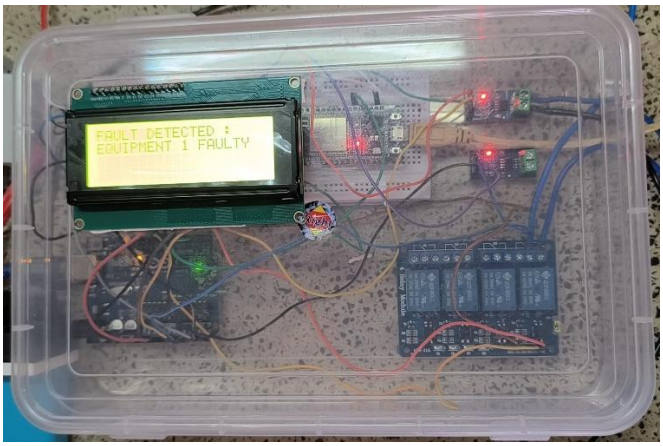


Figure 5 : Fault Occurred at Equipment 1

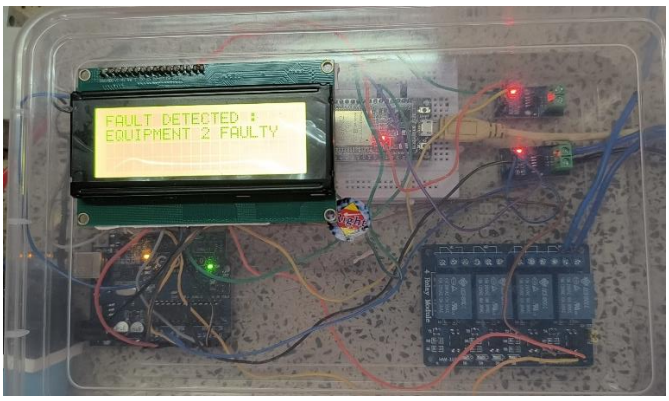


Figure 6 : Fault Occurred at Equipment 2

Figure 7 : Messages Received On Telegram

10. OBSERVATIONS

During the implementation of this current leakage detection system, it was observed that even small, unintended leakages to the ground could be effectively identified using ACS712 current sensors. The sensors provided reasonably accurate real-time readings when calibrated properly, allowing us to distinguish between normal operating currents and leakage faults. The integration of a relay proved to be a reliable method for immediate disconnection of the power supply during fault conditions, ensuring safety. Additionally, the LCD display offered a clear, user-friendly interface to monitor system status and fault alerts. While testing, it became evident that proper grounding, noise filtering, and correction factors are crucial for the accurate detection of faults. Overall, the project not only worked as expected but also demonstrated how affordable components can be combined to create a practical and responsive safety system for electrical setups.

11. CONCLUSIONS

The project on detecting fault current in an earthing pit, combined with automatic system shutdown and fault identification, offers a smart and practical approach to electrical safety. By monitoring the system in real-time and immediately isolating faulty sections, it helps prevent fires, equipment damage, and other serious risks. What makes it especially effective is its ability to identify exactly where the fault occurred—making repairs faster and more efficient. Overall, this kind of proactive system improves safety, reduces downtime, and keeps operations running smoothly.

12. REFERENCES

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