SPEED CONTROL OF ELECTRICAL MACHINES USING PLC

[1]Sneha.A, [2]Judesam.J, [3]Karthikeyan.K
[4]Er.B.Rengammal sankari, [5]Er. S.T. Rama

[4,5]Assistant professor
[1,2,3]Dept. of Electronics and Instrumentation Engineering
[4,5]Dept. of Electrical and Electronics Engineering
DR. MGR Educational and Research Institute

Abstract— **This paper discusses about the speed control of the electrical motors using Programmable Logic Controller (PLC). Primarily Programmable Logic Controller are used in automation industries to control the manufacturing process. The aim of this paper to control the speed of the electrical motors at desired speed using PLC. This operation takes place under closed loop condition, so the PLC monitors whether the motor has reached the desired output (speed) from the feedback signal received from the motor.**

Keywords—**PLC, Electric motors, Drives, Speed control, closed-loop.**

I.INTRODUCTION

Today's industries seek process automation across all industries since it boosts productivity, lowers costs, and improves quality. For system control and monitoring, advanced automation system requires special hardware and software called PLC is used. According to definition, a programmable logic controller is a unique kind of computer used in industry to manage and run machines and production processes. The application of a PLC in industry was to directly replace electromechanical relays as logic components, substituting instead a solid-state digital computer with a ladder diagram programming, able to simulate the interconnection of several relays to carry out specified logical operations. In a computer-based protection system, measurements of voltages, currents, and temperature are made and transferred to the computer via a PLC to make the final control and protection decisions. Due to the fact that it is a totally automated process and can be more accurate. Automation systems using PLC improve dependability and flexibility while lowering manufacturing costs. Use of PLC interfaced with power converters, computers, and other electrical apparatus is required to get precise industrial electric drive systems.

Due to the fact that industrial settings employ motors often, controlling and protecting them against overvoltage, overcurrent, and overheating situations is crucial. PLC based monitoring and controlling used. Along with this drives and PLCs (programmable logic controllers), are utilized for speed control of motors, which has a very broad application in the industrial sector.

Therefore, if motor speed can be controlled by a PLC, then other parameters can also be controlled wherever a motor is used. PLCs offer a quick and simple solution to complex automation issues. PLCs are more advantageous than other control techniques because they are less likely to get damaged, more dependable, simpler to maintain, and more resistant to external factors.

II.LITERATURE SURVEY

Speed Control of DC Motor using Programmable Logic Controller-

DC voltage sources are used to power numerous industrial drives. Most of the time, changing the amount of a dc source's voltage is necessary. Motor speed control refers to the deliberate change in speed necessary to accommodate a motor-related work load. The work entails utilizing a PLC to supply a fixed source of electricity to a dc motor. Depending on the reference speed, which changes the duty cycle of the dc motor, PWM (Pulse Width Modulation) is used to switch a dc motor ON or OFF. Speed is obtained in accordance with needs and load variation by suitably adjusting the duty ratio. This technique shows that utilizing electrical methods to manage speed has more benefits than using mechanical ones. Considering how quick, simple, and effective it is.

Speed Control of DC motor by Programmable Logic Control with High Accuracy-

The DC motor is regulated at different speeds for various industrial applications due to its quick performance. Using a PLC integrated with a PID (Proportional Integral Controller), the speed of the DC motor is controlled in this case so that it runs at the required speed. The motor speed is constantly monitored by the PLC. PID coefficients and motor speed are shown via a human interface device, or HMI. Its benefits include rapid speed control, reduced overshoot, and usefulness in businesses to prevent part damage.

Speed Control of 3-phase Induction motor using PLC under Open and Closed Loop Condition-

In the modern world, all industries want process automation, and automation systems cannot function without variable speed drives that regulate the motor's speed. Here, the goal is to use a PLC to track the speed regulation of a three-phase induction motor under various load situations, including both NO load and ON load driven AC drives. Both open loop and closed loop are utilized (where encoder is used for feedback signal). By enhancing motor efficiency using PLC, we can examine data more quickly.

Speed Control of the Induction Motor using PLC through VFD-

PLC and VFD are widely used for induction motor speed control in the industrial sector (Variable Frequency Drive). This technique uses a VFD to regulate the speed of the three-phase induction motor. The VFD is based on the V/F approach, where supply voltage changes the frequency that is set in the inverter, which changes the speed of the motor. Here, the output (speed) is managed by altering the PLC-controlled VFD's input. As a result, the induction motor's speed is altered. This demonstrates why it is simple to manage the speed of an induction motor using a VFD and PLC, as well as how it will improve power quality and safeguard the motor from transient currents and short circuit problems.

III.PROPOSED WORK

Many projects have been developed and put into action to increase the effectiveness of controlling the motors' speed utilizing PLC integrated with different techniques such PID controller, VFD, PWM, and sensor-based.

The methods described above are limited to motors that are powered by a drive or PID controller, though. Our objective is to control electrical motor’s speed using a PLC in a straightforward manner. For managing a large number of drives-controlled motors, we use the PLC, which has a wide range of control applications.

Our project aims to monitor the output while controlling the speed of the electrical motors using a thyristor controller board and PLC. In a closed loop process, speed control via PLC is done.

Components used are

PC: The user interface for programming ladder logic and specifying the required value for the output is provided by the personal computer (PC). For PC-PLC communication, USB or Ethernet cables are utilized. Connect the pc to the controller with an Ethernet cable.

PLC: Programmable Logic Controllers, sometimes known as PLCs, are robust computers used in industrial automation. These controllers are equipped to automate a single machine operation, a complete production line. The PLC processes data from connected sensors or input devices before launching outputs based on pre-programmed settings.

Depending on the inputs and outputs, a PLC can execute a number of operations, such as monitoring and recording run-time data like operating temperature, starting and stopping processes automatically, alarming in the event of a machine malfunction, and more.

PCB board: The primary purposes of PCBs are to mechanically support and connect electrical components in a circuit. They serve as a motor-PLC interface. It will enhance the incoming input signals using its controllers.

SCR: The SCR is a three-terminal thyristor with an input current-controlled conductor that functions like a silicon rectifier diode. SCRs are uni-directional devices they only allow current to flow in one direction. By merely blocking the AC sine wave's negative half cycle, an SCR connected in series with the armature winding of a DC motor transforms AC into DC.

TRIAC: Triac are three-terminal AC switch that can operate in either way depending on the applied gate signal, whether it be positive or negative. Consequently, it can function as a switch in AC systems. The triac regulates the flow of alternating current to the load by alternating between the conduction state and the cut-off state during the positive and negative half cycles of the power supply.

DC motor: In order to change the input power, DC motor controller vary the alternating current source. The drive operating mode, communication interface, intended use, and motor type are the main specifications to consider. Also, for electric vehicles, machine tools, and other devices, these aid in controlling motor torques and speeds. Direct current motor controllers allow the motor's voltage to be changed.

AC motor: The frequency power of an AC motor can be changed, which changes the input power to the motors. This aids in controlling the output speed and torque. Important specifications include power rating, drive operating mode, loop system classification, and motor type. Moreover, AC motor controllers are typically used in process applications to control the speed of blowers, pumps, etc.

MOC 7811 sensor (Encoder): An IR transmitter and a photodiode are installed on the slotted opto isolator module known as the MOC-7811 IR Opto Isolated Sensor. The MOC 7811 sensor are used for sensing Non-Contact Objects. In order to determine the position of the wheel, this is typically utilized as a positional sensor switch or as Position Encoder sensors. It is employed to control the location and speed of motors.

Frequency to Voltage convertor board: The conversion of frequency or pulse into proportional electrical outputs like voltage or current takes place in a frequency to voltage converter. For electro-mechanical measurements involving repetition, it is a crucial instrument. Hence, a frequency to voltage converter circuit will produce a proportional DC output when a frequency is applied across it.

IV.WORKING AND OUTPUT

The components and connections of the project are made as show in fig.1 & 2.

The components of the project are:

- PLC Software – GE Fanuc
- PCB board
- SCR power pack (DC motor)
- TRIAC (AC motor)
- DC motor
- AC motor
- MOC 7811 sensor (Encoder)
- Frequency to Voltage convertor board.

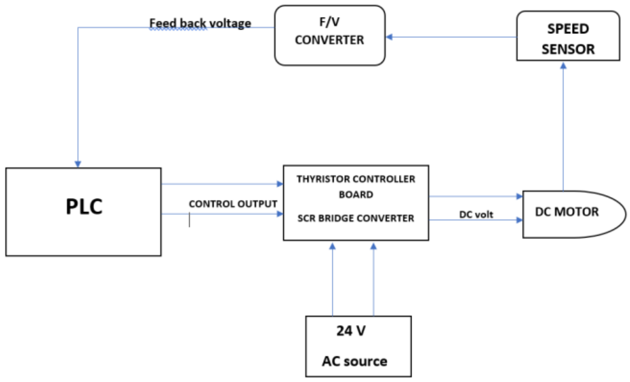

Fig.4.1 Block and Connection Diagram of DC Motor speed control and monitoring

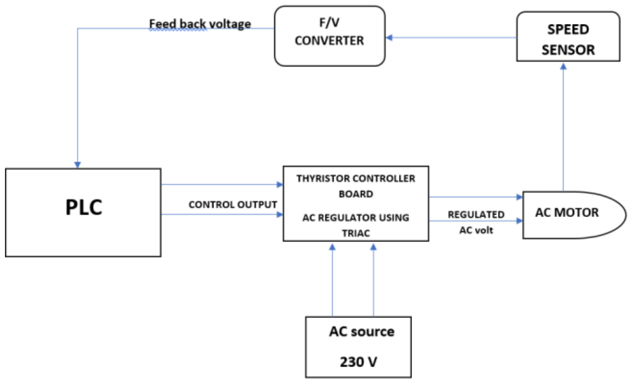

Fig.4.2 Block and Connection Diagram of AC Motor speed control and monitoring

The PLC program (ladder logic) is written first, after which the output from the PLC is provided to an interface such a PCB board that has an SCR. The control signals on the PCB board will amplify the signals coming from the plc before passing them on to the SCR that is attached to it. The SCR will then produce an output signal that will be used as an input signal by the motor. The signal the SCR sends to the motor controls how it operates.

An anti-parallel SCR will be connected to an AC motor to create the ac voltage, while a PWM pulse from a PLC will be applied to an SCR to create the dc voltage needed by a DC motor.

A speed-calculating encoder will be installed close to the motor shaft. The MOC 7811 sensor in the encoder generates a square pulse based on the motor speed. The frequency to voltage converter will be supplied the pulse from the sensor. Once the voltage from the F to V converter has been obtained, we can compute and display the rpm.

Due to the feedback signal it provides on the motors' speed and the output it produces, the closed loop operation is employed.

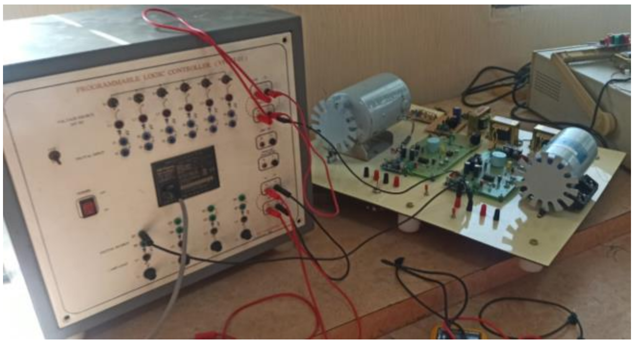

Fig.4.3 Hardware Setup

V.SIMULATION AND RESULTS

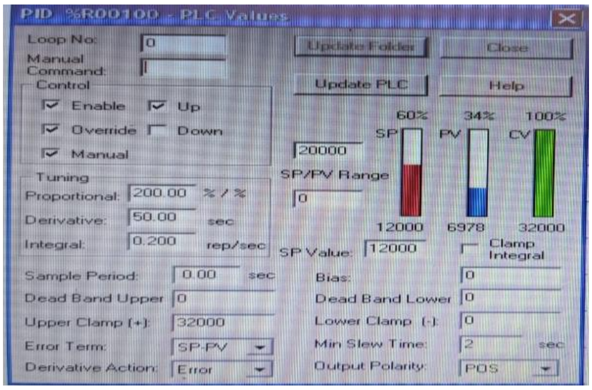

Fig.5.1 Simulation of Ladder Logic Diagram When SP of Speed is 20000 Rpm

The motor's set point ranges from 12000 to 32000 revolutions per minute (rpm).

Yet, the set point for the motor speed in the simulation mentioned above is 20000 rpm. When the process value is 34% and the set point is 60%, the controlled value is 100%. From this, we may deduce that the motor produces the desired output even when only 60% of the set point value is covered. The controlled value demonstrates total control over the motor speed. It is evident that the motor speed is managed in accordance with the set point value, producing the intended output.

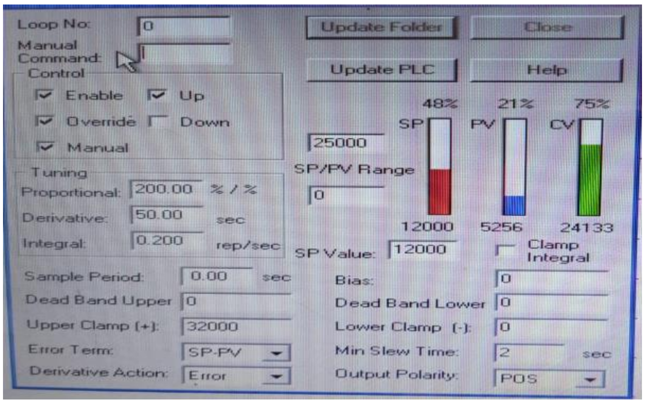

Fig.5.2 Simulation of Ladder Logic Diagram When SP of Speed is 25000 Rpm

The set point for the motor speed is 25000 rpm, as can be seen from the simulation above. In this case, the process value becomes 20% when the set point of 48% is reached, resulting in a controlled value of 75%. This illustrates how quickly the motor is controlled when it only reaches 48% of the set point on 75% of the motor. When the simulation reaches 60% of the set point, it returns 100% of the regulated value. Only for comparison, we have displayed a controlled value of 75%.

Although the simulations have different rpms, they both produce the needed output quickly. From these simulations, it is clear that the speed may be adjusted to any rpm, which in turn produces the appropriate output in accordance with the input by manipulating them.

Also, it gives insight that the motor speed can be varied easily only by changing the rpm. These, simulation is applied for AC and DC motor without any differences

By modifying the motor's speed in line with the specifications, the project is successfully attempted. In contrast to other conventional techniques, the motor's speed control is precise and it generates the necessary output for the given input value (rpm).

VI.CONCLUSION

In this paper we conclude that the speed of the electrical motors controlled using PLC through a drive circuit is a quick and easy operation. We have enhanced the operation from controlling the speed of electrical motors through a VFD drive to simple controlling circuit. Since the whole operation is done under closed loop condition the output speed is monitored. The purpose of this is to control the electrical motors by reducing the cost and saving energy.

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