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Adaptive and Smart Starter for 3 Phase Induction Motor

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Abstract : This project report show cases a protection system designed to safeguard induction motors against single phasing and excessive temperatures. For industries that heavily depend on motors, a failure of even one motor can severely disrupt production. Therefore, implementing a protection system that ensures the safety of industrial motors, pumps, lifts, etc. is of utmost importance.

Keywords :- GSM 900A, APR33A3 Voice recorder, DTMF decode, Microcontroller, Current Transformer (CT), potential transformer (PT), 16*2 LCD Display, Inductions motor.

1. INTRODUCTION :-

The three-phase induction motor is prone to various issues, which include but are not limited to under-voltage, over-voltage, excessive heat, single phasing, and phase reversal. When the supply voltage exceeds the rated voltage, the motor can become overheated. To prevent this fault, our project incorporates a variable resistance. When the supply voltage drops below the rated voltage, the resistance causes a higher voltage drop, thereby safeguarding the motor against damage.[1]
However, if the supply voltage becomes too low, the voltage drop across the resistance may not be adequate, resulting in the motor failing to start. In the case of a single-phase supply, the problem of single phasing occurs when the supply voltage falls below the rated voltage, leading to the motor once again failing to start.
In both large and small-scale industries, where small motors are commonly used, protection against input supply variations is necessary for induction motors. Small-scale industries may have budget constraints and cannot afford expensive protection for their drives, which would increase their capital costs. Hence, a cost-effective and space-efficient solution has been developed to protect the induction motor from issues such as imbalanced voltages, low voltage, high voltage, electrical shorts, and overheating through the implementation of protective measures.[8]

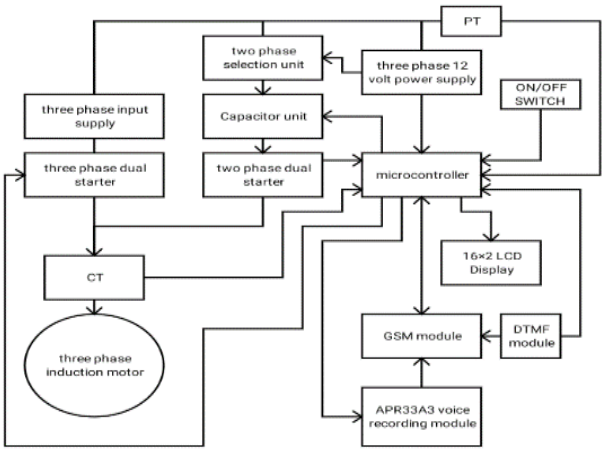
2. PROBLEM STATEMENT: -

Currently, a significant amount of research is being conducted on induction motors, particularly three-phase induction motors. However, in the event of single phasing, three-phase induction motors are unable to operate, resulting in various sectors being impacted by this problem. Single phasing is a common fault that can lead to motor damage or even burning.

It is remarkable to statement this issue to ensure efficient and uninterrupted motor operation. Researchers are exploring various solutions, including the use of advanced protection mechanisms to prevent single phasing and improve the overall reliability of induction motors.

By developing effective strategies to prevent single phasing and other common faults in induction motors, we can ensure their longevity and optimal performance. This would benefit various sectors that rely on these motors, including industrial, commercial, and residential applications.

3. BLOCK DIAGRAM: -



The block diagram above represents the components of the prototype. Each block or component has a different function in the system, and therefore every component should be explained separately in this report. The Three Phase Input Supply is generally a 440-volt, 50 Hz AC supply taken from the service mains. It is connected to the Three Phase DOL Starter, Two Phase Selection Unit, Three Phase 12 Volt Power Supply, and P.T. The Three Phase DOL Starter is used for protection and switching purposes, and provides overload protection to the three phase DOL system.[8]

The C.T. (Current Transformer) is used to measure current flowing through the system, as well as the two-phase system. The supply system's supply goes through the C.T. coil to the motor. The Three Phase Induction Motor is a device that converts three-phase AC supply (or electrical energy) into mechanical energy. It has a power rating of 1HP, 1400 rpm, 440volt, 50 Hz. The Two Phase Selection Unit is activated when a single-phasing fault occurs. It

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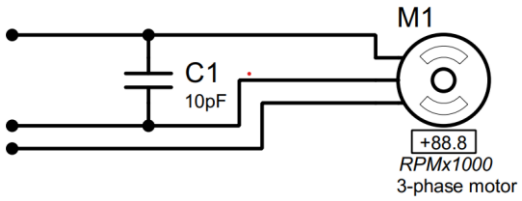
selects two healthy phases from the three-phase, three-wire system. [6]

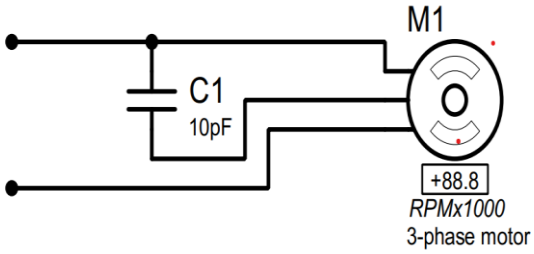
The Capacitor Unit is activated when two phases are available from the Two Phase Selection Unit. It converts the two-phase to three-phase using the capacitor split-phase method. The capacitors' value depends upon the input voltage. The Two Phase DOL Starter is a switching device with overload protection that has an input from the Capacitor Unit. The Three Phase 12-volt Power Supply uses a single-phase 0-12 volt transformer, 1 ampere, for each phase. A rectifier and filter circuit are used to obtain a pure DC supply for sensing and operating purposes.

The Microcontroller is the most important device in the system, used for controlling the system. The system uses an 'ATMEGA 2560' AVR-based microcontroller, which has 100 pins. The GSM Module (Global System for Mobile Communication) connects the system to the internet, calling, and SMS purposes. The system uses a GSM module 'SIM 900A.' The Voice Recording Module is an 8-channel device that can store audio for duration of 14 minutes. The system usesAPR333A3.'

4. METHODOLOGY:-



Three phase system

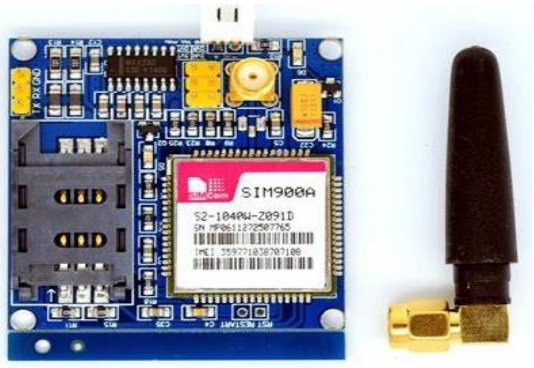


Two phase system

Converting a two-phase power supply to a three-phase power supply using a capacitor-split method is possible but not common. It involves using capacitors to create the necessary phase shift and generate a third phase. Determine the required capacitance: The required capacitance depends on the power rating and load characteristics of the connected equipment. Select capacitors: Choose capacitors that match the required capacitance value. It's important to use capacitors with suitable voltage ratings and appropriate power factor correction capabilities to ensure safe and reliable operation.

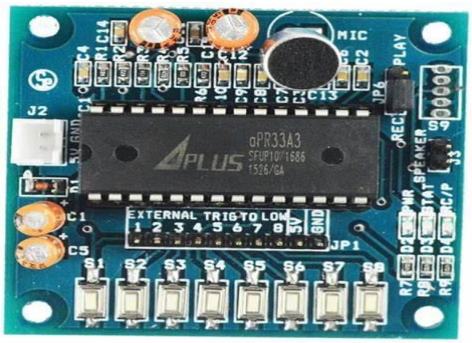
5. HARDWARE:-

5.1. GSM 900A:-



This wireless module is highly compact and dependable. It is the SIM900A, a SMT module that offers a complete Dual-band GSM/GPRS solution and can be incorporated in customer applications. The SIM900A boasts an industry-standard interface and provides GSM/GPRS 900/1800MHz performance for voice, SMS, and C. [7]

5.2. DTMF decode:-



Prior to the introduction of Dual-tone multi-frequency (DTMF) signaling, telephone numbers were dialed by users using a signaling method known as loop-disconnect (LD) signaling or pulse dialing (dial pulse, DP) in the United States. This technique involved interrupting the current in the local loop between the telephone exchange and the caller's telephone at a specific rate using a switch in the telephone. The switch was operated by the rotary dial as it returned to its resting position after each desired number was selected.However, this method had limitations in terms of its range due to electrical distortions, and it only worked on direct metallic links between the endpoints of a line. In contrast, operators utilized an earlier form of multi-frequency signaling that could transmit signals over longer distances.[5]

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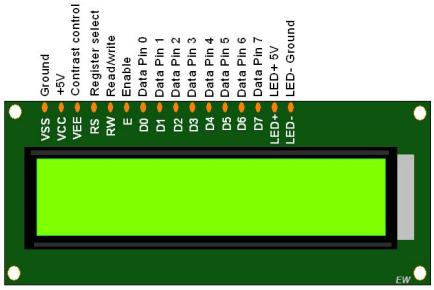
5.3. APR33A3 Voice recorder:-

In this conference, we will determine the APR33A3 Voice Record & Playback Module and its integration with a microcontroller. The APR33A3 is an 8-Channel Voice Record & Audio Playback Board that utilizes the APR33A series IC. This IC is a robust audio processor featuring high-performance analog-to-digital converters (ADCs) and digital-to-analog converters (DACs). Our main focus will be on the practical utilization of this module, including the process of recording audio and playing it back. Furthermore, we will demonstrate how to create projects with audio capabilities using a microcontroller. The module offers versatile applications such as an Audio Notification System for Accident Detection, a Namaste Greeting Robot utilizing PIR Sensor Technology, doorbells, Voice-Controlled Robots, Robotic machines, railway public address systems, and automated telephonic response devices. By the end of this seminar, you will ensure a comprehensive understanding of how to interface the APR33A3 Voice Record & Playback Module with a microcontroller and develop projects that incorporate audio functionality.[5]

5.4.16*2 LCD Display:-



The 16x2 LCD display gets its name from that it has 16 columns and 2 rows. While there are different size options available, like 8x1, 8x2, 10x2, 16x1, etc., the 16x2 configuration is the most commonly used. This particular configuration allows for a total of 32 characters, with each character composed of 5x8 pixel dots. Below is an illustration of a single character displaying all its pixels. By knowing that each character consists of 40 pixels (5x8), we can calculate that there are a total of 1280 pixels for 32 characters.

In order to control the LCD module and instruct it about pixel positions, a microcontroller unit (MCU) is typically used. Understanding the functionality of the HD44780 IC is crucial for developing a custom library to interface the LCD module with a microcontroller. The HD44780 is an integrated circuit (IC) that serves as a character generator and controller. It enables the display of alphanumeric characters and symbols on an LCD screen.

The IC communicates with the microcontroller through a parallel interface, receiving commands and data for display control. These commands encompass instructions for setting the display mode, cursor position, character data, and more. The HD44780 IC incorporates a character generator ROM that stores the font patterns required to display characters on the LCD. Furthermore, it features a CGRAM (Character Generator RAM), which can store up to eight user-defined character patterns for displaying symbols or special characters.

To control the various functions of the LCD module, the IC utilizes several pins. These include the RS (Register Select) pin for selecting the instruction or data register, the RW (Read/Write) pin for choosing read or write operations, the E (Enable) pin for enabling data transfer, and the DB0-DB7 pins for actual data transfer and commands. Detailed information about these pins and their functionalities can be found in the HD44780 IC's datasheet

5.5. Microcontroller:-

A microcontroller is a small integrated circuit chip that consists of one or more central processing units (CPUs), programmable input/output peripherals, and memory. These chips are specifically designed for embedded applications, distinguishing them from the microprocessors used in general-purpose computing. Unlike system-on-a-chip (SoC) devices, microcontrollers are typically less advanced and do not integrate features like graphics processing units (GPUs) or Wi-Fi controllers. Microcontrollers find wide usage in products and devices that require automated control, such as automobile engine control systems, medical implants, remote controls, office equipment, appliances, power tools, toys, and other embedded systems. By combining multiple functions on a single chip, microcontrollers are cost-effective and compact, enabling digital control of various devices and processes. In the context of the internet of things (IoT), microcontrollers serve as popular and affordable means for data collection, sensing, and actuation as edge devices in

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the physical world. Some microcontrollers operate using four-bit words and low frequencies, like 4 kHz, to minimize power consumption. They often have the capability to remain functional while waiting for specific events, such as button presses or other interrupts.[4]

5.6. Capacitor unit:-

A capacitor is an electrical device created to store electric charges by collecting them on two adjacent surfaces separated by an insulating material. Its purpose is to accumulate electrical energy by gathering charges on closely positioned electrodes that are electrically isolated from each other. This passive component possesses two terminals and is commonly known for its effect called capacitance. While there is always some capacitance between close electrical conductors in a circuit, a capacitor is specifically designed to enhance capacitance in a circuit.

The electronic component formerly known as a condenser is now referred to as a capacitor in modern electronics terminology. However, certain compound terms still utilize the term condenser, such as the condenser microphone. Capacitors find widespread application in electronic circuits for various purposes, including energy storage, filtering, and decoupling. They are available in a variety of types and sizes, ranging from compact surface-mount devices to large electrolytic capacitors utilized in power supply circuits.[3]

5.7. Current Transformer (CT):-

A Current Transformer, commonly referred to as a CT, is a device utilized to measure the electrical current of another circuit. This technology has a widespread application, especially in monitoring high-voltage lines across national power grids globally. The fundamental aim of a CT (current transformer) is to produce an AC (alternating current) in its secondary coil that precisely mirrors the electric current being detected in its primary coil. This ensures accurate measurement and monitoring of the primary current.[6]

5.8. Potential transformer (P .T.):-

A conceivable "Transformer Model" (T.M.) is a device transformer employed for safeguarding and gauging tasks in power grids. Its fundamental purpose is to precisely gauge the elevated alternating voltage present in the power network.[6]

5.9. Inductions motor:-

An induction motor, excessively mentioned to as an asynchronous motor, is an AC electric motor that generates torque through electromagnetic induction from the magnetic field of the stator winding. It does not require any electrical connections to the rotor for its operation. The three-phase induction motor is an electromechanical device that converts three-phase electrical energy into mechanical power. Its components consist of a stationary stator and a rotating rotor. The stator comprises three-phase windings that generate a rotating magnetic field, thereby inducing current in the rotor. [3]

6.RESULT:-

Normal condition: - (3-phase system)

Supply side voltage	voltage	current
R-Y	230	0.9
Y-B	230	0.9
B-R	230	0.9

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Abnormal condition: - (2-phase system)

Supply side voltage	Motor side voltage	current
R-N-34	R-Y-376	R-0.9
Y-N-230	Y-B-371	Y-1.2
B-N-230	B-R-366	B-1.2

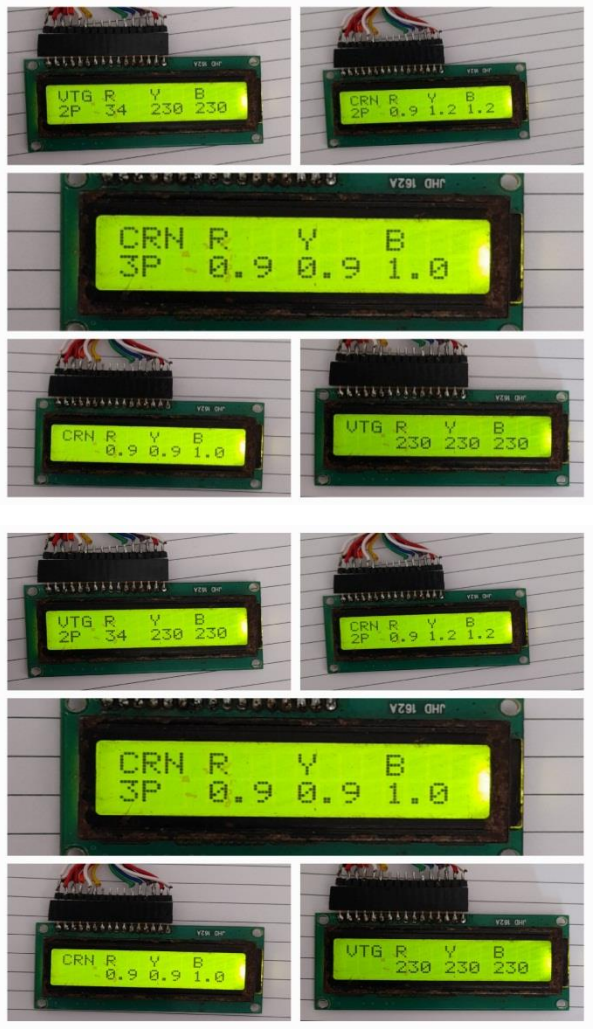
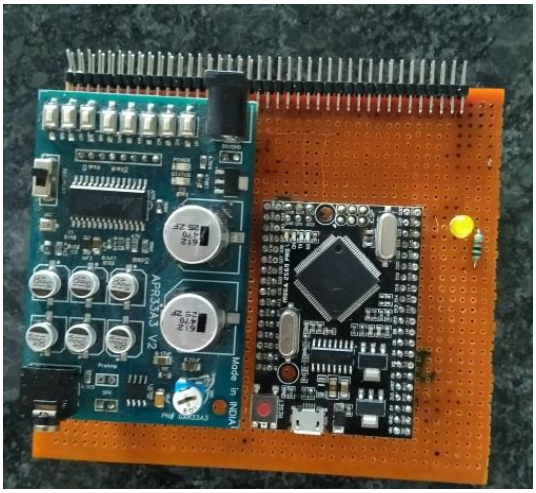


Fig. LCD normal condition and abnormal condition (3 phase and 2 phase system)



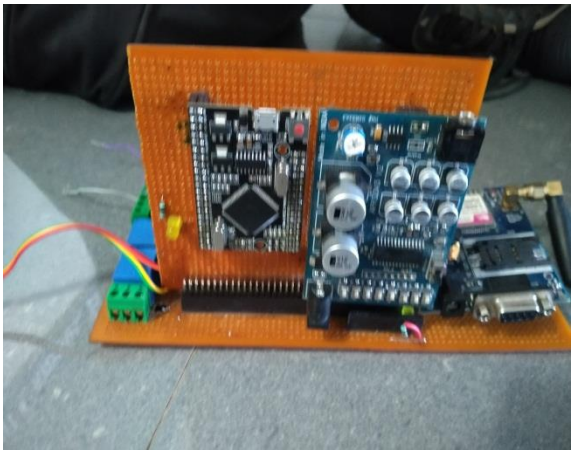


Fig.Circuit of Adaptive and Smart Starter for 3 Phase Induction Motor

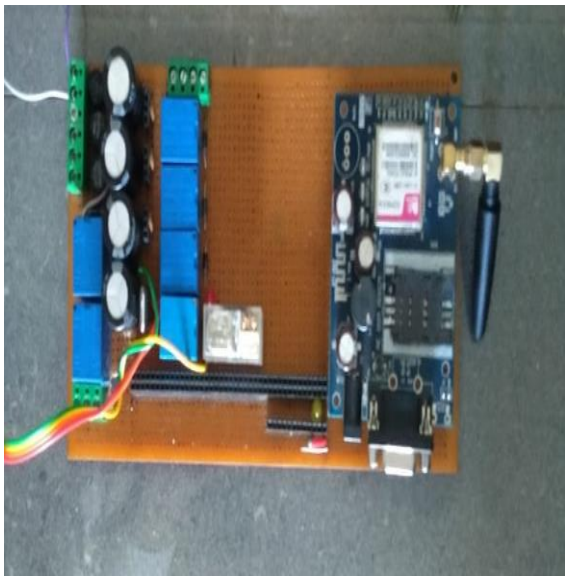


Fig.GSM Circuit

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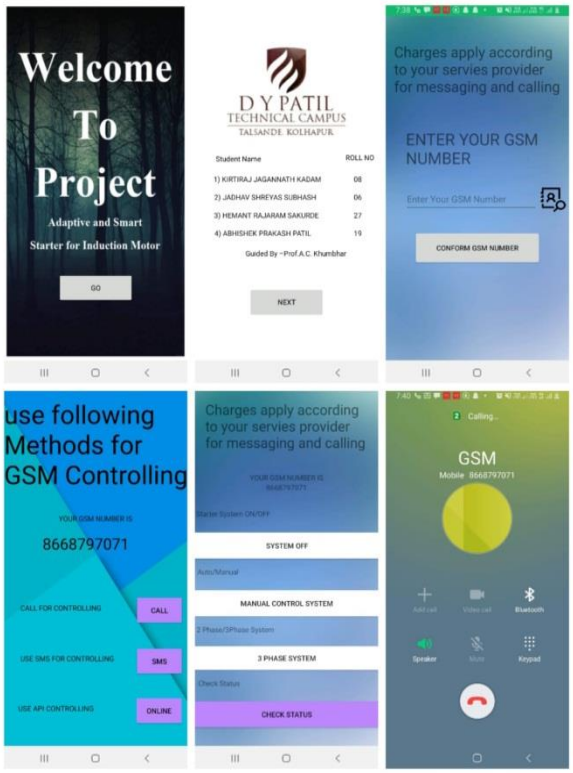
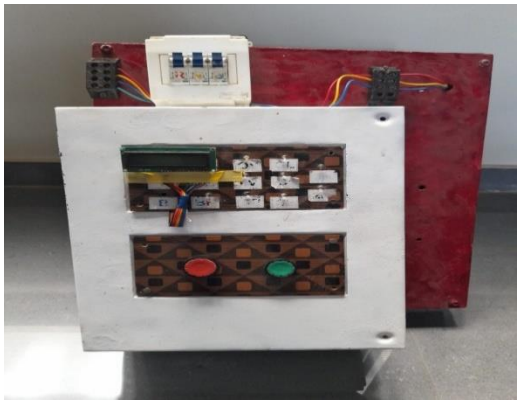


Fig.application of GSM

Fig.Noise graph induction motor



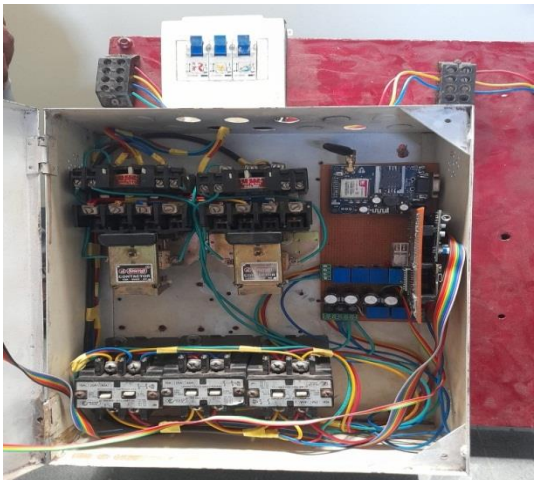


Fig.project images

7.CONCLUSION**:-**

This system is designed to allow the use of a motor on both two-phase and three-phase supply, ensuring smart operation and motor longevity. By recovering the phase and balancing the load between one selected phases converted to two phases, and converting another single phase, the motor can operate normally on three-phase supply.

The system provides protection for the motor on a single-phasing supply, operating smartly to prevent any damage and increase industry efficiency. Additionally, it reduces the risk of single-phasing faults, ensuring the motor's longevity and efficiency.

8.FUTURE SCOPE:-

In future we can advance monitoring system is used like cloud and recent technology developing also we can add this to replace GSM Module.

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