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UNDERGROUND CABLE FAULT DETECTION

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ABSTRACT

Industrial synchronous motors have a constant speed drive. It is favored over the alternative because of its durability and large load capacity.c. motors for operations at a steady pace. Due to a number of issues and challenges, the synchronous motor's speed regulation has not been developed until recently in the industrial sector. This project focuses on controlling the motor's speed by altering the stator's supply frequency. Three phase MOSFET bridge inverters are used to acquire three phase supply voltage. By using a diode bridge circuit to correct the ac voltage that is accessible from the ac mains, MOSFET bridges are provided with a set dc voltage. A shunt capacitor filter is employed.

circuit for control. The control circuit provides the gating pulses needed to activate the MOSFET. The output frequency of the MOSFET Bridge may be regulated by adjusting the gating pulse frequency. Variations in the gating signal frequency also affect the output frequency of the MOSFET bridge. As a result, the output has a variable frequency. Because gating signals from controller ports are so weak, they cannot be applied directly to MOSFET bridges. Thus, a driving circuit and isolator are employed. Opto Isolator is used to achieve the necessary separation of the low power control circuit from the high power bridge.

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I. INTRODUCTION

I.1. Overview

Up until the last few decades, cables were designed to be installed overhead; today, they are installed underground, which is an improvement over the previous technique. Because unfavorable weather conditions including storms, snow, heavy rainfall, and pollutants have no effect on subterranean cables. However, it is challenging to identify any cable defects. Thus, we shall proceed to pinpoint the precise fault site. The project's goal is to locate faults digitally as the world has gotten more digitalized. In many urban locations, the subterranean cable system is more widely used. When a problem arises for any reason, fixing that specific wire becomes challenging since not

Fault in cable is represented as:

- Any defect,
- Inconsistency,
- Weakness or non-homogeneity that affect performance of cable.
- Current is diverted from the intended path
- Caused by breaking of conductor& failure of insulation

Importance of Fault Detection: Underground cables play a crucial role in modern power distribution networks, particularly in urban and densely populated areas where overhead transmission lines pose significant risks. Fault detection in these cables is essential to ensure reliable power supply, reduce downtime, and minimize repair costs. Accurate fault detection can significantly improve the maintenance process and system reliability.

I.2. Objective

This paper goal is to measure the underground cable fault's distance in kilometers from the base station. When a fault arises for any reason, it might be challenging to repair that specific cable since the precise position of the issue is unknown. The goal of the suggested approach is to pinpoint the precise fault site. The project makes advantage of the well-known idea of Ohm's law, which states that current will fluctuate based on the position of a cable defect when a low DC voltage is supplied at the feeder end across a cable line. The voltage across series resistors varies in the event of a short circuit (Line to Ground), which is then passed to an internal

kilometers.

- To develop a system that detects the exact location of faults in underground cables.
- To utilize a microcontroller-based approach for fault detection.
- To enhance the reliability and efficiency of power distribution networks.
- To provide a low-cost and robust solution for underground cable fault detection.

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II. LITERATURE SURVEY

For the real worldwide operated voltage distribution lines underground cables have been used from many years. In order to reduce the sensitivity of distribution networks to environmental influences underground voltage cables are highly used. Underground cables have been widely used in power distribution networks due to the advantages of underground connection, more enhanced security than overhead lines in adverse weather condition, less liable to damage by storms or lightning. It is less costly for larger distance, eco- friendly and low maintenance cost. But if any fault occur in cable, then it is difficult to its type. So this system is use to detect the location and type of fault in digital way. The requirement of locating the faulty point in an underground cable in order is to facilitate quicker repair, improve the system reliability and reduced outage period.

Underground cables have been widely used in power distribution networks due to their advantages, including enhanced security, lower maintenance costs, and reduced susceptibility to environmental influences. The main challenge with underground cables is fault detection, which is crucial for timely repairs and system reliability. Various methods have been proposed and implemented over the years to address this issue.

enhanced functionality.

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III. METHODOLOGY

a. Overview

This paper primary goal is to calculate the underground cable fault's distance in kilometers from the base station. Cable faults are a frequent issue in many metropolitan locations. It is quite challenging to track a defect when it happens for any cause without knowing the position of that specific wire. The suggested approach is intended to track the precise position of the cable failure.
The main idea behind this research is to calculate the kilometers that separate an underground cable defect from the base station. A microprocessor is used in the suggested system to calculate the defect distance based on variations in resistance caused by the problem.
The resistance and current flow in an underground cable are changed when a fault arises. Ohm's Law may be used to locate the defect by supplying a low DC voltage at the feeder end and measuring the current that results. The power supply, cable simulation model, fault detection circuitry, microprocessor, and display unit are some of the system's essential parts.

b. Explanation

While fault occurs for some reason, at that time the repairing process related to that particular cable is difficult due to not knowing the exact location of cable fault.
When a fault occurs in an underground cable, it alters the current flow and resistance in the cable. By applying a low DC voltage at the feeder end and measuring the resulting current, the fault location can be determined using Ohm’s Law. The system consists of several key components

- DC Power Supply: Provides a stable voltage to the system.
- Cable Part: Represented by a series of resistors and switches that simulate faults at various locations
- Controlling Part: Includes an analog-to-digital converter (ADC) and a microcontroller that processes the input signals and calculates the fault distance.
- Display Part : Displays the fault distance on an LCD screen.

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BLOCK DIAGRAM:

The paper uses the simple concept of OHMs law where a low DC voltage is applied at the feeder end through a series resistor. The current would vary depending upon the length of fault of the cable in case there is a short circuit of LL or 3L or LG etc.

The series resistor voltage drop changes accordingly which is then fed to an ADC to develop precise digital data which the programmed microcontroller would display the same in Kilo meters. The project is assembled with a set of resistors representing c able length in KMs and fault creation is made by a set of switches at every known KM to cross check the accuracy of the same.This is proposed model of underground cable fault distance locator using microcontroller. It is classified in four parts –DC power supply part, cable part, controlling part, display part.

DC power supply part consist of ac supply of 230v is step down using transformer, bridge rectifier converts ac signal to dc & regulator is used to produce constant dc voltage.

The cable part is denoted by set of resistors along with switches Current sensing part of cable represented as set of resistors &switches are used as fault creators to indicate the fault at each location. This part senses the change in current by sensing the voltage drop.

Next is controlling part which consist of analog to digital convertor which receives input from the current sensing circuit, converts this voltage into digital signal and feeds the microcontroller with the signal.The microcontroller also forms part of the controlling unit and makes necessary calculations regarding the distance of the fault.

The display part consists of the LCD display interfaced to the microcontroller which shows the status of the cable of each phase and the distance of the cable at the particular phase, in case of any fault.

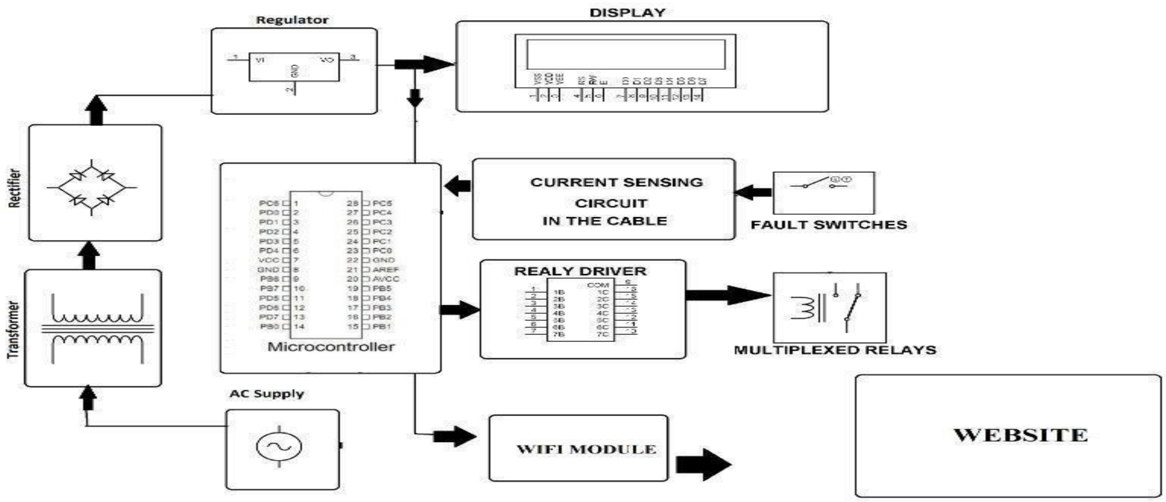

Fig.1 – Block Diagram

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The circuit consists of a power supply, 4 line display, arduino and resistance measurement circuit. To induce faults manually in the kit, fault switches are used. About 12 fault switches are used which are arranged in three rows with each row having 4 switches. The 3 rows represent the 3 phases namely R, Y and B. The fault switches have 2 positions-No fault position(NF) and fault position(F).Main component of the underground cable fault detection circuit is low value resistance measurement. It is constructed using a constant current source of 100mAmps. It can measure very low value resistance as the cables have around 0.01 Ohm/meter resistance. For 10meter cable resistance becomes 0.1 Ohm. This circuit can measure resistance up 50 Ohm, Maximum cable length it can check up to 4 kilometres. So starting from the reference point 3 sets of resistances is placed in series. These 3 sets of resistances represent the three phases

c. Hardware Requirements

- Transformer
- Relay
- LCD
- Rectifier
- Crystal Oscillator
- Resistors
- Capacitor
- LEDs
- Slide Switches
- ATMEGA328

Transformer

The step-down converters are used for converting the high voltage into low voltage. The converter with output voltage less than the input voltage is called as a step-down converter, and the converter with output voltage greater than the input voltage is called as step-up converter. There are step-up and step-down transformers which are used to step up or step down the voltage levels. 230V AC is converted into 12V AC using a step-down transformer. 12V output of stepdown transformer is an RMS value and its peak value is given by the product of square root of two with RMS value, which is approximately 17V.

Fig.2 – Transformer

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RELAY

Relay is sensing device which senses the fault &send a trip signal to circuit breaker to isolate the faulty section. A relay is automatic device by means of which an electrical circuit is indirectly controlled &is governed by change in the same or another electrical circuit. There are various types of relay: Numerical relay, Static relay & electromagnetic relay. Relay are housed in panel in the control room.

Rectifier

A rectifier is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction.
The process is known as rectification, since it "straightens" the direction of current. Physically, rectifiers take a number of forms, including vacuum tube diodes, mercury-arc valves, stacks of copper and selenium oxide plates, semiconductor diodes, silicon-controlled rectifiers and other silicon-based semiconductor switches. Historically, even synchronous electromechanical switches and motors have been used. Early radio receivers, called crystal radios, used a "cat's whisker" of fine wire pressing on a crystal of galena (lead sulfide) to serve as a point-contact.

Crystal oscillator

A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a precise frequency. This frequency is often used to keep track of time, as in quartz wristwatches, to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters and receivers. The most common type of piezoelectric resonator used is the quartz crystal, so oscillator circuits incorporating them became known as crystal oscillators, but other piezoelectric

Fig.3- Crystal oscillator

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Resistors

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. High-power resistors that can dissipate many watts of electrical power as heat, may be used as part of motor controls, in power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity.
indicated on the component.

Capacitor

A capacitor is a device that stores electrical energy in an electric field. It is a passive electronic component with two terminals.
The effect of a capacitor is known as capacitance. While some capacitance exists between any two electrical conductors in proximity in a circuit, a capacitor is a component designed to add capacitance to a circuit. The capacitor was originally known as a condenser or condensator. This name and its cognates are still widely used in many languages, but rarely in English, one notable exception being condenser microphones, also called capacitor microphones.

The physical form and construction of practical capacitors vary widely and many types of capacitor are in common use. Most capacitors contain at least two electrical conductors often in the form of metallic plates or surfaces separated by a dielectric medium. A conductor may be a foil, thin film, sintered bead of metal, or an electrolyte. The non-conducting dielectric acts to increase the capacitor's charge capacity. Materials commonly used as dielectrics include glass, ceramic, plastic film, paper, mica, air, and oxide layers.
Capacitors are widely used as parts of electrical circuits in many common electrical devices. Unlike a resistor, an ideal capacitor does not dissipate energy, although real-life capacitors do dissipate a small amount. (See Non-ideal behavior) When an electric potential, a voltage, is applied across the terminals of a capacitor, for example when a capacitor is connected across a

battery, an electric field develops across the dielectric, causing a net positive charge to collect on one plate and net negative charge to collect on the other plate.

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IV. PROPOSED SYSTEM

Finding the precise location of a problem from the base station itself is the focus of an underground cable fault detector. The fault's precise location is determined using the suggested system. The traditional idea of Ohm's law is used in this study, i.e. Depending on where the cable defect is located, the current will change as soon as a low DC voltage is provided at the feeder end through a series resistor. There is some resistance in cables. The resistance is the primary emphasis. Depending on the cable's length, resistance may change. The resistance value will rise in tandem with the cable's length. Should

Any variation in the resistance value will be referred to as a failure spot, and Arduino technology will be used to locate it. The fault point represents the standard distance (kilometers) from the base station. This value is shown on the LCD display unit. Another feature is that a fault detection message, the position of the problem, and the distance in kilometers from the base station are all sent to the base station via GSM. When a cable malfunctions, the buzzer sounds a warning so that field staff may respond right away.

a. Working

Knowing the location and route of the direct concealed primary cable is crucial before trying to locate subterranean cable problems. It is even more crucial to know the precise path if the problem arises on the secondary connection. It makes sense to become proficient in cable locating and tracking before beginning the fault locating procedure since it is very difficult to locate a cable issue without knowing where the cable is Finding an underground cable and detecting faults are mostly dependent on the skill, knowledge and experience of that person. Although tracing of the cable can be an intricate job, it will very likely become even more complex as more underground plant is installed. It is just as important to understand how the equipment works.

Before attempting to find underground cable faults, it is essential to know the cable's route and direction. Fault tracking involves applying a low DC voltage at the feeder end and measuring the resulting current. The voltage drop across a series resistor changes according to the distance of the fault, which is then processed by the microcontroller to display the fault distance.

- Initial Setup: The power supply is connected, and the system is initialized.
- Fault Simulation: Faults are introduced in the cable simulation model using switches.
- Measurement and Calculation: The current sensor measures the resulting current, and the ADC converts the analog signal to digital data. The microcontroller processes the data and calculates the fault distance using Ohm’s Law.
- Result Display: The calculated fault distance is displayed on the LCD screen for easy interpretation.

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V. RESULT

The AT Mega 328 Microcontroller was therefore used to identify the underground cable defect from the feeder end in a kilometer. An individual resistor is linked between zones in order to measure the specific distance and position. A solid state relay is a sensing device that operates at a certain cable position. It notifies the microcontroller of the fault and shows the problem's distance on an LCD display. The ATmega328 microcontroller is successfully used in the study to pinpoint the precise location of defects in subterranean cables. An LCD panel shows the outcome of the system's measurement of the fault's distance from the feeder end. The correctness of the system is guaranteed by simulating malfunctions using switches and resistors.

a. Test Setup

A simulated underground cable model with known resistances and fault sites is part of the test setup. To confirm its accuracy and dependability, the system is put through a variety of tests. The test process is described in the phases that follow. • Initial Calibration: To guarantee precise readings, the system is calibrated using known resistance values. • Fault Introduction: Switches are used to introduce faults at various locations in the wire simulation model. • Measurement and Analysis: For every test scenario, the system determines the fault distance by measuring the resultant current.

b. Test Results

Using the ATmega328 microcontroller, the device effectively locates flaws in subterranean cables. An LCD panel shows the outcome of the system's measurement of the fault's distance from the feeder end. The correctness of the system is guaranteed by simulating malfunctions using switches and resistors. Important conclusions include. • Accuracy: Within a few meters of the actual fault location, the technology offers precise fault distance readings. • Reliability: The system routinely finds errors in a variety of test scenarios, proving its dependability. • Usability: The system is simple to use and comprehend because to its LCD display and intuitive interface.

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VI. CONCLUSION

In this work, we use the microcontroller ATmega328 to pinpoint the precise position of a short circuit problem in an underground wire from the feeder end in kilometers.In order to make defect detection and repair simple, we employ the basic idea of OHM's law. As a result, the AT Mega 16 Micro controller project on underground cable fault detection was completed. We have suggested an inexpensive way to improve subterranean cable problem detection. It is strong, safe, and energy-intensive. It may be applied to any kind of cable to prevent subterranean cable faults. The study effectively uses a microcontroller-based method to locate short circuit defects in subterranean cables. Using Ohm's Law offers a straightforward but efficient

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