

Implementation of PLC Based Star Delta Starter for Starting and Direction Control Of Three Phase Induction Motor

Shruti Kharait*, Prof. Sudhir Phulambrikar**

*(Student IV SEM, Department of Electrical Engineering, SATI, VIDISHA M.P.), ** (HOD Department of Electrical Engineering, SATI, VIDISHA M.P.)

Abstract

In this paper the basic concepts of Programmable logic controller (PLC) and its applications are discussed. The hardware set up of 3 phase star delta starting of induction motor using PLC is implemented. Both the description of hardware and software is presented in this paper. The flexibility and efficient controllability of plc helps in the growth of automation.

1. INTRODUCTION

Monitoring and inspection of several processes is becoming dominant part of the automation technique in any industry. So the automation is basically the delegation of human control function to technical equipments for increasing productivity and quality, reducing costs, increasing safety in working conditions [1],[3]. PLC forms one of the computerized machines and hence regarded as the heart of automated control system. The first PLC came into existence which was 'MODICON 084' and since the Dick Morley was one of the dedicated members working with the association so he is credited with the invention of PLC and known as "father of PLC". The product range now has been extended to 984 in its appearance [4],[5].

Earlier sequencers, cam timers, electromechanical relays were used for controlling and interlocking purposes. The control panel consists of thousands of wires

which interconnects many relays to operate the various machines. So in case of error, machines have to be stopped and complete rewiring is required which is not only hectic job but also costs more. Also time was wasted in finding out errors and even distance control was not possible. Because of such problems the relays were replaced by PLCs [4].

The control diagram for star delta starting of three phase induction motor for forward as well as reverse direction [10] is shown below in fig.1.

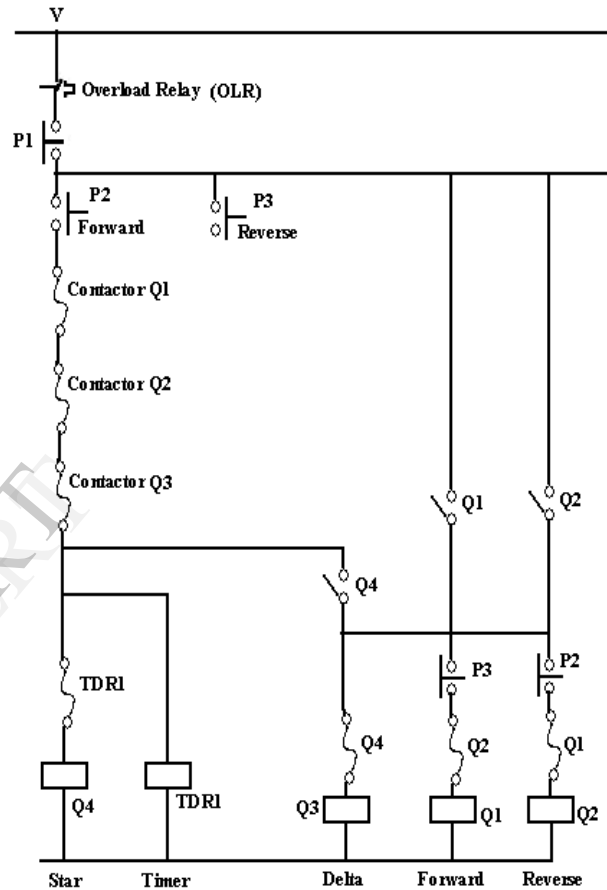


Figure 1. Control Diagram of star delta starting

2. DESCRIPTION OF HARDWARE

The devices used for the development of the setup are Schneider PLC, 3 phase squirrel cage induction motor, power supply, connecting wires, and contactors.

2.1 SCHNEIDER PLC

PINS	AVAILABLE	USED
Discrete inputs	16 DISCR	1
Discrete outputs	10 relays	4
Power supply	(100-240V) AC	



Figure 2. View of PLC used

2.2 THREE PHASE INDUCTION MOTOR

The 3 phase induction motor is very popularly used as they are rugged, have low price and easy to maintain. It consists of stator and rotor. For the set up, the induction motors is used having the following ratings-5HP, 440V, 6.8A, and 1450 rpm.

The star delta starting uses reduced supply voltage in starting. For starting, the stator windings are first connected in star and when the machine is running the winding arrangements are changed to delta. With the changeover of the circuit configuration from star to delta, the current drops to zero, and the speed of the motor reduces depending on the load. The changeover to delta then causes a dramatic rise in the current, as the full mains voltage is now applied to the motor windings. The motor torque also jumps to a higher value during changeover, which causes additional loading on the entire drive system. By connecting the stator windings, first in star and then in delta, the line current drawn by the motor at starting is reduced to one-third as compared to starting current with the windings connected in delta.

2.3 CONTACTORS

Contactors are devices that function as switches rather than being advanced forms of switches. They are commonly used to control motors and to perform opening/closing operations. Here the contactors are operated through the PLC. It consists of two contact parts- stationary and movable. The whole circuit is connected to the stationary part and the movable part consists of a coil. When the coil is energized the movable contacts are closed against the

stationary contacts, and the circuit gets completed. Ordinary Relays are normally used for Low current but contactors are used for switching higher current. Four contactors of 4 poles, 16 Amp, 230 V are used in the circuit.



Figure 3. Connection of PLC with induction motor

3. MAIN CIRCUIT DIAGRAM AND CIRCUIT DETAILS

The circuit consists of FOUR contactors among them Q1, Q2, Q3, Q4 are used for star delta starting and the circuit arrangement is shown in Fig.4. Firstly the Q1, Q4 which depict the motor have started and moving in the forward direction with motor first running in the star then Q4 is de-energized and Q3 is made active so the motor now running in delta. The forward direction rotation is carried for the specific time given in timers. Similarly for Reverse rotation the Contactors Q2, Q4. Again for the motor starting with star and then moving to delta the motor will change from Q4 to Q3. So the sequence now becomes Q2, Q3. The whole process can be repeated according to our requirements.

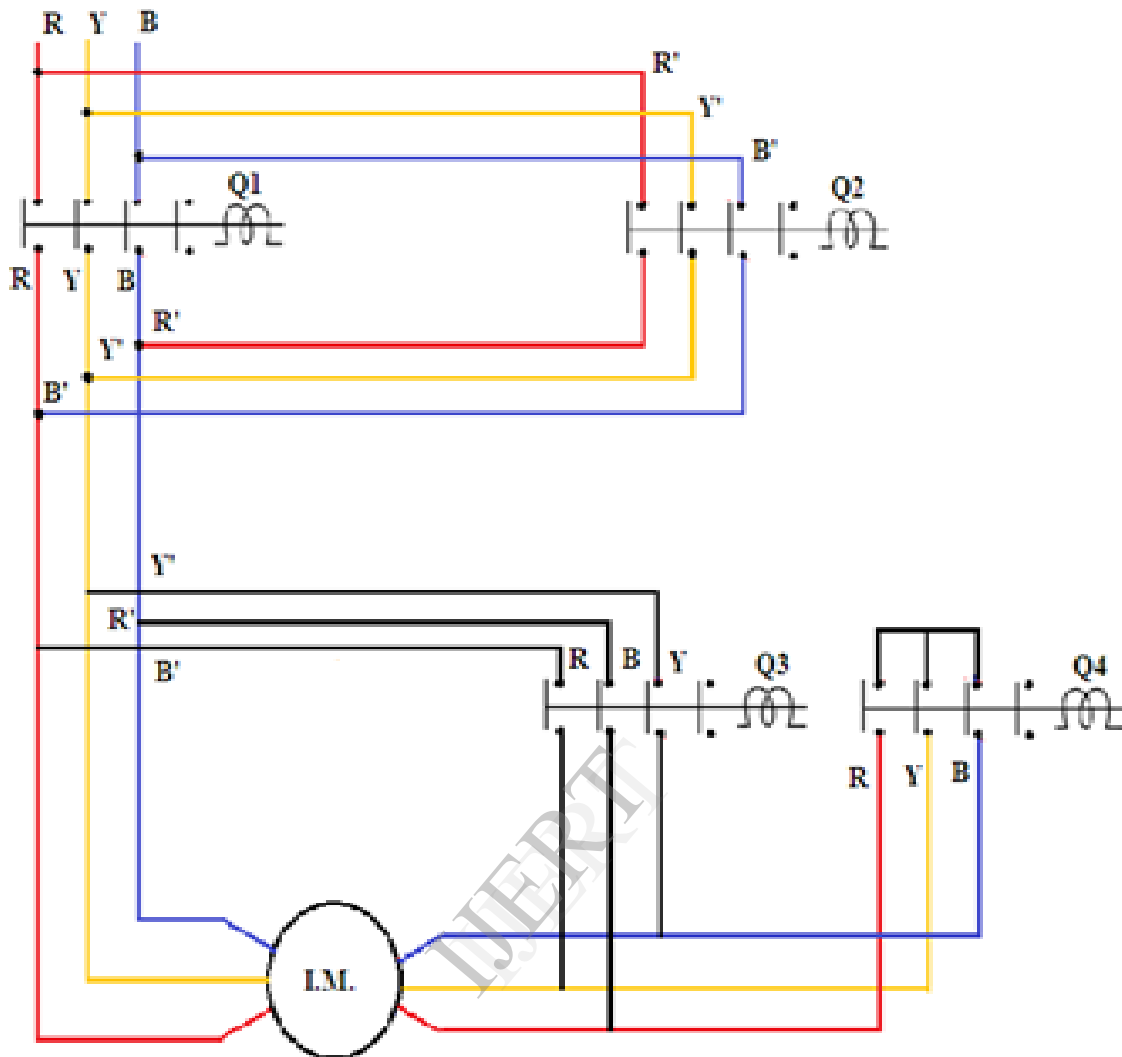


Figure 4. Main circuit diagram used for implementation

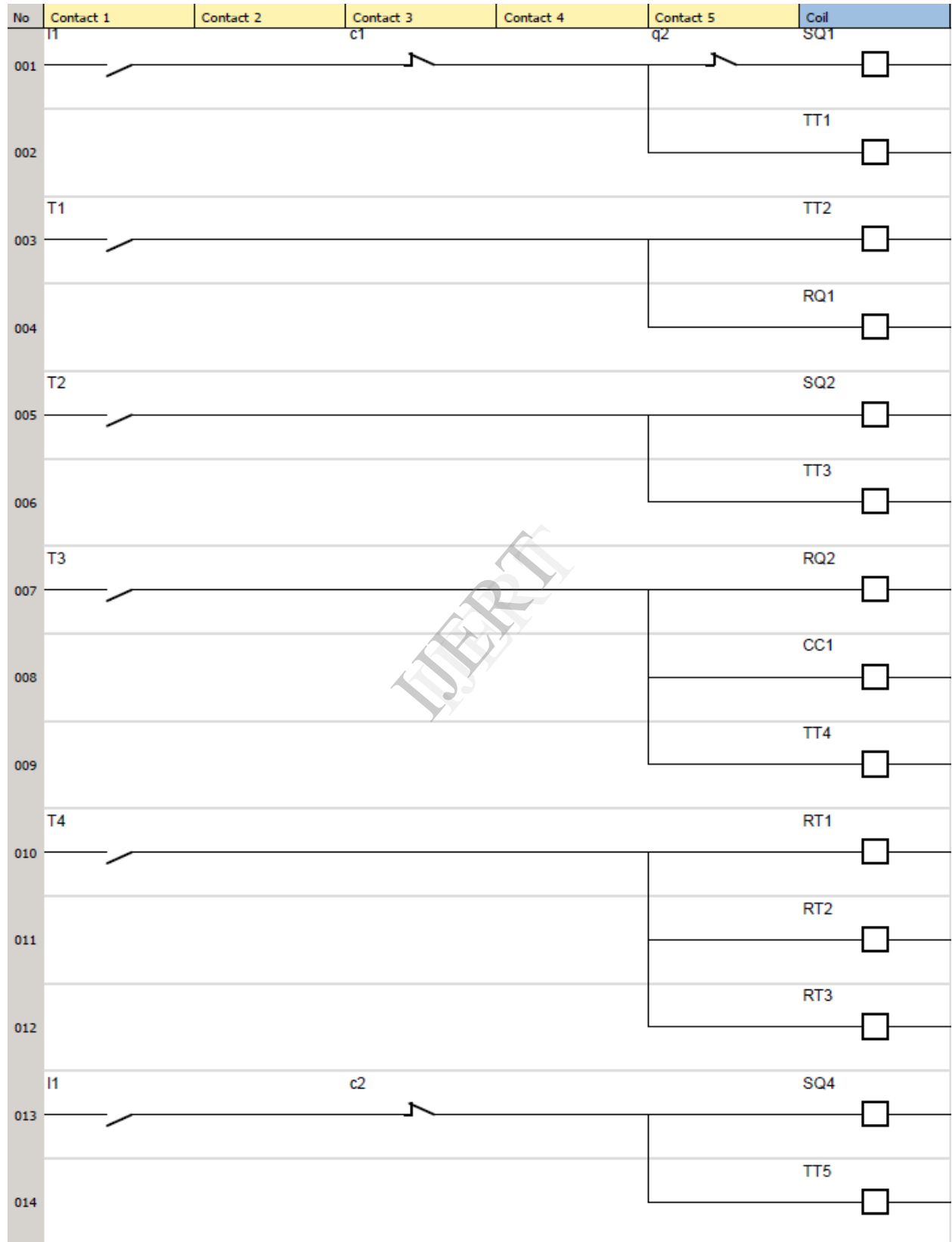
4. DESCRIPTION OF SOFTWARE

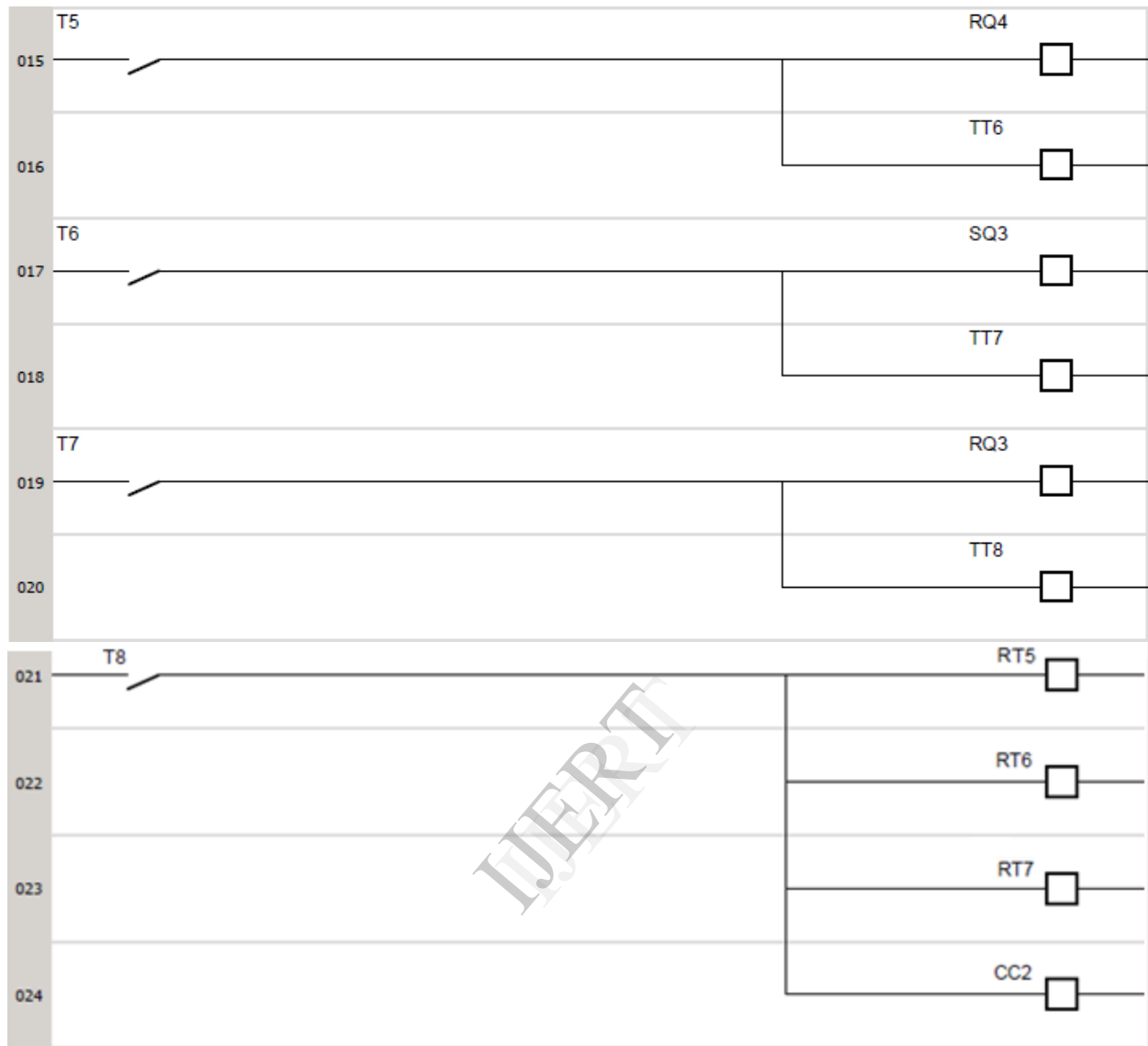
The software used for the development of the set up is "ZELIOSOFT 2" and the module used is SR3B261FU. It consists of two programming methodologies, one is the functional block diagram (FBD) and the other is the ladder logic diagram (LD). The programming used is ladder logic diagram which is a graphical representation of the program steps using relay contacts and coils such that the ladder is drawn with contacts to the left side of the

sheet and coils to the right. Basically the ladder work sheet consists of 120 program lines known as *rungs*. Each rung comprises a maximum of 5 contacts and a coil. It is divided into two zones.

1. Test Zone- It displays the conditions necessary for triggering an action (contact).
2. Action Zone- It is the zone which applies the result following a logical test combination (coils).

5. LADDER DIAGRAM USED





6. DIFFERENT FIELD OF AREAS WHERE PLC IS USED

The plc is being used in many automation processes and several areas of industries. The main task involved with the PLC is the controlling of any operation which is acquired through programming. Its usage is noticed in areas like envelope monitoring, machines protection, smoke detection, system interlocking indicators etc.

Some of the application areas are discussed below:

6.1 Motion and Direction Control

This application of PLC can be seen in our daily life such as in elevators, swings in amusement parks, in robots. Elevators are utilized by people to reach the different floor levels so it can be operated by plc for

both the directions. Similarly swings can be rotated in clockwise and anticlockwise motion without need of manual labour.

6.2 PLC used as a switch

The switching operation is obtained by controlling the contactor through ladder diagram. The on/off operation should be automatic and its requirement is seen in the controlling of machines involved with moldings, grinding and injection. Also seen in frequent door opening and closing requirements.

6.3 Multiple applications of PLC

The PLCs are applicable to many industries such as steel production industry, steel and glass cutting industry, in the construction industry e.g. milling operation, in the brick making industry also used for controlling temperature and pressure of the boilers in chemical industry.

6.4 PLCs used in official works

PLCs are being used in Data computation works as because it can perform all sorts of calculations such as arithmetic, logical, matrix.

Star Delta starting is suitable for medium and high hp motors. It is found in applications of the lifting, pumping, ventilation and electrical traction type, or in centrifuges. They are used in industry, e.g. in iron and steel plants, in marine applications, water and water treatment, and port infrastructure, in mines and quarries, and in paper mills.

7. CONCLUSION

Hence the set up was implemented for the PLC based star delta starter for starting and direction control of three phase induction motor. The time of forward rotation and backward rotation is controlled using timers in the ladder diagram program. It is found that a great flexibility is available in PLC programming as any sort of changes can be done through only changing the prescribed commands in the ladder diagram. Thus PLC has proved to be universal controller and utilized for the growth of the automation technology.

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