Automation of Ash Handling System with Event Logger

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***Abstract*— Parli thermal power plant one of the old power plants in Maharashtra. This plant are under control of MAHAGENCO (MSEB).Parli unit no.3 commissioned in 1984-85.such old power plant require renovation in order to increase efficiency and output. Main plant renovation is done in 2004 by using HF CONROL DCS but most of the subsystem was not renovated. Such as coal handling plant, ash handling plant, water treatment plant etc. it is necessary that for ash handling plant to be renovate, same done by me by using Programmable Logic Controller Allen Bradley micrologix 1500. Embedded I/O and expansion I/O are used.1769 IQ 32 module used as digital input channels.1769 IQ 32 module having 32 digital input. Another module is OW16, it is digital output module. Having 16 output channels and End cap or terminator is required at the end of last module. .**

***Keywords*— PLC- Programmable logic controller, I/O-Input/output, HP-High pressure**

I. INTRODUCTION

Most of the old power plant subsystem controlled by electromechanical relay and H&B analog control system. These systems are very difficult for maintenance & not having proper user interface. By using hundred of relay in series and/or parallel combination for particular tripping or staring interlock is defined. Most of the control circuit uses 110VAC as control supply. If we are using 110VAC as control supply then it is not required that any type of AC to DC conversion. The most common control supply used for sequence control interlock panels is 50VDC which require battery arrangement. In order to fulfil reliability constrain there should stand by feeder & auto changeover of supply. The changeover should be bumping less. In case of electromechanical relay logic troubleshooting is very difficult. The programmable logic controller eliminates all disadvantages of analog systems. PLC is the one of the suitable solution for plant operating in batch manner.

II. SYSTEM OVERVIEW

As shown in fig. 1 ash disposal system consist of two slurry tank .slurry tank A and slurry tank B. pulverized coal from the pulverize come in the furnace & combustion process is carried out in furnace. The burned coal converted into ash, this ash is collected in the bottom ash hopper. There are four bottom ash hoppers for 210MW BHEL coal based power plant. This collected ash need to be removed from hopper as per the load condition. If 210MW unit is running at full load then we have to remove bottom ash hopper two times in shift of 8 hours. The bottom ash collected in hopper is removed by using clinker grander. This removed bottom ash is collected is slurry tank A and B. The removing of bottom ash is carried out by using high pressure water. The high pressure water is taking from HP water pump. The bottom ash collected in the slurry tank is removed by using slurry disposal pump. There are three slurry disposal pumps. The slurry disposal area is about 100 hectors where ash is dumped. As the distance of disposal area is about 10 km from the plant it is require that the slurry should have high pressure & flow in order to reach at distance of 10km.There are three pump arranged in series manner in order to built up pressure. As pressure is building in successive stages the pumps need the sealing so that slurry should not come out from the pump bearing. The sealing is provided by seal water. The seal water is provided by seal water pump. Water impounded bottom ash hopper receivers the bottom ash from the furnace, where it is stored and periodically discharged hydraulically through clinker grinder and hydroejetor for transfer through transport line to ash slurry pump. A maximum of thirty tones of bottom ash is collected in every eight hours working shift.

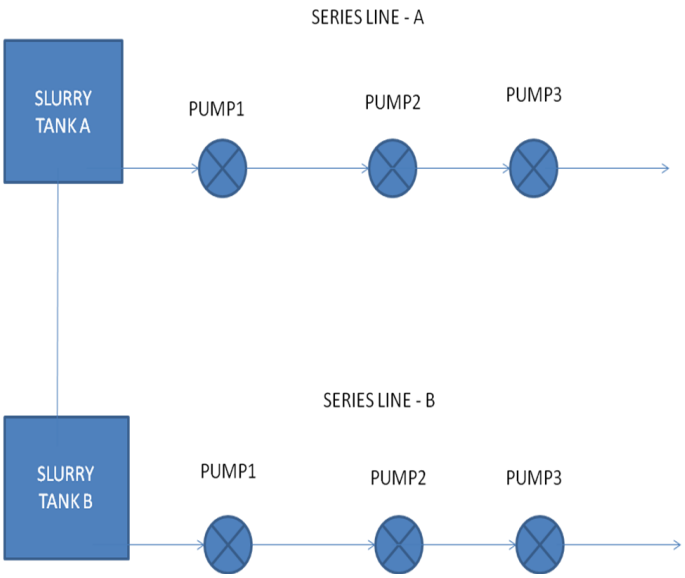


Fig. 1 Ash disposal system overview

The bottom ash system is capable of disposing this ash in one hour. The water filled ash hopper, receives furnace ash from the boiler, chilling it as it enters the water to minimizing clinkering and storing it for periodic removal. The hopper consists of two section has two sets of inclined feed gate hosing clinker grinder, ejector feed pump and hydro ejector. The mixture of ash and water is discharged simultaneously from each section through an inclined feed gate and clinker grinder, which reduces the size of the clinker to about 25mm size .crushed clinker and ash water mixer falls into ejector feed pump and is fed to hydro ejector. The hydro ejector provides the jetting action by means of pressurized water to carry the mixture through discharge line to ash slurry trough. Hopper flushing nozzles are provided in bottom ash hopper to agitate and remove settled ash from the bottom hopper. The clinker grinder is equipped with automatic reversing mechanism should an overload occur in the grinder, it stops automatically and reverses and a time delay relay keeps the grinder running in the reverse direction. After grinder returns in forward direction, same sequence is repeated if overload occurs. A pressure switch located in the bottom ash transport line will sense a high discharge thereby indicating a blockage or obstruction. When this occurs clinker grinder stops operating when the pressure drops to present level, grinder will again commence operating. This switch thus prevents possibility of additional ash being fed into the discharge line. If water at desired pressure is not available for a hydro ejector or for grinder sealing then the hopper feed gate closes and clinker grinder stops operating. When pressure of water at hydro ejector, or for grinder sealing become normal, clinker grinder starts operating and hopper feed gate opens. The fly ash and bottom ash is collected in the ash tank and disposed to disposal area by ash series pump. Seal water pump provide the water for pump sealing purpose. The seal water pressure requirement for three pumps is different. Pump No.1 seal water pressure is 3.5kg/cm square. Pump No.2 seal water pressure is 4.5kg/cm square. Pump No.3 seal water pressure is 5kg/cm square.

Ash series pump starting interlock:

1. Ash water tank level should be normal.
2. Suction valve should be open.
3. Discharge valve should be open.
4. Seal water pressure should be normal/ok.
5. Electrical protection should not be operated.

Ash series pump tripping interlock:

1. Ash water tank level low.
2. Seal water pressure abnormal.
3. Suction/discharge valve closed.

The ladder logic is mostly used in PLC programming. Allen Bradley micrologix1500 controller is used.

III. ARCHITECTURE OF SYSTEM

The fig.2 shows system architecture of required configuration. The first block in the figure is controller of LSPC series. The LSPC series controller having 12 digital input and 12 digital outputs embedded on it. The maximum eight number of I/O card can be connected to the controller. First two slot is programmed is for 1769 IQ 32. This card work as digital input and having 32 channels.24VDC supplies is used for digital input channels.110VAC is used for digital output channel. I/O forcing is the ability to override the actual status of the I/O at the user's discretion. The Micrologix 1500 and RSLogix 500 both support I/O forcing.

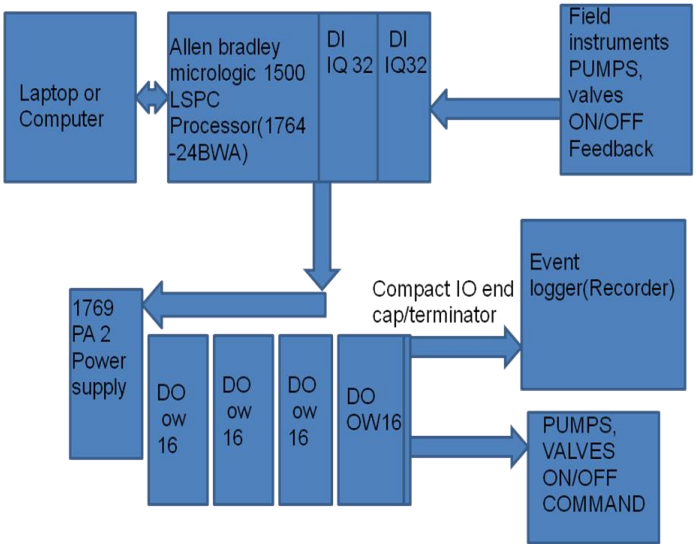
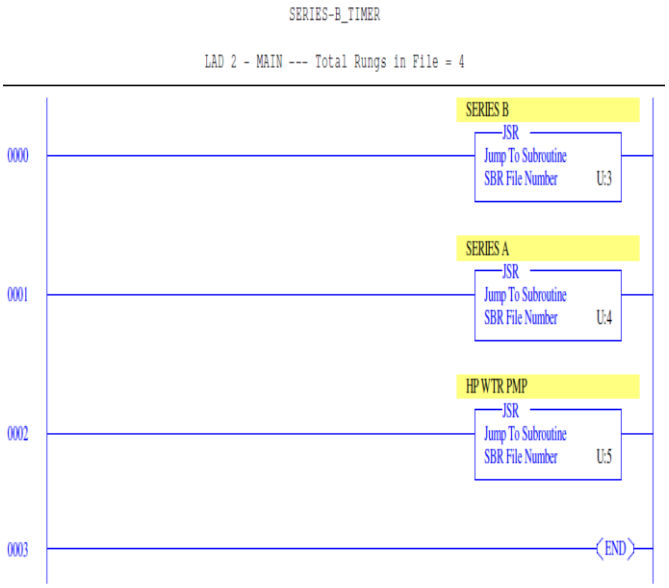


Fig. 2 Architecture of system

When an input is forced, the value in the input data file is set to a user-defined state. For discrete inputs, you can force an input "on" or "off". When an input is forced, it no longer reflects the state of the physical input. For embedded inputs, the controller reacts as if the force is applied to the physical input terminal. When an input is forced in the controller, it has no effect on the input device connected to the controller. When an output is forced, the controller overrides the status of the control program, and sets the output to the user-defined state. Discrete outputs can be forced "on" or "off". The value in the output file is unaffected by the force. It maintains the state determined by the logic in the control program. However, the state of the physical output will be set to the forced state.

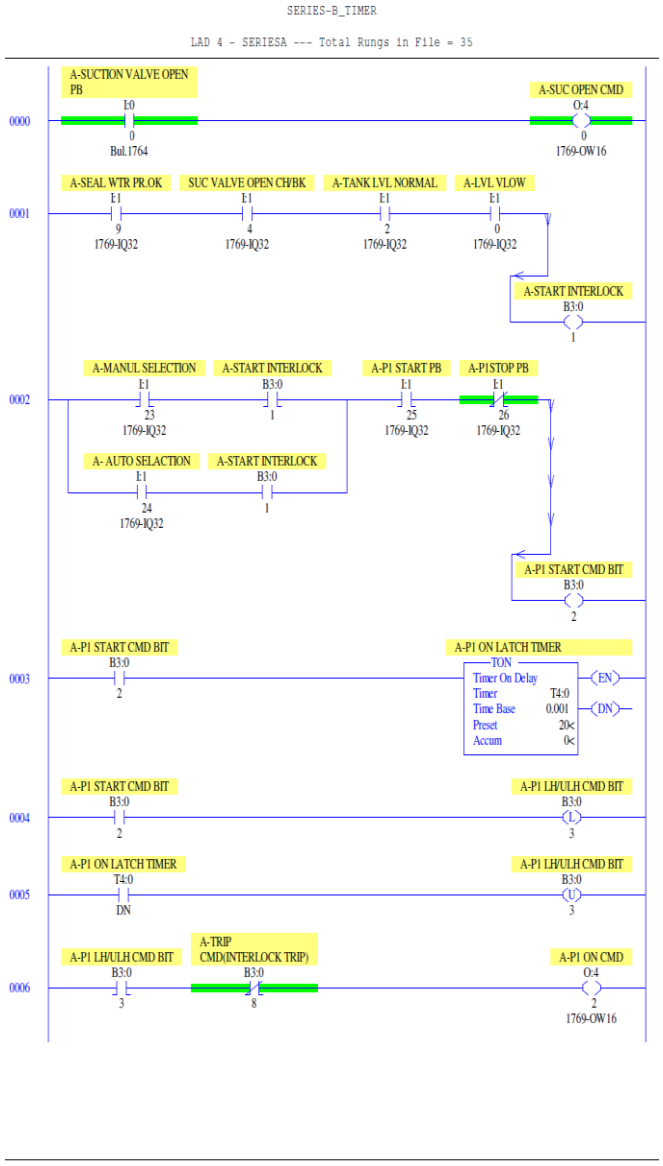
1769 PA2 is extended power supply. It is providing power for cards in last three slots. The power required for internal working of cards is provided by extended power supply. The end cap/terminator is mounted at the end of configuration. If end cap is not connected at the end card then base unit is not detect cards. The IQ32 card is of 32 channels of digital input (DI). This is externally powered card; 24VDC supply is used for DI changeover sensing. For DO 110VDC supply is used in order to drive relay or output commands. Base unit required power supply for internal processing and working; 230VAC is used for that purpose. Compact 32 point 24V DC input module IQ 32 is used as DI. Two IQ32 card is configured in slot 1 and 2. Additional grounding connections from the module's mounting tabs or DIN rail (if used), are not required unless the mounting surface cannot be grounded.

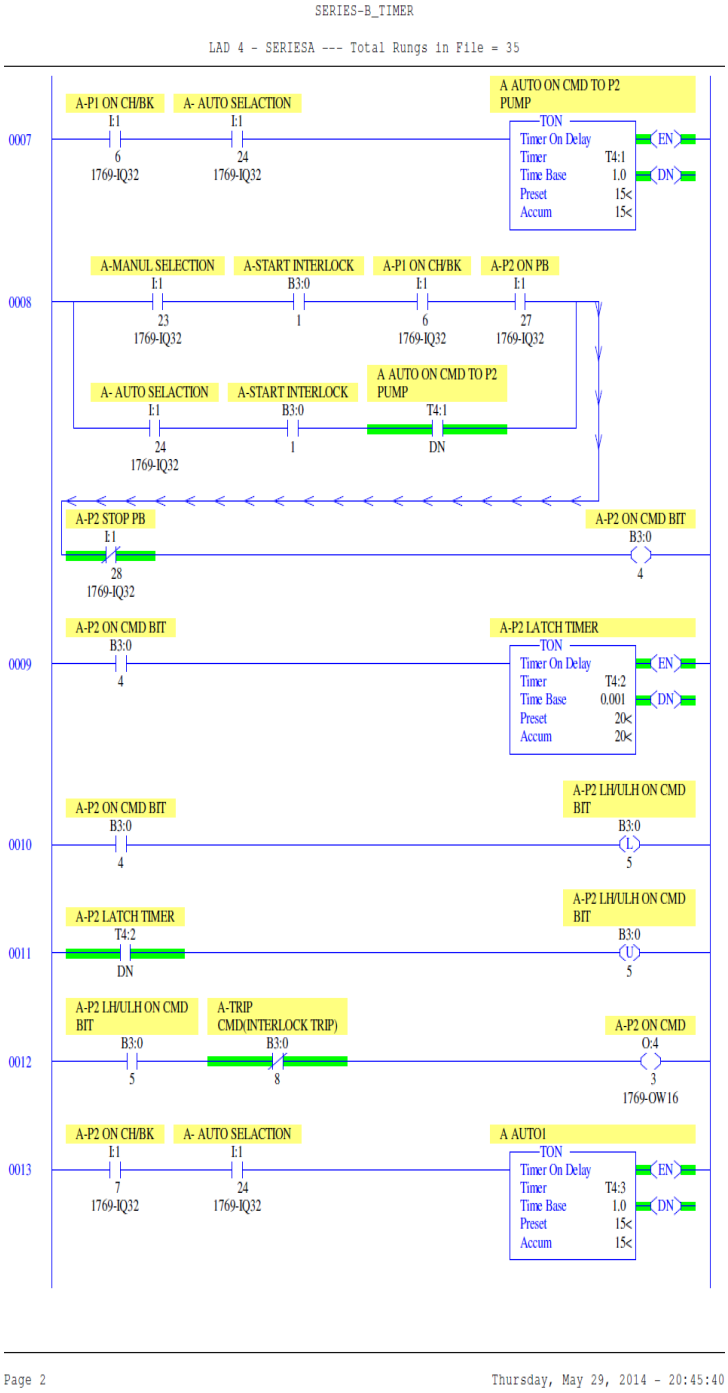
IV LADDER LOGIC



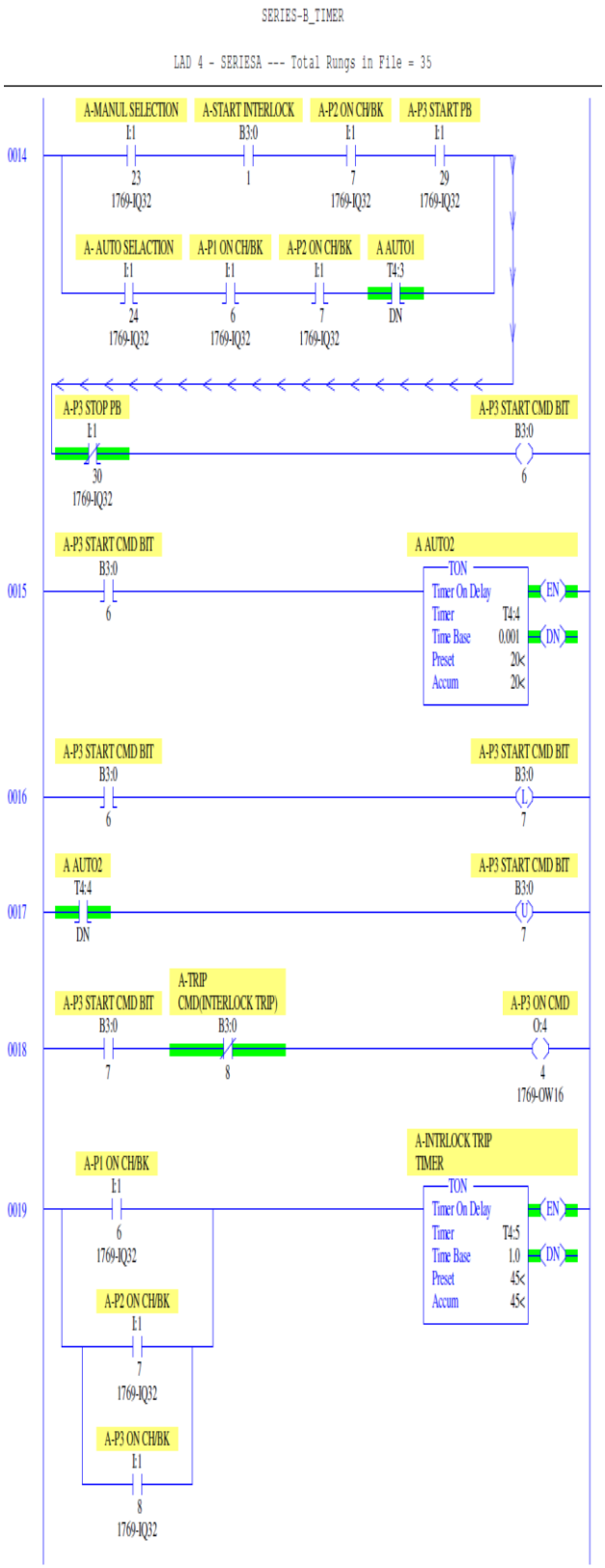
The ladder logic implementation of circuit is shown above. System consists of two parallel series. One series have three pumps inline. A1, A2 and A3 pump in one series. B1, B2 and B3 pump in second series. Two series are standby to each other. Ladder logic for series B is prepared in ladder 3, for series-A prepared in ladder 4. Annunciation circuit ladder logic prepared in ladder 5 file. Three pumps should start at an interval of 15 Sec. Total series should start in 45 Sec. In order to start pump the command should latch for 15 msec. For this latch /unlatch bit is used, latch/unlatch bit will be latch for 20 msec and it should be unlatch. In order to inform the operator about the abnormal condition of plant annunciation system also designed. Annunciation means indication of abnormal condition and hotter sound. Operator need to acknowledge this take necessary action. Thirty four annunciations provided for operator.

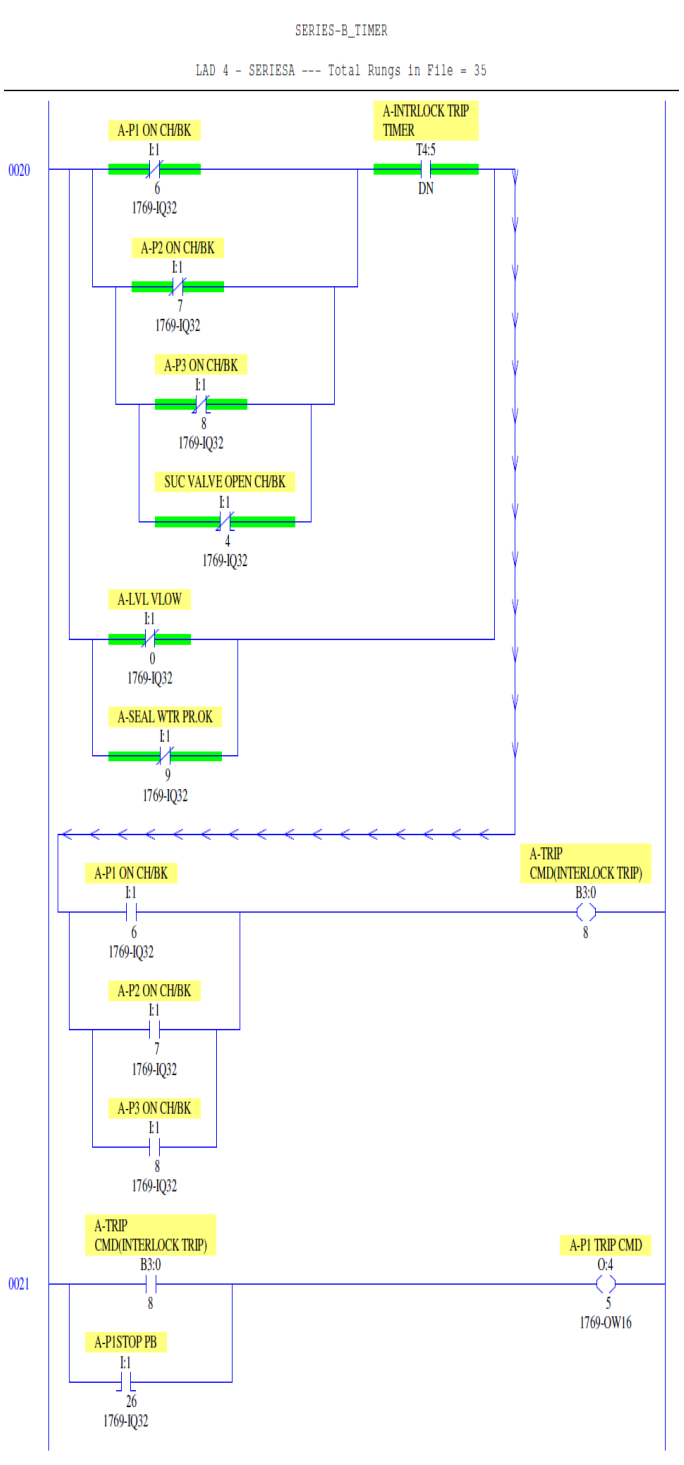
Communication between PLC and Laptop/PC carried out using RS232 to Round cable. This is

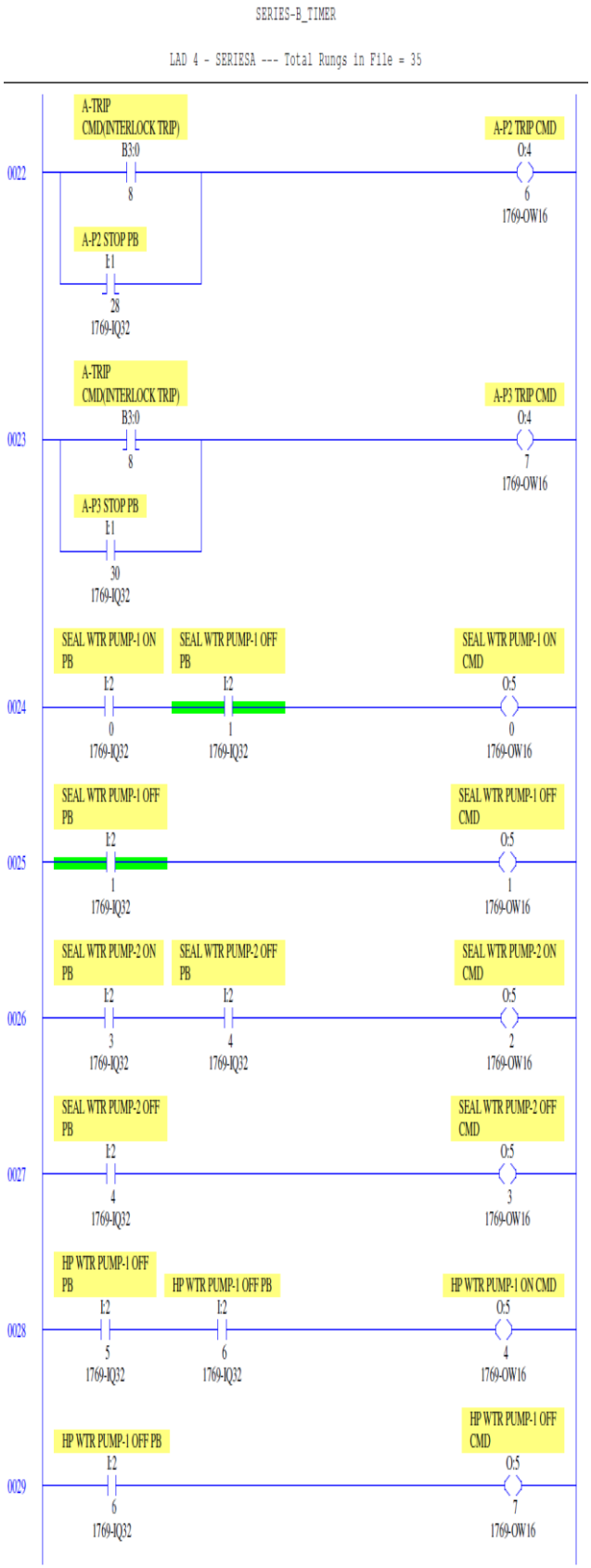


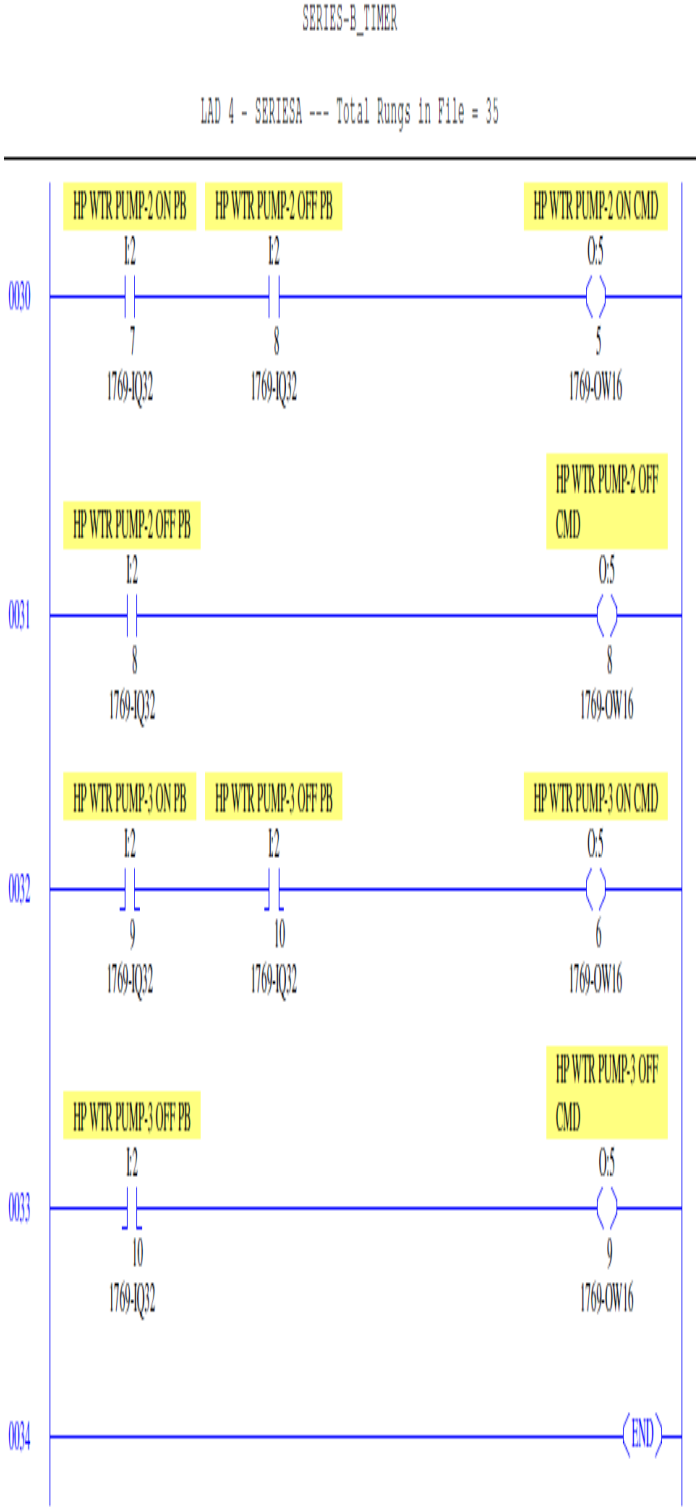


Mostly used for Allen Bradley controller. DF1 full Duplex protocol is used for communication purpose. DF1 protocol is an asynchronous byte oriented protocol, which is used to communicate with most Allen Bradley RS232 interface modules. DF1 protocol consists of link layer and application layer formats. Link layer serial frame is a composition of conventional RS232 serial frame with the communication.


SERIES-B_TIMER
LAD 4 - SERIESA --- Total Rungs in File = 35
0014
A-MANUL SELECTION
A-START INTERLOCK
A-P2 ON CH/BK
A-P3 START PB
A- AUTO SELACTION
A-P1 ON CH/BK
A-P2 ON CH/BK
A AUTO1
A-P3 STOP PB
A-P3 START CMD BIT
0015
A AUTO2
TON
Timer On Delay
Timer T4:4
Time Base 0.001
Preset 20
Accum 20
0016
0017
0018
A-TRIP CMD(INTERLOCK TRIP)
A-P3 ON CMD
1769-IQ32
1769-OW16
0019
A-INTRLOCK TRIP TIMER
Timer T4:5
Time Base 1.0
Preset 45
Accum 45


SERIES-B_TIMER
LAD 4 - SERIESA --- Total Rungs in File = 35
0020
A-P1 ON CH/BK
A-INTRLOCK TRIP TIMER
DN
A-P2 ON CH/BK
A-P3 ON CH/BK
SUC VALVE OPEN CH/BK
A-LVL VLOW
A-SEAL WTR PR.OK
A-TRIP CMD(INTERLOCK TRIP)
0021
A-P1 TRIP CMD
A-P1STOP PB
1769-IQ32
1769-OW16


SERIES-B_TIMER
LAD 4 - SERIESA --- Total Rungs in File = 35
A-TRIP CMD(INTERLOCK TRIP)
B3:0
8
A-P2 TRIP CMD
O:4
6
1769-OW16
A-P2 STOP PB
I:1
28
1769-IQ32
A-TRIP CMD(INTERLOCK TRIP)
B3:0
8
A-P3 TRIP CMD
O:4
7
1769-OW16
A-P3 STOP PB
I:1
30
1769-IQ32
SEAL WTR PUMP-1 ON PB
I:2
0
1769-IQ32
SEAL WTR PUMP-1 OFF PB
I:2
1
1769-IQ32
SEAL WTR PUMP-1 ON CMD
O:5
0
1769-OW16
SEAL WTR PUMP-1 OFF PB
I:2
1
1769-IQ32
SEAL WTR PUMP-1 OFF CMD
O:5
1
1769-OW16
SEAL WTR PUMP-2 ON PB
I:2
3
1769-IQ32
SEAL WTR PUMP-2 OFF PB
I:2
4
1769-IQ32
SEAL WTR PUMP-2 ON CMD
O:5
2
1769-OW16
SEAL WTR PUMP-2 OFF PB
I:2
4
1769-IQ32
SEAL WTR PUMP-2 OFF CMD
O:5
3
1769-OW16
HP WTR PUMP-1 OFF PB
I:2
5
1769-IQ32
HP WTR PUMP-1 OFF PB
I:2
6
1769-IQ32
HP WTR PUMP-1 ON CMD
O:5
4
1769-OW16
HP WTR PUMP-1 OFF PB
I:2
6
1769-IQ32
HP WTR PUMP-1 OFF CMD
O:5
7
1769-OW16
0022
0023
0024
0025
0026
0027
0028
0029

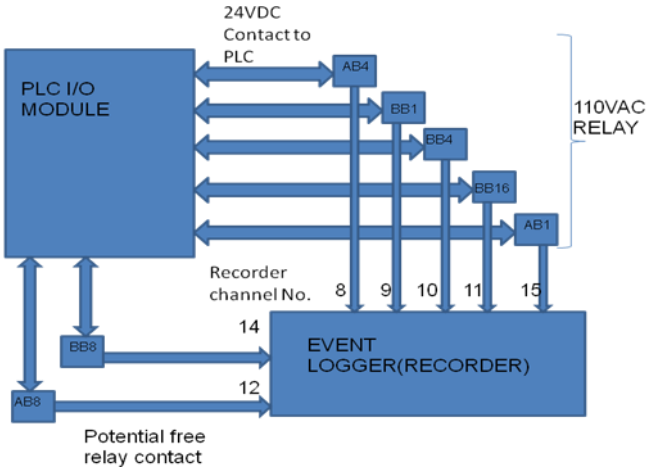

SERIES-B_TIMER
LAD 4 - SERIESA --- Total Rungs in File = 35
HP WTR PUMP-2 ON PB
I:2
7
1769-IQ32
HP WTR PUMP-2 OFF PB
I:2
8
1769-IQ32
HP WTR PUMP-2 ON CMD
O:5
5
1769-OW16
HP WTR PUMP-2 OFF PB
I:2
8
1769-IQ32
HP WTR PUMP-2 OFF CMD
O:5
8
1769-OW16
HP WTR PUMP-3 ON PB
I:2
9
1769-IQ32
HP WTR PUMP-3 OFF PB
I:2
10
1769-IQ32
HP WTR PUMP-3 ON CMD
O:5
6
1769-OW16
HP WTR PUMP-3 OFF PB
I:2
10
1769-IQ32
HP WTR PUMP-3 OFF CMD
O:5
9
1769-OW16
END
0030
0031
0032
0033
0034

V RECORDING

Event logging is one of the important processes. In order to calculate running time of series the event logger is used. PLC and recorder interfacing is done with the help of multiplying contact type relay. Site contact of valves, pumps ON/OFF feedback is given to relay. Relay one contact is give to Recorder, which is potential free contact. Contact which is used for PLC digital input card is having 24VDC supply. In order to protect PLC cards fused TB are used. Fused TB carries glass fuses of specific amps rating. The 6000 series recorder is used for data logging. We can data by using USB or Ethernet port. Recorder having 48 channel that can be programmed for sensing as RTD, thermocouple and digital input. For security purpose there are different four login are provided to recorder. Recorder has touch screen display. Different four login are operator, instrumentation engineer and two spare login.

In order to interface PLC and recorder the 110VAC relay are used. One contact of relay used for PLC Digital Input card and other one to recorder. Seven contacts are interfaced with recorder. Logged event can be view on any pattern on recorder, such as graph and alarm statement. Event logger with PLC is one of the new hybrid configurations. Annunciation circuit is designed with help of Accept push button, Accept relay, Reset relay, Flasher relay, Reset push button, hotter. Annunciation circuit require 110VAC supply for it proper working and operation.

Fig.3 PLC and Recorder interfacing



CONCLUSION

The most important aspect of any power plant is the boiler control. Several techniques can be implemented but, the method that has to be used relies on varied objectives like superior quality, increased efficiency and high profit depending upon the purpose of the company that implies it. The ceaseless changes that are relentlessly taking place in the contemporary scenario of the industrial segment. Emphasis has been given to the automation process that is now rapidly taking its place in all the power plants across the globe. The Paper has furnished itself to study the integral parts of the entire process involved, their implementation and the problems that may show up have also been given their due importance.

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REFERENCES

- Knight. U. "The Power System and its Operational and Control Infrastructure in emergencies" from contingency planning to crisis management.
- W. Bolten. "Programmable Logic Controller".
- Tony. "Advanced PLC Programming".
- Rockwell Automation. "Micrologix 1500 user manual".
- Joanna Marie M. Baroro. "Automation of Packaging and Material Handling Using Programmable Logic Controller" International Journal of Scientific Engineering and Technology (ISSN: 2277 – 1581) Volume No. 3, Issue No. 6, pp: 767 – 770.
- Ezell, Barry, "Supervisory Control and Data Acquisition Systems for Water Supply and Its Vulnerability to Cyber Risks" available on the internet at: http://watt.seas.virginia.edu/~bce4k/home.html.
- Speck, "Reusable industrial control systems," IEEE Trans. Ind. Electron, vol. 50, pp. 412–418, June 2003.