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Three Phase Induction Motor Control Using PLC

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ABSTRACT

Because of its great durability, dependability, affordability, efficiency, and exceptional self-starting ability, induction motors are the most widely used motor type in industry. The majority of these applications require an intelligent and quick speed control system. A single-phase induction motor can be made to run at the desired speed using a variety of speed control techniques. This paper describes a speed control and monitoring system based on PLC. This system consists of a PLC controller, a driver circuit, and a PWM inverter. This technique uses a constant V/Hz ratio to determine the induction motor's supply voltage based on the frequency output need. The computer screen displays and monitors a number of parameters, including the motor's speed, voltage, and current. It offers safer, more accurate, and less expensive

Keywords: Programmable Logic Controller, PWM Inverter, Induction Motor (IM), Design Automation.

I. INTRODUCTION

In several commercial, industrial, residential, and utility applications, INDUCTION motors are frequently utilised. This is due to the motor's resilience, excellent efficiency, wide speed range, and cheap manufacturing costs [1]. Nevertheless, compared to DC and permanent magnet machines, they require far more sophisticated management strategies and more costly, higher rated power converters due to the involved model nonlinearities [2].

Traditional safeguarding methods for three phases Introduced A variety of mechanical and electrical devices, including contactors, timers, electromagnetic switches, thermal relays, over current relays, and over/lower voltage relays, are typically used to provide motors [3]. These devices feature mechanical components, and when compared to electronic devices, they respond relatively slowly. The equipment's mechanical components can shorten the system's lifespan and decrease its efficiency while in use. Economically speaking, digital gear has recently been less expensive whereas traditional relays have become

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more expensive [4]. Numerous scholars have investigated a range of malfunctions and their origins, as well as detection strategies, contemporary developments, and diagnostic approaches facilitated by artificial intelligence, microprocessors, computers. The usage of PLCs (programmable logic controllers) with power electronics in electric machine applications has been introduced in the production automation since technology for motion control of electric drives became accessible. Benefits from this use include virtually unity power factor control over motors and other equipment and reduced voltage drop when turned on. PLCs are widely used in companies to automate processes, reduce production costs, and improve quality and dependability [6]. Additional uses for PLCs include machine machines that have better precision CNC (computerised numerical control). PLCs interfaced with power converters, PCs, and other electric equipment are required to obtain precise industrial electric drive systems. However, this increases the sophistication and complexity. This study introduces a PLC-controlled online protection system that functions effectively with all kinds of motors and load scenarios. Note that protective relays, no matter how advanced, are not able to accurately anticipate fault conditions. The suggested online protection system makes use of sensors to prevent and anticipate against different types of motor failure with complete protection coverage, affordable cost, and high performance. With the aid of the PLC, numerous operational defects involving the phase currents, phase voltages, speed, and winding temperatures of an IM have been resolved, and the PC has been used to track them.

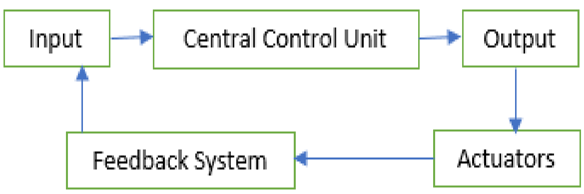

Figure 1: - PLC Architecture

A programmable controller, sometimes known as a PLC, is a tiny computer used to automate tasks in the real world. Industrial equipment can be configured to sense, activate, and control PLCs. In order to interface various electrical signals, a PLC has several I/O points. The control programme is loaded into the PLC memory, and the input and output components of the processes are connected to the PLC. Fig. 1depicts the PLC's fundamental construction[6].

II. LITERATURE SURVEY

According to Kersting, a three-section induction motor can continue to operate even if one phase of the power supply fails. A protection device or a motor's fuse blowing could occur at the feeder end or the transformer. For three-phase induction motors, single phasing poses a risk; thus, it is best to take them out of operation right once to avoid overheating. Once the phase opens at the step-down transformer or feeder end, the stator and rotor losses quadrupled, and the shaft output power collapses to zero. Shaft power is lowered by approximately 70% when single phasing takes place at motor terminals, despite the fact that the losses are doubled in comparison to steady state losses [7].

According to Sutherland and Short, 3-phase reclosers are frequently used on distribution feeders in the case of a single-phase fault. Faults in one phase are the most prevalent. The other two-phase consumers suffer as a result of the distribution line being used to supply the load to single-phase customers. If the service is not available for three-phase recloses, issues occur for the three-phase industry. 70% of the time, there are single-phase faults, 20% are two-phase faults, and 10% are three-phase faults[8]

In the event of a single-phase fault, 3-phase reclosers are frequently used on distribution feeders, as Sutherland and Short explained. The majority of faults are single-phase. The load supplied to single-phase customers via the distribution line has a negative impact on the other two-phase customers. If three-phase recloses do not open for the service, issues develop for the three-phase industry. Faults in one phase happen 70% of the time, in two phases 20% of the time, and in three phases 10% of the time [9]. The 3-phase induction motor is examined by Pillay et al. in relation to undervoltage and overvoltage. The voltage at the motor terminals in a highly loaded industrial system may drop below the nominal value and may also surpass the par value in a complex industrial system. Alternative power organisations, NEMA, and IEEE have all defined it differently. These definitions do not require a great deal of complex algebra. This work computes voltage imbalance using complex algebra and compares the results to NEMA standards [10]. Unbalanced voltages have a detrimental effect on the performance of three-phase induction motors, claim Faiz et al. The definitions of voltage unbalance provided by the IEEE, NEMA, and IEC (International Electrotechnical Commission) are contrasted in this article. The study found that the IEC definitions are three times easier to calculate than the NEMA, IEEE, and IEC definitions. All three, meanwhile, just provide a strategy for redressing the disparity in proportions [11].

Javed and Izhar have built the protection of a three-phase induction motor based only on voltage measurements, which is insufficient to safeguard the motor when a fault occurs at the distribution transformer or substation feeder. Voltage testing will protect the motor in the event that an issue arises at the terminals. This assessment tool cannot function without a protection device in place. Because the faulty phase can draw negative sequence current and function as a voltage generator if the fault occurs someplace other than the motor terminals, they have also proposed a device to measure the phase difference of voltages. This would make it possible to calculate the phase difference. As a result, although the voltage produced is near to the line voltage, the phasor dissimilarity of a problematic phase change cannot be identified using the measuring setup [12].

III. SYSTEM MODELLING

In this study, an induction motor's speed, voltage, current, and temperature are all measured by the PLC using analogue inputs and sensors. Additionally, it activates the outputs in accordance with the programme and continuously monitors the inputs.

The study reveals effect of various parameters like current, voltage, speed of actuators, using different sensors and feedback systems.

1] Software

An incremental encoder with 360 pulses per revolution used to measure the rotor speed, a true rms to dc conversion card, a Siemens CPU 224, three voltage transformers with transformation ratios of 220/5 V, three current transformers with current ratios of 1000:1, a temperature sensor with transformation ratio of 10 mV for each 1◦C increasing temperature (LM-35 sensor), and an incremental encoder with 360 pulses per revolution are all part of the protection system used in this study [2].

2] Software

Siemens PLC S7-200 module with 14 digital input/10 digital output addresses with CPU 224 sample is used (14∗DI 24 V dc /10∗DO 24 V dc). The PLC programming memory used is composed of 4096 words. STEP 7—Micro/Win 32 programmer was used as the software. Statement list editor (STL) and ladder diagram (LAD) were used as programming languages. Software of the PLC was prepared on the computer and loaded on the PLC by RS 232 - RS 485 PC/plan- position indicator (PPI) cable.

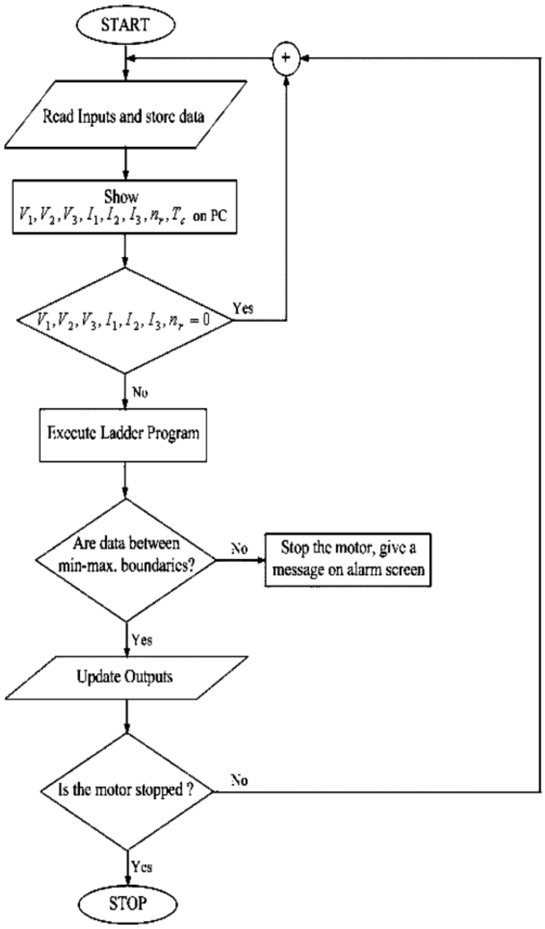

Figure 2: - Operational Flowchart

The baud rate between the PLC and the computer is crucial while the prepared programme is being loaded onto the PLC from the computer. In a manual switch setup, the baud rate needs to match the bound cable. Analogue signal processing is done with an analogue module. Generally, analogue modules function with 8- or 12-bit systems. The analogue module may be attached to one or more analogue sensors. Digital data is created by processing analogue data. A PLC cannot read analogue measurement signals directly. PLCs only detect signals that are logical. For a PLC to sense analogue signals, an analogue module is required. The temperature, the phase currents and voltages.

IV. CONCLUDING REMARKS

The most significant fault kinds are handled by the protective relay that is PLC-controlled. The motor is halted and a warning message is shown on the computer if a malfunction is detected while the motor is operating online. Because electronic equipment rather than mechanical equipment was employed in the trials, this method is faster and more efficient than the classical techniques. It also costs less than a computer-based protection solution because it doesn't require a conversion card. In addition, it offers a visual environment, which increases the system's usability compared to protection methods based on PICs.

Lastly, the suggested protection system outperforms other PLC-based protection systems that have been researched due to its range setting flexibility. It is possible to implement this suggested safety mechanism on many ac motors by doing small modifications in both the hardware and the software

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