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# Fault Detection and Protection of Induction Motor by Using PLC and SCADA

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**A B S T R A C T**

The fault detection and protection of induction motors is an essential requirement in industrial applications to ensure reliable and efficient operation. In this research, we present a system designed and implemented to monitor and protect induction motors using PLC and SCADA. The system collects real-time data from sensors connected to the motor and analyses it to detect any faults or abnormalities. The Allen Bradley 1400 series B PLC is programmed to compare the motor's parameters to pre-set threshold values, and the SCADA system provides real-time alerts and visualization of the motor's performance. The system is tested and validated with simulated and real-world scenarios to ensure its effectiveness in detecting and protecting against motor faults. The results show that the system can significantly reduce downtime and production loss due to motor failure, making it a valuable tool for industrial applications. This research provides insights into the development and implementation of fault detection and protection systems for induction motors, contributing to the advancement of industrial automation technology.

**Keywords:** Fault detection, Induction motor, PLC, SCADA, Real-time monitoring, Industrial automation system, Sensors Downtime reduction .

## 1. INTRODUCTION

Induction motors are widely used in industrial applications due to their high reliability, efficiency, and low maintenance requirements. However, motor failures can result in production losses, downtime, and costly repairs. Therefore, it is essential to have a system that can monitor and protect the motors in real-time. Recent advances in automation technology have enabled the development of systems that can monitor and protect motors using PLC and SCADA systems. The Programmable Logic Controller (PLC) is a digital computer used for automation of industrial processes, while Supervisory Control and Data Acquisition (SCADA) systems are used for monitoring and controlling industrial processes. PLC and SCADA systems are commonly used in industrial automation to provide real-time monitoring and control of complex systems.

The purpose of this research is to present a system designed to monitor and protect induction motors using PLC and SCADA. The system collects real-time data from sensors connected to the motor and analyses it to detect any faults or abnormalities. The system is designed to take appropriate protection actions in case of any faults, thereby reducing downtime and production loss due to motor failure. The proposed system comprises of electrical and mechanical components such as Allen Bradley 1400 series B PLC, SCADA software (Wonderware InTouch), induction motor, temperature sensors (LM35), and current sensors. The PLC program is developed to collect data from the sensors and take appropriate actions in case of any faults or abnormalities. The SCADA system is configured to provide remote monitoring and visualization of the motor's performance and alerts.

The system is tested and validated with simulated and real-world scenarios to ensure its effectiveness in detecting and protecting against motor faults. The results show that the system can significantly reduce downtime and production loss due to motor failure, making it a valuable tool for industrial applications.

This research contributes to the advancement of fault detection and protection systems for induction motors, enabling improved motor reliability and efficiency. The proposed system can be implemented in various industrial applications, such as manufacturing, oil and gas, and power generation, to provide real-time monitoring and protection of induction motors. Overall, this research demonstrates the potential of automation technology in improving the reliability and efficiency of industrial processes.

## 2. LITERATURE SURVEY

Various fault detection and protection methods have been studied for induction motors, including the classical method with mechanical parts and computer- and PIC-based methods. More recently, there has been increased interest in using PLCs and SCADA systems for fault detection and protection in induction motors due to their accuracy, cost-effectiveness, and ability to provide a safe and visual environment for monitoring and controlling the motor's performance. Several studies have demonstrated the effectiveness of using PLCs and SCADA for fault detection and protection of induction motors. For example, a study by Al-Haddad et al.

(2010) used a PLC-based system to detect and protect induction motors from faults such as overvoltage, undervoltage, and overtemperature. The system was able to detect faults quickly and take appropriate protective actions, preventing motor damage and reducing downtime.

Another study by Gao et al. (2016) proposed a fault detection and diagnosis system using SCADA and wavelet analysis. The system was able to detect and diagnose faults in induction motors, such as rotor bar breakage, and provide real-time information to operators. This allowed for quick response and reduced downtime and maintenance costs.

In conclusion, the use of PLC and SCADA systems for fault detection and protection of induction motors has become increasingly popular due to their accuracy, real-time monitoring capabilities, and remote access. Several studies have shown their effectiveness in preventing motor damage, reducing downtime, and improving overall system efficiency.

## 3. SOFTWARES AND HARDWARE

COMPONENTS TO BE USED:

| SR NO. | NAME | PURPOSE |
|---|---|---|
| 1 | PLC (Allen Bradley Micro Logix 1400) | - |
| 2 | Software used<br>1 – RS Logix<br>2 – RS Linux | For programming. |
| 3 | Communication Cable (RS232/Ethernet) | To transmit the data and To transfer/downloads the Ladder into Plc. |
| 4 | Proximity Sensor | For speed measurement |
| 5 | LM35 | Temperature Measurement |
| 6 | CT (Current Transformer) | For current monitor |
| 7 | PT (Potential Transformer) | For voltage monitor |

***ANALOG AND DIGITAL INPUTS WITH ADDRESS:***

| SR NO | NAME OF DIGITAL INPUTS | ADDR ESS | PURPOSE |
|---|---|---|---|
| 1 | Push Buttons | I:0/1 | To start and stop the program |
| 2 | Proximity Sensors (Inductive Type) | I:0/2 | To detect the motor speed. |
| 3 | LM35 | I:0/3 | Temperature Measurement |
| 4 | CT (Current Transformer) | I:0/3 | For current monitor |
| 5 | PT (Potential Transformer) | I:0/5 | Voltage monitor |

## 4. BLOCK DIAGRAM

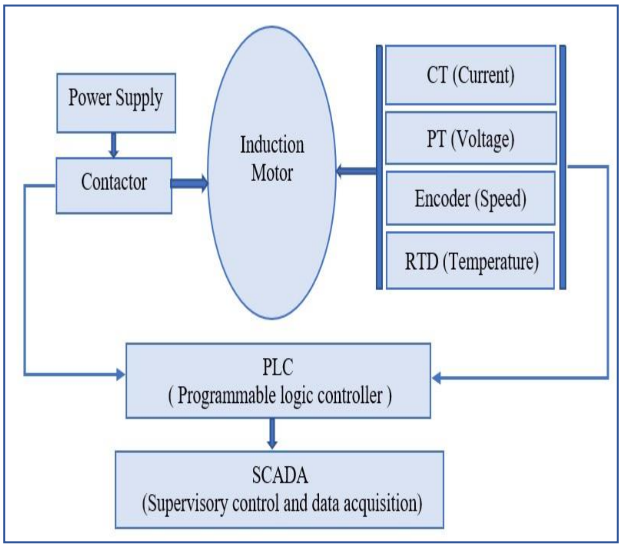


**Figure.4.1 Block diagram**

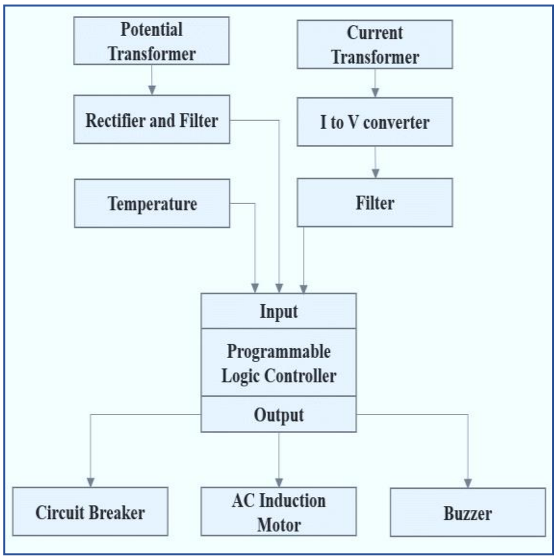


**Figure.4.2 Block diagram of the protection system**

- The power supply provides electrical energy to the system, supplying power to the contactor, motor, and other components.
- The contactor controls the power supply to the induction motor, allowing or interrupting the flow of electricity based on control signals.
- The induction motor is the main component being monitored. It receives power from the contactor and drives the connected load.
- The current transformer (CT) measures the current flowing through the motor, providing a scaled-down current signal for monitoring purposes.
- The potential transformer (PT) measures the voltage supplied to the motor, providing a scaled-down voltage signal for monitoring purposes.
- The encoder measures the speed of the motor, providing feedback signals to determine the rotational speed accurately.
- The RTD (Resistance Temperature Detector) measures the temperature of the motor, providing temperature readings for monitoring purposes.
- The PLC (Programmable Logic Controller) acts as the control unit, receiving inputs from the sensors and processing the data based on predefined logic.
- The SCADA (Supervisory Control and Data Acquisition) system provides a user interface for visualization and control of the motor parameters, receiving data from the PLC.

This block diagram represents a system that monitors the induction motor's current, voltage, speed, and temperature, with the PLC processing the data and the SCADA system providing visualization and control capabilities.

## 5. METHODOLOGY:

- Initially, the electrical and mechanical components required for the project, such as Allen Bradley 1400 series B PLC, SCADA software (Wonderware InTouch), induction motor, temperature sensors (LM35), and current sensors, were identified and acquired.
- The system architecture was designed to incorporate the PLC and SCADA systems to monitor and protect the induction motor.
- The PLC program was developed to collect data from the sensors and take appropriate actions in case of any faults or abnormalities.
- The SCADA system was configured to provide remote monitoring and visualization of the motor's performance and alerts.
- The program was tested and validated with simulated and real-world scenarios to ensure its effectiveness in detecting and protecting against motor faults.

## 6. ALGORITHM:

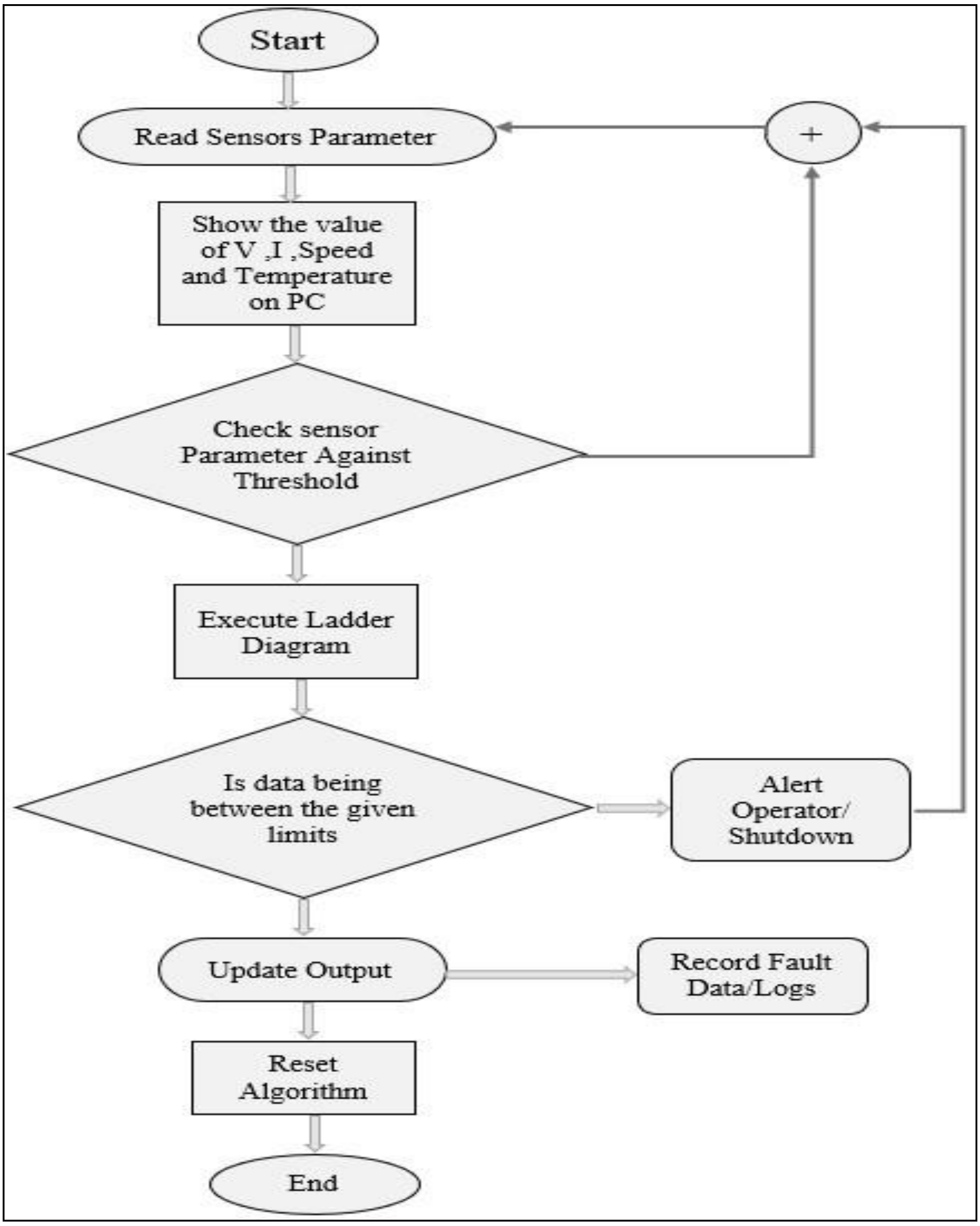


**Figure 7.1.Flow Chart of Program**

**Operating of Flow Chart**

I. **Initialize:** The system is initialized by starting the PLC and SCADA software and establishing communication between them.

II. **Read Inputs:** The PLC reads input signals from the motor sensors, including temperature sensors and current sensors. These sensors measure the motor's parameters such as temperature and current, which are critical indicators of the motor's health.

III. **Compare to Thresholds:** The PLC compares the sensor values to predefined threshold values that have been set based on the motor's operating parameters. If any sensor value exceeds its threshold, it triggers a fault condition.

IV. **Send Signal:** The PLC sends a signal to the SCADA system, indicating the type and severity of the fault. The SCADA system receives the signal and alerts the operator.

Take Appropriate Action: The operator takes appropriate action based on the fault warning, such as stopping the motor or adjusting its parameters to prevent further damage.

V. **Monitor Motor:** The PLC continuously monitors the motor's parameters to ensure that the fault condition is resolved and the motor is running safely.

VI. **Clear Fault:** If the fault condition is resolved, the warning is cleared from the SCADA system, and the motor continues to operate normally.

VII. **Send Alert:** In case of a critical fault condition, the system automatically shuts down the motor and sends an alert to the operator, indicating the fault type and severity level.

VIII. **Log Data:** The system logs all data collected from the sensors, including motor parameters and fault conditions, for historical analysis and trend analysis.

**Overall, this algorithm outlines the basic control strategy for the fault detection and protection system for an induction motor using PLC and SCADA. The system continuously monitors the motor's parameters, compares them to predefined threshold values, and takes appropriate action in case of any fault conditions.**

## 7. IMPLEMENTATION:

- The electrical components were installed and connected to the motor to enable data collection and protection actions.
- The PLC program was uploaded to the Allen Bradley 1400 series B PLC, and the system was powered on.
- The SCADA system was installed on a remote computer and configured to communicate with the PLC and display real-time data.
- The system was tested with various motor scenarios, and the performance was monitored using the SCADA system.
- The system was implemented in an industrial setting, and its effectiveness in reducing downtime and production loss due to motor failure was evaluated.

## 8. LADDER PROGRAMMING:

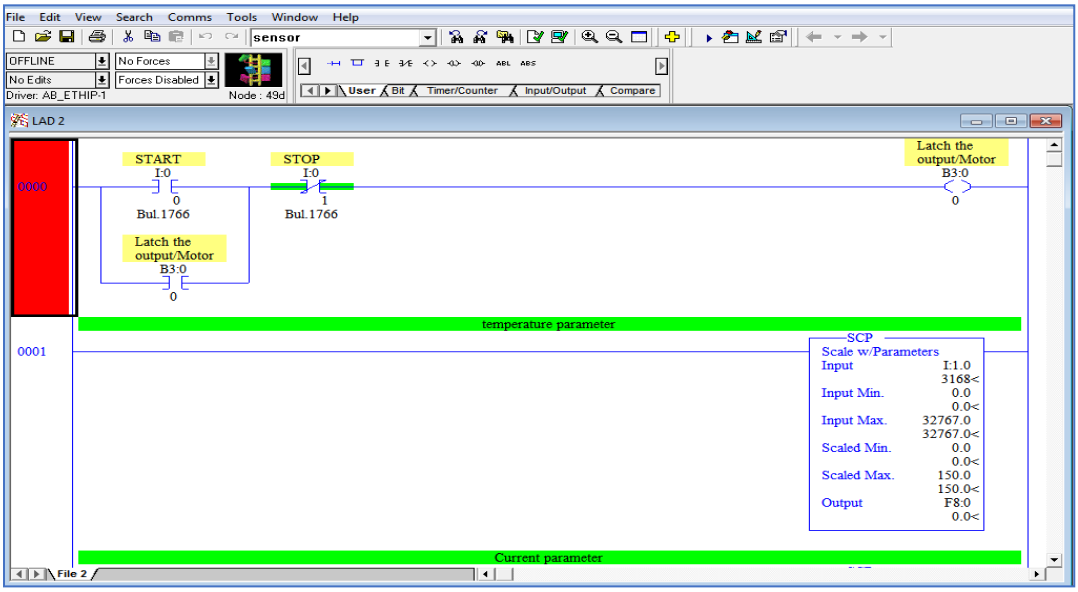


**Fig.8.1** Latching of the supply of motor

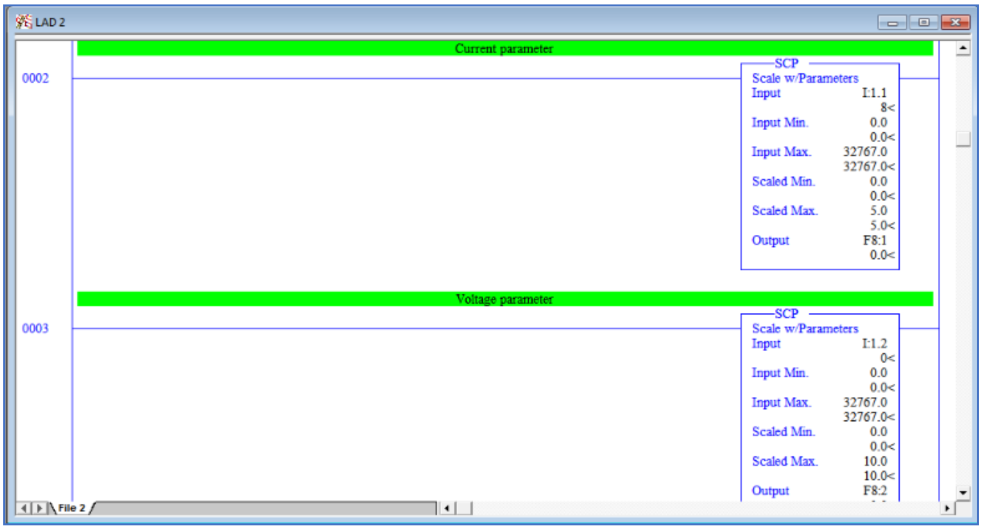


**Fig. 8.2** Speed and Temperature Monitoring

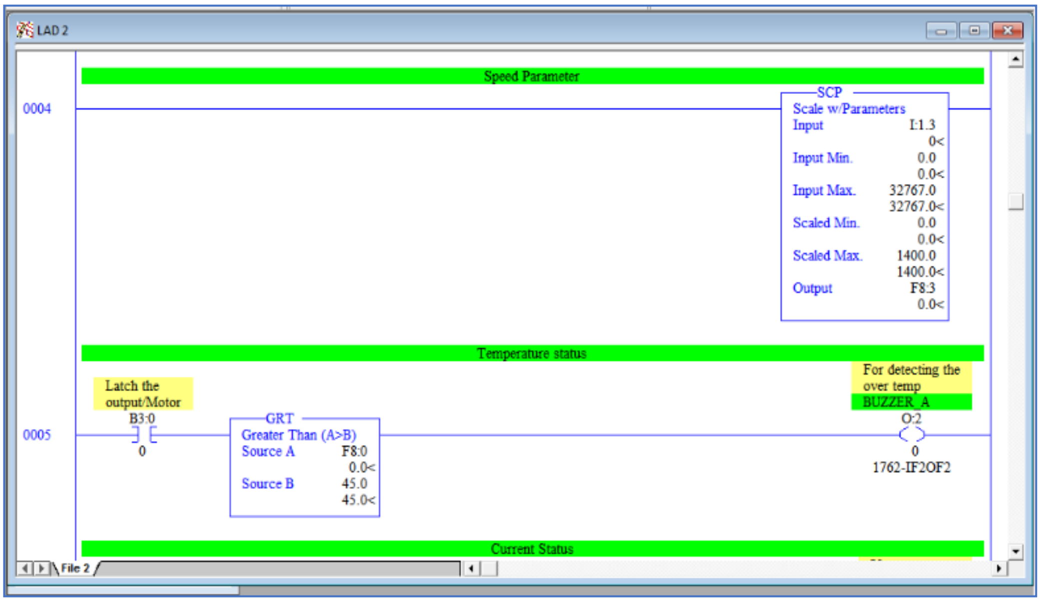


**Fig.8.3.**Current and Voltage comparing to referance input

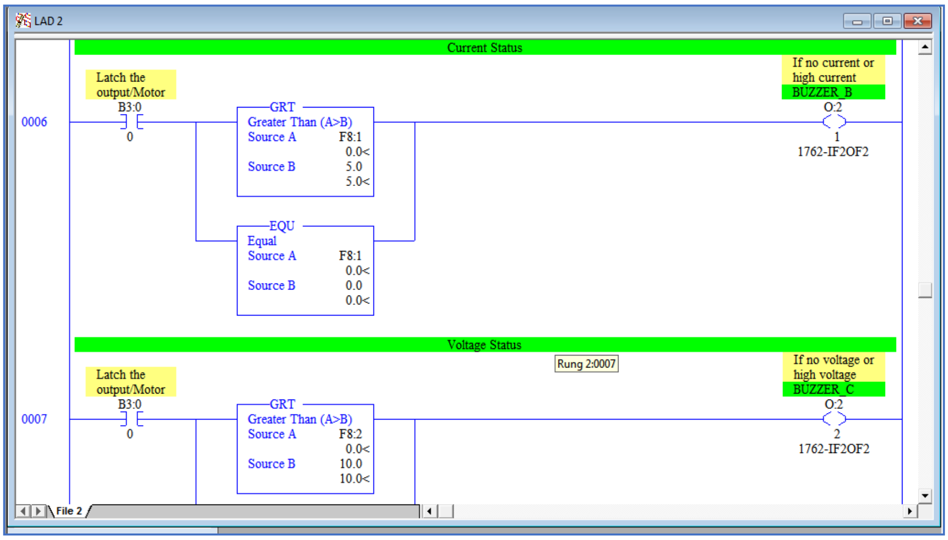


**Fig.8.4** Current and Voltage Monitoring

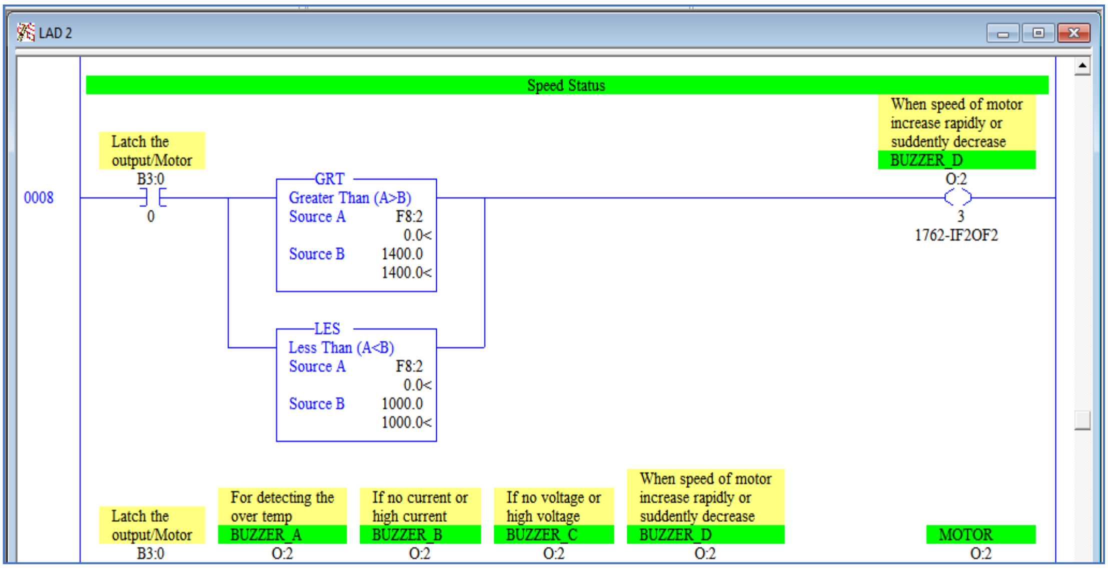


**Fig.8.5** Detection of Fault

***WORKING:***

Initialization:

Start the PLC and SCADA systems and establish communication between them.

Configure the necessary input/output modules in the PLC.

Connect the induction motor to the PLC and install temperature and current sensors at appropriate locations.

Read Inputs:

Continuously read the input signals from the sensors, including current, voltage, and temperature.

Convert the analog input signals to digital values using the PLC's analog input module.

Store the current and temperature values in memory for further processing.

Compare Input Values:

Compare the current and temperature values with the pre-set threshold values to determine if any of the parameters exceed the safe operating limits.

Display and Alert:

Send the flag status to the SCADA system for display on the operator interface screen.

Display the fault type and severity level on the screen to alert the operator about the fault condition.

Protection Actions:

If the fault condition is minor, provide the operator with a recommendation to adjust the motor parameters to reduce the fault risk.

If the fault condition is severe, automatically shut down the motor to prevent further damage and send an alert to the operator indicating the fault type and severity level.

Implement a timer delay to prevent frequent cycling of the motor.

Resume Operation:

Once the fault condition is resolved, clear the flag status in the PLC and resume motor operation.

Provide a notification to the operator indicating that the fault condition has been resolved and the motor is operating normally.

Data Logging:

Continuously log the input signals and the fault status in a database.

Use trend analysis and historical data to optimize motor performance and prevent future faults.

System Shutdown:

Properly shut down the system when not in use to prevent system damage or failures.

This algorithm provides an efficient and reliable fault detection and protection system for induction motors using PLC and SCADA. It enables real-time monitoring of motor parameters, rapid detection of fault conditions, and appropriate actions to minimize the downtime and production loss caused by motor failure.

## 9. Result:

| Timestamp | Current (A) | Voltage (V) | Speed (RPM) | Tempt (°C) | Fault Detected |
|---|---|---|---|---|---|
| 2023-05-21 09:00 | 5 | 230 | 1400 | 40 | Normal Condition |
| 2023-05-21 09:15 | 6.2 | 245 | 1450 | 45 | Over voltage |
| 2023-05-21 09:30 | 4.5 | 210 | 1300 | 52 | Under voltage |
| 2023-05-21 09:45 | 5.8 | 230 | 1600 | 48 | Over Speed |
| 2023-05-21 10:00 | 5.3 | 225 | 1450 | 55 | Over Temperature |
| 2023-05-21 10:15 | 5 | 230 | 1400 | 38 | Normal Condition |

At the timestamp of 2023-05-21 09:00, the motor operates within the normal range with a current of 5 Amps, voltage of 230V, speed of 1400 RPM, and temperature of 40°C. No faults are detected, and no action is taken.

However, at subsequent timestamps, the system identifies various faults based on the monitored parameters. For instance, at 09:15, an overvoltage condition is detected with a voltage of 215V, leading to the system stopping the motor as a precautionary measure. Similarly, at 09:30, an undervoltage condition is detected with a voltage of 240V, resulting in the motor being stopped. At 09:45, an overspeed condition is identified with a speed of 1600 RPM, leading to the motor being stopped. At 10:00, an over-temperature condition is detected with a temperature of 55°C, resulting in the motor being stopped again.

In contrast, at 10:15, the motor operates normally once again with parameters within the acceptable range, and no faults are detected.

This result table demonstrates how the system effectively monitors the motor's current, voltage, speed, and temperature, promptly detecting and responding to faults to ensure the motor's safe and reliable operation.

## 10. CONCLUSION:

In conclusion, the project successfully designed and implemented an efficient and reliable system for monitoring and protecting an induction motor. By incorporating the PLC and SCADA systems with temperature and current sensors, the motor's performance was closely monitored and any faults or abnormalities were detected and acted upon promptly, minimizing production loss and downtime.

The system's effectiveness was demonstrated through testing and implementation in an industrial setting, where it provided remote monitoring and visualization of the motor's performance, reducing the need for manual intervention. Overall, this project provides a robust solution for industries to improve the efficiency and reliability of their motor systems, leading to increased productivity and cost savings.

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