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MONITORING, CONTROLLING AND PROTECTION OF CONVEYOR MECHANISM USING PLC

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ABSTRACT:

Conveyor systems in thermal power stations cater the need of fuel flow from mines to thermal power stations for power generation. Conveyors are seen virtually in the coal handling plant (CHP) that are having number of conveyors. The conveyor system has many combinational conveyor sequences. The control systems used for these conveyors are important for the safe operation the plants. In order to ensure the safe belt conveyor operation a reliable, centralized monitoring and controlling is necessary. The conveyor scheme operational system has enormous control components to achieve a starting logic, stopping logic, tripping logic. The control components are mostly electromagnetic relays, timers and indicating lamps etc. Also the system has many other indicating, sensing components for its monitoring and protection purpose. The system has limitation for future modification due to the complexity of hard wired circuit. In order to overcome the above complexity problem and achieve better optimized result, PLC is proposed to control the conveyor system. PLC is automatic controller device which minimizes more number of requirements of electromagnetic relay, timers etc. and it can be programmed to accept the operational logic in a minimal time.

Key words: PLC, Conveyor, relays, NLC, CHP

INTRODUCTION

In NLC Thermal Power Station fuel transport is done through many sequences of conveyors with various combinations to cater the need of fuel flow for power generation. Conveyors are seen virtually in the coal handling plant. CHP are having number of conveyors. In thermal station we have to use belt conveyor for transferring coal. The control systems used for these conveyors are important for operating safe plant. In order to ensure the conveyor operation safe and reliable, centralized monitoring and controlling is necessary. The conveyor system has many combinational conveyor sequences. The conveyor scheme operational system has enormous control components to achieve a starting logic, stopping logic, tripping logic. The control components are mostly electromagnetic relays, timers and indicating lamps and many other indicating, sensing components for its monitoring and protection purpose. The system has limitation for future modification due to the complexity of hard wired circuits. The usage of electromagnetic relays, timers also creating major problem such as operational trouble such as start, stop/trip increases, consuming more time on fault tracing, consumption more spares on circuit elements, inventory increases, cost of maintenance is more, increasing number of call duties. In order to overcome the problems and achieve desired result in this paper suggested to implement the PLC method to regular the conveyor system.

Conveyor system has a sensing device like zero speed sensing, receiving conveyor position sensing. It has also facility for selection to operate conveyor avoiding control system (Makarand Joshi et al., 2012). The cranes are drive manually in the industry for the segregation and transportation of products in multiple conveyors. The process results in increased time delay for the products to reach the destination and also needs manpower to control the cranes. The operation of cranes and monitoring the status of the conveyor belt are also tedious for the workers (Hemant Ahuja et al., 2014). The coal height is sensed by means of real time feedback sensor and data is send to downstream system for further processing. The height of the coal is analysed in silos, bunkers. Three type of sensor used in coal level detection are Ultra sonic, Radar and Laser based system (Ralph Taylor et al., 2010). Fuzzy logic controller used in this process for the control action can be increased at many parameters. It will increase the control action accuracy of the system (Manoj Krishna,S and Avinash, R K et al., 2016). A coal handling plant (CHP) is set in every power station to handle the coal safely. The coal mined from underground has to be sized, processed, and handled effectively and efficiently

(Bernhardt G.A.Skrotzki et al, 2009 and Sudhanandhi, K and Bharath,2016).

CONVEYOR OPERATING METHOD

In any process Industry conveying of material from one place to another for different processing with multiple combinational conveying system, The combination may be one or more cascaded conveyors. The reliable operation of conveyor is more important to fulfil the particular operation. For example in thermal power station uninterrupted coal flow from storage yard/mines to the power house upto mill is very much essential.

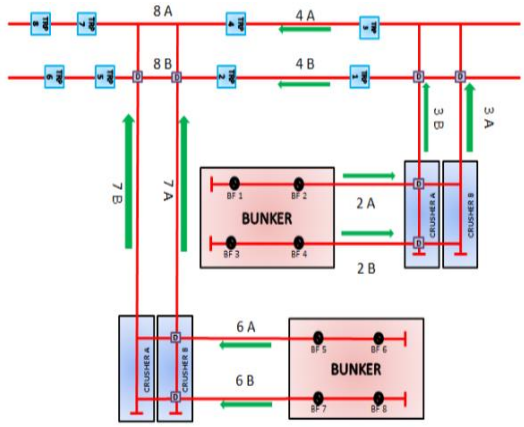


Figure-1: Typical layout of conveyors

VARIOUS TYPES OF CONVEYOR SEQUENCES

SEQUENCE 1: 6A, CR A, 7A, 8A
SEQUENCE 2: 6A, CRA, 7A, 8B
SEQUENCE 3: 6A, CRA, 7B, 8A
SEQUENCE 4: 6A, CRA, 7B, 8B
SEQUENCE 5: 6B, CRA, 7B, 8A.

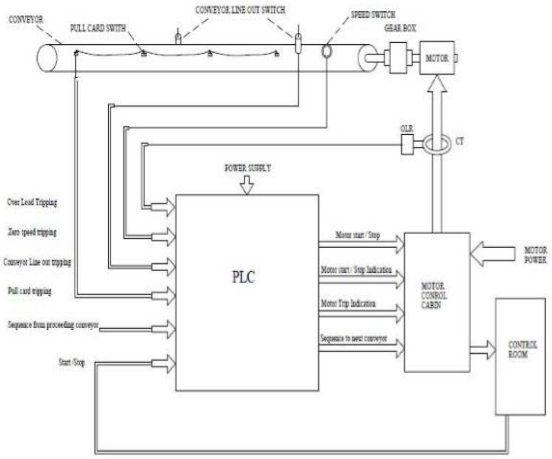


Figure-2: Block diagram of PLC based Conveyor system

If any of intermediate place conveyor fails the whole process gets haltered. So, the reliable operation of the conveyor is very much important. The motor control is very important role in the conveyor system.The power supply is given to the PLC. The supply is passed to the motor by the motor control cabin which acts as the motor drive. The motor is coupled with the GEARBOX and then it is connected to the conveyor end drum and the drum starts to rotate. The current supply is given to the motor, there is a CURRENT TRANSFORMER connected to the supply.

The CT measures the flow of current, if there is over current the OVER CURRENT RELAY senses and gives the indication to the PLC, and motor trip indication is activated. The ZERO SPEED TRIPPING is connected to the conveyor belt which senses the running speed of the conveyor. If there are some faults like belt tear up of nil speed then the ZERO SPEED SWITCH senses and the PLC gets an indication, suddenly the motor trip indication is given to the motor drive. The CONVEYOR LINE OUT SWITCH is connected on both sides of the conveyor, to check the conveyor lineout path from its track. The conveyor line out switch can also said as the BELT SWAY SWITCH. Sway the word itself says for what purpose this switch is used. When there is lineout of the belt from its track then the belt corners get in contact with the switch and the indication is received from the PLC. The same process as for the previous fault is done here the conveyor trip indication is given by the PLC to the motor drive.

The pull cord switch is connected along the path of the conveyor belt with tag rope, in case if any person fell in the conveyor flow then the rope is pulled and the pull cord switch is acted, the signal from the switch is received to the plc and trip signal is executed to the motor drive which cuts off the power supply to the motor. a sequence circuit is connected to the drum of the conveyor end.The sequence is one of major deciding part for starting the present conveyor after the successful running of the previous conveyor. it is an art of relaying information through systematic logic. many conveyors are in series from feeding source to receiving end. the art of controlling consists of staring, stopping, tripping etc.Starting sequence should be necessarily from receiving end conveyor then immediate succeeding conveyor and then starting of feeding source. Stopping sequence of conveyor is exactly opposite of starting sequence that is from feeding source to receiving source. In order to empty any load on conveyor system.

MONITORING

Its movement along its path on rollers monitored without any sway/ line out. Its speed continuous movement is to be monitored in order to avoid dumping of lignite at intermittent level. Otherwise it causes major breakdown or halt of entire system. If fails to sense these-problem. Recovery is time consuming and leads production loss.

Belt tearing is to be monitored to ensure detection of the tear at the initial stage otherwise wire huge financial loss to be increased by replacing new belt. Normal loading pattern are to be monitored in respect to its capacity, otherwise frequent tripping, subsequent spillage developed in and around the system.

DATA ANALYSIS AND INTERPRETATION

During the detailed study of the conveyor system on control, monitoring and protection aspects, It is observed that the system involves many electromagnetic relays, timers, pull cord switches, zero speed switches, belt sway switches, damper pins, potential transformers PT, current transformers CT, power contactors and LT breakers etc.

The conveyor system control requires binary signal and analog signal for achieving system logics to ensure start, stop, trip, monitoring and protection purpose.

The existing system built in with many electromagnetic relays and timers etc., to achieve the logics of the conveyor control system.Many problems has arrived for the usage of electromagnetic relays and timers. Since these electromagnetic relays and timers have limitations.

PLC ON CONVEYOR CONTROL

A programmable logic controller is a microprocessor-based controller that uses a programmable memory such as logic, sequencing, timing, Counting and arithmetic in order to control machines and processes and are designed to be operated by engineers with perhaps a limited knowledge of computers and computing languages.

Designers of the Programmable logic controller have pre-programmed it so that the control program can be entered using a simple, rather intuitive, form of language.

SPLIT UP OF CONVEYOR SYSTEM

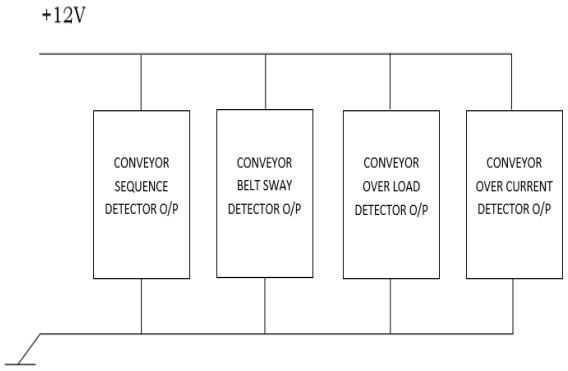


Figure-3: Split up of conveyor system

OMRON PLC

- Provides relay, timer, counter, and time switch functions, easily programmable in ladder-view format.
- With weekly and calendar timers, flexible mounting expansion via 8-point I/O units, twin-timer operation, and Multilanguage display.

SOFTWARE IMPLEMENTATION OF PLC

Algorithm for Ladder Diagram

The OMRON PLC is loaded with program in the form of ladder diagram using Zen software tool.

Ladder diagrams are drawn using the Zen software tool v4.14. The ladder diagram operates with the logic. We have 6 inputs I0, I1,I2,I3,I4,I5, 4 outputs Q0,Q1,Q2,Q3 5 timers , counters and internal relays M0, M1, M2, M3, M4, M5, M6, M7, M8, M9 in the software which can be used in Ladder diagram.

STEP 0: I0 input is used for power supply of the PLC. If there is less than 2 KSC the input will close and energizes M0

STEP 1:I3 input is used for checking the belt slip. If there is belt slip 1.5 KSC the input will close and M8 energise.

STEP 2:I0 is used for checking the power supply of the 3.3KV to the conveyor. The input will close if there is the required power supply and will energise the M1.

STEP 3: I1is used for checking sequence of the previous conveyor. The input will close if the sequence is received from the previous conveyor M1 will energise.

STEP 4: If M1 and M2 are energised M3 will get energised.

STEP 5: If M0, M8, C4 are de energised then Mc will get energised.C4 will get energised only when belt slip and the over current are not in action.

STEP 6: If Mc is energised and M1 is de energised T0 starts.

STEP 7: After 10 seconds T0 will get energised and if M2 is also energised then conveyor starts.
STEP 8: If the slip is present then T1 starts and M2 closes and indication takes place.
STEP 9:If the over load is high the timer T3 starts and M2 closes and indication takes place.
STEP 10: If the emergency switch is acted then M4 closes and the indication continues till 1 KSC.
STEP 11: If the power supply is low, M0 energises and if B0 is pressed manual indication takes place.
STEP 12:If M0 de-energised and M3 energised M4 will get energised.
STEP 13: If Mc, T2, M1 are energised, that is when overload is low and belt slip is none 1KSC Q1 is energised discharging takes place.
STEP 14: If MC, T4, M1 are energised, that is when over current is high 1 KSC, Q1 is energised discharging takes place.
STEP 15: To retain the normal current, we use M5 which will be energised in intermediate supply.
STEP 16: If the sequence is not present, B1 is pressed for manually for sequence.
STEP 17:If the flash is above and conveyor protection is acted then M5 is energised.
STEP 19: If the flash is low M6 will get energised, and when M3 is also energised T1 starts.
STEP 20: If the flash is low and over load is also low then M1 will be de energised and will start T1
STEP 21: If M2 is de energised, that is when the belt slip is absent,T2 starts.
STEP 22-23: M8 will get energised if charging or discharging takes place because of sequence.
STEP 24:If conveyor protection is acted,I4 energises and makes M7 energise.
STEP 25:Ifconveyor protection is acted,I5 will energise and makes M6 energise.
STEP 26: If the flash is high, M7 will get energised, and when M3 is also energised T3 starts.
STEP 27: If the belt slip is over load, M1 is de energised and T3 starts.
STEP 28: If the overload is high and acted, M2 will be energised T4 starts.
STEP 29-30:If loading and unloading takes place due to sequence, then Ma energises.
STEP 31-38: T5 will start when belt slip is acted after heavy load dumping in one side and so in many operations.
STEP 39-40: If there is any fault in the automatic operation Mb will get energised. To accept the fault button B2 should be pressed.
STEP 41: Flash timer T6 is energised.
STEP 42-43: If too many operations are carried out or when there is fault in automatic operation Q2 is energised.
STEP 44-47: If emergency switch is acted or over flash occurred is high or over current low or sequence is not acted then Q4 energises.
STEP 48-55: For high load, less belt slip, local mode is activated from the remote mode and clearing operations are carried out.
STEP 56-59: When the button B6 is pressed, all the counters C0, C1, C2, C3, C4 will get reset.

INPUTS /OUTPUT OF PLC

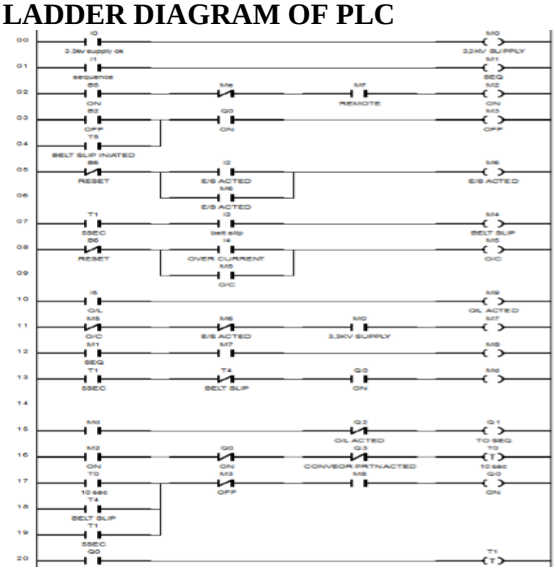
INPUTS Table-1: Input of PLC

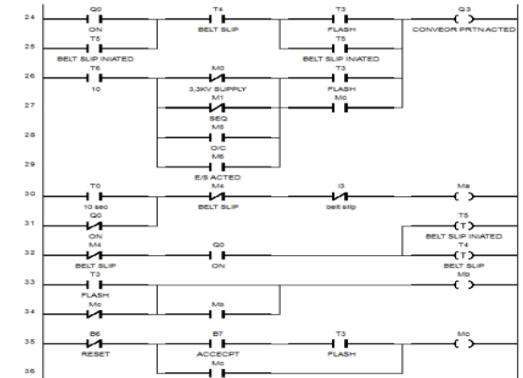
Inputs	Parameters	Position
I0	Power supply	Open (Off)
		Close (On)
I1	Sequence	Open (Off)
		Close (On)
I2	Emergency switch	Open (Off)
		Close (On)
I3	Belt Slip	Open (Off)
		Close (On)
I4	Over Current	Open (Off)
		Close (On)
I5	Over Load	Open (Off)
		Close (On)

OUTPUTS

Q0 Conveyor sequence detector output
Q1 Conveyor Input Supply
Q2 Conveyor Over Load
Q4 Conveyor Over Current and Conveyor Belt Sway

LADDER DIAGRAM OF PLC





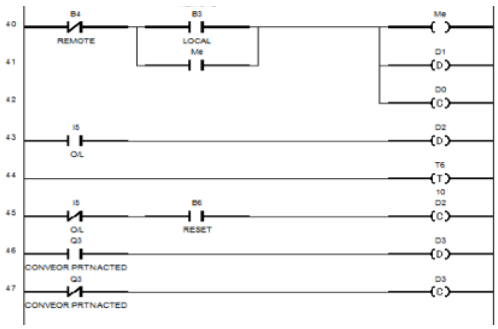


Figure-4: Ladder diagram of PLC

RESULT AND DISCUSSION

RESUT FOR MODES OF OPERATION

Mode 1: The power supply is given to the PLC, all the input switches are remained open and the operation is in remote condition.

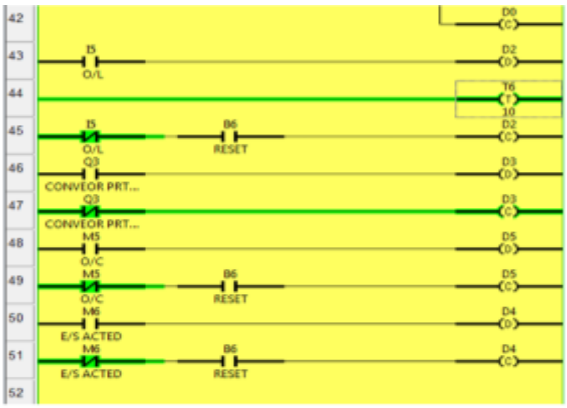


Figure-5: Mode 1 switching sequence of PLC

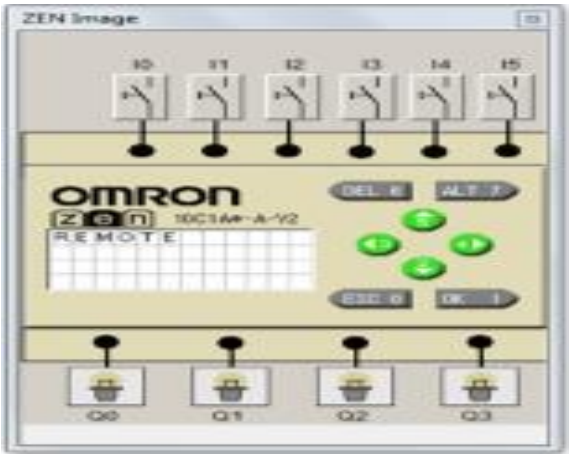


Figure-6: Input switches are remained open

Mode 2 :

The simulation is started and when no input contacts are closed then it gives the command as protection acted and Q3 indication starts to glow.

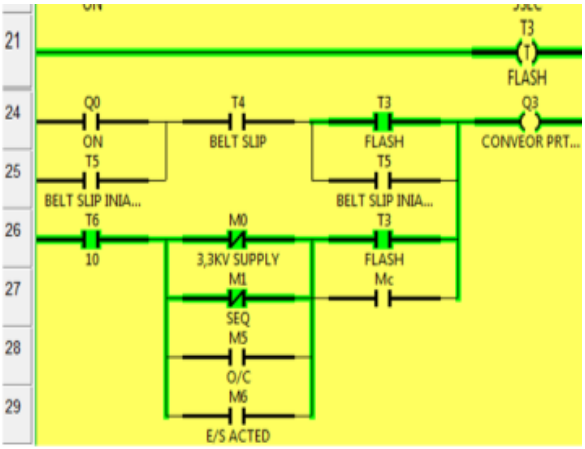


Figure-7: Mode 2 switching sequence of PLC

Figure-8: Protection acted Q3 starts glow

Mode 3: The inputs 3.3KV supply and Sequence (I0 and I1) is moderately closed, the coils M1 and M2 makes up in the simulation ladder and gets highlighted.

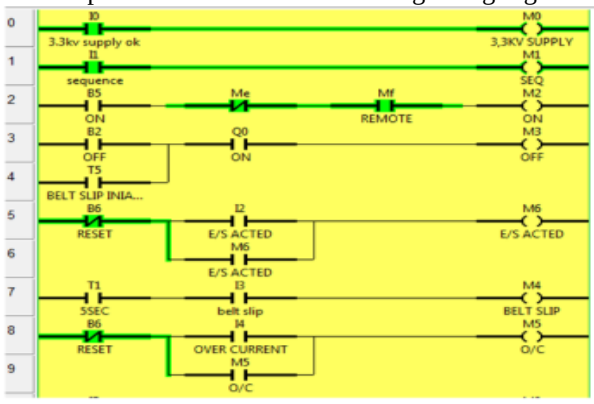


Figure-9: Mode 3 switching sequence of PLC

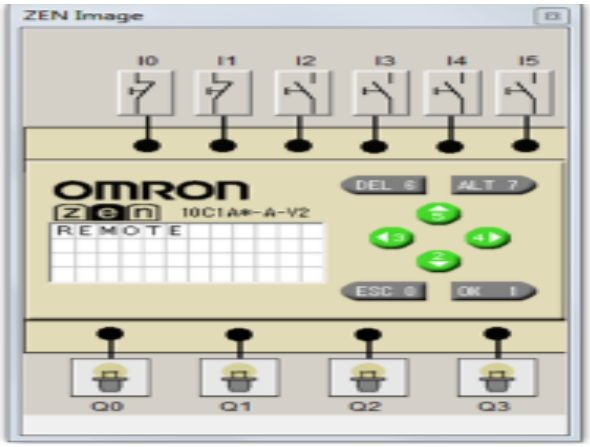


Figure-10: I0 and I1 is moderately closed

Mode 4: The input switch I3 is closed, the coils are makes up which are responsible for the I0 and I1.

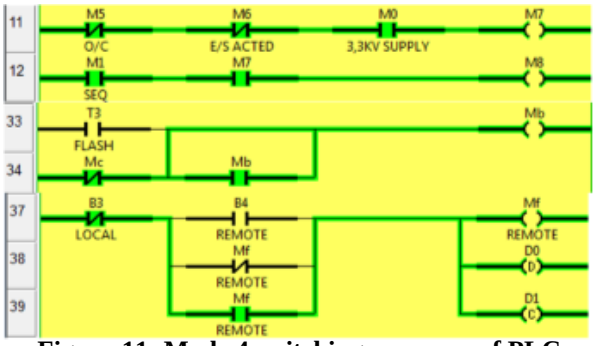


Figure-11: Mode 4 switching sequence of PLC

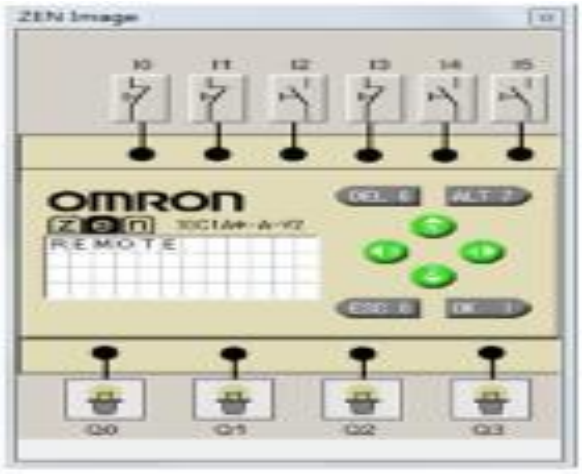


Figure-11: Mode 3 switching sequence of PLC

Mode 5: The button 5 is pressed for the running operation of the conveyor motor, Q0 indication shows the 3.3KV power supply and after few seconds the sequence output is shown in Q1 indication which glows up.

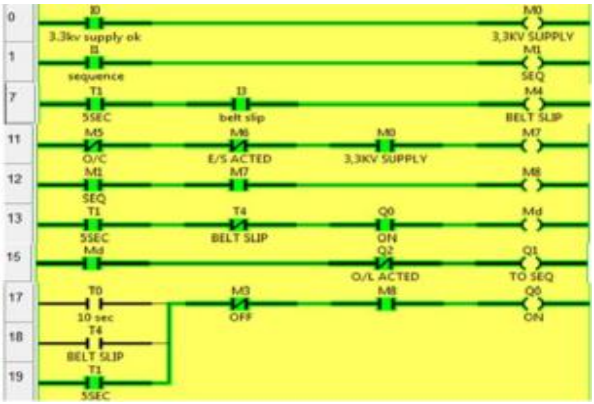


Figure-12: Mode 3 switching sequence of PLC

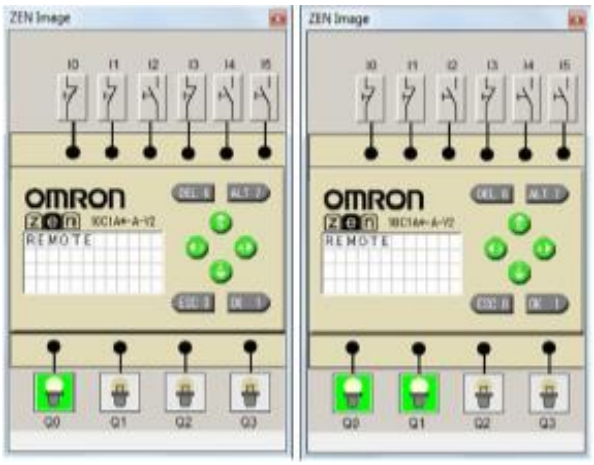


Figure12: **Sequence output Q1 indication glows up.**

BENEFITS OF THE PROPOSED SYSTEM

Table-2: Results comparison

FEATURES	EXISTING SYSTEM	PROPOSED SYSTEM
Monitoring control	By using Relays, contactor, timers	By using automatic control/manual switches in PLC
Wiring system	Complex wiring	More than 80% of wiring is reduced
Size occupied	Occupied size is large	The system occupies less space
Maintenance	Required frequent maintenance	Maintenance not required
Reliability	Performs only installed functions	Relays and timers can be used reliably
Power consumption	Power consumption is about 24V DC	Power consumption is only till 12V DC

CONCLUSION

In Neyveli Lignite Corporation's thermal power station-1, this has been so carried out on its conveyor belt-mechanism, in order to have an efficient operation on its various scenarios of monitoring, controlling and protection. In this paper, a robust and straightforward methodology of the above operations on monitoring, controlling and protection has been implemented and suggested for the effective operation and controlling of the plant, using the PLC controller, which makes use of the latest software of ladder programming in its simulation concerned, so as to show the effectiveness of the results of the proposed approach.

It can be evident from their better results that have been displayed through the software and e simulation of the hardware as presented above.

It is noteworthy that the operation and maintenance problems have been better encountered and resolved for its best efficiency in the conveyor control, monitoring and protection systems and the existing problems were eliminated by the introduction of PLC, thereby achieving very high operational efficiency on the existing system through the proposed method.

As a result of which, the following are the outcomes:

i. Complexity of wiring is reduced. ii. Downtime is reduced. iii. Inventory is reduced. iv. System failures are reduced. v. Cost of maintenance reduced. vi. Achieving logic with minimal time with the help of PLC technology.

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